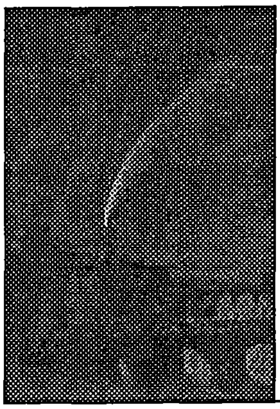


THE COMET'S TALE

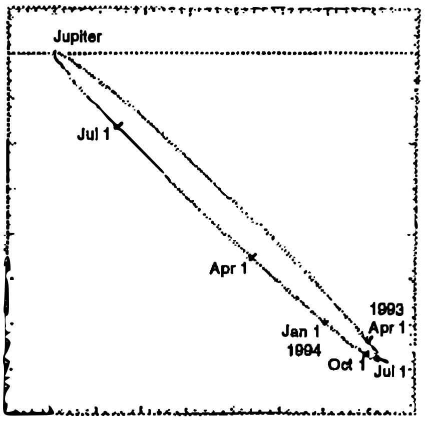
Newsletter of the **Comet Section** of the **British Astronomical Association** 1994 May

Comet Shoemaker-Levy 9 (1993e) to smash into Jupiter during third week of July!

THE NINTH comet to be discovered by the team of Eugene and Carolyn Shoemaker and David Levy is in orbit around Jupiter with a massive smash to take place between July 16–22. Or rather a series of impacts since the comet, also named 1993e, was broken up by Jupiter's gravitational pull during its last close approach to the planet in mid-1992 and now comprises at least twenty-one parts stretching over a million km. Their appearance has been likened to a 'string of beads' (see image below).

The sizes of the cometary fragments are not well known, but estimates based on various models—from detailed structural analysis to simple orbital mechanics—gives a few hundred metres to a few km. The actual sizes, and therefore masses, will determine the nature of the impacts and the effects which may be seen from Earth and satellites including Hubble, Voyager 2 and Galileo.

The fragments will plunge into the Jovian atmosphere at around 60 km/s at an approach angle of 45°. At an altitude of about 100 km above the visible clouds, each fragment will be torn apart. Smaller fragments will create only 'ripples' but the larger ones may give rise to huge plumes of hot gas, a fireball which may illuminate the Galilean moons and a shock wave that may create long-lasting weather systems on the planet.



The orbit of SL9 relative to Jupiter: note the high inclination and large eccentricity

The dust sheet also impacts the planet, but its fate may be less drastic: it may enhance the dust ring around Jupiter or even create a new ring of its own. This may have implications for the origins of other planetary ring systems.

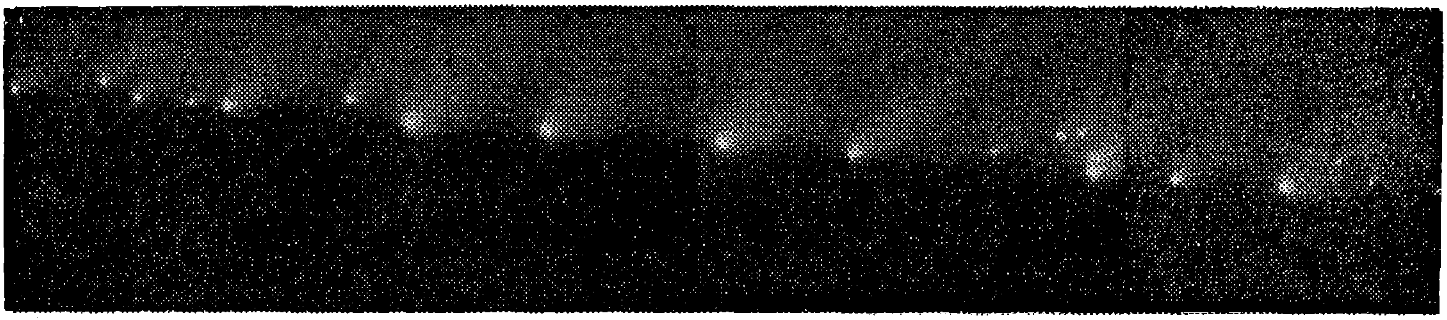
The comet will act as a probe of Jupiter's atmosphere which may then throw light on the extinction of the dinosaurs on Earth some 65 Myr ago.

This is the first time that such an event will be observed, but there have been at least two other occasions when comets have split, notably Biela's comet.

For more information on observing the planet, contact John Rogers of the Jupiter Section.

James Lancashire

Hubble Space Telescope image of SL9: the fragments are lettered officially from left to right as A–W: this means that impacts occur from left to right. North is at the top. Note the dust sheet to the NW blown away from the Sun by radiation pressure.



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Imaging Co-ordinator: *to be announced*

Editorial

Readers will have noticed immediately that their newsletter has a new look: I hope that there is a unified feel to the whole publication and that all my efforts in beating the computer typesetting program into some sort of shape will reap rewards.

My first thought on being asked to become editor was to entitle the newsletter 'nucleus', picking a good cometary term. Further thoughts and editorial development, however, made this evolve: I hope to attract articles on *all* aspects of cometary astronomy from history through current observations to future prospects, and so I set before you *The Comet's Tale* which I hope will encompass all these.

Observers have had something of a plethora of objects to view recently, and there are currently *four* comets reasonably placed around midnight when the sky is dark. Look in the observing supplement for ephemerides on these objects and charts with positions. Do tell me your views on the content and format. A copy of the new report form is also included.

Current economic conditions dictate that a small subscription charge be levied: this is £3 for those who contribute to the section (observations, articles, data entry, etc.) and £5 for those who don't. This covers two years (four issues at present) and cheques made payable to the BAA should be sent to the Director.

As is the wont of any editor, I ask you, the readers, for support. I ask for articles on any subject of relevance to cometary astronomy, and also illustrations, be they photographs or CCD images, or simply drawings or sketches.

I can receive 'hard copy' at my home address, but electronic files are preferable, which I can receive at my home address then load directly into the publishing program.

Files on computer disc, in a simple ascii format please, sent to my home address can also be used.

Typed manuscripts or illustrations on paper can be read or scanned onto computer, but do need much longer to format correctly.

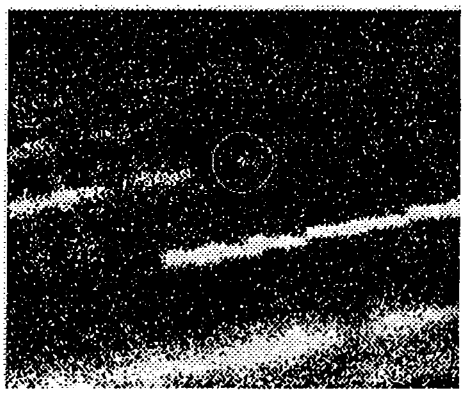
I should appreciate comment, preferably constructive, on your new-look newsletter, and suggestions for future ideas, articles of formats. I shall be happy to publish correspondence, and hope to update readers on developments in software and technology.

Finally, I mention that I aim to publish the next issue of *The Comet's Tale* in 1994 November, so the deadline for contributions is the end of October.

Read, subscribe and contribute!

James Lancashire

Halley halfway out



The record-breaking CCD image above captures Comet Halley at magnitude 26.5 and at a solar distance of 18.8 AU (about as far away as Uranus).

The remarkable CCD imaging was done in January at ESO's 3.5m New Technology Telescope.

Since perihelion in 1986, the comet has traveled more than halfway to its aphelion which it will reach in thirty years' time.

The image shows no coma, suggesting that the comet's surface is frozen.

Imaging of the comet all round its orbit should be possible; when it turns sunward again, Halley will be three magnitudes fainter.

Mankind has reached a little further out.

From Sky & Telescope *1994 June*

Section news from the Director

Dear Section member,

You will see from the list of section officers that there have been a few changes recently. Sadly Harold Ridley's health is failing him and he feels unable to continue to coordinate the photographic work. At the moment he is in hospital with a chest infection, but hopes to be out soon. He plans to move to Colchester, where he will be close to Michael Hendrie. I know that all section members wish him well. I have not yet appointed someone to take over from Harold but the new position will include the co-ordination of CCD observations as well as photographic observations.

Whilst on the subject of photographic observations, the comet section is participating in the International Comet Watch in support of the Ulysses spacecraft. If you take any photographs which show a gas tail, particularly if the tail shows any features or disconnection events, please send me a copy (until the new co-ordinator is appointed). For this work it is important that the precise start and stop time of the exposure is recorded, as very rapid motions have been recorded on occasion.

Denis Buczynski has found it difficult to combine the editorial duties with his heavy observational program and I have asked James Lancashire to take over. James is relatively new to comet observing—he is a former observations secretary and chairman of the Cambridge University Astronomical Society (posts which I also held) and his observing interests also include Jupiter and meteors. As you will have noticed from this newsletter desk top publishing is another of his skills! Please send him articles or information for the newsletter.

Our thanks go to Harold and Denis for all their efforts on behalf of the section over the years. Another section stalwart has also been contributing—Michael Hendrie has been working on a report on comet Arend-Roland 1956 h and this is nearing completion.

Since I last wrote to you I have spent two months in the Antarctic and South Africa. Those who attended the BAA Winchester weekend (a very worthwhile event at which everybody can learn something) had the chance to see some of my latest slides, and to see something of what I do down there. This trip we were stuck in the ice for a week, giving me extra time for entering archival data. Altogether I entered around 1000 observations and was able to do some formatting of observations published in TA, including many of comet Levy 1990 c. Hopefully you will see some tangible results soon as I have completed the report on this comet and am awaiting referees' comments. Analysis of the observations shows that an aperture correction is needed and that the observed coma size makes a difference to the reported magnitude (generally observers in poor conditions see less coma and report fainter magnitudes).

A month after I returned to the UK I was travelling again, this time to the International Workshop on Cometary Astronomy at Selvino, Italy. A full report appears elsewhere in this issue. I am pleased to say that I have been asked to organise the next IWCA and this will provisionally be held in Cambridge in 1999 after the total solar eclipse. Another upcoming meeting, not quite so far in the future, is a joint meeting of the comet and Jupiter sections which is scheduled for February or March 1995. It goes without saying that the topic for discussion will be comet P/Shoemaker-Levy (9) and the effects of its impact on Jupiter.

I have recently enhanced my home computer and now have a CD-ROM drive which gives me access to the GSC. This should enable me to reduce more of the archival observations and has already helped with several enquiries from section members.

The exhibition meeting in June is an opportunity to display some of your observations, so if you have any nice drawings or photographs that you would like to exhibit please send me a copy. I will be putting on a display to encourage beginner observers and some light curve analyses.

In the past six months observations or contributions have been received from the following BAA members:

Sally Beaumont, Denis Buczynski, Paul Howarth, Guy Hurst, Graham Keitch, James Lancashire, Brian Manning, Glyn Marsh, Martin Mobberley, Roy Panther, Jonathan Shanklin, Melvyn Taylor

and also from:

John Bortle, Paul Camilleri, Vidican Dan, Alfons Diepvens, Bjorn Granslo, Werner Hasubick, Atilla Kosa-Kiss, Ornulf Midtskogen, Herman Mikuz, Alfredo Pereira, Richard Schmude, David Seargent, Tonny Vanmunster and Vittorio Zanotta;

of comets:

P/Encke, P/Schwassmann-Wachmann (1), P/Schwassmann-Wachmann (2), Mueller 1993 a, P/Tempel (1) 1993c, P/Hartley(3) 1993 m, P/West-Kohoutek-Ikemura 1993o, Mueller 1993 p, P/Spitaler 1993 r, P/McNaught-Russell 1993 v, P/Kushida 1994 a and Takamizawa-Levy 1994 f.

At the moment there are four comets which are relatively easy to observe:

P/Tempel (1) 1993 c, P/McNaught-Russell 1993 v, Takimazawa-Levy 1994 f and Takamizawa 1994 i.

Ephemerides for each of these comets are published in the observing supplement.

A preliminary analysis of P/McNaught-Russell 1993 v using section data shows that its brightness is varying as:

$$m = 8.8 + 5 \log d + 5.8 \log r$$

An interesting conjunction of comets McNaught-Russell and Takamizawa-Levy was drawn to my attention by Mr P A Morris: on the evening of June 8th they will be close together some three degrees north of alpha Draconis at around 10m.

Please use the new report form to record observations of these comets (though by all means complete any old forms first). I have combined the previous three report forms into one, removing some of the columns, so it should be easier to complete. The most important things to record are the date, total magnitude, coma dia-meter and telescope aperture, and these are high-lighted on the form. The method for the observation (MM), the source of comp-arison star magnitudes (ref), the telescope type, f number and magnification are less important, and the degree of condensation, tail length and position angle, sky condi-tions and reliability of the observation are of least importance.

In view of the discussions at the IWCA you could put N after the DC if there is a nucleus and C if there is a distinct central condensation. There is also a bit more space for comments to put down any amp-lification of the basic details. If you see any features in the coma or significant tail detail, make a separate drawing, putting your name, the comet name and the date on the drawing.

Finally a couple of reminders: I haven't had any nominations for the Keedy award— this is an annual award so you can submit nominations at any time. I have re-ceived a number of cheques for the newsletter, but by no means from all section members—if you think that the newsletters are worthwhile send me (Jonathan) a cheque made payable to the BAA. The rate is £3.00 for two years for those that contribute to the work of the section (observations, articles, data entry or whatever) and £5.00 for two years for those that don't.

If you have any comments on the section or suggestions for improvements do write and let me know. Without your input I'll never know if you want changes.

Best wishes,

Jonathan Shanklin

Recent comet news and thoughts regarding observing techniques

One of the most remarkable events in terms of comet observation in recent months relates to the obscure Periodic Comet Spitaler (1993r) which was recovered by J.V.Scotti with the Space-watch telescope on 1993 Oct 24. It had not been seen since its discovery in 1890. Nakano had published a prediction with T = 1993 Oct 4.0 and when found the comet was within a few arc minutes of the line of variation at ΔT = +108.7 days.

However although the recovery was unusual, it was the follow-up amateur astronomer contribution by Martin Mobberley that qualified for the 'remark-able' claim. On 1993 Nov 11 Martin, using the 0.47-m reflector at Galleywood, Chelmsford recorded an image of this comet with CCD equip-ment. [See image on facing page—ed.] The estimated total magnitude of the comet was m_1 = 17–18, surely making this one of the faintest comets ever to have been recorded from this country by an amateur astronomer? It was an outstanding achievement and clearly illustrates one of the valuable uses of CCDs in the comet field, i.e. using the extended range to record comets which have hitherto been far too faint for visual or photographic work.

The result in itself was exceptional in merely recording such a faint comet but not content with merely 'storing' the computer file, it was arranged that Nick James undertake an astrometric measure. Noticeably this involved the use of stars from the Guide Star Catalogue which has recently been released by NASA on compact disk and is now widely used by those with a suitable 'CD' drive. The main advantage of this new 'star field' option is that it contains stars as faint as magnitude 15–16 and critically, in the vast majority of cases, enough stars within even the small field of the CCD system to enable an accurate position to be measured.

The 'old days' when amateurs first became interested in astrometry were full of problems of which the usual cry was there were just not enough stars in the field with reliable positions to make a proper reduction possible. At one point the SAO Catalogue was used and I can remember some fields of one degree which only contained one catalogued star but then the limiting magnitude of the catalogue was only about 9!

Astrometry will now become common place and Nick James has developed other software which assists in taking measure-ments and the GSC data to almost automate fully the reduction process.

But having illustrated the important developments supported by the new technology, I would not wish observers to think that the days of the visual comet observer are numbered.

To illustrate this we can turn to Periodic Comet Schwassmann-Wachmann 1 which is often listed with an ephemeris mentioning its magnitude as 18. This is clearly enough to put the visual observer off even having a look! However the comet undergoes outbursts which are far more regular than originally thought and as recently as 1994 Feb 1, one of our [TA] observers Ornulf Midtskogen in Norway visually observed it at m_1 = 11.0. The result was actually obtained by him during a visit to the OSA (Observatorio Scandinavos de Axarquia in Malaga, Spain). It was seen with a 0.203-m Schmidt Cassegrain telescope.

Of course there are other easier options from time to time for the visual observer as is being afforded currently by Comet McNaught-Russell (1993v). Again there is a remarkable background to this comet. According to S.Nakano and I.Hasegawa in Japan this object is the same comet as that seen in the year 574! There is a suggestion of a revolutionary period of about 1,440 years! I presume that the comet may have been magnit-ude 4 or brighter to be discovered that long ago or were the darker skies and more acute eyesight of those observers of long ago capable of finding even fainter fuzzy objects?

Observations are already streaming in suggesting the comet did brighten to around magnitude 6 this time. However results to the end of March, although placing the comet near magnitude 7 by month end, also depict a rather poorly condensed object.

This brings me to another important point. Many telephone calls received relate to observers inability to see certain comets which according to their magnitude should be visible. It is however a combination of magnitude, diameter and degree of condensation (DC) which determines visibility. Comet 1993v is certainly bright but it is not so prominent as other comets of magnitude 6–7 I have seen since I started observing them in 1971, and it is the poorly condensed aspect which 'mars' the view.

This is just a short article illustrating notes on recent comets and how all disciplines, whether CCD, photographic or visual can play their part. My role is to collate and help the visual observer. If you need guidance do write but do not be afraid to send in results even if you are a beginner as it is easier for me to help by seeing your work than discussing it in merely general terms.

For rapid feedback we are publishing preliminary data from your reports in the monthly magazine *The Astronomer* [TA] and the Director, Jonathan Shanklin, is undertaking follow-up analyses to be presented in the *BAA Journal*.

In addition computer files of your observations are being sent for inclusion in the archive of the *International Comet Quarterly* [ICQ]. This database is made available for access by professional astronomers so by including observations in all these places we are maximising your contribution of visual comet notes.

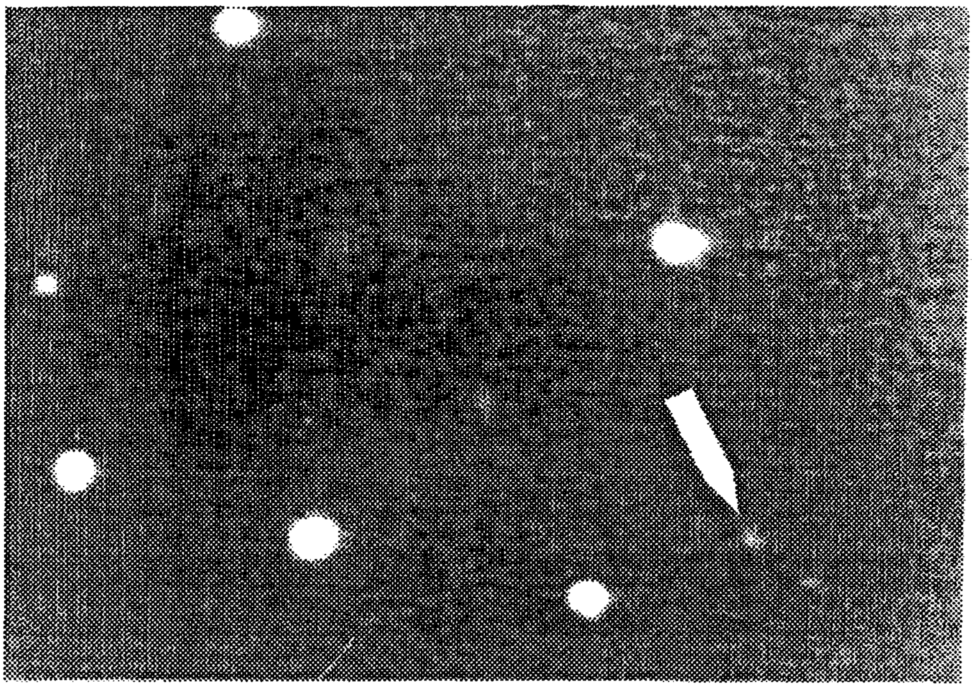
Keep sending them in, we need your help!

Guy M Hurst

STOP PRESS: the latest analysis is the lightcurve of 1993v shows a decline in brightness from about ten days after perihelion, with the magnitude now following

$$m = 9.1 + 5.0 \log d + 17.0 \log r.$$

Period Comet Spitaler 1993r



Martin Mobberley's CCD image of P/Spitaler 1993r at mag 17–18 on 1993 Nov 11.84. The imaging is done with a 0.49m f/4.5 Newtonian for 320 sec with Starlite Xpress.

The International Workshop on Cometary Astronomy

A workshop on comet observing was organised at Selvino, Italy, on 1994 February 18–19, in conjunction with the International Comet Quarterly, by the Circolo Astrofili Bergamaschi and the Circolo Astrofili di Milano under the patronage of the Unione Astrofili Italiani and the Comune di Selvino. Dan Green chaired the proceedings; other well known observers present included John Bortle, Herman Mikuz, Charles Morris and Vittorio Zanotta who was in charge of the local organisation. Selvino is a small village in the foothills of the alps, and there was plenty of snow on the ground. These are my excerpted notes from the meeting and as such will inevitably be liable to subjective interpretation (i.e. spelling, errors etc !); the formal proceedings will be published in the July issue of ICQ.

Dan Green started the proceedings by giving a history of the ICQ and the philosophy behind it. The archive holds little data prior to the 1910 apparition of comet Halley, and little between then and the 1930s. Data is included for over 75% of all comets after 1931. The archive is available on 9-track tape and in limited amounts by e-mail. Some 20,000 observations have been added in the last three years. Local co-ordinators ease the task of data entry by sending in observations by e-mail. There are 2,500 observations of long-period comets (LP) between 1932–59, 3000 from 1960–69, 6000 from 1970–79, 13,000 from 1980–89 and 10,000 from 1990–94! There are 25,000 observations of short-period comets (SP, with $P < 20$ years) from 1909 to the present. ICQ will be publishing magnitude parameters for short-period comets in the near future. SP comets typically brighten as 15–20 log R and sometimes as 20–30 log R; LP comets usually brighten as 7–8 log R.

The US DoD is planning a Clementine II mission to fly past Phaethon (the Geminid parent and possibly an extinct comet) and some other comet. Six trans-Neptunian objects, each about 100 km in diameter, have been discovered in the last 2 years. Only one has a good orbit (the first one), which is near circular at 40 AU. Some are in the Trojan area of Neptune and may actually be Trojans. None of the latest four have been re-observed since their discovery last September. Fred Whipple is still working on comet magnitudes. Japan has the largest population of comet observers. CCD observations are now going to mag 18 and tie in well with visual observations. Unfiltered CCD total magnitudes are usually within 0.1-0.3 mag of the visual magnitude (depending on the chip), however the use of a V-band filter is preferred. Some comets,discovered with large telescopes are assigned visual magnitudes that are far too faint; comet McNaught-Russell 1993 v is a case in point. It is worth attempting observation of some of these fainter comets just in case they are brighter than predicted.

The ICQ recommends observing procedures and reduction practices (e.g. the calculation of extinction). Observers are requested to submit their observations promptly, because they are often used by professionals planning observing sessions on large telescopes. You should include as much detail as possible in your personal log, even if this isn't submitted to the BAA or ICQ. It is possible to include a line for comments in the ICQ format, though these shouldn't be too verbose. Some observers go rather over the top with their descriptions!

Observing techniques

A discussion forum, led by John Bortle and Charles Morris went through observing techniques. The observed visual magnitude is dependent on how much defocussing is used (rack inwards on reflectors if possible to avoid vignetting), the telescope aperture, focal length and magnification: the smallest aperture and shortest focal length that clearly shows the comet should be used where possible (aiming for a 5mm exit pupil); comet filters should not be used for magnitude estimates.

A dark site helps you to make good estimates: if you can't see a mag 7 comet in 7x50B then you should try and find a darker site, the higher the better. The coma diameter is regarded as being diagnostic of the site by the ICQ, so that better sites report larger diameters (I will be dropping the limiting magnitude information from the BAA forms).

The use of good comparison sequences is important; these include the AAVSO atlas (AA), the North Polar Sequence (NP), Variable star charts (AC, V, VB) which use photoelectric sequences, the Yale Bright Star Catalogue (Y), the Hubble Guide Star Catalogue (the printed one (GA), not the CD astrometric catalogue (HS)), Ever-hart's sequences published in Sky & Tel (E); of these the NPS is perhaps best as it can be used for most comets (unless you have a telescope with an English equatorial mount!). Beware of using some older VS charts which often use 'guesstimated' magnitudes; it is always a good idea to check several stars in the sequence and to use several different comparison stars.

To encourage proper methodology the ICQ is planning a project to observe selected Messier objects; these will probably include M78 and M53 for binoculars and M66, M84, M86, M81, NGC 3640 and NGC 4147 for telescopes. Comparison star charts for these fields will be issued as part of the project. It is worth comparing your observations with those made by experienced observers: they should vary in the same way, though it is quite common to have a systematic difference; equally don't force your observations to agree with the ephemeris magnitude, which can often be out by several magnitudes. As the total magnitude depends on the surface brightness and size an apparently faint, large diffuse comet can actually be quite bright.

The BAA recommends the use of the Sidgwick (S) technique for magnitude estimates, which is good for diffuse or faint comets and poor skies. The Bobrovnikoff (B) or Morris (M) methods are better for well condensed comets (DC >6); in the B method you may have to defocus to 2 or 3 times the coma diameter so it is poor for large comae. In the Beyer (E) method you defocus until the comet disappears, which is good for bright comets. The M method is a combination of S and B where you just defocus the coma enough to flatten the peak brightness of the coma.

When reducing comet magnitudes for analysis of the light curve an aperture correction can be applied, which will vary according to instrument, observer, sky conditions, DC etc. The published raw data must never include this, though an extinction correction should be applied when necessary.

There was some confusion over the reporting of DC when the comet has a central condensation or false nucleus, which presents a step in the brightness distribution. The DC should be estimated as if these were not present.

A comet which is completely diffuse with no apparent change in intensity across the coma has a DC of 0. A comet which appears as a nearly star-like point or disc has a DC of 9. By contrast a comet which brightens a little towards the centre, but which also has a star-like false nucleus might only have a DC of 3. The Dutch group take DC 5 as being when 50% of the total light lies within the half maximum. I hope to publish illustrative figures in the near future.

A true central condensation is rarely seen and is possibly caused by an outburst; if so its diameter should increase from night to night, and should be measured. The magnitude of this condensation (or the nuclear magnitude) can be recorded, but generally is only of indicative use.

Tails come in two sorts. Type I are gas tails, straight, blue and filamentary, with the possibility of disconnection events. Type II are curved, yellow dust tails. The visual observation of comet tails is generally not important to professional astronomers and their observation is best left to photographers and CCD observers. The position angle should be measured near the head where the feature first appears. The end of the tail should not be used, unless this is to indicate the curvature. Only record the longest tail in the tabulated data, others can be included with descriptive comments.

The coma diameter can be measured by timing the passage across a micrometer wire ($d = t/4 \cos \delta$). This works well up to 60° declination, and a variation of the technique is to time a nearby pair of stars aligned east-west and estimate relative to this. Alternatively a known pair can be used—the maths is easier if they are aligned north-south. A bifilar micrometer could be used, but few people have access to one.

The Lumicon comet filter is based on the C2 Swan band and enhances a gassy comet (but don't use them for a magnitude estimate). Some may actually be too thick for a faint comet. The DC etc may change when viewed through the filter.

National observing programmes

Presentations were given by a number of national groups describing their observational programs. I started by describing the BAA comet section and its history.

A Nakamura (Japan) said that fewer discoveries were now made from Japan owing to light pollution. The average age of Japanese observers was also increasing, with no young observers coming in, possibly because of the light pollution.

Karastori (Hungary) described their young group, which is just starting a research program.

Guiseppe Canonoco (Belgium) described the interesting discovery of observations of a comet seen off the Cape of Good Hope in 1733 and recorded in old ship's logs which were good enough to obtain a new orbit.

Stephane Gareau (France) said that his country had many enthusiasts, but few observers.

Andreas Kammerer (Germany) said that his group had been founded in 1984. It issued a bi-monthly newsletter and used e-mail communication. Observations included astrometry and spectroscopy and were published in *Sterne und Weltram* and *PCM*. They hold an annual meeting in Violau, Bavaria. He also presented a new analysis of comet tail lengths, as he had wanted to derive a formula to predict likely tail lengths. He used 2,500 observations from ICQ and found that he could correlate the tail length with heliocentric magnitude and found that

length = 2.25 x 106 - 0.26 (H) km.

A further poster paper showed the use of 3-day running means to produce light curves, though it was necessary to weed out 'bad' observers.

Diego Garcia (Spain) said that their group was founded in 1975 following the apparition of Comet West. They had participated in the IHW. He commented that only bright comets were being observed, so that they had around 30 observers for bright comets, but only 4 or 5 for faint ones. They set up projects on specific comets, especially if they are bright enough for beginners. They try to get daily observations, and find a correlation between solar activity (using a jam-jar magnetometer) and comet magnitude. The same observers observe many things and there are probably only 13 regular observers in the whole of Spain. They provide information for the public and have some open observing evenings.

A Milani (Italy) said that their group was also founded after Comet West in 1976. They have just a few active observers.

Bern Brinkman (Germany: Ruhr) described their observatory in the Eifel region, used by five people in their group. It was at an altitude of 550 m and had a 34/50 cm Schmidt and several other telescopes.

Alex Scholten (Holland) said that the Dutch group was also formed in 1976 after the appearance of Comet West. They have about 20 active observers, but only three or four observe faint comets; last year they totalled around 100 observations. They only have low altitude observing sites (some below sea level!). They issue a newsletter and also have an instruction book (I am in the process of preparing one for the BAA).

Vittorio Zanotta (Italy) had a comet hunting program, planned on the basis of the solar rising azimuth. He had found 3 comets with his homemade 15 cm reflector (though only one is named after him), but none with expensive 25x150B.

Herman Mikuz (Slovenia) spoke on CCD photometry. He can reach mag 15 comets with a 20 cm telescope. It needs a good site—he is at 800 m in rural Slovenia which has around 100 clear nights a year. He uses an ST6 camera which is red sensitive and therefore uses a v filter. He doesn't observe when the airmass is more than 2. He uses the YBS catalogue for comparison stars, along with the AAVSO atlas. A five minute exposure is needed to record the comet, but often only 10–30 seconds for the comparison (he uses separate exposures). He processes the images in five steps:

(a) remove dark current. (b) take mean. (c) flat field. (d) clip stars from within the coma. (e) do photometry (may need to calculate extinction).

He has observed 16 comets and made 102 observations in the range mag 9–15 in the past 18 months. P/Schwassmann-Wachmann 1 has many outbursts and seems to be more often bright than faint. He showed images of many of the comets. Typical magnitude error is less than 0.05 mag for a mag 15 comet and less than 0.01 mag for a mag 10 comet, the former reducing to 0.1 mag when other errors (seeing, atmosphere etc) are taken into account. He also uses a 400mm f/2 telephoto lens which gives a 1.3° x 1° field; this is too short for astrometry, though this can be done with an 800mm lens.

Andrea Boatini (Italy) showed some pre-recovery images of P/Swift-Tuttle taken with the professional Schmidt camera at Asiago (this is similar in size to the Cambridge Schmidt, but is in a much better location). He had taken several search plates in January 1992, but was only able to find the very faint near stellar image when the orbit was known.

Peter Bus (Holland) showed CCD images of P/Swift-Tuttle which had been processed using the technique of Larsen & Sekanina. He had used the 1.04 m (f= 3.672 m) reflector at Puimichel and a 208 x 384 pixel CCD camera, giving a field of 8' x 6'. These showed details in the coma on a scale of 2', with strong jets being visible, even in the unprocessed images.

John Bortle gave a talk on the 'Art of Drawing Comets'. Very few comets show features in the coma. He proposed a classification scheme for features.

H: hoods or envelopes: only seen in bright comets near perihelion and more often photographed. They are the largest features to be seen. R: rays of the ion tail: they rarely extend all the way to the false nucleus, usually ending a few minutes out. They are blue, can be seen with the Lumicon comet filter and are quite common. S: shadow of the nucleus: rare and needs a 40 cm or larger to be seen easily. F: fountains: around 1' high in the sunward direction, suppressed by a Swan band filter. They are diffuse features, subtending a few to 100 degrees angle and are more common than jets. J: jets: are the rarest feature, very fine and delicate, always curving and possibly spiral, rapidly changing and less than 60" high. Again they need a large aperture to be seen.

There are a number of techniques that can be used for drawing:

(a) pseudo isophotes —a good technique for beginners.
(b) negative shading (the normal technique)—rub a pencil on a sheet, then use a finger or tissue to transfer the graphite to the sketch pad; a paper stump can be used to add tone or a rubber to subtract it.
(c) stipple: the best method for a non artist.

Remember to put a scale bar (e.g. 1') and the mark the north point. He commented that there are no good 'landscape' artists at work today. It is best to make a sketch and notes at the eyepiece then complete the drawing indoors. Beware of bias and drawing what you expect to see. White on black drawings are very difficult to do.

Charles Morris discussed lessons from the recent apparition of P/Halley. He presented a lightcurve using data from 7 selected observers (5 American!) and compared it with infra red observations giving the dust production rates. All show real variations on a background steady state, but you need nightly observations from a single observer to show the short term variation. The magnitude doesn't correlate well with dust production rate prior to perihelion, but is much better after perihelion. He suggested that prior to perihelion the coma is freely growing, but is eventually constrained in size by solar wind pressure.

Jonathan Shanklin

Periodic Comet Schwassmann-Wachmann 2

Martin Mobberley's 320 sec CCD image of P/Schwassmann-Wachmann 2 at mag 10 on 1994 Feb 7. Martin used a 0.49m f/4.5 Newtonian with Starlite Xpress CCD.

Short note on computer information

E-mail circulars
Readers will no doubt be aware of the circulars issued by the IAU, BAA and *The Astronomer* (TA), some available by e-mail. TA has organised a competitive subscription for access to e-mail for its members—see page 237 of Vol. 30 (1994 Feb) or contact Nick James. The Royal Greenwich Observatory offers access to the latest IAU Circulars; see the BAA Newsletter of 1993 Oct for details.

News on Internet
For those with access to the Internet newsgroups through programs like rn or news, `sci.astro` provides some interesting observational news, in particular a weekly posting of ephemerides for comets by Jost Jahn (although the Cambridge news server seems rather unreliable—ed); the major problem is that one has to wade selectively through much junk and many stupid debates for the useful information — a newsreader like trn simplifies this process greatly.

WWW: the world-wide web
This is a fantastic information network described as a 'global hypermedia system' but needs an advanced terminal for display. Of most relevance are the 'home pages' of major astronomical establishments; the one for Cambridge is at
`http://cast0.ast.cam.ac.uk/`
with a user guide, local information and pointers to other observatories.

FTP: file transfer protocol
In addition to what are interactive sessions, one can access files in public areas on observatory computers. Using the ftp command on certain network login programs, one can download files like text information files, archival data or the latest HST images. Returning to one's home machine, one can print the text, manipulate the data or display the images. Images and programmes may be compressed and in binary format, so uncompression routines are needed. Shareware and freeware programs, in particular ephemeris and sky-plotting programs, are available by ftp, but one needs the address of the host system and the file location on that system; this may be ad-vertised on the Internet News or can be found using archie.

James Lancashire

Cometary collisions at the Royal Astronomical Society

The RAS held a discussion meeting on Cometary Collisions on March 11th. This was attended by James Lancashire and myself and these notes summarise the proceedings.

Ian Gilmore (Open University): Carbon Chemistry of the KT boundary. The impact event was probably a C1 chondrite impacting into carbonate rock. The impact layer is thin, with ejecta only present in North America. Various forms of carbon are present, including diamond and C60. The diamonds are not meteoritic or terrestrial. The presence of lots of soot implies fire, and the k13C of -26%% implies biomass combustion, with the possibility of extinctions being caused by darkness, cold, poisons, mutagens or greenhouse warming. The impact is proven, though the mechanism for extinction or even if it occurred is not.

Max Wallis (Cardiff): The comet hypothesis for the KT boundary. There is a sharp iridium peak, but a broad peak in AIB (extra-terrestrial amino acid) over perhaps 100,000 years. He proposes the fragmentation of a giant comet, with one impact over this period. There is a low probability of keeping graphite and mineral grains from the fragmentation within the solar system owing to radiation pressure, but organic grains (< 0.1 μm) may remain. He expects that climate fluctuation including ice ages may have occurred. [There were many inconsistencies in this talk, which was difficult to follow and I am rather sceptical. JDS].

David Hughes (Sheffield): Influx of comets and asteroids to Earth. Look at cratering records on earth and find that N varies as D^{-2}. Considerable extrapolation was used, with much uncertainty in the basic measurements and he brought out several inconsistencies. Impact: either energy had to be proportional to D^2, though experiment suggested it was proportional to $D^{3.5}$; or the mass index had to be around 1.57, though observation suggested 2.0; or the measured diameters are wrong (possible). Asteroids are more likely to hit than comets. [Well presented, with hand waving arguments, based on severe extrapolation and assuming a single population of objects. JDS]

Mark Bailey (Liverpool): Comets from the Oort cloud and Kuiper belt. Large comets dominate the mass and perhaps one per century come inside Jupiter's orbit (e.g. the Kreutz group, and Comet Sarabat 1729 as long-period comet examples, Chiron, Pholus as shor-period comets and 92 QB1, 93 FW in the outer solar system: all are of order 200 km dia-meter). Orbital study shows that Chiron could have been earth crossing ($P = 5$ yr, $q = 0.5$ AU) 15 ky ago for around 5 ky, during which time it would have emitted around 1500 times the mass of comet Halley into the inner solar system. Evi-dence for such events occurring is supported by the Encke/Taurid complex. He presented simulations showing that comet Machholz could eventually impact the sun, and that asteroid 5335 Damocles could become a sungrazer. Even for comet Halley, q is secularly decreasing and it could become a sun-grazer within a million years. Comet Encke could become a sungrazer in 80,000 years. Giant comets are perhaps 0.1% of the comet population, with one captured into the inner solar system every 100,000 years (c.f. climate cycles and asteroid impact frequency). Orbits are chaotic and can switch from large to small q in as little as 100 years, with a secular trend towards sungrazing being common. This would give rise to disintegration and is consistent with catastrophism. Perturbation of comets into sub Jovian orbits is a secular process and is more common than indicated by Monte-Carlo simulations.

Bill Napier (Oxford): Climatic effects of comets. The presence of giant comets in the inner solar system would give rise to terrestrial effects, probably within the period of civilisation on earth. The Encke/Taurid complex could input 10^{20} g /century into the inner solar system over a lifetime of perhaps 3000 years for a Chiron-sized parent body. Most of the mass resides in large particles, though most of the surface area is in small ones. Such a disintegration could continuously input 1.5 tons/km^2/y onto the earth, giving an atmospheric loading of 6 x 10^{14}g (c.f. the largest eruption in history, Toba, which put around 10^{15} g into the atmosphere). This would give an optical depth $0.05 < \tau < 0.3$, a decrease in temperature of around 5° and probably an ice age.

Victor Clube (Oxford): Giant comets and short term catastrophes. Long term observations of fireballs by the Chinese show periods of enhanced activity (in the autumn months) in the tenth and fifteenth centuries. This may be illustrated in some historic woodcuts. The Spacewatch and DoD observations show an enhanced flux of small bodies compared to the extrapolation, which implies a non-homogenous population. He suggested that Tunguska was a partially devolatilised comet core. He would expect 10^4 similar events per 10^6 years per giant comet, but the rates would be higher for short periods, giving perhaps one impact per country per century, which would be noticed! He thought that the Dark Ages and decline of the Roman empire around AD 500 and the Sumerian collapse of around 2000 BC may have been triggered by such events and predicted that the next series would occur around AD 3000. Deserted lands in the Roman empire (e.g. England in the fifth century) had posed a problem to the administration, and millenarianism (fear of the end of the world) was rife. A search through Chinese records had found several descriptions which might of Tunguska like events, starting in 193 AD.

Chris Traynor (Leeds): The Tunguska event. This was caused by a comet or asteroid airbust at 5–10 km altitude, giving a 10–15 MT explosion. He showed several slides of the site, which is in a mix of Taiga, swamp and sandy heath. Observed effects included air pressure waves, seismic traces, haloes, bright nights and poor astronomical seeing. Local effects included flattened trees for 10–25 km, fires and dead reindeer. It may have changed the swamp and left ripples in it. Residues include spherules, trace element perturbation and two possible 'craters', about 20 cm across in the wall of Churgym canyon, which were probably caused by hyper-velocity impact, though no macroscopic fragments have ever been found.

Neil McBride (Kent): Comet debris measured by LDEF. An asymmetry in the large particle impacts between the north and south pointing faces of the spacecraft may be due to the Taurid complex and could represent 1/3 of all particles seen.

Alan Fitzsimmons (Belfast): Near Earth Objects. Four programs are searching for them: two at Palomar (Gene Shoemaker and Elenor Helin) and the AANEAS in Aust-ralia using Schmidt plates, and the Space-watch telescope using a CCD which can record objects fainter than mag 22. 43 new NEOs had been discovered in 1993 alone. Toutatis and 1989 PB were double. The origin of these bodies is uncertain. Some NEOs are asteroids, some are sus-pected of being dormant comets, e.g. because of the orbit, association with meteor streams or D type spectra. Asteroid 4015 = 1979 VA = Comet Wilson-Harrington 1949 III, though it has a C type spectrum. There are not enough C or D type NEOs to be extinct comets or comets don't turn into C or D type asteroids.

Iwan Williams (London): P/Shoemaker-Levy 9 (SL9) is in a near-circular orbit at 5AU, viewed alternatively it is in a high inclination, high eccentricity Jovian orbit which is evolving rapidly due to solar perturbation. The 'string of pearls' is caused by the differing orbital periods given by the differing gravitation potential energy of the fragments when the comet broke up. It is possible to calculate a likely size from the spread of the fragments, which gives the difference in perijove of around 1.5 km and hence a minimum diameter of 3 km. If the breakup occurred after perijove this would increase to around 10 km. Calculations also suggest that the density cannot be more than 2.5 g/cc. The comet is fading, implying a one-off dust ejection and no gas emission has been detected; this could imply that the comet is actually an asteroid. Some of the emitted dust won't impact the planet.

Galileo will be well placed to view the impacts, but can't send back many images. Good astrometric positions are required in order to get the absolute timing to better than 10 minutes; the relative timing is already quite good. The estimated energy of the impacts is 10^{23} J (10^7 MT). The brightness of the events depends on the penetration depth: if 300 km there would be a faint flash, followed by a hot plume ejection and a second flash over a minute or so, with most energy in the infra-red. If the impact is high in the atmosphere there would just be one flash. Thermal waves are likely to be seen in the atmosphere after each impact. It might be possible to see reflections off satellites in eclipse—this particularly applies to fragments K and W (fragment A = 21 hits first). Spectroscopy will show atmospheric mixing. Seismic waves may probe the internal structure. Enhancement of the Jovian ring may occur from the impact of parts of the dust trail which miss the planet.

Cranks are having a field day with prognostications of doom, and he hoped that the media would only remember the prophets getting it wrong if the event turned out to be a complete flop.

Jonathan Shanklin
James Lancashire

Osculating heliocentric orbital elements for Shoemaker-Levy 9 fragments

These are orbit solutions as of 1994 February 22 and computed by D.K. Yeomans and P.W. Chodas of JPL.This not an ephemeris, but the orbital elements and shows what a drastic perturbing effect that Jupiter has.

Jonathan Shanklin

Fragment Q = 7 Reference solution = Q16 (Component Q1=7a)

Date	e	q	Node	w	i	Tp
94 Feb 25	.11009438	5.37534900	223.696493	.073339475	3.565411	94 Jul 1.899777
94 Mar 11	.12375044	5.37769454	222.838881	358.922947	3.900170	94 Jun 7.250287
94 Mar 25	.13923847	5.37928070	222.150194	357.887673	4.271623	94 May 17.285271
94 Apr 8	.15707305	5.38015645	221.612719	356.930617	4.689901	94 Apr 29.360581
94 Apr 22	.17803981	5.38031659	221.214729	356.019958	5.170020	94 Apr 13.984427
94 May 6	.20340099	5.37968764	220.950624	355.125679	5.735388	94 Mar 31.791274
94 May 20	.23533615	5.37809014	220.822273	354.215852	6.425179	94 Mar 20.537446
94 Jun 3	.27803727	5.37513991	220.842902	353.248833	7.311964	94 Mar 11.112895
94 Jun 17	.34106656	5.36996058	221.048089	352.157863	8.552852	94 Mar 3.658438
94 Jul 2	.46612102	5.35899586	221.586198	350.683798	10.80459	94 Feb 26.953039
94 Jul 4	.49334066	5.35665082	221.698857	350.441529	11.26190	94 Feb 26.790379
94 Jul 6	.52547396	5.35393082	221.826437	350.181519	11.78813	94 Feb 26.820303
94 Jul 8	.56432286	5.35072285	221.972254	349.899489	12.40563	94 Feb 27.102691
94 Jul 10	.61279643	5.34685560	222.141119	349.589314	13.14915	94 Feb 27.731712
94 Jul 12	.67598463	5.34205177	222.340460	349.241710	14.07674	94 Feb 28.866429
94 Jul 14	.76387032	5.33581996	222.582778	348.841469	15.29592	94 Mar 2.804052
94 Jul 16	.89981292	5.32716262	222.892134	348.360681	17.03970	94 Mar 6.192874
94 Jul 18	1.1589738	5.31353081	223.327159	347.738006	19.97625	94 Mar 12.893127
94 Jul 20	2.1242032	5.28423789	224.149781	346.809232	28.12403	94 Apr 2.793963
94 Jul 22	.64892979	1.30757058	46.6824041	336.798307	58.66176	96 Sep 13.903716

Research notes from selected journals

Comet formation

In *Nature* of 1994 April 21 (Vol. 368, pp 721–723) Weidenschilling considers the formation of comets from the solar nebula and suggests a two-stage process, each stage of which is a current theory. After icy grains have settled in the central plane, planetesimals form by collision and are carried round with the nebular gas. There is a shear, however, which causes turbulence so that the particle layer cannot become gravitationally unstable. The collisional accretion continues until the bodies are large enough (tens of metres) to decouple from the gas. Then gravitational instability of the layer produces macroscopic bodies. This happens preferentially further from the Sun. The outer parts of the solar nebula experience a lower tidal effect of the Sun, have greater solid:gas ratio owing to condensation of ices, and produce less drag owing to lower gas density. The paper suggests bodies of size of order 10 km (i.e. typically cometary). The composition and size have implications for the Kuiper belt.

Short-period comets from the outer solar system

Holman & Wisdom in the *Astronomical Journal* of 1993 May (Vol. 105, pp 1987–1999) perform numerical integration over 20–800 Myr. The test particles comprise orbits initially near Lagrange L4 and L5 points of the Jovian planets (i.e. 'Tro-jans'), and those with circular ecliptic orbits with radii 5–50 AU (i.e. Kuiper belt objects). The Trojan-like objects exhibit some considerable wandering around their Lagrange point but are essentially stable over the timescale investigated. Asteroid-like objects between Jupiter and Neptune are cleared from the region within 10 Myr. For objects between Neptune and about 43 AU, survival is rather longer, up to 100 Myr; these objects cross Neptune's orbit and maintain their semi-major axes although their eccentricity varies irregularly. The flux of these objects from this model of the Kuiper belt decays slowly, only inversely with time. Taking a reasonable flux of new short-period comets of one per century, the authors assume that 17% of these comets become visible and estimate that nearly 10 billion comets formed the Kuiper belt, with roughly half this number remaining; they find a similar mass of 0.2 Earth masses in the current Kuiper belt to that previously estimated by modeling perturbations of Halley's orbit.

Cometary apparent brightness

In *Monthly Notices* of the RAS Vol. 263 pp 247–255 (1993), Hughes *et al.* investigate the Δ-effect which is simply the effect of the Earth-comet distance on the comet's brightness. An inverse-square law is usually assumed, but this has been questioned. The actual value of the exponent (-2 in the usual case) can vary with the size of cometary coma and the apparent magnitude. Hughes *et al.* consider the method used by most observers in making visual estimates, i.e. comparison with defocussed stars, and point out traps for the inexperienced observer faced with a large comet. They use a CCD to find the true luminosity relationship and apply this to P/Halley and P/Encke but conclude that for comets further than about 0.03 AU from Earth the inverse-square law holds. This is the same relationship, of course, as for point sources.

Source of Jupiter family comets

Pittich & Rickman in *Astronomy & Astrophysics* Vol. 281 pp 579–587 (1994) simulate the breakup of giant comets and integrate the fragments. The fragments encounter Jupiter and as a result lose their 'memory' of previous orbital similarity, even down to the quasi-constant Tisserand parameter. The authors conclude that the observed Jupiter family cannot be used to distinguish a common origin for a substantial part of the family. This means that nor can the family be used to rule out its formation from cometary splitting.

Search for Jupiter family comets

In *Icarus* Vol 107 (2) pp 311–321 (1994), Tancredi & Lindgren give the results of the first search for comets in the vicinity of Jupiter. 36 ESO Schmidt plates taken during 1992 March & April were searched but no comets were found. The limiting magnitude for stellar objects is estimated to be around mag 20, with the corresponding comet nuclear (absolute) magnitude around mag 14. Compared to asteroids at the same distance, comets near Jupiter have a lower relative velocity and thus leave different trails on the plates. The distribution of Jovian family comets is significantly higher nearer to Jupiter, so the search was limited to this region. The authors extrapolate an upper limit of 210 comets brighter than mag 14 in the Jupiter family, which means that only about half are currently known. The plates did not detect Comet 1993e before its assumed breakup in 1992 July, but its absolute magnitude is assumed to be fainter than the survey limit anyway.

Origin of crater chains on Ganymede and Callisto, and models of SL9

Melosh and Schenk write in *Nature* of 1993 Oct (Vol 365 pp 731–733) that the long, straight crater chains on Ganymede and Callisto were formed by the impact of a fragmented comet, similar to Comet 1993e. After the return of data from Voyager 1, the craters were initially thought to be secondary craters produced by debris from a larger primary impact, but the search for these source craters had proved unsuccessful. The authors point out that if the chains were indeed the remnants of an extended impact by a comet or asteroid then the (usually) hyperbolic nature of the orbits should place the impacts, and therefore the chains, on the Jupiter-facing side of the tidally-locked satellites. 11 out of 13 of the crater chains on Callisto satisfy this requiremnt. Ganymede's chains also fit this bill, but they are fewer in number owing to the moon's closer distance to the parent body. Melosh & Schenk then model the splitting of a comet and investigate the separation of the fragments when parameters like the initial comet size and approach conditions to Jupiter are varied. The tidal breakup of the comet is assumed to take place at perijove, and the resulting fragments form a line, although this is not the case if the comet is initially rotating. The authors compare these results with images of SL9 and state 'excellent agreement'.

James Lancashire

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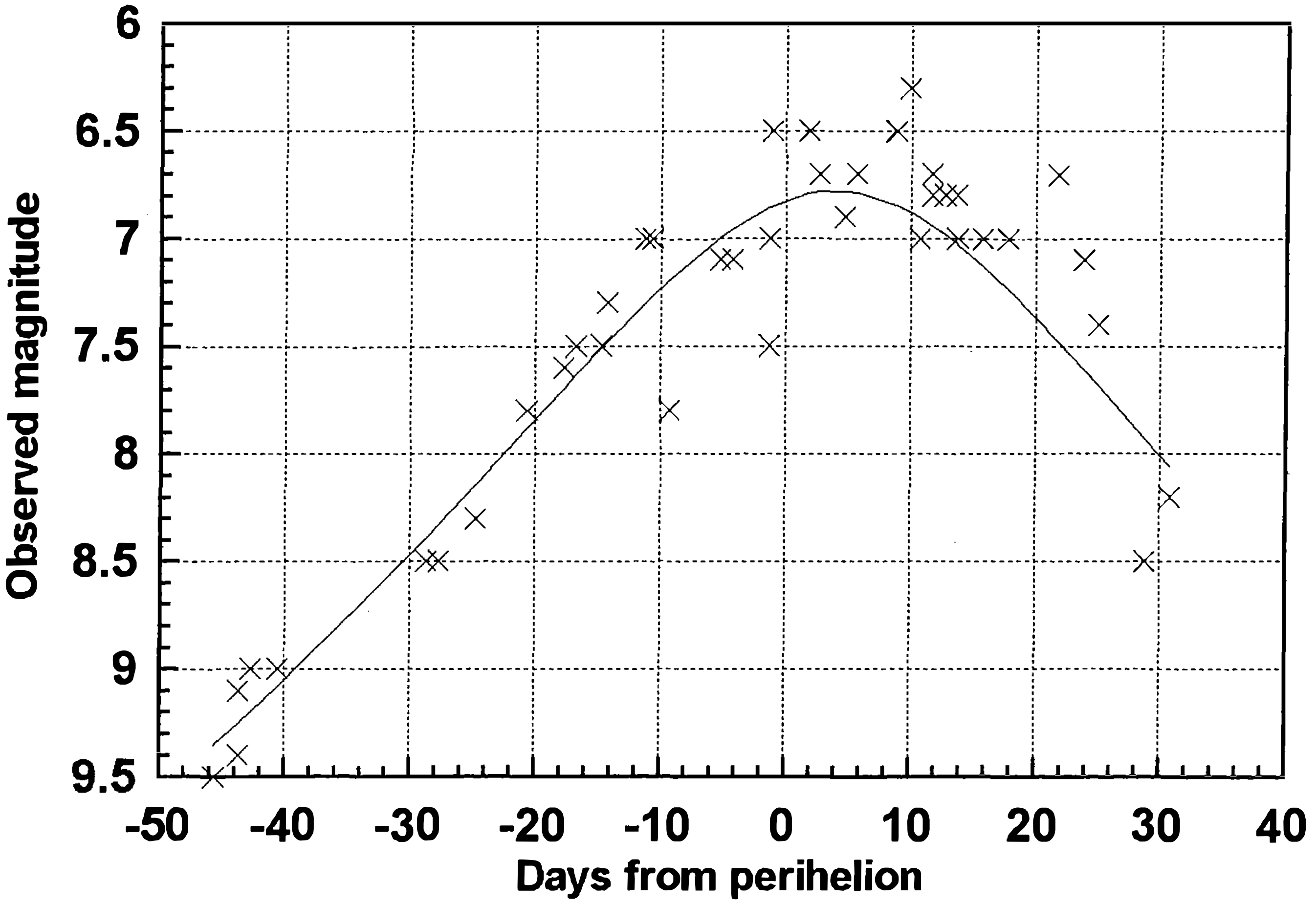
Comet McNaught-Russell 1993 v

$$m = 8.8 + 5 \log d + 5.8 \log r$$



STOP PRESS: The brightness of 1993v has declined since about ten days after perihelion, with the magnitude now following:

$$m = 9.1 + 5.0 \log d + 17.0 \log r$$

Review of comet observations for 1994 Jan–Apr

In addition to the Director's report and lightcurves based on observations from BAA members, I present a review of comets so far in 1994, with information gleaned from IAU circulars and TA. Note that the figures quoted have been rounded off from their original published accuracy. Full reports of some comets will appear elsewhere in due course.

Comets with names printed in ***bold italic type*** have ephemerides and charts printed later in this newsletter. Please use the new comet report form for your observations!

1986III (P/Halley): recorded at mag 26 at solar distance of nearly 19 AU, making Halley the faintest comet ever observed.

P/Schwassmann-Wachmann 1: nuclear magnitude given as mag 17 but frequent outbursts: mag 13 in early Jan, mag 11 in mid Jan, mag 13 by end Jan, mag 11 in early Feb.

CO emission from P/SW1 was detected using the JCMT on 1993 Oct 22, Nov 11, 12; the production rate of 2000 kg/s is sufficient to drive dust activity. First direct evidence that activity in comets beyond the orbit of Jupiter can be powered by CO. (IAUC 5929)

P/Schwassmann-Wachmann 2: mag 12 in early Jan, mag 10 by end Jan and mid Feb, mag 12 in mid Mar.

P/Encke: mag 10 in early Jan, mag 6 in mid Feb, mag 9 in mid Mar.

1993a (Mueller): perihelion on 1994 Jan 13, hyperbolic orbit (e = 1.002), inclination 125°; mag 9 from Dec to Feb.

1993c (P/Tempel 1): mag 15 in early Feb, mag 13 by mid Feb, mag 12 by early Mar.

1993p (Mueller): perihelion on 1994 Mar 29, inclination of 105°. Closest appr-oach of 0.90 AU to Earth on May 8. Mag 11 in early Jan, mag 10 in mid Jan, mag 9 in late Jan, mag 11 in early Feb.

1993s (P/Mueller 5): perihelion on 1994 Sept 20; inclination 16°, eccentricity 0.26, period of 13.8 yr.

1993t (Kushida-Muramatsu): perihelion on 1993 Dec 6, inclination 2.4°, eccentricity 0.27, period 7.4 yr.

1993v (McNaught-Russell): discovered before its perihelion on 1994 Mar 31. Inclined at 51°. Eccentricity 0.99. Closest approach of 0.46 AU to Earth on Apr 3. Magnitude prediction 4 mags too faint as comet brightened to mag 9 in mid Feb and mag 6 in late Mar.

STOP PRESS: the magnitude started to decline about ten days after perihelion. New mags in ephemeris. (1994 May 17).

Nakano suggests that 1993v is identical with comet of 574 for which there is an earlier similar given orbit. This gives a period of 1430 ± 30 yr with residuals of up to 1.6° in 574, and is compatible with the eccentricity. (IAUC 5943)

1994a (Kushida): discovered after its perihelion date of 1993 Dec 13. Low inclination of 4°. Orbit of eccentricity 0.63, therefore a short period of 7.4 yr. Mag 11 in early Jan, mag 10 in mid Feb, mag 9 in early Mar, mag 11 in late Mar.

1994b (P/Wild 3): recovered with Spacewatch Telescope at mag 20.

1994c (Mueller): discovered at mag 17. Perihelion on 1993 Dec 1, inclination 145°. Closest approach of 1.4 AU to Earth on Apr 3 at mag 16.

1994d (Shoemaker-Levy): mag 13 in early Mar, mag 14/15 in early Apr but brightened to mag 13 in mid Apr.

1994e (P/Russell 2): recovered at mag 22.

1994f (Takamizawa-Levy): discovered around mag 10 in mid Apr. Inclination of 132°. Perihelion on 1994 May 22, closest approach of 0.9 AU on May 24.

1994g (P/Harrington): recovered at mag 18.

1994h (P/Maury): recovered at mag 18.

1994i (Takamizawa): discovered at mag 11/12 with perihelion on Jul 8, inclination of 135°. Closest approach of 1.0 AU on May 23.

1994j (P/Brooks 2): recovered at mag 18.

James Lancashire

Comet ephemerides for 1993c, 1993v, 1994f & 1994i

Computed by Jonathan Shanklin

Comet ephemerides give the following information for an arbitrary location in the UK (long. 0°, lat. 53°):—

- Name of comet
- Orbital elements (1950)
- Magnitude formula

Conditions for the comet to be observable. This is a rough indication only. The sun must be 13° or more below the horizon (i.e. sky is dark) and the comet a distance above the horizon depending on its predicted brightness. A bright comet may be visible outside these limits. Equally a faint comet in poor skies may be invisible!

- Month, year. **All times are in Greenwich Mean Astronomical Time (GMAT)** i.e. the day is the day on which the night starts. To convert to UT (GMT) add 12 hours. If the value is then greater than 24, add 1 to the day and subtract 24 from the hour. If necessary convert to local time. Strictly ephemeris time is used, this is currently some 55 seconds ahead of UT.

- Column headings.

a) Day and time in GMAT.
b) Right ascension in hours and minutes Declination in degrees and minutes (These are for **epoch 1950** which is the epoch most often used in star atlases)
c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.
d) Distance from the Earth in AU.
e) Distance from the Sun in AU.
f) Time of transit, i.e. when the comet is highest in the sky.
g) Period of observability subject to the constraints in line 7. The comet may be visible outside this period.
h) Elongation from the sun in degrees.

Ephemerides follow

Ephemeris for Comet P/Tempel 1 1993 c

Omega=178.8679 OMEGA= 68.3203 i= 10.5500 q= 1.494152 a= 3.114471
e=0.520255 P= 5.496 T= 1994 July 3.3085
Magnitudes calculated from m= 5.0+5.0*Log(d)+25.0*Log(r)+0.000*Beta

May		1994			Times in GMAT		Positions for Epoch 1950		
Day	Time	R.A.	Dec	Mag	D	R	Trans	Observable	Elong
16	12.0	12 54.7	7.44	9.1	0.69	1.57	9.19	9.53 to 13.60	133
17	12.0	12 54.6	7.27	9.1	0.70	1.57	9.15	9.56 to 13.57	132
18	12.0	12 54.6	7.10	9.1	0.70	1.56	9.11	9.59 to 13.54	131
19	12.0	12 54.7	6.52	9.0	0.70	1.56	9.07	10.02 to 13.51	131
20	12.0	12 54.8	6.33	9.0	0.70	1.56	9.03	10.05 to 13.48	130
21	12.0	12 54.9	6.15	9.0	0.70	1.55	8.60	10.08 to 13.45	129
22	12.0	12 55.1	5.56	9.0	0.70	1.55	8.56	10.11 to 13.43	128
23	12.0	12 55.3	5.37	9.0	0.71	1.55	8.52	10.14 to 13.40	128
24	12.0	12 55.5	5.17	9.0	0.71	1.55	8.48	10.17 to 13.37	127
25	12.0	12 55.8	4.57	9.0	0.71	1.54	8.45	10.20 to 13.34	126
26	12.0	12 56.2	4.37	9.0	0.71	1.54	8.41	10.23 to 13.32	126
27	12.0	12 56.6	4.16	8.9	0.71	1.54	8.38	10.26 to 13.29	125
28	12.0	12 57.0	3.56	8.9	0.72	1.54	8.34	10.28 to 13.26	124
29	12.0	12 57.5	3.35	8.9	0.72	1.53	8.31	10.31 to 13.23	124
30	12.0	12 58.0	3.14	8.9	0.72	1.53	8.27	10.34 to 13.21	123
31	12.0	12 58.6	2.52	8.9	0.72	1.53	8.24	10.37 to 13.18	122

June		1994			Times in GMAT		Positions for Epoch 1950		
Day	Time	R.A.	Dec	Mag	D	R	Trans	Observable	Elong
1	12.0	12 59.2	2.31	8.9	0.73	1.53	8.21	10.40 to 13.15	122
2	12.0	12 59.8	2.09	8.9	0.73	1.53	8.17	10.43 to 13.09	121
3	12.0	13 0.5	1.47	8.9	0.73	1.52	8.14	10.46 to 13.04	120
4	12.0	13 1.2	1.25	8.9	0.74	1.52	8.11	10.49 to 12.59	120
5	12.0	13 2.0	1.02	8.9	0.74	1.52	8.08	10.51 to 12.54	119
6	12.0	13 2.8	0.39	8.9	0.74	1.52	8.04	10.54 to 12.49	119
7	12.0	13 3.7	0.17	8.9	0.75	1.52	8.01	10.57 to 12.43	118
8	12.0	13 4.6	-0.06	8.9	0.75	1.51	7.58	10.59 to 12.38	117
9	12.0	13 5.5	-0.29	8.9	0.75	1.51	7.55	11.02 to 12.33	117
10	12.0	13 6.5	-0.53	8.9	0.76	1.51	7.52	11.04 to 12.28	116
11	12.0	13 7.5	-1.16	8.9	0.76	1.51	7.49	11.06 to 12.23	116
12	12.0	13 8.6	-1.39	8.9	0.76	1.51	7.47	11.08 to 12.18	115
13	12.0	13 9.7	-2.03	8.9	0.77	1.51	7.44	11.10 to 12.13	115
14	12.0	13 10.9	-2.27	8.9	0.77	1.51	7.41	11.12 to 12.07	114
15	12.0	13 12.0	-2.51	8.9	0.78	1.50	7.38	11.14 to 12.02	114
16	12.0	13 13.3	-3.14	8.9	0.78	1.50	7.35	11.15 to 11.57	113
17	12.0	13 14.5	-3.38	8.9	0.78	1.50	7.33	11.17 to 11.52	113
18	12.0	13 15.8	-4.02	8.9	0.79	1.50	7.30	11.18 to 11.47	112
19	12.0	13 17.1	-4.27	8.9	0.79	1.50	7.28	11.18 to 11.42	112
20	12.0	13 18.5	-4.51	8.9	0.80	1.50	7.25	11.19 to 11.37	111
21	12.0	13 19.9	-5.15	8.9	0.80	1.50	7.22	11.19 to 11.32	111
22	12.0	13 21.3	-5.39	8.9	0.80	1.50	7.20	11.19 to 11.26	110
23	12.0	13 22.8	-6.03	8.9	0.81	1.50	7.17	11.19 to 11.21	110
24	12.0	13 24.3	-6.28	8.9	0.81	1.50	7.15	Not Observable	109
25	12.0	13 25.8	-6.52	8.9	0.82	1.50	7.13	Not Observable	109
26	12.0	13 27.4	-7.16	8.9	0.82	1.50	7.10	Not Observable	108
27	12.0	13 29.0	-7.41	9.0	0.83	1.50	7.08	Not Observable	108
28	12.0	13 30.7	-8.05	9.0	0.83	1.49	7.06	Not Observable	108
29	12.0	13 32.3	-8.29	9.0	0.84	1.49	7.03	Not Observable	107
30	12.0	13 34.0	-8.53	9.0	0.84	1.49	7.01	Not Observable	107

Ephemeris for Comet P/McNaught-Russell 1993 v

Omega=353.4724 OMEGA=165.6601 i= 51.5944 q= 0.867609 a=136.530300
e=0.993645 P= 1595.304 T= 1994 March 31.0990
Magnitudes calculated from m= 9.1+5.0*Log(d)+17.0*Log(r)+0.000*Beta

May	1994			Times in GMAT			Positions for Epoch 1950		
Day	Time	R.A.	Dec	Mag	D	R	Trans	Observable	Elong
16	12.0	11 24.0	76.33	10.3	0.91	1.20	7.49	9.53 to 13.60	78
17	12.0	11 36.2	76.21	10.4	0.92	1.22	7.57	9.56 to 13.57	78
18	12.0	11 47.7	76.07	10.5	0.93	1.23	8.04	9.59 to 13.54	78
19	12.0	11 58.6	75.52	10.6	0.95	1.24	8.11	10.02 to 13.51	78
20	12.0	12 8.9	75.34	10.7	0.96	1.25	8.17	10.05 to 13.48	79
21	12.0	12 18.7	75.16	10.8	0.97	1.26	8.23	10.08 to 13.45	79
22	12.0	12 27.8	74.56	10.9	0.99	1.28	8.28	10.11 to 13.43	79
23	12.0	12 36.5	74.35	11.0	1.00	1.29	8.33	10.14 to 13.40	80
24	12.0	12 44.6	74.13	11.1	1.01	1.30	8.37	10.17 to 13.37	80
25	12.0	12 52.2	73.50	11.2	1.03	1.31	8.40	10.20 to 13.34	80
26	12.0	12 59.4	73.27	11.3	1.04	1.32	8.44	10.23 to 13.32	80
27	12.0	13 6.1	73.03	11.4	1.05	1.34	8.46	10.26 to 13.29	81
28	12.0	13 12.5	72.38	11.5	1.07	1.35	8.49	10.28 to 13.26	81
29	12.0	13 18.5	72.13	11.5	1.08	1.36	8.51	10.31 to 13.23	81
30	12.0	13 24.2	71.48	11.6	1.09	1.37	8.52	10.34 to 13.21	81
31	12.0	13 29.6	71.22	11.7	1.11	1.39	8.54	10.37 to 13.18	82

June	1994			Times in GMAT			Positions for Epoch 1950		
1	12.0	13 34.7	70.56	11.8	1.12	1.40	8.55	10.40 to 13.16	82
2	12.0	13 39.5	70.29	11.9	1.13	1.41	8.56	10.43 to 13.13	82
3	12.0	13 44.1	70.03	12.0	1.15	1.43	8.56	10.46 to 13.11	82
4	12.0	13 48.5	69.36	12.1	1.16	1.44	8.57	10.49 to 13.08	83
5	12.0	13 52.6	69.08	12.2	1.17	1.45	8.57	10.51 to 13.06	83
6	12.0	13 56.6	68.41	12.3	1.18	1.46	8.57	10.54 to 13.03	83
7	12.0	14 0.4	68.14	12.4	1.20	1.48	8.57	10.57 to 13.01	83
8	12.0	14 4.0	67.46	12.5	1.21	1.49	8.57	10.59 to 12.59	83
9	12.0	14 7.5	67.18	12.5	1.22	1.50	8.56	11.02 to 12.57	84
10	12.0	14 10.8	66.51	12.6	1.24	1.51	8.55	11.04 to 12.55	84
11	12.0	14 14.0	66.23	12.7	1.25	1.53	8.55	11.06 to 12.53	84
12	12.0	14 17.1	65.55	12.8	1.26	1.54	8.54	11.08 to 12.51	84
13	12.0	14 20.1	65.27	12.9	1.28	1.55	8.53	11.10 to 12.50	85
14	12.0	14 22.9	64.59	13.0	1.29	1.57	8.52	11.12 to 12.48	85
15	12.0	14 25.7	64.30	13.0	1.30	1.58	8.51	11.14 to 12.47	85
16	12.0	14 28.4	64.02	13.1	1.31	1.59	8.49	11.15 to 12.46	85
17	12.0	14 31.0	63.34	13.2	1.33	1.61	8.48	11.17 to 12.45	85
18	12.0	14 33.5	63.06	13.3	1.34	1.62	8.47	11.18 to 12.45	86
19	12.0	14 36.0	62.38	13.4	1.35	1.63	8.45	11.18 to 12.44	86
20	12.0	14 38.3	62.09	13.4	1.37	1.64	8.44	11.19 to 12.44	86
21	12.0	14 40.7	61.41	13.5	1.38	1.66	8.42	11.19 to 12.44	86
22	12.0	14 42.9	61.13	13.6	1.39	1.67	8.40	11.19 to 12.45	86
23	12.0	14 45.1	60.45	13.7	1.41	1.68	8.39	11.19 to 12.46	86
24	12.0	14 47.3	60.16	13.8	1.42	1.70	8.37	11.18 to 12.47	87
25	12.0	14 49.4	59.48	13.8	1.43	1.71	8.35	11.18 to 12.48	87
26	12.0	14 51.4	59.20	13.9	1.45	1.72	8.33	11.17 to 12.49	87
27	12.0	14 53.4	58.52	14.0	1.46	1.73	8.31	11.15 to 12.51	87
28	12.0	14 55.4	58.24	14.1	1.47	1.75	8.29	11.14 to 12.53	87
29	12.0	14 57.3	57.56	14.1	1.48	1.76	8.27	11.13 to 12.54	87
30	12.0	14 59.2	57.28	14.2	1.50	1.77	8.25	11.11 to 12.57	88

Ephemeris for Comet Takamizawa-Levy 1994 f

Omega= 61.6416 OMEGA=306.1751 i=132.8646 q= 1.359320 a=**********
e=1.000000 P=********* T= 1994 May 22.5420
Magnitudes calculated from m= 8.0+5.0*Log(d)+10.0*Log(r)+0.000*Beta

May Day	1994 Time	R.A.	Dec	Mag	Times in GMAT D	R	Positions for Epoch 1950 Trans	Observable	Elong
16	12.0	20 23.3	45.16	9.2	0.95	1.36	16.47	9.53 to 13.60	88
17	12.0	20 17.6	47.13	9.2	0.94	1.36	16.37	9.56 to 13.57	88
18	12.0	20 11.4	49.10	9.2	0.93	1.36	16.27	9.59 to 13.54	89
19	12.0	20 4.5	51.08	9.2	0.92	1.36	16.16	10.02 to 13.51	89
20	12.0	19 56.7	53.05	9.1	0.92	1.36	16.04	10.05 to 13.48	89
21	12.0	19 48.1	55.02	9.1	0.91	1.36	15.52	10.08 to 13.45	90
22	12.0	19 38.5	56.56	9.1	0.91	1.36	15.38	10.11 to 13.43	90
23	12.0	19 27.8	58.47	9.1	0.91	1.36	15.23	10.14 to 13.40	90
24	12.0	19 15.7	60.35	9.1	0.91	1.36	15.07	10.17 to 13.37	90
25	12.0	19 2.3	62.17	9.1	0.91	1.36	14.49	10.20 to 13.34	90
26	12.0	18 47.3	63.53	9.1	0.91	1.36	14.30	10.23 to 13.32	90
27	12.0	18 30.5	65.21	9.2	0.92	1.36	14.09	10.26 to 13.29	90
28	12.0	18 12.1	66.40	9.2	0.92	1.36	13.47	10.28 to 13.26	89
29	12.0	17 51.9	67.49	9.2	0.93	1.36	13.23	10.31 to 13.23	89
30	12.0	17 30.2	68.47	9.2	0.94	1.37	12.57	10.34 to 13.21	89
31	12.0	17 7.1	69.31	9.2	0.95	1.37	12.30	10.37 to 13.18	88

June Day	1994 Time	R.A.	Dec	Mag	Times in GMAT D	R	Positions for Epoch 1950 Trans	Observable	Elong
1	12.0	16 43.1	70.02	9.3	0.96	1.37	12.02	10.40 to 13.16	88
2	12.0	16 18.7	70.20	9.3	0.97	1.37	11.34	10.43 to 13.13	87
3	12.0	15 54.5	70.25	9.3	0.98	1.37	11.06	10.46 to 13.11	87
4	12.0	15 31.0	70.17	9.4	0.99	1.37	10.38	10.49 to 13.08	86
5	12.0	15 8.8	69.58	9.4	1.01	1.38	10.12	10.51 to 13.06	86
6	12.0	14 48.0	69.29	9.4	1.02	1.38	9.48	10.54 to 13.03	85
7	12.0	14 28.9	68.53	9.5	1.04	1.38	9.25	10.57 to 13.01	84
8	12.0	14 11.6	68.10	9.5	1.06	1.38	9.04	10.59 to 12.59	84
9	12.0	13 56.0	67.22	9.6	1.08	1.39	8.45	11.02 to 12.57	83
10	12.0	13 42.0	66.30	9.6	1.10	1.39	8.27	11.04 to 12.55	82
11	12.0	13 29.5	65.36	9.7	1.12	1.39	8.11	11.06 to 12.53	81
12	12.0	13 18.3	64.40	9.7	1.14	1.40	7.56	11.08 to 12.51	81
13	12.0	13 8.3	63.43	9.8	1.16	1.40	7.42	11.10 to 12.50	80
14	12.0	12 59.4	62.45	9.8	1.18	1.40	7.29	11.12 to 12.48	79
15	12.0	12 51.4	61.47	9.9	1.20	1.41	7.17	11.14 to 12.47	78
16	12.0	12 44.2	60.50	9.9	1.22	1.41	7.06	11.15 to 12.46	77
17	12.0	12 37.8	59.53	10.0	1.25	1.41	6.56	11.17 to 12.45	77
18	12.0	12 31.9	58.57	10.0	1.27	1.42	6.46	11.18 to 12.45	76
19	12.0	12 26.7	58.02	10.1	1.30	1.42	6.37	11.18 to 12.44	75
20	12.0	12 21.9	57.08	10.1	1.32	1.43	6.28	11.19 to 12.44	74
21	12.0	12 17.6	56.16	10.2	1.34	1.43	6.20	11.19 to 12.44	73
22	12.0	12 13.6	55.24	10.3	1.37	1.44	6.12	11.19 to 12.45	72
23	12.0	12 10.0	54.34	10.3	1.39	1.44	6.05	11.19 to 12.46	71
24	12.0	12 6.7	53.46	10.4	1.42	1.45	5.57	11.18 to 12.47	71
25	12.0	12 3.7	52.58	10.4	1.44	1.45	5.50	11.18 to 12.48	70
26	12.0	12 1.0	52.12	10.5	1.47	1.46	5.44	11.17 to 12.49	69
27	12.0	11 58.4	51.27	10.5	1.49	1.46	5.37	11.15 to 12.51	68
28	12.0	11 56.1	50.44	10.6	1.52	1.47	5.31	11.14 to 12.53	67
29	12.0	11 54.0	50.01	10.6	1.55	1.47	5.25	11.13 to 12.54	66
30	12.0	11 52.0	49.20	10.7	1.57	1.48	5.19	11.11 to 12.57	66

Ephemeris for Comet Takamizawa-Levy 1994 f (contd)

July		1994			Times in GMAT		Positions for Epoch 1950		
Day	Time	R.A.	Dec	Mag	D	R	Trans	Observable	Elong
1	12.0	11 50.2	48.40	10.7	1.60	1.48	5.13	11.09 to 12.59	65
2	12.0	11 48.5	48.01	10.8	1.62	1.49	5.08	11.07 to 13.01	64
3	12.0	11 46.9	47.23	10.8	1.65	1.49	5.02	11.05 to 13.04	63
4	12.0	11 45.5	46.46	10.9	1.67	1.50	4.57	11.03 to 13.06	62
5	12.0	11 44.2	46.10	10.9	1.70	1.51	4.52	11.01 to 13.09	61
6	12.0	11 43.0	45.36	11.0	1.73	1.51	4.46	10.58 to 13.08	61
7	12.0	11 41.8	45.02	11.0	1.75	1.52	4.41	10.56 to 12.56	60
8	12.0	11 40.8	44.29	11.1	1.78	1.53	4.36	10.53 to 12.43	59
9	12.0	11 39.8	43.57	11.1	1.80	1.53	4.31	10.51 to 12.32	58
10	12.0	11 38.9	43.26	11.2	1.83	1.54	4.27	10.48 to 12.20	57
11	12.0	11 38.1	42.56	11.2	1.85	1.55	4.22	10.46 to 12.09	56
12	12.0	11 37.3	42.26	11.3	1.88	1.55	4.17	10.43 to 11.59	56
13	12.0	11 36.6	41.57	11.3	1.90	1.56	4.12	10.41 to 11.49	55
14	12.0	11 36.0	41.29	11.4	1.93	1.57	4.08	10.38 to 11.39	54
15	12.0	11 35.4	41.02	11.4	1.95	1.57	4.03	10.35 to 11.29	53
16	12.0	11 34.8	40.35	11.5	1.98	1.58	3.59	10.32 to 11.19	52
17	12.0	11 34.3	40.10	11.5	2.00	1.59	3.54	10.30 to 11.10	52
18	12.0	11 33.9	39.44	11.6	2.03	1.60	3.50	10.27 to 11.01	51
19	12.0	11 33.4	39.20	11.6	2.05	1.60	3.46	10.24 to 10.52	50
20	12.0	11 33.1	38.55	11.7	2.08	1.61	3.41	10.21 to 10.43	49
21	12.0	11 32.7	38.32	11.7	2.10	1.62	3.37	10.19 to 10.34	49
22	12.0	11 32.4	38.09	11.7	2.12	1.63	3.33	10.16 to 10.26	48
23	12.0	11 32.1	37.47	11.8	2.15	1.63	3.29	10.13 to 10.17	47
24	12.0	11 31.9	37.25	11.8	2.17	1.64	3.24	Not Observable	46
25	12.0	11 31.6	37.03	11.9	2.19	1.65	3.20	Not Observable	45
26	12.0	11 31.4	36.42	11.9	2.22	1.66	3.16	Not Observable	45
27	12.0	11 31.3	36.22	12.0	2.24	1.67	3.12	Not Observable	44
28	12.0	11 31.1	36.02	12.0	2.26	1.67	3.08	Not Observable	43
29	12.0	11 31.0	35.42	12.1	2.28	1.68	3.04	Not Observable	42
30	12.0	11 30.9	35.23	12.1	2.31	1.69	2.60	Not Observable	42
31	12.0	11 30.8	35.04	12.1	2.33	1.70	2.56	Not Observable	41

Ephemeris for Comet Takamizawa 1994 i

Omega=191.6850 OMEGA= 50.4120 i=135.9980 q= 1.952140 a=**********
e=1.000000 P=********* T= 1994 June 28.8770
Magnitudes calculated from m= 7.0+5.0*Log(d)+10.0*Log(r)+0.000*Beta

May		1994			Times in GMAT		Positions for Epoch 1950		
Day	Time	R.A.	Dec	Mag	D	R	Trans	Observable	Elong
16	12.0	16 1.2	-7.01	10.1	1.03	2.02	12.26	9.53 to 13.60	166
17	12.0	15 54.3	-7.16	10.1	1.02	2.02	12.15	9.56 to 13.57	167
18	12.0	15 47.2	-7.31	10.1	1.02	2.02	12.04	9.59 to 13.54	168
19	12.0	15 40.1	-7.47	10.1	1.01	2.01	11.53	10.02 to 13.51	168
20	12.0	15 33.0	-8.02	10.1	1.01	2.01	11.42	10.05 to 13.48	168
21	12.0	15 25.8	-8.16	10.0	1.01	2.01	11.31	10.08 to 13.45	167
22	12.0	15 18.7	-8.31	10.0	1.01	2.00	11.20	10.11 to 13.43	165
23	12.0	15 11.5	-8.45	10.0	1.01	2.00	11.08	10.14 to 13.40	163
24	12.0	15 4.4	-8.59	10.0	1.01	2.00	10.57	10.17 to 13.37	161
25	12.0	14 57.3	-9.12	10.0	1.02	2.00	10.46	10.20 to 13.34	159
26	12.0	14 50.3	-9.25	10.0	1.02	1.99	10.35	10.23 to 13.32	157
27	12.0	14 43.3	-9.37	10.0	1.03	1.99	10.24	10.26 to 13.29	155
28	12.0	14 36.5	-9.49	10.1	1.03	1.99	10.14	10.28 to 13.23	153
29	12.0	14 29.7	-10.01	10.1	1.04	1.99	10.03	10.31 to 13.11	150
30	12.0	14 23.1	-10.12	10.1	1.05	1.98	9.52	10.34 to 12.58	148
31	12.0	14 16.7	-10.22	10.1	1.06	1.98	9.42	10.37 to 12.46	146

Ephemeris for Comet Takamizawa 1994 i (contd)

June		1994			Times in GMAT		Positions for Epoch 1950		
Day	Time	R.A.	Dec	Mag	D	R	Trans	Observable	Elong
1	12.0	14 10.4	-10.32	10.1	1.07	1.98	9.32	10.40 to 12.34	143
2	12.0	14 4.2	-10.42	10.1	1.08	1.98	9.22	10.43 to 12.21	141
3	12.0	13 58.2	-10.51	10.2	1.10	1.98	9.12	10.46 to 12.10	139
4	12.0	13 52.4	-10.59	10.2	1.11	1.97	9.02	10.49 to 11.58	136
5	12.0	13 46.7	-11.07	10.2	1.13	1.97	8.52	10.51 to 11.46	134
6	12.0	13 41.3	-11.15	10.2	1.14	1.97	8.43	10.54 to 11.35	132
7	12.0	13 36.0	-11.22	10.3	1.16	1.97	8.34	10.57 to 11.23	130
8	12.0	13 30.9	-11.29	10.3	1.17	1.97	8.25	10.59 to 11.12	128
9	12.0	13 25.9	-11.36	10.3	1.19	1.97	8.16	Not Observable	126
10	12.0	13 21.2	-11.42	10.3	1.21	1.96	8.07	Not Observable	124
11	12.0	13 16.6	-11.49	10.4	1.23	1.96	7.59	Not Observable	122
12	12.0	13 12.2	-11.54	10.4	1.25	1.96	7.50	Not Observable	120
13	12.0	13 7.9	-12.00	10.4	1.27	1.96	7.42	Not Observable	118
14	12.0	13 3.9	-12.06	10.5	1.29	1.96	7.34	Not Observable	116
15	12.0	12 60.0	-12.11	10.5	1.31	1.96	7.26	Not Observable	114
16	12.0	12 56.2	-12.16	10.5	1.33	1.96	7.18	Not Observable	113
17	12.0	12 52.6	-12.21	10.6	1.35	1.96	7.11	Not Observable	111
18	12.0	12 49.2	-12.26	10.6	1.37	1.96	7.04	Not Observable	109
19	12.0	12 45.9	-12.30	10.6	1.39	1.96	6.56	Not Observable	107
20	12.0	12 42.7	-12.35	10.7	1.42	1.95	6.49	Not Observable	106
21	12.0	12 39.6	-12.40	10.7	1.44	1.95	6.42	Not Observable	104
22	12.0	12 36.7	-12.44	10.7	1.46	1.95	6.35	Not Observable	103
23	12.0	12 33.9	-12.49	10.8	1.48	1.95	6.29	Not Observable	101
24	12.0	12 31.3	-12.53	10.8	1.51	1.95	6.22	Not Observable	100
25	12.0	12 28.7	-12.58	10.8	1.53	1.95	6.15	Not Observable	98
26	12.0	12 26.3	-13.02	10.9	1.55	1.95	6.09	Not Observable	97
27	12.0	12 23.9	-13.06	10.9	1.58	1.95	6.03	Not Observable	95
28	12.0	12 21.7	-13.11	10.9	1.60	1.95	5.57	Not Observable	94
29	12.0	12 19.6	-13.15	11.0	1.62	1.95	5.51	Not Observable	92
30	12.0	12 17.5	-13.19	11.0	1.65	1.95	5.45	Not Observable	91

Comet charts for 1993c, 1993v, 1994f & 1994i

The charts opposite are produced using *Voyager II* (Carina Software). They show the paths of the four comets which appear conveniently as pairs in two parts of the sky. The paths start in mid May and end in early July, with marks (√) every five days and dates every ten.

1993v & 1994f: The comets come within 20' near noon on June 9.

1993c & 1994i: 1994i is about 2° from Jupiter (marked ♃) on June 1 & 2.

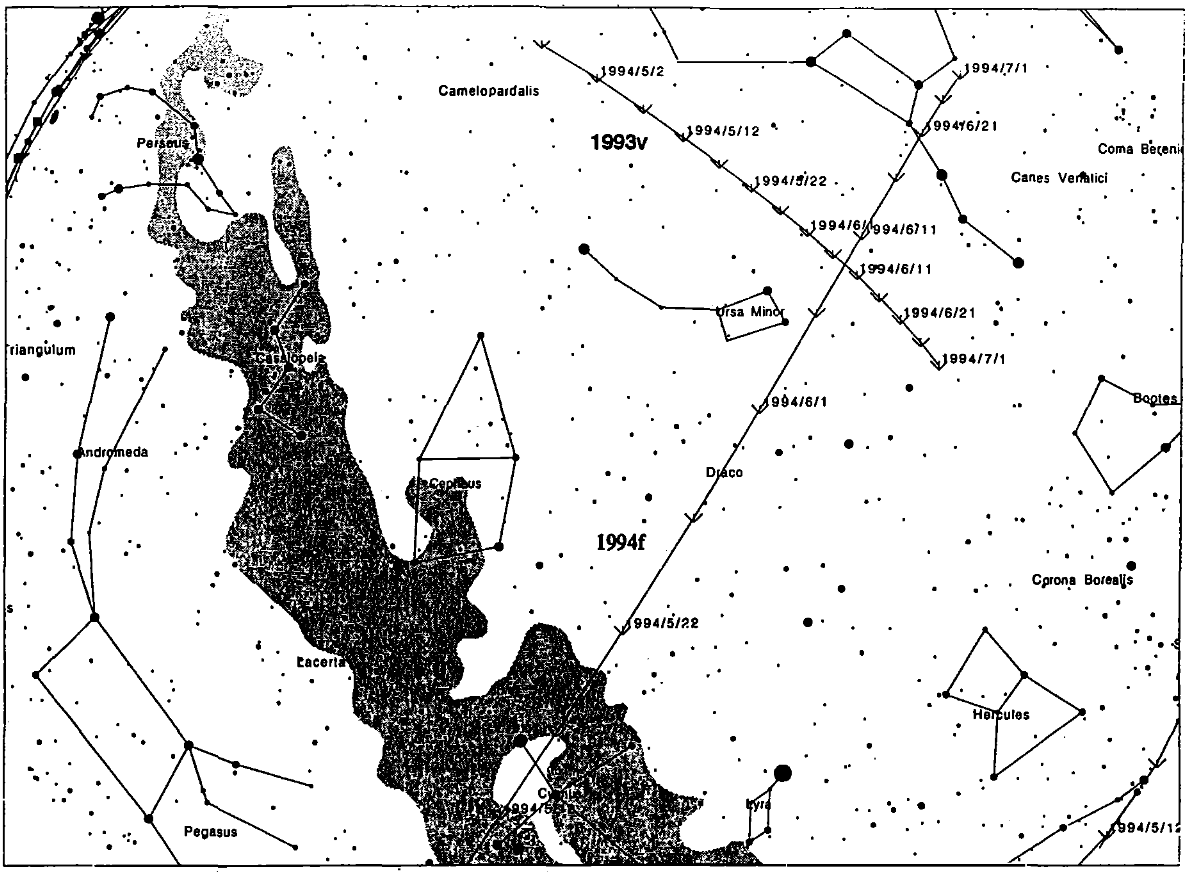
STOP PRESS: Comet McNaught-Russell (1993v) has declined in brightness since about ten days after perihelion, the magnitude now following:

$$m = 9.1 + 5.0 \log d + 17.0 \log r$$

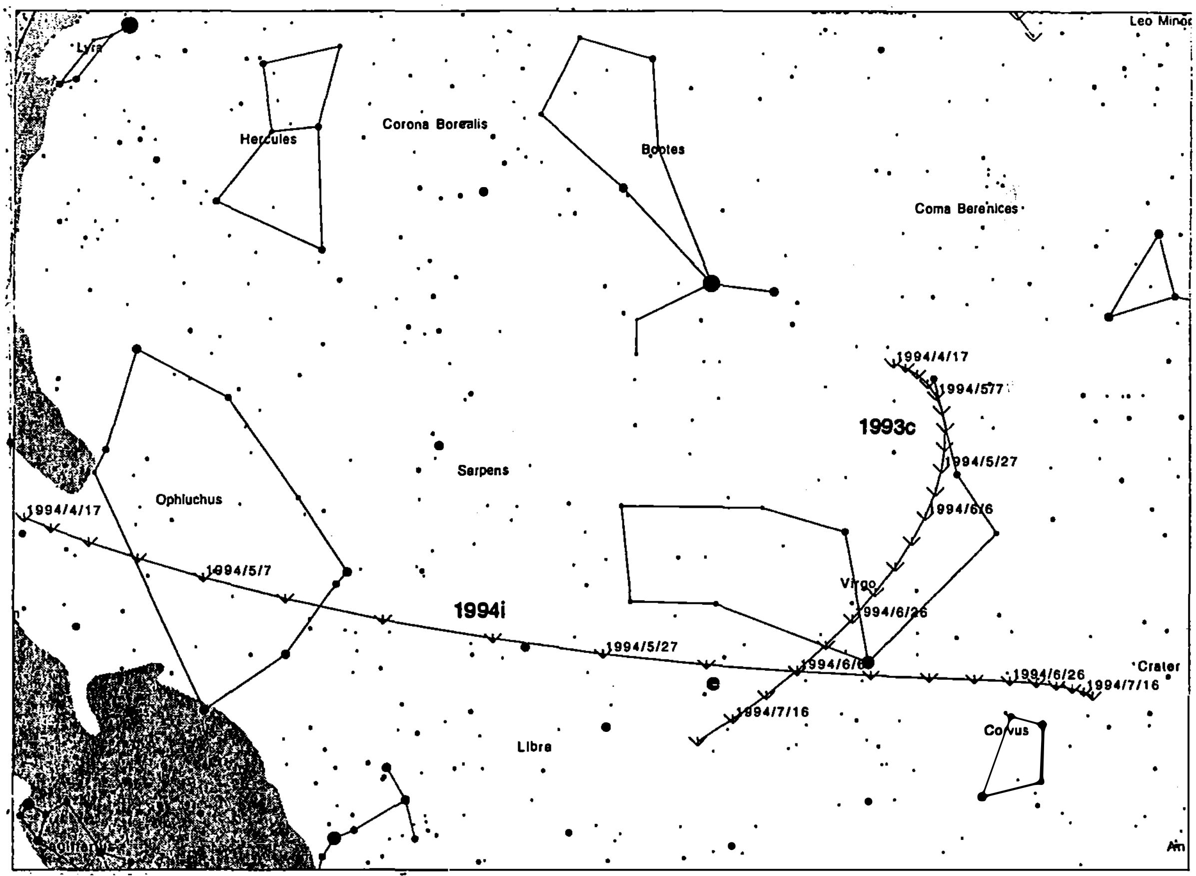
which means that the comet will probably not be seen after the end of May.

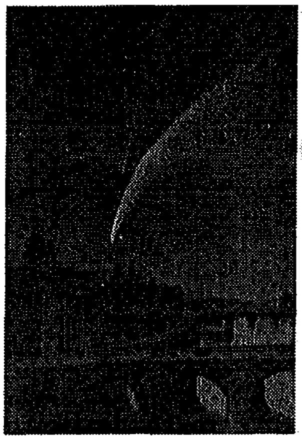
There is a copy of the new report form following the charts. By all means use up copies of the old form, but do photocopy the new form for you own use later.

Comets 1993v & 1994f



Comets 1993c & 1994i





THE COMET'S TALE

Newsletter of the **Comet Section** of the **British Astronomical Association** 1994 Nov

The collision between Shoemaker-Levy 9 and Jupiter

David W. Hughes, Department of Physics, The University, Sheffield

NEVER before in the history of astronomy have we been able to predict when two solar system bodies would collide and then sit back and witness the event nearly a year and a half later. During 1994 July 16–22 twenty or so fragments of the Jovian cometary satellite Shoemaker-Levy 9 hit Jupiter. The comet came off worse.

Last days of the comet! ESO's view of the gravitationally-elongated dust comae (lower right) against scattered light from Jupiter.

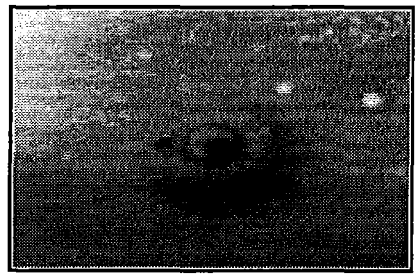
A global network of ground-based observatories and a small armada of spacecraft (Hubble Space Telescope, Galileo, Voyager-2 and Ulysses) observed the event. It was the largest concerted observational programme ever embarked upon in the history of astronomy. Before July astronomers see-sawed between predicting that little would be seen and foretelling a celestial spectacular.

In fact much was seen, but very little was learnt. If you want to learn about comets it is clear that smashing them to smithereens with a planetary hammer moving at 60 km s^{-1} and then violently stirring the bits into a swirling cloudy atmosphere, is not a good experimental plan. And if you want to do cosmic physics, by inputting a specific amount of material and energy into the Jovian atmosphere it helps if you have a good idea as to the amounts in question.

This, unfortunately, was not the case. Such fundamental quantities as fragment size, density and mass were unknown.

Cometary nuclei are dirty snowballs and not rocky ice-balls. Cometary experts guess that their densities are around 200 kg m^{-3}. An analysis of the way in which the comet split apart as it passed inside Jupiter's Roche limit indicated that the diameter of the precursor was about 1 km. So the biggest fragment was probably about 0.25 to 0.5 km across. Thus the maximum fragment impact was between about 3 x 10^{18} and 2 x 10^{19} J (36,000 to 300,000 "Hiroshima" bombs).

In mid-July it was soon realised that the intensity of the impact phenomena was only roughly related to the pre-impact brightness of the incoming cometary fragment. The cometary string consisted of fragments A, C, D, E, G, H, K, L, Q, R, S, U, V and W which were on a straight line and fragments B, F, N, P, and T which were off this axis. Fragments G, H, K, Q and S were very bright, E, L and R were bright, A, B, C, F and T were of medium intensity and D, N, M, U and V were faint. Fragment A produced a bright impact signature whereas fragment B's impact resulted in



Hubble image of impact site G (with earlier site D to left) on July 18.

an almost undetectable blemish. Fragments that were off the axis of the main "string of pearls" were complete flops. They were probably dust clouds not solid fragments.

All the impacts occurred at a Jovian latitude of -44°. They also hit the side of Jupiter that was facing away from both the Earth and the Sun. The comet path was inclined at 45° to the Jovian cloud layers. *continued on page 3*

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Editorial

Many thanks for your kind comments relating your satisfaction with your new-look newsletter. Do keep in touch by letter or e-mail with any thoughts and, in particular, any articles or observing notes, or general illustrative material!

Computer technology changes so quickly that not only is it hard for one to keep up-to-date, but that very dynamism forces one to continually adapt. Owing to this, I have had to use a different desk-top publishing package to produce this issue. I hope this program (if not the version number!) will be around for some time. So there are necessarily some (hopefully) minor changes in design and layout.

I have consequently been rather busy at the production stages, and I must thank all the contributors. Those articles and images (mostly arriving in electronic form) have saved me hours at the keyboard and also many trips to libraries in search of content for this issue. I have been able to devote my time to actually *editing* the newsletter!

On to observational matters. No sooner had my charts appeared in May showing the prospect of four comets over the summer than some of these comets started to fade and become more diffuse. I can accept responsibilty only for terrestrial matters I'm afraid!

The summer, though, was notable for split comets: in addition to Shoemaker-Levy 9, comets 1994o and 1994g displayed several components. I saw two of the components of 1994o – how many did you see?

I have avoided any mention thus far of the great comet crash, when SL9's fragments impacted Jupiter during the third week of July. This is for numerous reasons.

First, amateurs *were* rewarded by an amazing sight of *Jupiter's* southern hemisphere pock-marked with dark impact scars, but this newsletter is not the place to discuss *those*.

Secondly, the leading article by Dr David Hughes is on this very subject, and he is more competent that I to deal with the theoretics involved.

And thirdly, much analysis of the vast amounts of data from every observatory on Earth remains uncompleted, after which the interpretation will no doubt change drastically our perspectives on comets and on planetary atmospheres. But this process will take months, if not years to complete. So we are now in transit, a knowledge *interregnum* if you like, from one set of models to the next, and I believe that unfounded speculation during this period is undesirable.

Having said that, some professional astronomers have met already at conferences, notably at the International Astronomical Union, at the Hyper-velocity Impact Symposium and at the Division of Planetary Sciences of the Association of Lunar and Planetary Observers. ESO will hold a meeting in the New Year.

For amateur astronomers, particularly in Europe, the Planetary Observers in Germany invite you to MEPCO '95 – see details elsewhere.

The comet and Jupiter sections of the BAA are meeting on Saturday, 1995 March 18 in Cambridge for a full day's discussion of the SL9 event. Again, details are given elsewhere and I hope that you will be able to attend.

The UK weather since the summer has been rather autumnal(!), with frontal systems following each other across the Atlantic and hardly any clear observing sky in between. There have been odd clear nights but these seem to have occured around Full Moons, so the few comets have simply been drowned out.

The prospects for 1995 aren't too good at the moment – see Jonathan's article. Observers with a CCD should try to follow P/Schwassmann-Wachmann 1 and note any outbursts.

Finally, if you haven't sent any sub to Jonathan then this will be your last issue until he has your £3 (for those active) or £5 (for others) to cover two years.

Once again, may I urge you to read, subscribe and contribute!

James Lancashire

The collision between Shoemaker-Levy 9 and Jupiter

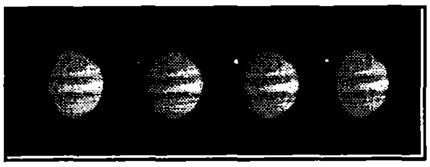
continued from page 1

Meteors and fireballs provide the best clue to the impact process. In the Earth's atmosphere a meteoroid starts ablating at a pressure of 10^{-7} bar. The lower molecular weight of the hydrogen and helium in Jupiter's atmosphere causes ablation to start at around 10^{-6} bar. The only "observed" Earth-comet impact was Tunguska. Here the comet blew up 8.5 km above the Earth's surface, where the pressure was 0.1 bar. In the Jovian case we multiply by a factor of ten (owing to the atmospheric constituents) and by another factor of ten for the additional mass of the impactors. The comet explosion thus occurs at a pressure of 10 bar, i.e. above Jupiter's clouds.

Each bit of Shoemaker-Levy 9 was expected to break up when the differential dynamic pressure across the fragment exceeded the tensile strength. When this happened the surface area of the ablating comet increased by a huge amount, the deceleration increased enormously and the comet dumped all its remaining energy more or less instantaneously. This produced a "hydrogen bomb" type explosion. Material was blown way above the Jovian cloud layers, and then fell back under gravity after a few minutes. The observation of this short-lived material plume signalled "friable comet". A stronger asteroidal fragment would not have undergone this explosive deceleration process.

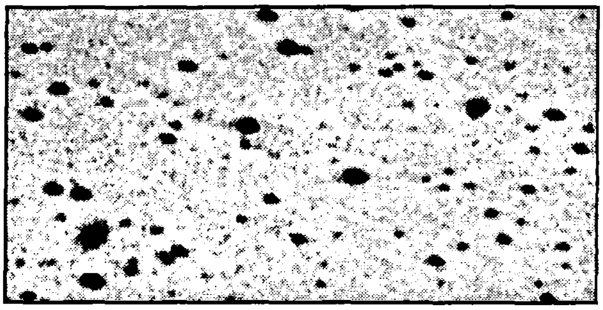
What was seen

(1) The fireball flash at the instance of impact was only imaged by the Galileo Spacecraft. Impacts L and W were spectacular. All the impacts occurred on the Jovian face pointing away from Earth, but as Jupiter rotates every 10 hours the site soon came into view.



Galileo's direct view of impact W over 7 s on 1994 July 22: the impact occurs just round the limb as seen from Earth, on Jupiter's 'dark side', at latitude 44° south (top here)

(2) The plume, the short-lived "H bomb like" cloud that rose and then fell back, was seen by the Hubble Space Telescope. In the case of the G impact the gas went up to a height of at least 3000 km (remember that Jupiter has a radius of 71,300 km) and fell back in about 18 minutes.



A remarkable amateur view of SL9: David Strange's image on 1994 March 17 taken with a Starlite Xpress CCD attached to a 20-inch f/4 Newtonian using ten 80 s exposures. The galaxy IC 4476 is tto the bottom left

(3) The expanding meteor train was easily observed (much more easily than expected). Here the highly energetic cometary material mixes with, excites, and warms up the jovian material. Dilution occurs extremely rapidly. As the cometary atoms and ions have an initial velocity of 60 km s^{-1}, their random walk away from the impact track means that within minutes they have mixed with many thousand times their own mass of Jovian material. A comet moving at 60 km s^{-1} has an equivalent "temperature" of 2,500,000 K. Within tens of minutes this has dropped to temperatures that are best detected in the near and far infra-red.

The expanding meteor train could be seen as a scar in the Jovian south-south temperate zone at latitude near 44° south. On average there was a hit every 7 hour and after a time this zone became a confused battle-field. For example F hit the E impact site; D, G and S ploughed into the same region; and W merged with K.

The spectral signature from the cooling impact region was dominated by methane. Visually the scars were dark whereas in the infrared they were bright. At visual wavelengths the train cloud region had a reflectivity that was lower than the underlying Jovian clouds. As time passed the train clouds sank, became assimilated by the normal clouds and disappeared from view. In the infrared K band at 2.2 microns the impact site shone like a beacon against the dark cold surface of Jupiter.

The Kuiper Airborne Observatory detected C_2H_2 (acetylene), C_2H_6 (ethane) and water vapour. The JCMT on Hawaii observed CO and HCN. S_2 and CS_2 and NH_3 have been seen in the UV. These molecules and radicals came from both the disruption of the comet and the Jovian ammonium hydrosulphide and ammonium clouds.

(4) cometary remnants. The pre-impact comet was a dirty snow-ball with an internal temperature of typically 140 K. Its 60 km s^{-1} impact with Jupiter released sufficient energy to completely atomise the material and excite the atoms. Any dust left over was expected to be a very small fraction of the initial dust content. The vast majority of the dust mass was smashed into excited atoms of Ca, Na, Fe, Mg, Si and O. The Intermediate Dispersion Spectrograph on the Isaac Newton Telescope showed a profusion of metal lines when the fresh meteor trains were observed.

Needless to say it is very difficult to vapourise all the dust. A cometary fragment of 0.5 km diameter contains about 4 x 10^9 kg of dust. If only one part in a million remains you are still sprinkling 4 tonnes of dust into the Jovian cloud layer, and this dark dust could produce a dark expanding cloud.

The cometary snow is mainly H_2O. For every twenty water molecules there is one carbon dioxide. Again only a small percentage of the cometary molecules survive the impact. Just try hitting water and carbon dioxide with a 60 km s^{-1} hammer. The usual end-product is very excited H, O and C.

The plasma in the meteor train contained many electrons. Some of these spiralled off along Jovian field lines. Their subsequent deceleration produced decimetric radio emissions.

Section news from the Director

Dear Section member,

Comet Shoemaker-Levy 9 has now killed off the Jovian dinosaurs, but we're still not sure if it was really an icy comet or a pulverised asteroid. What is clear is that there is a wide range of different types of bodies in the outer solar system, some of which turn into fully fledged comets. In many cases it will be amateur observations that will help to elucidate their nature, so keep sending in your observations. As you will see elsewhere in the newsletter we are going to have a meeting to discuss the comet next March, by which time some of the scientific results should have been announced. The MEPCO meeting also promises to be a worthwhile forum for discussion, with the star attraction of Gene Shoemaker.

In the past six months observations or contributions have been received from the following BAA members:

Sally Beaumont, Denis Buczynski, Werner Hasubick, Paul Howarth, Guy Hurst, Nick James, David Keedy, James Lancashire, Brian Manning, Glyn Marsh, Oernulf Midtskogen, Martin Mobberley, Bob Neville, Roy Panther, Jonathan Shanklin, Melvyn Taylor and Alex Vincent

and also from:

John Bortle, Eric Broens, Paul Camilleri, Matyas Csukas, Vidican Dan, Alfons Diepvens, Bjorn Granslo, Roberto Haver, Graham Keitch, Atilla Kosa-Kiss, Martin Lehky, Antonio Milani, Herman Mikuz, Alfredo Pereira, Richard Schmude, David Seargent, Chris Spratt, Tonny Vanmunster and Vittorio Zanotta;

and of comets:

P/Encke, P/Schwassmann-Wachmann 1, P/SchwassmannWachmann 2, Mueller 1993a, P/Tempel 1 1993c, P/Shoemaker-Levy 9 1993e, P/Reinmuth 2 1993g, P/Hartley 3 1993m, P/West-Kohoutek-Ikemura 1993o, Mueller 1993p, P/McNaughtRussell 1993v, P/Kushida 1994a, Takamizawa-Levy 1994f, Takamizawa 1994i, P/Brooks 2 1994j, P/Borrelly 1994l, Nakamura-Nishimura-Machholz 1994m, Machholz 2 1994o and Machholz 1994r.

Briefly looking at the comets observed since the last newsletter came out: **1993v** faded rapidly after mid May and was last seen in mid June when it was 12^m. **1994f** reached a peak brightness of 8^m in early June. Observations continued until mid July by which time it had faded to nearly 11^m. **1994i** reached 9.5^m, though observations are rather scattered. The last observations put it near 12^m in early July. Comet Borrelly, **1994l**, is not quite living up to initial expectations and has only reached 8.5^m, which is consistent with $H_{15} = 7.0^m$, similar to that recorded at the last apparition in 1987, suggesting that the high *r* coefficient used elsewhere may be an artifact. It has shown an interesting anti-tail as it crosses through the nodal plane. If it continues with a 15 log *r* behaviour it should be 8^m throughout November, and will then slowly fade into the new year.

1994m was well observed and a full report will appear in the Journal in due course. It was around 9.5^m when discovered in early July and peaked at around 8^m. It became steadily more diffuse and was last seen in mid September at 10^m. **1994o** was a curious object which split into several components, though it seems likely that the major components (A and D) separated some time ago. Its position in the morning sky discouraged many observers, though it was interesting to see two comets in the same field. It peaked at around 7^m in early September and it was around 9.5^m in mid October after which it was too far south for UK observation. **1994r** was the third Machholz discovery of the year which puts him ahead of David Levy with nine visual discoveries, but still behind Anton Mrkos (11) and Bill Bradfield (16). It is a diffuse 11^m object and is unlikely to become any better.

I have completed reports on:

- The Analysis of Comets,
- Comet Levy 1990c, and
- Comet Shoemaker-Levy $1991a_1$

which have been accepted for publication in the Journal and also on the comets of 1990 which has just been submitted to the Papers Secretary.

Prospects for comets in 1995 appear elsewhere in the newsletter, and will also appear in the Journal as the readership of the two publications is slightly different. Further papers on the history of the BAA comet section and on the measurement of DC have been submitted to the ICQ; the former appeared in the October issue and the latter will appear in January. The measurement of DC is not at all consistent, despite the apparent consensus reported in the last issue. It turns out that Charles Morris, John Bortle and myself are all using different interpretations. For the moment continue to use the interpretation given in the last issue and I hope to report the final word next time.

Whilst preparing the report on the comets of 1990 I found a distinct lack of drawings and photographs in the section archives. Please make sure that you submit copies of any worthwile photographs and drawings directly to me, so that I can illustrate future articles. If you have material from 1950–1990 which has never been submitted, do send it in to me, as sooner or later I hope to do reports on the archival observations. The priority will be to complete reports on periodic comets that have been observed several times by section members.

The comet section *Keedy award* for 1993 has been awarded to **Atilla Kosa-Kiss** from Romania, who has been contributing comet observations to the section for several years. He lives in a small town on the border with Hungary and has been an observer for over 24 years. He graduated from a hydrometeorological college in 1975 and is a technologist in a water treatment works. He has published about 200 papers on his observations in various magazines and journals. The 1994 award goes to **James Lancashire** for his excellent work in producing this newsletter. This is an annual award and you can submit nominations at any time; if anyone has suggestions for the 1995 award please let me know.

As a new service I can obtain copies of two American publications for BAA members. The CBAT 9th Catalogue of Cometary Orbits is available for £21 in book form, £35 by e-mail and £75 on floppy disc. Subscription to the *International Comet Quarterly* (comet observations, occasional articles, charts, predictions and an annual handbook which gives elements and ephemerides for all comets due to return during the year) costs £25 for 4 issues (or £15 by surface mail); if enough members want to subscribe it will be possible to offer a reduction on this to £21 (£12 by surface mail). Group subscription has to have at least five subscribers and they must all subscribe at the same time. The handbook by itself costs £12. Please contact me if you are interested in subscribing; if there is sufficient interest I will send in a group subscription in April.

I will be away visiting the Antarctic again from mid-December to late-March (and will probably miss the section meeting). During this time any urgent correspondence should be sent to James Lancashire, and observations should go to Guy Hurst as usual. I hope to continue with data entry from the archives whilst I'm away and will also complete formatting the data from 1991 and 1992 which I've had scanned from *TA*. This should enable me to complete reports on all the comets from these years, so you may find rather a glut of comet papers in the Journal!

Best wishes,

Jonathan Shanklin

Michael Philip Candy M.Sc, FRAS (1928–1994)

Mike Candy and his comet-seeker taken shortly after the discovery of comet Candy (photograph 78 in* BAA Memoir *Vol 42 part 2* The Second Fifty Years*)

MEMBERS will be sorry to hear that Mike Candy died on 1994 November 2. He collapsed at work in Perth, Australia, with a brain haemorrhage and never regained consciousness. We offer our sympathy to his family and friends.

Michael Candy was born on 1928 December 23 and elected to the BAA on 1950 November 29. His main interest was in comets and meteors and as well as being an active observer he was adept in computing ephemerides and orbits for newly-discovered comets. Before electronic calculating was available, log tables or hand-cranked calculating machines had to be used and this involved the burning of much midnight oil.

Dr Gerald Merton was Director of the BAA Comet Section when the first few observations of comet Arend-Roland came to hand in 1956 November. Candy quickly computed a preliminary orbit. This was followed by an accurate orbit which he described at the Association's meeting on 1957 March 27. Candy was the first to see the comet after perihelion from this country, on the evening of April 20. He was appointed Assistant Director of the Section four days later.

Mike Candy was a professional astronomer at the Royal Greenwich Observatory, then at Herstmonceux Castle, Hailsham, Sussex and amongst other things observed double stars with the 28-inch refractor. He also worked with the 13-inch astrographic telescope on occasion.

Upon Gerald Merton's retirement from the directorship in 1958 April, Candy was appointed to run the Section and edit the BAA Circulars, which he did with great enthusiasm until the end of 1967 when he left the RGO to take up an appointment at the Perth Observatory, Bickley, Western Australia. He remained in Australia and continued to take an active part in study of the smaller bodies of the Solar System for the rest of his life.

During his term as Director, Mike Candy greatly encouraged both established Section members and newcomers. He had a friendly manner and was always approachable. He found time to reply to all letters and acknowledged observations, usually by postcard, in his own clear hand, adding useful bits of information or an extended ephemeris.

On 1960 December 28 Candy was testing an eyepiece in his 5-inch short focus refractor (a comet-seeker made for him by Horace Dall). Observing from an upstairs window at his home in Hailsham he discovered comet Candy 1961 II, then about 8th magnitude and in Cepheus. Although he undertook searches for new comets after that, this was to be his only discovery.

In addition to his observational work Candy also did much work on periodic comet orbits and on the orbits of meteor streams.

In later years Mike Candy was much involved in the world-wide effort to obtain accurate astrometric data for the 1986 return of Halley's Comet. The official IHW records show that Perth Observatory reported the highest number of positions of any station, 538 in number, of which Candy was personally involved in obtaining 412.

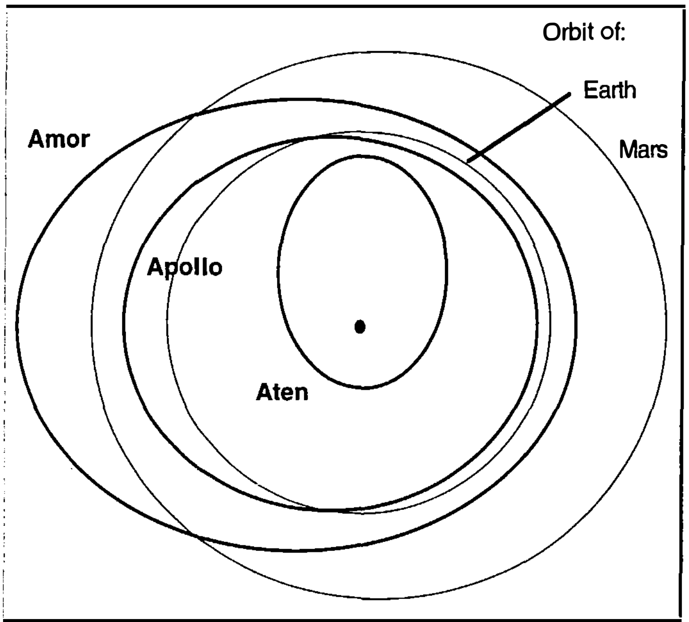
Many of us had not seen Mike for nearly thirty years but we can remember the time when he was active in the BAA Comet Section with pleasure. He was enthusiastic, energetic, helpful and had a good sense of humour. He made us feel that a foot or two of snow was no excuse for missing an observation. There were some good comets around and their study had yet to become quite respectable amongst professional astronomers. Mike Candy personally did much to make it a memorable time for us to be observing comets.

Mike Hendrie

Near Earth Objects

APART from the main asteroid belt between the orbits of Mars and Jupiter which contains many minor planets, there are hundreds of small bodies orbiting the Sun farther in and away. Some come near to the Earth and are known as Near Earth Objects (NEOs).

There are three classes of NEO: Amor, Apollo and Aten. The orbits of **Amor** asteroids cross the orbit of Mars, but do not come inside that of the Earth; **Apollo** asteroids come inside the orbit of the Earth; and the **Aten** asteroids stay mainly inside the orbit of the Earth.



Typical orbits of three classes of Near Earth Objects

Some of these objects are no more than about 6 or 9 m in diameter and one of them known as 1991 BA flew past the Earth on 1991 January 18 at a distance of only 171,000 km – less than half the Moon's distance. It is quite likely that some of the large meteorites on Earth may well have been one of these smaller Near Earth Objects before plunging into our atmosphere.

It is possible that these Near Earth Objects are the nuclei of extinct comets which have used up all their volatiles. A comet is a mixture of ice and dust and on each orbit it loses a vast amount of material, particularly as it passes through perihelion. Eventually, once its volatiles are gone, only the nucleus will be left. Thus nothing remains of the comet but a large lump of rock.

When some comets (for example P/Schwassmann - Wachmann 1) are quiescent, they have the colour and brightness of RD asteroids, whilst other comets such as Arend-Rigaux resemble S-type asteroids when quiescent. When these comets have used up all their volatiles, they will not be distinguishable from asteroids. Comet Arend-Rigaux is on its way to becoming an asteroid.

Asteroid No 3200 "Phaethon", discovered in 1983, approaches the Sun at a distance of only 21,000,000 km (0.14 AU) at perihelion and goes out to 295,000,000 km (1.97 AU) at aphelion. It is 5 km in diameter and has a revolution period of 522 days. It shares the orbit of the Geminid meteor stream which peaks in December every year.

It has always been known that meteor streams are associated with comets, for example the Perseids with comet Swift-Tuttle, but the Geminids seem to be associated with an asteroid. This may explain why the Geminid meteoroids are more dense than those associated with comets which are more fluffy in nature. It could be due to the asteroid crumbling away or even the crumbling nucleus of an extinct comet. The Geminids may have been more fluffy in the past.

Some of the sporadic meteors which are not members of any showers may be associated with NEOs. A large stream of these objects may be orbiting the Sun in the inner Solar system

Asteroid No 4015 discovered by Eleanor Helin in 1979 is identical with Comet Wilson-Harrington which was discovered in 1949. The period of this comet is now calculated to be 4.3 years, but it was cometary only at its discovery. So it seems that some of these near Earth objects are the nuclei of dead comets and the author suggests that they be termed "cometoids".

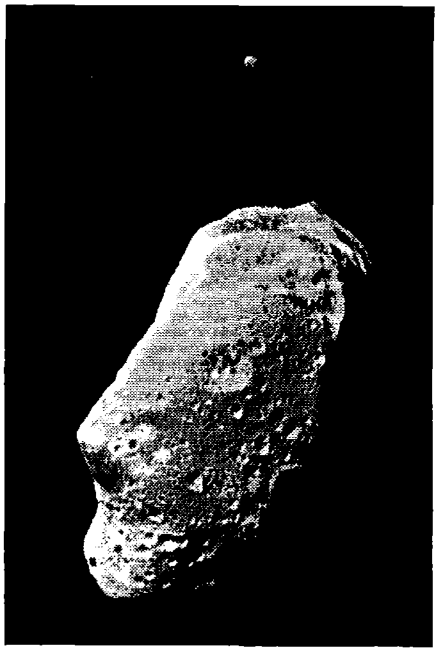
Some of the NEOs may be fragments of a comet or comets which broke up, as in the case of Comet Biela. Some comets may have fragmented, which may have occurred at (or near) their perihelion passage or during a close encounter with a planet like Jupiter. Some asteroids orbit the sun in a comet-like fashion, for example Icarus, Adonis, Hidalgo and Oljato, and are probably ex-comets.

The spacecraft Clementine which has been photographing the Moon is due to fly past and photograph a Near Earth object called Geographos. This would have been the first to be looked at close range but the spacecraft's motors failed. Clementine would have approached Geographos to within 100 km on 1994 August 31. Geographos lies 122,000,000 km from the Sun at perihelion and 243,000,00 km at aphelion.

Plans have been made for spacecraft to visit other near Earth objects in the near future. If these NEOs are extinct or dormant comets then the probes may reveal a dark object resembling a cometary nucleus. The probes may also reveal some other cometary material such as ice, gases, dust and other volatiles which these near Earth objects may still retain.

Alex Vincent

Galileo's view of Ida with Dactyl



IAU resolution on the designation of comets

THE FOLLOWING resolution concerning designations and names of comets was adopted by the International Astronomical Union at its General Assembly in The Hague on Aug. 24:

1. Commission 20 of the IAU, considering that:

(a) there is essentially a 1:1 correspondence between the provisional (year/letter) and definitive (year/Roman numeral) designation systems for comets;

(b) the procedure for interpolating old discoveries of comets into the existing designation systems is unsatisfactory, particularly when orbit determinations are not available;

(c) the application of a new designation at each return of a periodic comet to perihelion is an unnecessary complication, particularly when the comet's recovery can be described as "routine", or for the rapidly increasing number of periodic comets that are followed all around their orbits; and

(d) there can be confusion whether a newly-discovered object is a comet or a minor planet,

proposes to replace the present designation systems for comets with a system that closely resembles, but is not identical to, the designation system for minor planets.

2. Specifically, it is resolved that the year/letter and year/Roman numeral systems be replaced by one in which each cometary discovery is given a designation consisting of the year of observation, the upper-case code letter identifying the halfmonth of observation during that year according to the procedure used for minor planets, and a consecutive numeral to indicate the order of discovery announcement during that halfmonth. Each new designation shall be supplied by the IAU Central Bureau for Astronomical Telegrams when the discovery is announced in one of its Circulars. For example, the third comet reported as discovered during the second half of February 1995 would be designated 1995 D3.

3. The nature of an object can further be indicated by an initial prefix. In particular, such prefixes should be applied in cases where comets have possibly been mis-designated as minor planets, or *vice versa*. If necessary, the prefix A/ would precede a comet designation that actually refers to a minor planet (or asteroid). For comets the acceptable prefixes are P/ for a periodic comet (defined to have a revolution period of less than 200 years or confirmed observations at more than one perihelion passage) and C/ for a comet that is not periodic (in this sense), with the addition of X/ for a comet for which a meaningful orbit can not be computed and D/ for a periodic comet that no longer exists or is deemed to have disappeared.

4. If a comet is observed to return (or have its periodicity established by observation through aphelion or from identifications), the P/ (or D/) shall be preceded by an official sequential number (e.g., 1P/1682 Q1 = Halley), the list to be maintained by the Minor Planet Center and published in the Minor Planet Circulars. Subsequent recoveries shall be acknowledged with further designations only when the predictions are particularly uncertain.

5. The practice of providing future predictions for the returns to perihelion of all periodic comets for which there is a reasonable chance of future observations will continue. While this currently means, for example, the publication of predictions for the comets for the year *n* in the batch of Minor Planet Circulars for May of the year *n* – 3, the elements being for the 40-day date closest to perihelion passage, it is to be expected that this process will be supplemented – and perhaps eventually supplanted – by one that provides the orbital elements for these comets routinely at epochs 200 days apart, as in the case of minor planets.

6. In the case of a comet that has separated into discrete components, those components should be distinguished by appending -A, -B, etc., to the designation (or to the P/ or D/ periodic comet number).

7. Noting that some redundancy of nomenclature is desirable, it is proposed to retain in general terms the tradition of naming comets for their discoverers. In this framework, a committee has been formed to establish more precise procedures to ensure fairness and simplicity.

8. It is proposed that comet names be announced in the IAU Circulars only following consultation between the Central Bureau for Astronomical Telegrams and the Commission 20 Small Bodies Names Committee.

9. Whereas the new designation system for comets implies the possibility of confusion (if incorrect spacing is used) with that for new planetary satellites, it is proposed to indicate satellites with the prefix S/.

10. It is proposed that the new designation system for comets be introduced at the beginning of the year 1995. In the interests of avoiding confusion and maintaining continuity, Roman numeral designations will be published in the Minor Planet Circulars for pre-1995 comet discoveries/recoveries passing perihelion in 1993 and 1994, and new-style designations will be supplied for pre-1995 comets, together with lists of correlations with both the year/letter and the year/Roman numeral systems.

Brian Marsden

Central Bureau for Astronomical Telegrams

Jonathan Shanklin adds:

Following the above statement, comet **Halley**, which was recovered on 1982 October 16 at its last apparition, would have been designated comet **1982 U1** under the new scheme. Periodic comets which are observed to return, or observed through aphelion, are also numbered in order of the computation of the orbit, so the full designation of comet Halley would be **1P/1982 U1**.

The tradition is to continue of naming comets after their discoverers, rather than after the person who first computed the orbit (like Halley, Encke or Crommelin).

The prefix D/ would now give **D/Shoemaker-Levy 9** !

Prospects for 1995

THE PROSPECTS for observing comets in 1995 can easily be summed up: they are not good! None of the 1994 comets discovered up to the end of September will be visible by 1995, and those periodic comets predicted to return are all relatively faint.

Ephemerides for currently observable comets are published in the Circulars and comet section Newsletter and instructions on comet observing may be obtained from the Director of the comet section.

P/Schwassmann-Wachmann 1 1989 XV

This annual comet has frequent outbursts and seems to be more often active than not, though it rarely gets brighter than 12^m. It is at opposition in early February and should be observable until late May. It is then in conjunction until early October, when it will be observable for the rest of the year. This comet is an ideal target for those equipped with CCDs and *it should be observed at every opportunity.* Orbital elements for the comet are given in Table 1.

P/d'Arrest 1989 II

This comet will be making its 17th observed return and may be briefly visible from July until mid August. It was first observed by La Hire in 1678 and only three other periodic comets (Halley, Swift-Tuttle and Tempel-Tuttle) have a longer observational interval. At a good return it can reach naked-eye brightness, but orbital perturbations have increased its perihelion distance over the past few returns and it is unlikely to get brighter than 11^m, though it can flare post perihelion which is in late July.

Table 1. Orbital elements for comet P/Schwassmann-Wachmann 1989 XV from 661 observations 1902–1991.

Epoch 1989 Nov 10

T 1989 Oct. 26.7238
q 5.771764
e 0.044661

	2000	1950
ω	49.8702	49.8974
Ω	312.8479	312.1226
i	9.3722	9.3674

P/Jackson-Neujmin 1987 VIII

This comet will be making its 5th observed return having been missed between discovery in 1936 and 1970. It should be observable from August to September, and at a reasonable elongation from the sun, but is not predicted to get brighter than 11^m. The circumstances are similar to the discovery apparition when it reached a photographic magnitude of 12, so it is quite possible that it will appear brighter than the predictions to visual observers.

P/Perrine-Mrkos 1968 VII

This comet will be making its 6th observed return, though it has not been seen since 1968. When discovered in 1896 it was 8^m, the next return was unfavourable but it was only 13^m in 1909. It was then lost between 1909 and 1955 when it was rediscovered at 9^m. It only reached 17^m in 1962 and 13^m in 1968, and was fainter than 19^m in 1975. It seems that the comet is subject to occasional outbursts, so it would be worth keeping an eye on and near the predicted ephemeris position. If an outburst does occur the comet is well-placed in the evening sky during the later part of the year.

P/Churymov-Gerasimenko 1989 VI

This comet will be making its 5th return since discovery in 1969. At a good apparition, such as in 1982, when it was well observed by the comet section, it can reach 9^m. This time it gets no closer than 0.9 AU, and may be observable from December until February 1996 in the evening sky, though it is unlikely to get brighter than 12^m.

P/Honda-Mrkos-Pajdusakova 1990 XIV

This comet will be making its 9th observed return since discovery in 1948 (it was missed in 1959). The comet is at perihelion on Christmas Day, in conjunction 20 days later and won't be visible from the northern hemisphere until late January 1996, when it may be picked up in binoculars in the morning sky as it fades rapidly from 8^m.

Other comets in 1995
Several other comets return to perihelion during 1995, however they are unlikely to become bright enough to observe.

P/de Vico-Swift was 7^m when discovered in 1844, but has been severely perturbed by Jupiter and in its present orbit won't get brighter than 17^m.

P/Finlay is having a very unfavourable apparition with closest approach being just under 2 AU. At a favourable apparition it may reach 7^m, but this time the best it does is 14^m.

P/Clark has a relatively favourable apparition and may reach 12^m, but is too far south for observation from the UK.

P/Tuttle-Giacobini-Kresak has an unfavourable apparition; at a good one it normally reaches 10^m, though in 1973 it experienced an outburst to 4^m.

P/Reinmuth 1 was 12^m when discovered in 1928, but has also been severely perturbed by Jupiter and in its present orbit won't get brighter than 15^m.

P/Schwassmann-Wachmann 3 has an unfavourable apparition this time round, being too close to the sun to observe; at the discovery apparition it reached 7^m, though at the past few apparitions it has only reached 12^m.

P/Longmore is an intrinsically faint, distant comet and won't get brighter than 17^m.

Many of the magnitude parameters given in the *BAA 1995 Handbook* are m_2 (for the nucleus) rather than m_1 (for the coma) or vice versa, and some comets are brighter than these predictions. This affects in particular comets Clark, d'Arrest and Honda-Mrkos-Pajdusakova.

Updated values for H_1 and K_1 are given in Table 2, where:

$$m_1 = H_1 + 5.0 \log d + K_1 \log r$$

1996 promises to be a little better, with a good return for P/Kopff and the possibility of a return of P/de Vico, though this was missed at its last return and hasn't been seen since its discovery in 1846.

Thanks are due to Harold Ridley for starting this series of prospects for comets, and without whose notes writing them would be much harder.

Jonathan Shanklin

References

1. Nakano, S. and Green D. W. E., Eds, *International Comet Quarterly 1995 Comet Handbook* (1994).
2. Kronk, G. W., *Comets: A Descriptive Catalogue*, Enslow (1984).
3. Taylor G. E., *The Handbook of the British Astronomical Association for 1995* (1994).

Table 2. Comets in 1995

Comet		T	q	P(yr)	N	H_1	K_1
P/de Vico-Swift	Apr	09.5	2.15	7.32	3	10.0	15
P/Finlay	May	05.0	1.04	6.76	11	12.0	10
P/Clark	May	31.2	1.55	5.51	4	10.5	15
P/d'Arrest	Jul	27.4	1.35	6.51	16	7.5	40
P/Tuttle-Giacobini-Kresak	Jul	28.6	1.07	5.46	7	10.0	40
P/Reinmuth 1	Sep	03.3	1.87	7.31	8	9.0	15
P/Schwassmann-Wachmann 3	Sep	22.8	0.93	5.34	3	12.0	15
P/Jackson-Neujmin	Oct	06.6	1.38	8.24	4	11.0	15
P/Longmore	Oct	09.3	2.40	6.98	3	11.0	10
P/Perrine-Mrkos	Dec	06.0	1.29	6.77	5	11.5	20
P/Honda-Mrkos-Pajdusakova	Dec	25.9	0.53	5.27	8	13.5	20

Elements for all these comets except P/Schwassmann-Wachmann 1 are given in the *BAA Handbook.*

Meetings in 1995

Gene Shoemaker is coming ...

... as the guest of honor and keynote speaker of the 2nd Meeting of European (and International) Planetary and Cometary Observers

MEPCO '95

in Violau, Germany (Bavaria), March 24–27, 1995

For more than ten years we, the Working Group of Planetary Observers of Germany, have been arranging the Planeten- und Kometen-Tagung (meeting of Planetary and Cometary Observers), which brings together more than 100 dedicated amateur observers from German-speaking regions every year.

Already for the second time, in the spring of 1995 we happily invite planetary and cometary observers from *all over Europe* and also the rest of the world, to continue our fruitful discussions from MEPCO'92, witness the progress in observing techniques and hear about the latest results – with emphasis, of course, on the comet collision with Jupiter. This meeting is **THE** chance to exchange observations of this remarkable event. (Other topics are permitted, too! Be they Saturn's recent white spots; past and coming Mars oppositions; observing and data analysis techniques – anything.)

We are especially proud to have among our guests one of the discoverers of comet P/Shoemaker-Levy 9, eminent geologist Eugene Shoemaker, who among many other things is being credited with the science behind the Apollo program and the discovery that the Noerdlinger Ries is indeed a major impact crater.

Official language will be English. We offer once again:
- a unique meeting atmosphere in a beautiful countryside, conference, accomodation and catering in one building, the Bruder-Klaus- Heim with the famous Violau Observatory, which is again expanding this year,
- discussions and workshops to foster Europe-wide contacts and collaboration,
- papers and posters on observational work and results in different countries,
- (new) a field trip to the Noerdlinger Ries crater, guided by Gene himself,
- and Proceedings included in the fee, which is only DEM 270.

To obtain further information, please contact:
Wolfgang Meyer, Martinstr. 1,
D–12167 Berlin , Germany.

Urgent questions can also be directed to Daniel Fischer:
by fax (xx49-2244-80298) or
e-mail (p515dfi@mpifr-bonn.mpg.de).

P.S.: Copies of the Proceedings of MEPCO'92 can still be ordered from Daniel Fischer for just DEM 10 plus postage.

Daniel Fischer
for the Organizing Committee

BAA/CUAS meeting at Cambridge

Saturday 1995 March 18

The Comet-Jupiter Collision

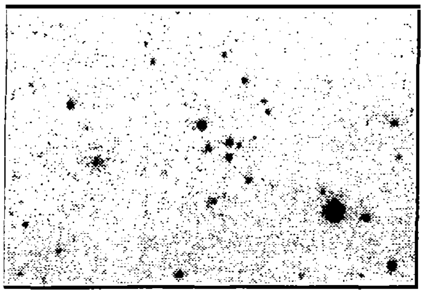
The annual Cambridge meeting will be a joint meeting of the BAA Jupiter and Comet Sections hosted by Cambridge University Astronomical Society. It will be on Saturday March 18, 10.30–18.30, at the Cavendish Lab, Madingley Rd, Cambridge. This is a full-day meeting about the comet impacts on Jupiter. Anyone interested is welcome.

Speakers will include:
- Mark Bailey (Liverpool) : Comet origins and dynamics
- Steven Miller (UCL, London): Fireball observations from Hawaii
- Peter Andrews (RGO, Cambridge): Fireball observations from La Palma
- Mark Kidger (Tenerife): Fireball observations from Tenerife
- Niel Brandt (IoA, Cambridge): ROSAT observations
- John Rogers (BAA, Cambridge): Visible impact sites
- Chris Trayner (Leeds): The Tunguska impact

There will also be an opportunity for BAA members to show slides or posters. Cars can be parked at the Cavendish. Tickets are £4 for entry or £6 (including buffet lunch). Please make cheques payable to C.U. Astronomical Society and send an s.a.e. after January 5 to:

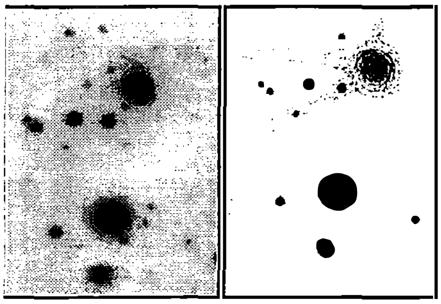
Paul McLaughlin, Trinity College, Cambridge, CB1 1TQ

Mueller (1993a)



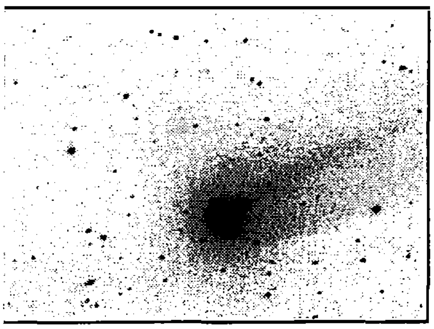
J. Danielsson's photgraph on 1993 October 16.80 from SE Sweden. He used a 200 mm telephoto lens piggy-backed to an 8-inch Celestron. The exposure was 10 min at f/4 on ISO 400 Tri-X film. [Reverse video – ed.]

McNaught-Russell (1993v)



Left: ***J. Danielsson's photgraph on 1994 April 05.81 from SE Sweden. Camera details as above. The exposure was 10 min at f/3.5 on hypered TP 2415 film. [Reverse video – ed.]*** **Right:** ***His sketch of features which are hard to reproduce here.***

P/Machholz 2 (1994o)



CCD image by Erich Meyer and Raab Herbert on 1994 August 08.09 from Linz, Austria. They used an ST-6 attached to a 288 mm f/5.2 Schmidt-Cassegrain. The image is a composite of three 20 s exposures taken for astrometric purposes. The field of view is 15' x 20' and there appears to be a faint component 5' NE of the main object. [Reverse video – ed.]

Research notes from

The rate of cometary splitting

In *Icarus* of 1994 April (Vol. 108, pp 265–271) Chen & Jewitt state that 21 comets have split during 1846–1976, with equal likelihood for both short- and long-period comets, and for both pre- and post-perihelion splitting. They have examined 49 comets with a CCD since 1986 and found that 3 (or about 6%) have split, namely P/Chernykh, P/Ciffreo & Wilson. They find the separation velocity to be 0.5 m s^{-1}.

The lifetime of the secondary is determined by the timescale for the loss of volatiles by sublimation due to solar heating, which in turn depends on heliocentric distance, size of secondary and orbital characteristics. They suggest that a body of 10 m diameter and of water ice could endure for order 1 year for sublimation at 1 AU. Given the small field of view, they estimate a lower limit for the splitting rate of order 0.01 yr^{-1} $comet^{-1}$. Although the sample is rather small, the authors suggest that, although observed rarely, splitting is statistically common among comets. This in turn suggests that each secondary is only a minor fraction (<0.1%) of the primary mass.

With the deduced rate of splitting applied to the thousand known short-period comets of 400 000 yr lifetime, the authors conclude that there are 4 million secondaries in a swarm related to the orbits of their parents. Where are these objects? The Spacewatch telescope has shown that Earth-approachers smaller than 100 m are over-abundant with respect to the magnitude-frequency distribution extrapolated from larger objects (for example, by two orders of magnitude for size 10 m). The authors state that spectral measurements suggest these small objects are debris from extinct short-period comets.

'Rubble piles' and the density of SL9

Asphaug & Benz in *Nature* of July 14 (Vol. 370, pp 120–124) state that interpretation of observations of the comet crash will depend on parameters such as mass and density of the fragments. They simulate the passage of the parent comet across the Roche zone of Jupiter over a few hours in 1992 July, with closest approach of 1.31 jovian radii resulting in a captured orbit of eccentricity 0.996.

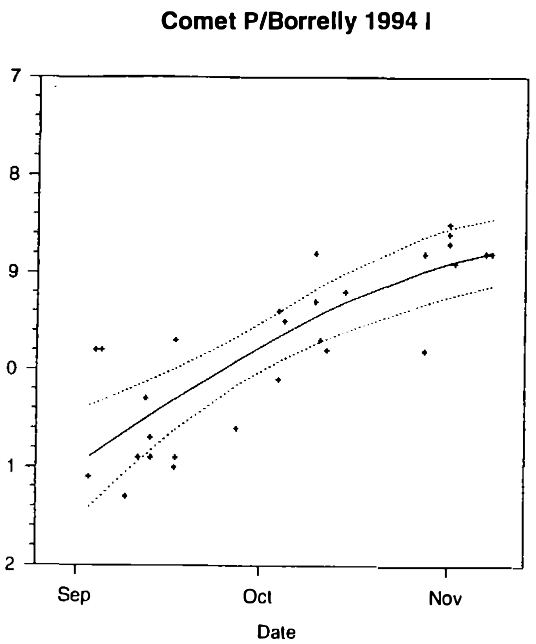
Simple fracture mechanics show that a uniform body of low but non-zero strength and *any* realistic density (>50 kg m^{-3}) cannot form a 'string of pearls', rather it must fracture into two similarly-sized components (which may then themselves split). The authors assume that the parent comet is already broken, as a strengthless aggregate of numerous grains – a 'rubble pile' – and find that the tidally-disrupted body condenses rapidly into clumps, driven by self-gravity.

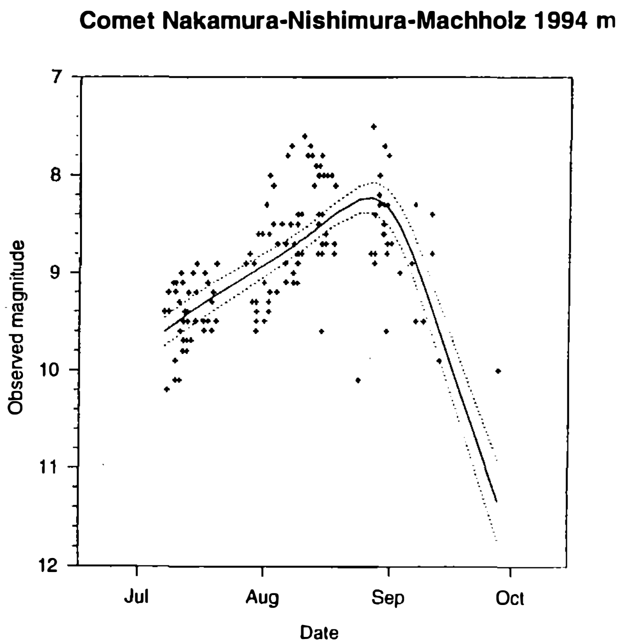
A fragment chain occurs only for density in the range 300–700 kg m^{-3}. About 20 similar-sized objects are formed for a non-rotating parent of 1.5 km diameter and bulk density 500 kg m^{-3}, suggesting that each has an impact energy of 10^{20} J. A slightly larger initial density leads to significant mass variation among the clusters and raises the possibility of a few 10^{21} J events.

For rotating comets, *prograde* rotation gives a longer fragment chain for the same initial size (for example, a 1.0 km diameter parent with a rapid 9 hr prograde rotation and bulk density 1000 kg m^{-3}, although this mass is only half that of the non-rotating example), whereas *retrograde* rotation leads to a massive central clump not seen in SL9 (this is also seen for non-rotating comets of density 1000 kg m^{-3}).

Gravitational instability condenses the clumps over a few hours after perijove. For density 500 kg m^{-3}, the authors find the same number of clumps for parents of diameter 600 m, 1.5 km and 4 km. The final mass distribution is determined quite early and the clumps continue on independent orbits.

The authors speculate finally on whether all comets are rubble piles. They estimate by scaling laws that a 1.5 km diameter ice body can be destroyed by impact with a single 1.5 m particle traveling at 50 km s^{-1} (and one such impact is likely during passage through Jupiter's ring) or by millions of hyper-velocity impacts with smaller grains. Hence, a rubble pile could be created *in situ* since Jupiter's ring contains such objects. So the passage through the Roche zone of a giant planet is hazardous in more ways than one.


Comet P/Borrelly 1994 l
7
8
9
0
1
2
Sep
Oct
Nov
Date


Comet Nakamura-Nishimura-Machholz 1994 m
Observed magnitude
7
8
9
10
11
12
Jul
Aug
Sep
Oct
Date

selected journals

Orbital history of P/Swift-Tuttle

Yau, Yeomans and Weissman write in *Monthly Notices* of the RAS Vol. 266 pp 305–316 (1994) of their long-term integration forwards to AD 2392 and backwards to 703 BC of the orbit of comet P/Swift-Tuttle. They use two 'trial orbits': one linking the 1862 and 1992 observations and using no non-gravitational effects; and another linking those of 1737 (by Kegler), 1862 and 1992 using non-gravitational effects. The observations for 1862 October from the Cape of Good Hope are discordant (by over 10 arcsec in RA and dec in some cases) with others from that apparition and are not included. A search through Chinese records yields (pre-telescopic) returns in AD 188 and 69 BC, and the two orbits are adjusted slightly (remaining always within the formal error) to achieve best fit. The non-gravitation solution is not compatible over this longer timespan, so these effects appear to be negligible.

The authors discuss the observed returns of AD 1737, AD 188 and 69 BC, and conclude a naked-eye limit for the comet of 3.4^m. They find three returns during AD 188–1737 when the comet would have been on the borderline of visibility and two much earlier 2^m returns, but state that very few records have survived from before 200 BC. These unobserved returns fix the comet's absolute magnitude which appears not to have changed significantly ($<0.5^m$) over 2000 years. The authors make a comparison with P/Halley, which becomes a naked-eye object at mag $3.5–4.0^m$ and which is about 1^m fainter pre-perihelion. They state that P/Halley outgasses more post-perihelion leading to a brighter object and an increase in period of 4 days at each return. They estimate that P/Swift-Tuttle would return about 12 days late on each return if it had the same mass and outgassing as P/Halley, and conclude that it probably has a much larger mass. A similar conclusion was drawn in an earlier study based on comparison of the comets' meteor streams.

The authors finally state that the next return in AD 2126 will be well away from the Earth at nodal crossing so there is no danger of collision!

Gamma-ray bursts from the Oort cloud?

In the *Astronomical Journal* of 1994 May (Vol. 107 (5), pp 1873–1878) Clarke, Blaes and Tremaine examine the possibility that gamma-ray bursts originate in the Oort cloud. They state that gamma-ray bursts are isotropic on the sky but not in space, suggesting a situation in an extended halo around our Galaxy. The subject gives three major problems. First, there is no known mechanism for the rate and energy of the bursts without violating other observational constraints. Secondly, the bright source counts do not fit the models for the distribution of Oort objects. And thirdly, the isotropy of the data does not fit the expected angular distribution of Oort sources. The authors conclude that Oort cloud models of gamma-ray bursts are extremely implausible.

CO emission driving coma formation

In *Nature* of September 15 (Vol. 371, pp 229–231) Senay & Jewitt give the first direct evidence for the mechanism whereby distant comets are sometimes observed to undergo outbursts that generate a surrounding coma. They studied P/Schwassmann-Wachmann 1 in its near-circular but beyond-Jupiter orbit and detected CO with the JCMT on 1993 October 22, November 11 & 12. In all cases, the CO line was blue-shifted (by 0.4 km s^{-1}) from its anticipated geocentric velocity, indicating sublimation of CO near the sub-solar point of the illuminated hemisphere and implying a jet of gas *and dust* approximately Sunward with this excess velocity. The authors estimate a lower limit to the CO production rate of 1500 kg s^{-1}.

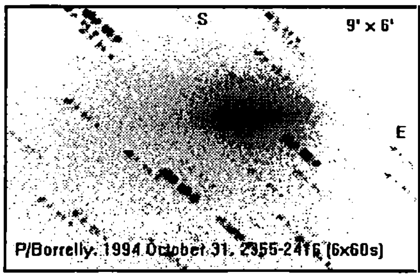
The authors consider the dust production rate derived in this work and that of others to estimate a much lower value, assuming sub-mm sizes are dominant. This indicates that it is CO, and not dust, that drives the optical dust coma.

Finally, the authors consider the likely local, rather than uniform, nature of sites emitting CO on the comet and estimate the total sublimating area to occupy 0.3–2.2 % of the surface area of the nucleus (depending on the comet's size) – this agrees well with estimates for other comets.

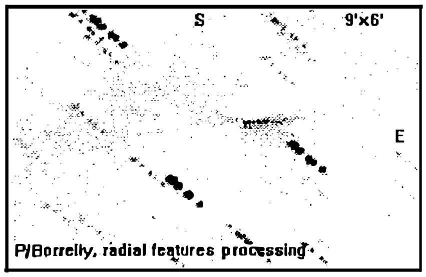
James Lancashire

P/Borrelly (1994l)

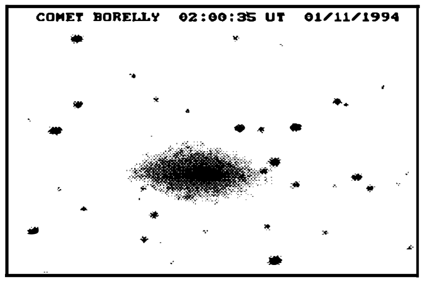
Nick James used a Sony ICX027BL CCD attached to a 0.3 m f/5.25 Newtonian for the first two images below.



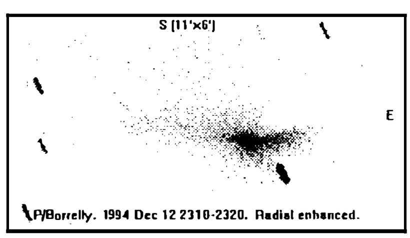
This is a composite of six 60s frames taken between 2355 and 2416 on October 31. The frames have been offset to compensate for the comet's motion and co-added after dark frame subtraction.



This is the result of processing the first frame to empasize radial detail. It shows the anti-tail quite clearly.



Another view later the same night! David Strange's image at 02:00:35 with a Starlite Xpress CCD attached to a 20-inch f/4 Newtonian and 40 s exposure.



A recent image by Nick James on December 3.96 (despite frame date). The tail is in pA 260° and the anti-tail in pA 110° (S at top). The geometry has changed since the second image.

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Rel	Comments

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

Review of comet observations for 1994 May–October

In addition to the Director's report and lightcurves based on observations from BAA members, I present a review of comets over the summer, with information gleaned from IAU circulars 5988–6105 and *The Astronomer* (1994 June–October). Note that the figures quoted are rounded off from their original published accuracy. Full reports on some comets will appear elsewhere in due course.

Comets with names printed in ***bold italic type*** have ephemerides and charts printed later in this supplement. Please use the new comet report form for your observations!

Four bright comets were binocular objects in mid-May: these were P/Tempel 1 1993c, P/McNaught-Russell 1993v, Takamizawa-Levy 1994f and Takamizawa 1994i.

P/Schwassmann - Wachmann 1: CCD mag 12.7 in early May.

Further CO emission from P/SW1 was detected at IRAM on 1994 May 10–11: a very sharp component blue-shifted and superimposed on a broader feature. The blue-shift of the sharp peak is due to outgassing from the illuminated side of nucleus, but its size is larger than expected from sublimation of pure CO ice. There is a good agreement with the previous report (on IAUC 5929), and the production rate is 10^{28} molecule s^{-1}. (IAUC 5994)

P/Schwassmann - Wachmann 2: mag 12 in June.

1993a (Mueller): mag 11 in May–June, mag 12 to mid July.

1993c (P/Tempel 1): mag 9 in May and to mid June; mag 11 in early September.

1993g (P/Reinmuth 2): CCD mag 15 in Aug; visual mag 13–14 in Aug–Sept.

1993p (Mueller): fainter than expected: mag 10 in early May, mag 11 in mid May.

1993v (McNaught-Russell): mag 8 in mid May, then quickly fading to mag 12 by mid June.

1994f (Takamizawa-Levy): mag 9 in early May, mag 8 in late May, mag 9 in mid June, mag 10 by mid July.

1994g (P/Harrington): on Oct 4 Scotti observed two faint (mag 20) close (9") companion nuclei about 23' from the main nucleus, which had brightened in mid Sept.

1994i (Takamizawa): mag 10 in early May, mag 9 in mid May, mag 10 to mid July.

1994j (P/Brooks 2): mag 13–14 in Aug–Sept.

1994k (P/Shoemaker): discovered at mag 17 in mid May with period of 15 yr, inclination 25° and perihelion on Oct 31.

1994l (P/Borrelly): recovered at mag 16 in mid June; mag 11 in early Sept, mag 10 from mid-Sept, mag 9 in early Oct, mag 8 by end Oct, with fan-shaped anti-tail in mid Nov.

1994m (Nakamura – Nishimura – Machholz): discovered just before its perihelion on Jul 13 with inclination 94° and closest approach to Earth of 0.4 AU on Aug 31. Mag 9 in early July, mag 8 by late July and through Aug, mag 9 in mid Sept and mag 10 by late Sept.

1994n (McNaught-Hartley): discovered at mag 16 in early July with period of 18 yr, inclination 18° and perihelion on Nov 11.

1994o (P/Machholz 2): discovered at mag 10 in early Aug well after closest approach to Earth of 0.3 AU on July 6 but well before perihelion on Sep 18 with period 5.2 yr and inclination 13°.

Brightened to mag 7 by end Aug, when second component (B) discovered at mag 11, fading to mag 12 in mid Sept. Third component (C) discovered near B at mag 13 in early Sept, then fourth (D) found at mag 12 near A and fifth (E) at mag 13 near B, the arrangement being:

A D CB E

stretching 1° NE from A.

A faded from mag 7 in mid Sept to mag 9 in late Sept and mag 10 by mid Oct, becoming also more diffuse. D became more condensed and brightened from mag 10 in early Sept to mag 8 in mid Sept then faded to mag 9 by late Sept, but developed two bright areas within its coma in early Oct.

1994p (P/Reinmuth 1): rec'd at mag 19.

1994q (P/Longmore): rec'd at mag 20.

1994r (Machholz): discovered at mag 11 just after perihelion on Oct 5 with inclination 102° and closest approach to Earth of 0.9 AU on Nov 29. Mag 10 to mid Nov.

James Lancashire

Comet ephemerides for 1994l, 1994r and P/SW1 (CCD)

Comet ephemerides are for an arbitrary location in the UK (long. 0°, lat. 53°) and give the following:–

- Name of comet
- Orbital elements (**epoch 2000**)
- Magnitude formula

Conditions for the comet to be observable. This is a rough indication only. The sun must be 13° or more below the horizon (i.e. sky is dark) and the comet a distance above the horizon depending on its predicted brightness. A bright comet may be visible outside these limits. Equally a faint comet in poor skies may be invisible!

- Column headings:

a) Double-date format.
b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are for **epoch 1950**).
c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.
d) Distance from the Earth in AU.
e) Distance from the Sun in AU.
f) Time of transit, i.e. when the comet is highest in the sky.
g) Period of observability subject to the constraints in line 7. The comet may be visible outside this period.
h) Elongation from the sun in degrees.

Ephemerides follow

Ephemeris for P/Borrelly (19941)

Omega=353.3590 OMEGA= 75.4240 i= 30.2710 q= 1.365120 a= 3.619088
e=0.622800 P= 6.885 T= 1994 November 1.4920 Epoch= 2000
Magnitudes calculated from m= 6.9+5.0*Log(d)+15.0*Log(r)

December 1994 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	8 55.4	37.38	8.1	0.62	1.41	16.16	7.29 to 18.19	121
2/ 3	12.0	8 57.7	38.28	8.1	0.62	1.41	16.14	7.20 to 18.20	122
3/ 4	12.0	8 60.0	39.17	8.1	0.62	1.42	16.13	7.10 to 18.22	122
4/ 5	12.0	9 2.2	40.06	8.1	0.62	1.42	16.11	6.59 to 18.23	123
5/ 6	12.0	9 4.4	40.55	8.1	0.62	1.42	16.09	6.48 to 18.24	123
6/ 7	12.0	9 6.6	41.44	8.2	0.62	1.43	16.07	6.36 to 18.25	124
7/ 8	12.0	9 8.8	42.33	8.2	0.62	1.43	16.06	6.24 to 18.26	124
8/ 9	12.0	9 10.9	43.21	8.2	0.62	1.43	16.04	6.10 to 18.27	125
9/10	12.0	9 13.0	44.10	8.2	0.62	1.44	16.02	5.55 to 18.28	125
10/11	12.0	9 15.1	44.57	8.2	0.62	1.44	16.00	5.38 to 18.29	126
11/12	12.0	9 17.1	45.45	8.3	0.62	1.44	15.58	5.19 to 18.30	126
12/13	12.0	9 19.1	46.32	8.3	0.62	1.45	15.56	5.17 to 18.31	127
13/14	12.0	9 21.0	47.19	8.3	0.63	1.45	15.54	5.17 to 18.32	127
14/15	12.0	9 22.9	48.05	8.3	0.63	1.45	15.52	5.17 to 18.32	127
15/16	12.0	9 24.8	48.50	8.4	0.63	1.46	15.50	5.18 to 18.33	128
16/17	12.0	9 26.6	49.35	8.4	0.63	1.46	15.48	5.18 to 18.34	128
17/18	12.0	9 28.3	50.20	8.4	0.64	1.47	15.46	5.18 to 18.35	128
18/19	12.0	9 30.0	51.04	8.4	0.64	1.47	15.44	5.18 to 18.35	129
19/20	12.0	9 31.6	51.47	8.5	0.64	1.47	15.41	5.19 to 18.36	129
20/21	12.0	9 33.2	52.30	8.5	0.64	1.48	15.39	5.19 to 18.36	129
21/22	12.0	9 34.7	53.12	8.5	0.65	1.48	15.37	5.20 to 18.37	130
22/23	12.0	9 36.2	53.53	8.6	0.65	1.49	15.34	5.20 to 18.37	130
23/24	12.0	9 37.6	54.33	8.6	0.65	1.49	15.31	5.21 to 18.38	130
24/25	12.0	9 38.9	55.13	8.6	0.66	1.50	15.29	5.21 to 18.38	130
25/26	12.0	9 40.1	55.52	8.7	0.66	1.50	15.26	5.22 to 18.39	131
26/27	12.0	9 41.3	56.30	8.7	0.67	1.51	15.23	5.23 to 18.39	131
27/28	12.0	9 42.4	57.07	8.7	0.67	1.51	15.21	5.23 to 18.39	131
28/29	12.0	9 43.4	57.44	8.8	0.68	1.52	15.18	5.24 to 18.39	131
29/30	12.0	9 44.4	58.19	8.8	0.68	1.52	15.15	5.25 to 18.40	131
30/31	12.0	9 45.2	58.54	8.8	0.69	1.53	15.12	5.26 to 18.40	131
31/32	12.0	9 46.0	59.28	8.9	0.69	1.53	15.09	5.27 to 18.40	131

January 1995 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	9 46.7	60.01	8.9	0.70	1.54	15.05	5.28 to 18.40	131
2/ 3	12.0	9 47.3	60.33	8.9	0.70	1.54	15.02	5.29 to 18.40	132
3/ 4	12.0	9 47.8	61.04	9.0	0.71	1.55	14.59	5.30 to 18.40	132
4/ 5	12.0	9 48.3	61.34	9.0	0.71	1.55	14.55	5.31 to 18.39	132
5/ 6	12.0	9 48.6	62.03	9.1	0.72	1.56	14.51	5.32 to 18.39	132
6/ 7	12.0	9 48.9	62.31	9.1	0.72	1.56	14.48	5.33 to 18.39	132
7/ 8	12.0	9 49.0	62.58	9.1	0.73	1.57	14.44	5.34 to 18.39	132
8/ 9	12.0	9 49.1	63.25	9.2	0.74	1.57	14.40	5.35 to 18.38	132
9/10	12.0	9 49.1	63.50	9.2	0.74	1.58	14.36	5.36 to 18.38	132
10/11	12.0	9 49.0	64.14	9.3	0.75	1.58	14.32	5.38 to 18.38	132
11/12	12.0	9 48.8	64.38	9.3	0.76	1.59	14.28	5.39 to 18.37	132
12/13	12.0	9 48.5	65.00	9.3	0.76	1.59	14.24	5.40 to 18.37	131
13/14	12.0	9 48.1	65.22	9.4	0.77	1.60	14.20	5.41 to 18.36	131
14/15	12.0	9 47.6	65.42	9.4	0.78	1.61	14.15	5.43 to 18.36	131
15/16	12.0	9 47.1	66.02	9.5	0.78	1.61	14.11	5.44 to 18.35	131
16/17	12.0	9 46.5	66.20	9.5	0.79	1.62	14.06	5.46 to 18.34	131
17/18	12.0	9 45.7	66.38	9.6	0.80	1.62	14.02	5.47 to 18.33	131
18/19	12.0	9 44.9	66.54	9.6	0.81	1.63	13.57	5.48 to 18.33	131
19/20	12.0	9 44.1	67.10	9.7	0.81	1.63	13.52	5.50 to 18.32	131
20/21	12.0	9 43.2	67.25	9.7	0.82	1.64	13.47	5.51 to 18.31	130
21/22	12.0	9 42.1	67.39	9.7	0.83	1.65	13.42	5.53 to 18.30	130

Ephemeris for P/Borrelly (1994l) (contd)

January 1995 *(contd)* Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
22/23	12.0	9 41.1	67.51	9.8	0.84	1.65	13.37	5.54 to 18.29	130
23/24	12.0	9 40.0	68.03	9.8	0.85	1.66	13.32	5.56 to 18.28	130
24/25	12.0	9 38.8	68.14	9.9	0.85	1.66	13.27	5.57 to 18.27	130
25/26	12.0	9 37.6	68.24	9.9	0.86	1.67	13.22	5.59 to 18.26	129
26/27	12.0	9 36.3	68.33	10.0	0.87	1.68	13.17	6.00 to 18.25	129
27/28	12.0	9 35.0	68.42	10.0	0.88	1.68	13.12	6.02 to 18.24	129
28/29	12.0	9 33.6	68.49	10.1	0.89	1.69	13.06	6.04 to 18.22	129
29/30	12.0	9 32.3	68.55	10.1	0.90	1.70	13.01	6.05 to 18.21	129
30/31	12.0	9 30.9	69.01	10.1	0.91	1.70	12.56	6.07 to 18.20	128
31/32	12.0	9 29.5	69.05	10.2	0.91	1.71	12.50	6.09 to 18.18	128

February 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	9 28.1	69.09	10.2	0.92	1.71	12.45	6.10 to 18.17	128
2/ 3	12.0	9 26.7	69.12	10.3	0.93	1.72	12.40	6.12 to 18.16	128
3/ 4	12.0	9 25.3	69.14	10.3	0.94	1.73	12.34	6.14 to 18.14	127
4/ 5	12.0	9 23.9	69.16	10.4	0.95	1.73	12.29	6.15 to 18.13	127
5/ 6	12.0	9 22.5	69.16	10.4	0.96	1.74	12.24	6.17 to 18.11	127
6/ 7	12.0	9 21.2	69.16	10.5	0.97	1.75	12.19	6.19 to 18.10	126
7/ 8	12.0	9 19.9	69.15	10.5	0.98	1.75	12.13	6.20 to 18.08	126
8/ 9	12.0	9 18.6	69.14	10.6	0.99	1.76	12.08	6.22 to 18.06	126
9/10	12.0	9 17.3	69.11	10.6	1.00	1.77	12.03	6.24 to 18.05	126
10/11	12.0	9 16.1	69.08	10.7	1.01	1.77	11.58	6.25 to 18.03	125
11/12	12.0	9 14.9	69.05	10.7	1.02	1.78	11.53	6.27 to 18.01	125
12/13	12.0	9 13.8	69.00	10.7	1.03	1.79	11.48	6.29 to 17.60	125
13/14	12.0	9 12.7	68.55	10.8	1.04	1.79	11.43	6.31 to 17.58	124
14/15	12.0	9 11.7	68.50	10.8	1.05	1.80	11.38	6.32 to 17.56	124
15/16	12.0	9 10.7	68.44	10.9	1.06	1.81	11.33	6.34 to 17.54	124
16/17	12.0	9 9.8	68.37	10.9	1.07	1.81	11.28	6.36 to 17.52	123
17/18	12.0	9 8.9	68.30	11.0	1.08	1.82	11.23	6.38 to 17.50	123
18/19	12.0	9 8.1	68.22	11.0	1.09	1.83	11.18	6.39 to 17.48	123
19/20	12.0	9 7.4	68.14	11.1	1.10	1.83	11.14	6.41 to 17.47	122
20/21	12.0	9 6.7	68.05	11.1	1.11	1.84	11.09	6.43 to 17.45	122
21/22	12.0	9 6.1	67.56	11.2	1.13	1.85	11.04	6.45 to 17.43	122
22/23	12.0	9 5.5	67.46	11.2	1.14	1.85	10.60	6.47 to 17.40	121
23/24	12.0	9 5.0	67.36	11.2	1.15	1.86	10.55	6.48 to 17.38	121
24/25	12.0	9 4.5	67.26	11.3	1.16	1.87	10.51	6.50 to 17.36	120
25/26	12.0	9 4.1	67.15	11.3	1.17	1.87	10.47	6.52 to 17.34	120
26/27	12.0	9 3.8	67.04	11.4	1.18	1.88	10.42	6.54 to 17.32	120
27/28	12.0	9 3.6	66.52	11.4	1.19	1.89	10.38	6.56 to 17.30	119
28/29	12.0	9 3.4	66.40	11.5	1.20	1.89	10.34	6.57 to 17.28	119

March 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	9 3.2	66.28	11.5	1.22	1.90	10.30	6.59 to 17.26	119
2/ 3	12.0	9 3.1	66.15	11.6	1.23	1.91	10.26	7.01 to 17.23	118
3/ 4	12.0	9 3.1	66.03	11.6	1.24	1.92	10.22	7.03 to 17.21	118
4/ 5	12.0	9 3.1	65.49	11.6	1.25	1.92	10.18	7.05 to 17.19	117
5/ 6	12.0	9 3.2	65.36	11.7	1.26	1.93	10.14	7.07 to 17.16	117
6/ 7	12.0	9 3.3	65.22	11.7	1.28	1.94	10.10	7.08 to 17.14	117
7/ 8	12.0	9 3.5	65.08	11.8	1.29	1.94	10.06	7.10 to 17.12	116
8/ 9	12.0	9 3.7	64.54	11.8	1.30	1.95	10.03	7.12 to 17.09	116
9/10	12.0	9 4.0	64.39	11.9	1.31	1.96	9.59	7.14 to 17.07	115
10/11	12.0	9 4.3	64.25	11.9	1.33	1.96	9.55	7.16 to 17.05	115
11/12	12.0	9 4.7	64.10	12.0	1.34	1.97	9.52	7.18 to 17.02	115
12/13	12.0	9 5.1	63.55	12.0	1.35	1.98	9.48	7.20 to 16.60	114
13/14	12.0	9 5.6	63.40	12.0	1.36	1.99	9.45	7.22 to 16.57	114
14/15	12.0	9 6.1	63.24	12.1	1.38	1.99	9.41	7.23 to 16.55	113

Ephemeris for P/Borrelly (1994l) (contd)

March 1995 *(contd)* Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
15/16	12.0	9 6.6	63.08	12.1	1.39	2.00	9.38	7.25 to 16.53	113
16/17	12.0	9 7.2	62.53	12.2	1.40	2.01	9.34	7.27 to 16.50	113
17/18	12.0	9 7.8	62.37	12.2	1.42	2.01	9.31	7.29 to 16.48	112
18/19	12.0	9 8.5	62.21	12.3	1.43	2.02	9.28	7.31 to 16.45	112
19/20	12.0	9 9.2	62.05	12.3	1.44	2.03	9.25	7.33 to 16.42	111
20/21	12.0	9 9.9	61.48	12.3	1.46	2.04	9.21	7.35 to 16.40	111
21/22	12.0	9 10.6	61.32	12.4	1.47	2.04	9.18	7.37 to 16.37	110
22/23	12.0	9 11.4	61.15	12.4	1.48	2.05	9.15	7.39 to 16.35	110
23/24	12.0	9 12.2	60.59	12.5	1.50	2.06	9.12	7.41 to 16.32	110
24/25	12.0	9 13.1	60.42	12.5	1.51	2.06	9.09	7.43 to 16.30	109
25/26	12.0	9 13.9	60.25	12.6	1.52	2.07	9.06	7.45 to 16.27	109
26/27	12.0	9 14.8	60.08	12.6	1.54	2.08	9.02	7.47 to 16.24	108
27/28	12.0	9 15.7	59.51	12.6	1.55	2.09	8.59	7.49 to 16.22	108
28/29	12.0	9 16.7	59.34	12.7	1.56	2.09	8.56	7.51 to 16.19	107
29/30	12.0	9 17.6	59.17	12.7	1.58	2.10	8.53	7.53 to 16.16	107
30/31	12.0	9 18.6	58.60	12.8	1.59	2.11	8.50	7.55 to 16.14	107
31/32	12.0	9 19.6	58.42	12.8	1.61	2.11	8.47	7.57 to 16.11	106

Ephemeris for Machholz (1994r)

Omega=143.2610 OMEGA=249.8530 i=101.8260 q= 1.844360 a=**********
e=1.000000 P=********* T= 1994 October 3.4290 Epoch= 2000
Magnitudes calculated from m= 8.0+5.0*Log(d)+10.0*Log(r)

December 1994 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	4 33.4	32.13	11.0	1.01	1.99	11.54	5.19 to 18.19	170
2/ 3	12.0	4 28.6	31.07	11.0	1.02	2.00	11.45	5.19 to 18.20	171
3/ 4	12.0	4 23.9	30.00	11.1	1.02	2.00	11.36	5.18 to 18.08	172
4/ 5	12.0	4 19.4	28.54	11.1	1.03	2.01	11.28	5.18 to 17.53	172
5/ 6	12.0	4 15.0	27.47	11.1	1.03	2.01	11.20	5.18 to 17.38	171
6/ 7	12.0	4 10.7	26.41	11.1	1.04	2.02	11.11	5.18 to 17.23	170
7/ 8	12.0	4 6.7	25.35	11.1	1.05	2.02	11.03	5.17 to 17.08	169
8/ 9	12.0	4 2.7	24.29	11.2	1.05	2.03	10.55	5.17 to 16.54	167
9/10	12.0	3 58.9	23.25	11.2	1.06	2.03	10.48	5.17 to 16.39	165
10/11	12.0	3 55.3	22.21	11.2	1.07	2.04	10.40	5.17 to 16.25	163
11/12	12.0	3 51.8	21.18	11.3	1.08	2.04	10.33	5.17 to 16.11	161
12/13	12.0	3 48.4	20.16	11.3	1.10	2.05	10.25	5.17 to 15.57	159
13/14	12.0	3 45.2	19.16	11.3	1.11	2.05	10.18	5.17 to 15.44	157
14/15	12.0	3 42.1	18.16	11.4	1.12	2.06	10.11	5.17 to 15.31	155
15/16	12.0	3 39.1	17.18	11.4	1.14	2.06	10.04	5.18 to 15.17	153
16/17	12.0	3 36.3	16.22	11.5	1.15	2.07	9.57	5.18 to 15.05	151
17/18	12.0	3 33.6	15.27	11.5	1.16	2.07	9.51	5.18 to 14.52	149
18/19	12.0	3 31.0	14.33	11.5	1.18	2.08	9.44	5.18 to 14.39	148
19/20	12.0	3 28.5	13.41	11.6	1.20	2.08	9.38	5.19 to 14.27	146
20/21	12.0	3 26.2	12.50	11.6	1.21	2.09	9.31	5.19 to 14.15	144
21/22	12.0	3 23.9	12.01	11.7	1.23	2.10	9.25	5.20 to 14.03	142
22/23	12.0	3 21.8	11.13	11.7	1.25	2.10	9.19	5.20 to 13.51	140
23/24	12.0	3 19.7	10.27	11.8	1.27	2.11	9.13	5.21 to 13.39	138
24/25	12.0	3 17.8	9.43	11.8	1.29	2.11	9.07	5.21 to 13.28	137
25/26	12.0	3 15.9	8.60	11.8	1.31	2.12	9.01	5.22 to 13.16	135
26/27	12.0	3 14.2	8.18	11.9	1.33	2.13	8.56	5.23 to 13.05	133
27/28	12.0	3 12.5	7.38	11.9	1.35	2.13	8.50	5.23 to 12.54	132
28/29	12.0	3 11.0	6.59	12.0	1.37	2.14	8.44	5.24 to 12.43	130
29/30	12.0	3 9.5	6.21	12.0	1.39	2.14	8.39	5.25 to 12.32	128
30/31	12.0	3 8.0	5.45	12.1	1.41	2.15	8.34	5.26 to 12.21	127
31/32	12.0	3 6.7	5.10	12.1	1.43	2.16	8.28	5.27 to 12.10	125

Ephemeris for Machholz (1994r) (contd)

January 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	3 5.5	4.37	12.2	1.46	2.16	8.23	5.28 to 11.60	124
2/ 3	12.0	3 4.3	4.05	12.2	1.48	2.17	8.18	5.29 to 11.49	122
3/ 4	12.0	3 3.2	3.34	12.3	1.50	2.18	8.13	5.30 to 11.39	121
4/ 5	12.0	3 2.1	3.04	12.3	1.52	2.18	8.08	5.31 to 11.28	120
5/ 6	12.0	3 1.1	2.35	12.3	1.55	2.19	8.03	5.32 to 11.18	118
6/ 7	12.0	3 0.2	2.07	12.4	1.57	2.20	7.58	5.33 to 11.08	117
7/ 8	12.0	2 59.3	1.40	12.4	1.59	2.20	7.53	5.34 to 10.57	115
8/ 9	12.0	2 58.5	1.15	12.5	1.62	2.21	7.49	5.35 to 10.47	114
9/10	12.0	2 57.8	0.50	12.5	1.64	2.22	7.44	5.36 to 10.37	113
10/11	12.0	2 57.1	0.26	12.6	1.67	2.22	7.39	5.38 to 10.27	111
11/12	12.0	2 56.5	0.03	12.6	1.69	2.23	7.35	5.39 to 10.17	110
12/13	12.0	2 55.9	-0.19	12.7	1.71	2.24	7.30	5.40 to 10.06	109
13/14	12.0	2 55.3	-0.40	12.7	1.74	2.24	7.26	5.41 to 9.56	108
14/15	12.0	2 54.8	-1.01	12.8	1.76	2.25	7.21	5.43 to 9.46	106
15/16	12.0	2 54.4	-1.21	12.8	1.79	2.26	7.17	5.44 to 9.36	105
16/17	12.0	2 54.0	-1.39	12.8	1.81	2.26	7.12	5.46 to 9.25	104
17/18	12.0	2 53.6	-1.58	12.9	1.84	2.27	7.08	5.47 to 9.15	103
18/19	12.0	2 53.3	-2.15	12.9	1.86	2.28	7.04	5.48 to 9.04	102
19/20	12.0	2 53.0	-2.32	13.0	1.89	2.28	6.60	5.50 to 8.53	101
20/21	12.0	2 52.8	-2.49	13.0	1.91	2.29	6.56	5.51 to 8.42	99
21/22	12.0	2 52.6	-3.04	13.1	1.94	2.30	6.51	5.53 to 8.31	98
22/23	12.0	2 52.4	-3.19	13.1	1.96	2.31	6.47	5.54 to 8.19	97
23/24	12.0	2 52.3	-3.34	13.1	1.99	2.31	6.43	5.56 to 8.07	96
24/25	12.0	2 52.2	-3.48	13.2	2.01	2.32	6.39	5.57 to 7.54	95
25/26	12.0	2 52.1	-4.02	13.2	2.04	2.33	6.35	5.59 to 7.41	94
26/27	12.0	2 52.0	-4.15	13.3	2.06	2.33	6.31	6.00 to 7.26	93
27/28	12.0	2 52.0	-4.27	13.3	2.09	2.34	6.27	6.02 to 7.08	92
28/29	12.0	2 52.1	-4.39	13.3	2.12	2.35	6.23	6.04 to 6.43	91
29/30	12.0	2 52.1	-4.51	13.4	2.14	2.36	6.19	Not Observable	90
30/31	12.0	2 52.2	-5.02	13.4	2.17	2.36	6.15	Not Observable	89
31/32	12.0	2 52.3	-5.13	13.5	2.19	2.37	6.12	Not Observable	88

Ephemeris for P/Schwassmann-Wachmann 1 (1989) ... **for CCD observers!**

Omega= 49.8700 OMEGA=312.8480 i= 9.3720 q= 5.771770 a= 6.041587
e=0.044660 P= 14.850 T= 1989 October 24.8500 Epoch= 2000
Magnitudes calculated from m= 6.0+5.0*Log(d)+10.0*Log(r)+0.000*Beta

[**Editor's note:** A correction of ΔT = -1.87 d has been applied here to the elements for P/SW1. This is to account for planetary perturbations since 1989 and gives positions in fair agreement with *ICQ*, and within the 'error box' of a CCD field. In doing so, however, the comet's solar distance is wrong.]

Observing constraints: Sun below -13. deg Object above 20. deg

December 1994 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	9 24.1	15.40	17.7	5.79	6.20	16.44	11.36 to 18.19	110
2/ 3	12.0	9 24.1	15.40	17.7	5.77	6.20	16.40	11.32 to 18.20	111
3/ 4	12.0	9 24.1	15.39	17.7	5.76	6.20	16.36	11.28 to 18.22	113
4/ 5	12.0	9 24.1	15.38	17.7	5.74	6.20	16.32	11.24 to 18.23	114
5/ 6	12.0	9 24.0	15.38	17.7	5.73	6.20	16.28	11.20 to 18.24	115
6/ 7	12.0	9 24.0	15.38	17.7	5.71	6.20	16.24	11.16 to 18.25	116
7/ 8	12.0	9 23.9	15.37	17.7	5.70	6.20	16.20	11.12 to 18.26	117
8/ 9	12.0	9 23.9	15.37	17.7	5.68	6.20	16.16	11.08 to 18.27	118
9/10	12.0	9 23.8	15.37	17.7	5.67	6.20	16.12	11.04 to 18.28	119
10/11	12.0	9 23.7	15.36	17.7	5.65	6.20	16.08	10.60 to 18.29	120
11/12	12.0	9 23.6	15.36	17.7	5.64	6.20	16.04	10.56 to 18.30	121

Ephemeris for P/Schwassmann-Wachmann 1 (1989) (contd)

December 1994 *(contd)* Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
12/13	12.0	9 23.5	15.36	17.7	5.63	6.20	16.00	10.52 to 18.31	122
13/14	12.0	9 23.3	15.36	17.7	5.61	6.20	15.56	10.48 to 18.32	123
14/15	12.0	9 23.2	15.36	17.7	5.60	6.20	15.52	10.44 to 18.32	124
15/16	12.0	9 23.1	15.36	17.7	5.59	6.20	15.48	10.40 to 18.33	125
16/17	12.0	9 22.9	15.36	17.7	5.57	6.20	15.44	10.36 to 18.34	126
17/18	12.0	9 22.7	15.36	17.7	5.56	6.20	15.40	10.31 to 18.35	127
18/19	12.0	9 22.5	15.36	17.6	5.55	6.20	15.36	10.27 to 18.35	128
19/20	12.0	9 22.4	15.37	17.6	5.54	6.20	15.31	10.23 to 18.36	129
20/21	12.0	9 22.1	15.37	17.6	5.52	6.20	15.27	10.19 to 18.36	130
21/22	12.0	9 21.9	15.37	17.6	5.51	6.20	15.23	10.15 to 18.37	131
22/23	12.0	9 21.7	15.37	17.6	5.50	6.20	15.19	10.11 to 18.37	132
23/24	12.0	9 21.5	15.38	17.6	5.49	6.20	15.15	10.06 to 18.38	133
24/25	12.0	9 21.2	15.38	17.6	5.48	6.21	15.11	10.02 to 18.38	135
25/26	12.0	9 21.0	15.39	17.6	5.46	6.21	15.06	9.58 to 18.39	136
26/27	12.0	9 20.7	15.39	17.6	5.45	6.21	15.02	9.54 to 18.39	137
27/28	12.0	9 20.5	15.40	17.6	5.44	6.21	14.58	9.49 to 18.39	138
28/29	12.0	9 20.2	15.40	17.6	5.43	6.21	14.54	9.45 to 18.39	139
29/30	12.0	9 19.9	15.41	17.6	5.42	6.21	14.50	9.41 to 18.40	140
30/31	12.0	9 19.6	15.42	17.6	5.41	6.21	14.45	9.37 to 18.40	141
31/32	12.0	9 19.3	15.42	17.6	5.40	6.21	14.41	9.32 to 18.40	142

January 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	9 18.9	15.43	17.6	5.39	6.21	14.37	9.28 to 18.40	143
2/ 3	12.0	9 18.6	15.44	17.6	5.38	6.21	14.33	9.24 to 18.40	144
3/ 4	12.0	9 18.3	15.45	17.6	5.37	6.21	14.28	9.19 to 18.40	145
4/ 5	12.0	9 17.9	15.45	17.6	5.36	6.21	14.24	9.15 to 18.39	147
5/ 6	12.0	9 17.6	15.46	17.6	5.36	6.21	14.20	9.10 to 18.39	148
6/ 7	12.0	9 17.2	15.47	17.6	5.35	6.21	14.15	9.06 to 18.39	149
7/ 8	12.0	9 16.8	15.48	17.6	5.34	6.21	14.11	9.02 to 18.39	150
8/ 9	12.0	9 16.5	15.49	17.6	5.33	6.21	14.07	8.57 to 18.38	151
9/10	12.0	9 16.1	15.50	17.6	5.32	6.21	14.02	8.53 to 18.38	152
10/11	12.0	9 15.7	15.51	17.6	5.32	6.21	13.58	8.48 to 18.38	153
11/12	12.0	9 15.3	15.52	17.6	5.31	6.21	13.54	8.44 to 18.37	154
12/13	12.0	9 14.9	15.53	17.6	5.30	6.21	13.49	8.40 to 18.37	155
13/14	12.0	9 14.5	15.54	17.6	5.30	6.21	13.45	8.35 to 18.36	157
14/15	12.0	9 14.1	15.56	17.5	5.29	6.21	13.41	8.31 to 18.36	158
15/16	12.0	9 13.6	15.57	17.5	5.28	6.21	13.36	8.26 to 18.35	159
16/17	12.0	9 13.2	15.58	17.5	5.28	6.21	13.32	8.22 to 18.34	160
17/18	12.0	9 12.8	15.59	17.5	5.27	6.21	13.28	8.17 to 18.33	161
18/19	12.0	9 12.3	16.00	17.5	5.27	6.21	13.23	8.13 to 18.33	162
19/20	12.0	9 11.9	16.02	17.5	5.26	6.21	13.19	8.08 to 18.29	163
20/21	12.0	9 11.4	16.03	17.5	5.26	6.21	13.14	8.04 to 18.25	164
21/22	12.0	9 11.0	16.04	17.5	5.25	6.21	13.10	7.59 to 18.21	166
22/23	12.0	9 10.5	16.05	17.5	5.25	6.21	13.06	7.55 to 18.16	167
23/24	12.0	9 10.0	16.07	17.5	5.25	6.21	13.01	7.50 to 18.12	168
24/25	12.0	9 9.6	16.08	17.5	5.24	6.21	12.57	7.46 to 18.08	169
25/26	12.0	9 9.1	16.09	17.5	5.24	6.21	12.52	7.41 to 18.04	170
26/27	12.0	9 8.6	16.10	17.5	5.24	6.21	12.48	7.37 to 17.59	171
27/28	12.0	9 8.2	16.12	17.5	5.24	6.21	12.44	7.32 to 17.55	172
28/29	12.0	9 7.7	16.13	17.5	5.23	6.21	12.39	7.28 to 17.51	173
29/30	12.0	9 7.2	16.14	17.5	5.23	6.21	12.35	7.23 to 17.46	175
30/31	12.0	9 6.7	16.16	17.5	5.23	6.21	12.30	7.18 to 17.42	176
31/32	12.0	9 6.2	16.17	17.5	5.23	6.21	12.26	7.14 to 17.38	177

Ephemeris for P/Schwassmann-Wachmann 1 (1989) (contd)

February 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	9 5.8	16.18	17.5	5.23	6.21	12.21	7.09 to 17.33	178
2/ 3	12.0	9 5.3	16.20	17.5	5.23	6.21	12.17	7.05 to 17.29	179
3/ 4	12.0	9 4.8	16.21	17.5	5.23	6.21	12.13	7.00 to 17.25	180
4/ 5	12.0	9 4.3	16.22	17.5	5.23	6.22	12.08	6.56 to 17.20	179
5/ 6	12.0	9 3.8	16.24	17.5	5.23	6.22	12.04	6.51 to 17.16	177
6/ 7	12.0	9 3.3	16.25	17.5	5.23	6.22	11.59	6.47 to 17.12	176
7/ 8	12.0	9 2.8	16.26	17.5	5.23	6.22	11.55	6.42 to 17.08	175
8/ 9	12.0	9 2.4	16.28	17.5	5.23	6.22	11.50	6.38 to 17.03	174
9/10	12.0	9 1.9	16.29	17.5	5.24	6.22	11.46	6.33 to 16.59	173
10/11	12.0	9 1.4	16.30	17.5	5.24	6.22	11.42	6.29 to 16.55	172
11/12	12.0	9 0.9	16.32	17.5	5.24	6.22	11.37	6.27 to 16.50	171
12/13	12.0	9 0.5	16.33	17.5	5.24	6.22	11.33	6.29 to 16.46	170
13/14	12.0	8 60.0	16.34	17.5	5.25	6.22	11.28	6.31 to 16.42	168
14/15	12.0	8 59.5	16.35	17.5	5.25	6.22	11.24	6.32 to 16.37	167
15/16	12.0	8 59.1	16.36	17.5	5.25	6.22	11.20	6.34 to 16.33	166
16/17	12.0	8 58.6	16.38	17.5	5.26	6.22	11.15	6.36 to 16.29	165
17/18	12.0	8 58.1	16.39	17.5	5.26	6.22	11.11	6.38 to 16.25	164
18/19	12.0	8 57.7	16.40	17.5	5.27	6.22	11.06	6.39 to 16.20	163
19/20	12.0	8 57.2	16.41	17.5	5.27	6.22	11.02	6.41 to 16.16	162
20/21	12.0	8 56.8	16.42	17.5	5.28	6.22	10.58	6.43 to 16.12	161
21/22	12.0	8 56.4	16.43	17.6	5.28	6.22	10.53	6.45 to 16.07	160
22/23	12.0	8 55.9	16.44	17.6	5.29	6.22	10.49	6.47 to 16.03	158
23/24	12.0	8 55.5	16.45	17.6	5.29	6.22	10.44	6.48 to 15.59	157
24/25	12.0	8 55.1	16.47	17.6	5.30	6.22	10.40	6.50 to 15.55	156
25/26	12.0	8 54.7	16.48	17.6	5.31	6.22	10.36	6.52 to 15.50	155
26/27	12.0	8 54.3	16.48	17.6	5.31	6.22	10.31	6.54 to 15.46	154
27/28	12.0	8 53.9	16.49	17.6	5.32	6.22	10.27	6.56 to 15.42	153
28/29	12.0	8 53.5	16.50	17.6	5.33	6.22	10.23	6.57 to 15.37	152

March 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	8 53.1	16.51	17.6	5.34	6.22	10.18	6.59 to 15.33	151
2/ 3	12.0	8 52.7	16.52	17.6	5.35	6.22	10.14	7.01 to 15.29	150
3/ 4	12.0	8 52.3	16.53	17.6	5.35	6.22	10.10	7.03 to 15.25	149
4/ 5	12.0	8 52.0	16.54	17.6	5.36	6.22	10.05	7.05 to 15.21	147
5/ 6	12.0	8 51.6	16.54	17.6	5.37	6.22	10.01	7.07 to 15.16	146
6/ 7	12.0	8 51.3	16.55	17.6	5.38	6.22	9.57	7.08 to 15.12	145
7/ 8	12.0	8 50.9	16.56	17.6	5.39	6.22	9.53	7.10 to 15.08	144
8/ 9	12.0	8 50.6	16.57	17.6	5.40	6.22	9.48	7.12 to 15.04	143
9/10	12.0	8 50.3	16.57	17.6	5.41	6.22	9.44	7.14 to 14.59	142
10/11	12.0	8 50.0	16.58	17.6	5.42	6.22	9.40	7.16 to 14.55	141
11/12	12.0	8 49.7	16.58	17.6	5.43	6.22	9.36	7.18 to 14.51	140
12/13	12.0	8 49.4	16.59	17.6	5.44	6.22	9.31	7.20 to 14.47	139
13/14	12.0	8 49.1	16.59	17.6	5.45	6.22	9.27	7.22 to 14.43	138
14/15	12.0	8 48.8	16.60	17.6	5.46	6.22	9.23	7.23 to 14.39	137
15/16	12.0	8 48.6	17.00	17.6	5.47	6.22	9.19	7.25 to 14.34	136
16/17	12.0	8 48.3	17.01	17.6	5.49	6.22	9.14	7.27 to 14.30	135
17/18	12.0	8 48.1	17.01	17.6	5.50	6.22	9.10	7.29 to 14.26	133
18/19	12.0	8 47.8	17.01	17.6	5.51	6.22	9.06	7.31 to 14.22	132
19/20	12.0	8 47.6	17.02	17.7	5.52	6.22	9.02	7.33 to 14.18	131
20/21	12.0	8 47.4	17.02	17.7	5.53	6.23	8.58	7.35 to 14.14	130
21/22	12.0	8 47.2	17.02	17.7	5.55	6.23	8.54	7.37 to 14.09	129
22/23	12.0	8 47.0	17.02	17.7	5.56	6.23	8.49	7.39 to 14.05	128
23/24	12.0	8 46.8	17.02	17.7	5.57	6.23	8.45	7.41 to 14.01	127
24/25	12.0	8 46.7	17.03	17.7	5.58	6.23	8.41	7.43 to 13.57	126
25/26	12.0	8 46.5	17.03	17.7	5.60	6.23	8.37	7.45 to 13.53	125
26/27	12.0	8 46.3	17.03	17.7	5.61	6.23	8.33	7.47 to 13.49	124
27/28	12.0	8 46.2	17.03	17.7	5.62	6.23	8.29	7.49 to 13.45	123
28/29	12.0	8 46.1	17.03	17.7	5.64	6.23	8.25	7.51 to 13.41	122

Ephemeris for P/Schwassmann-Wachmann 1 (1989) (contd)

March 1995 *(contd)* Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
29/30	12.0	8 46.0	17.02	17.7	5.65	6.23	8.21	7.53 to 13.37	121
30/31	12.0	8 45.9	17.02	17.7	5.67	6.23	8.17	7.55 to 13.33	120
31/32	12.0	8 45.8	17.02	17.7	5.68	6.23	8.13	7.57 to 13.29	119

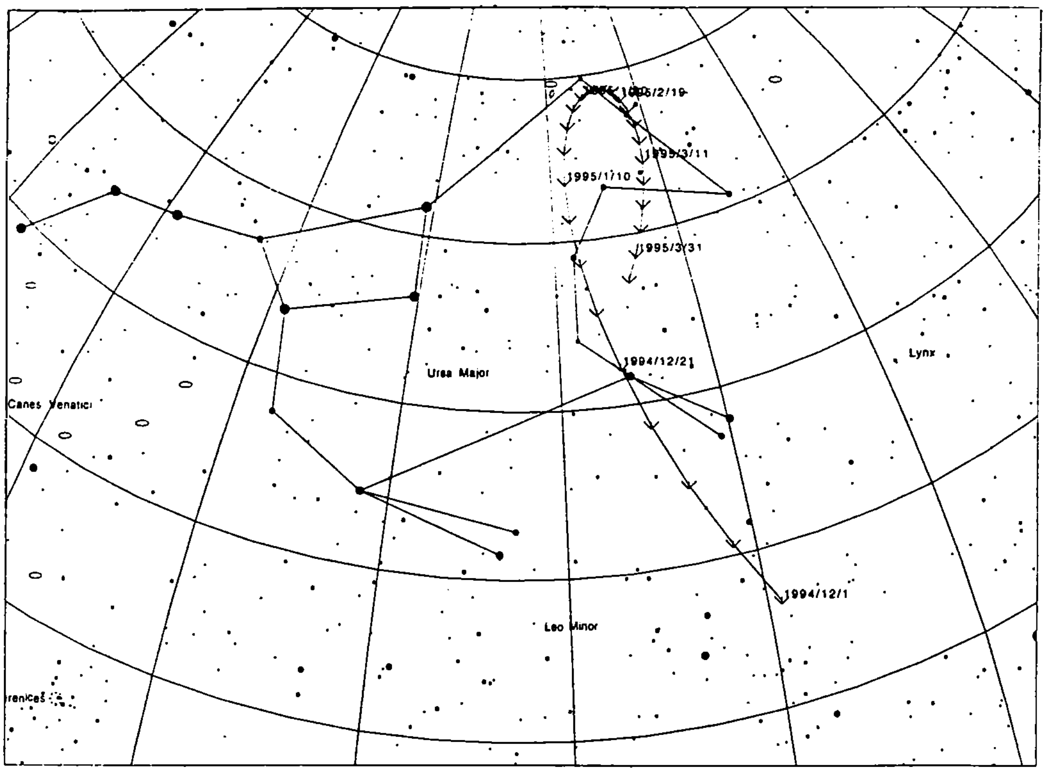
April 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	8 45.7	17.02	17.7	5.69	6.23	8.09	7.59 to 13.25	118
2/ 3	12.0	8 45.6	17.02	17.7	5.71	6.23	8.05	8.02 to 13.21	117
3/ 4	12.0	8 45.5	17.01	17.7	5.72	6.23	8.01	8.04 to 13.16	116
4/ 5	12.0	8 45.5	17.01	17.7	5.74	6.23	7.57	8.06 to 13.12	115
5/ 6	12.0	8 45.4	17.01	17.7	5.75	6.23	7.53	8.08 to 13.08	114
6/ 7	12.0	8 45.4	17.00	17.7	5.77	6.23	7.49	8.10 to 13.04	113
7/ 8	12.0	8 45.4	16.60	17.8	5.78	6.23	7.45	8.12 to 13.00	112
8/ 9	12.0	8 45.4	16.59	17.8	5.80	6.23	7.41	8.15 to 12.56	111
9/10	12.0	8 45.4	16.59	17.8	5.81	6.23	7.37	8.17 to 12.52	110
10/11	12.0	8 45.4	16.58	17.8	5.83	6.23	7.33	8.19 to 12.49	109
11/12	12.0	8 45.4	16.58	17.8	5.84	6.23	7.29	8.21 to 12.45	108
12/13	12.0	8 45.5	16.57	17.8	5.86	6.23	7.25	8.24 to 12.41	107
13/14	12.0	8 45.5	16.56	17.8	5.87	6.23	7.21	8.26 to 12.37	106
14/15	12.0	8 45.6	16.56	17.8	5.89	6.23	7.17	8.28 to 12.33	105
15/16	12.0	8 45.7	16.55	17.8	5.91	6.23	7.14	8.31 to 12.29	104
16/17	12.0	8 45.7	16.54	17.8	5.92	6.23	7.10	8.33 to 12.25	103
17/18	12.0	8 45.8	16.53	17.8	5.94	6.23	7.06	8.35 to 12.21	102
18/19	12.0	8 45.9	16.52	17.8	5.95	6.23	7.02	8.38 to 12.17	101
19/20	12.0	8 46.0	16.51	17.8	5.97	6.23	6.58	8.40 to 12.13	101
20/21	12.0	8 46.2	16.50	17.8	5.99	6.23	6.54	8.42 to 12.09	100
21/22	12.0	8 46.3	16.49	17.8	6.00	6.23	6.51	8.45 to 12.05	99
22/23	12.0	8 46.4	16.48	17.8	6.02	6.23	6.47	8.47 to 12.01	98
23/24	12.0	8 46.6	16.47	17.8	6.03	6.23	6.43	8.50 to 11.57	97
24/25	12.0	8 46.7	16.46	17.9	6.05	6.23	6.39	8.52 to 11.54	96
25/26	12.0	8 46.9	16.45	17.9	6.07	6.23	6.35	8.55 to 11.50	95
26/27	12.0	8 47.1	16.44	17.9	6.08	6.23	6.32	8.57 to 11.46	94
27/28	12.0	8 47.3	16.43	17.9	6.10	6.23	6.28	9.00 to 11.42	93
28/29	12.0	8 47.5	16.41	17.9	6.11	6.23	6.24	9.03 to 11.38	92
29/30	12.0	8 47.7	16.40	17.9	6.13	6.23	6.20	9.05 to 11.34	91
30/31	12.0	8 47.9	16.39	17.9	6.15	6.23	6.17	9.08 to 11.30	90

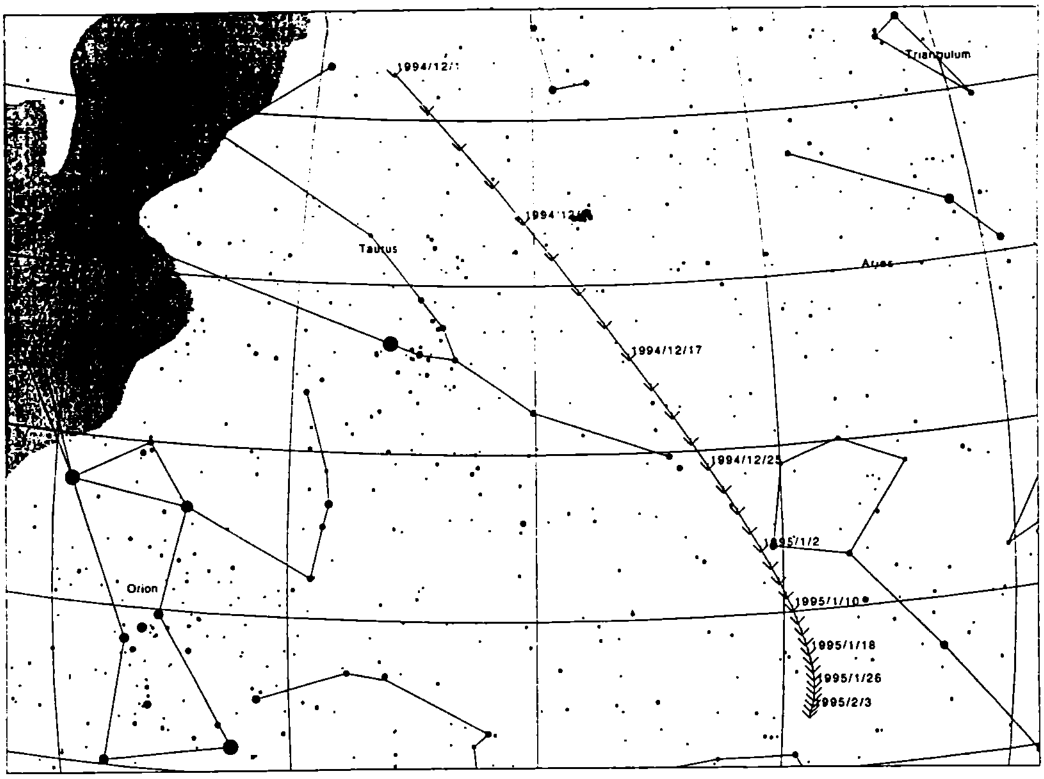
May 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	8 48.2	16.37	17.9	6.16	6.23	6.13	9.10 to 11.27	89
2/ 3	12.0	8 48.4	16.36	17.9	6.18	6.23	6.09	9.13 to 11.23	89
3/ 4	12.0	8 48.7	16.35	17.9	6.19	6.23	6.06	9.16 to 11.19	88
4/ 5	12.0	8 48.9	16.33	17.9	6.21	6.23	6.02	9.19 to 11.15	87
5/ 6	12.0	8 49.2	16.32	17.9	6.23	6.24	5.58	9.21 to 11.11	86
6/ 7	12.0	8 49.5	16.30	17.9	6.24	6.24	5.55	9.24 to 11.08	85
7/ 8	12.0	8 49.8	16.28	17.9	6.26	6.24	5.51	9.27 to 11.04	84
8/ 9	12.0	8 50.1	16.27	17.9	6.28	6.24	5.47	9.30 to 11.00	83
9/10	12.0	8 50.4	16.25	17.9	6.29	6.24	5.44	9.32 to 10.56	82
10/11	12.0	8 50.7	16.23	17.9	6.31	6.24	5.40	9.35 to 10.52	81
11/12	12.0	8 51.0	16.22	18.0	6.32	6.24	5.36	9.38 to 10.49	80
12/13	12.0	8 51.3	16.20	18.0	6.34	6.24	5.33	9.41 to 10.45	80
13/14	12.0	8 51.7	16.18	18.0	6.36	6.24	5.29	9.44 to 10.41	79
14/15	12.0	8 52.0	16.16	18.0	6.37	6.24	5.26	9.47 to 10.37	78
15/16	12.0	8 52.4	16.14	18.0	6.39	6.24	5.22	9.49 to 10.34	77
16/17	12.0	8 52.7	16.13	18.0	6.40	6.24	5.18	9.52 to 10.30	76
17/18	12.0	8 53.1	16.11	18.0	6.42	6.24	5.15	9.55 to 10.26	75
18/19	12.0	8 53.5	16.09	18.0	6.43	6.24	5.11	9.58 to 10.22	74
19/20	12.0	8 53.9	16.07	18.0	6.45	6.24	5.08	10.01 to 10.19	73

Comet P/Borrelly (1994l)



Comet Machholz (1994r)

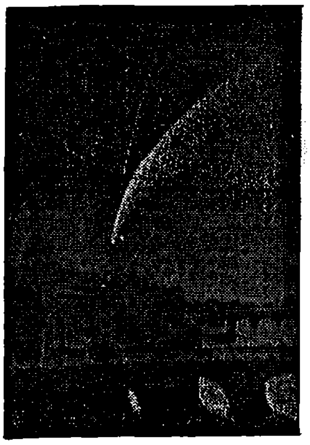


BAA Comet Section Visual Observation Report Form

Observer.......................... Comet.......................

Year........... Location......................

Month	Day.dd UT	M M	Total Mag	ref	Tel Ap	Type	f no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Rel	Comments



THE COMET'S TALE

Newsletter of the **Comet Section** of the **British Astronomical Association** 1995 June

Volume 2 No 1 (Issue 3)

Comet crash discussed at BAA meeting in Cambridge

James Lancashire, BAA Comet Section & CUAS

THE EIGHTH annual meeting organized by Cambridge University Astronomical Society for BAA observing sections took place at the Institute of Astronomy, Cambridge on Saturday, 1995 March 18, and covered the great comet crash of SL9 with Jupiter in 1994 July and its aftermath. After arrival refreshments, Paul McLaughlin, CUAS Observations Secretary, gave a short welcome before introducing the first speaker in a packed international programme.

Mark Bailey (Liverpool) spoke about the origins and dynamics of comets. Theory indicates three phases in the origin of the solar system. (1) Proto-stellar material contains sub micron-sized grains which, during the collapse to star and proto-planetary disc (for which models are rather uncertain), aggregate to leave sub metre-sized snowballs and boulders. (2) Once the star has 'switched on' and blown away the gas, gravitational instability gives rise to planetesimals, in good agreement with the Kuiper belt model. (3) The accretion of planetesimal occurs by collision, the timescale of which is independent of many parameters except solar distance. This theory gives rise to a planetary zone out to 30 AU, and an outer zone with primordial cometary material where there simply has not been sufficient time for planet formation. With this model, comets should be different from one another, with various sizes, structures and compositions. Dr Bailey concluded by talking about the long-term dynamics of comets, investigated using numerical integration. Perturbations by Jupiter and Saturn are known to affect many comets (including P/Halley and P/Encke) so that they will eventually fall into the Sun as 'sungrazers'. Near-misses break comets into constituent parts ('multiplication by division'), which may be important in the formation of meteor streams and secondary nuclei.

Jim Scotti (Arizona) then spoke on Comet Shoemaker-Levy 9. He had taken images of the comet and noticed 'wings' of material pushed away from the Sun by the solar wind. By tracking the orbits of the fragments back to perijove at 1.3 R_J, the spread, and therefore initial size, was estimated to be less than 2.2 km. By 1994 January, the dust wings had faded and the nuclei had developed tails of their own; some had moved 'off-axis' from the main string. Just prior to the impacts, the inner comae were observed to have elongated by gravitational attraction as they approached Jupiter again. At collision, the impacts gave rise to a ring of ejected material, expanding at 450 ms^{-1}, with a plume rising to around 3000 km after about 400 s. These effects occured independently of nucleus size, although some nuclei – including some of the brightest! – had no effect.

Niel Brandt (Cambridge) then concluded the first session with a talk about ROSAT observations of jovian x-ray auroral emissions during the impacts. Jupiter's aurora is normally active in UV through to x-rays, with power around a hundred times that of the Earth! During the impacts, nothing unusual was detected at the impact sites, but very bright auroral emission was seen from the northern conjugate points for impacts K and P, and possibly W. Dr Brandt then mentioned two models for the observations: (1) charged dust pickup as the incoming fragments pass through the tidal radius; and (2) dust-fragment interactions with Jupiter's magnetic field.

continued on page 3

Participants (l-r): Paul McLaughlin, James Lancashire, Mark Kidger, Niel Brandt, Peter Andrews, Seiji Kimura, Steven Miller, Jim Scotti, John Rogers, Richard McKim, Mark Bailey, Chris Trayner, Derek Hatch. [Photo: David Graham]

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1472 comet manuscript	*6*	*Lightcurves*	*10*

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Editorial

Welcome once again to the Comet Section Newsletter. With no comets around currently to urge you to observe, Jonathan and I decided to delay publication until the BAA Exhibition Meeting on June 24. Needless to say, a bright comet has not been discovered, despite the Moon heading towards New and leaving vast swaths of newly-dark sky in which an uncharted fuzzy object might be found. I have reported an interesting article on bright comets on page 9.

The current dearth does enable one, however, to write up and submit one's past months' (I hope not *years*'!) observations of comets to the Director – report forms containing magnitude estimates, drawings, CCD images or photographs will be welcomed!

In the intervening period since the last issue of *The Comet's Tale*, the Comet and Jupiter Sections of the BAA held a discussion meeting in Cambridge which was hosted by Cambridge University Astronomical Society at the Institute of Astronomy. Around a hundred people attended to hear a packed international speaker programme, and my report starts on the front cover.

Some sad news appeared in February with the death of Harold Ridley, a comet section stalwart. Although I met him only once at a meeting in London, he was full of enthusiasm for his subject and very encouraging towards my first ventures into cometary astronomy. He served, of course, on the BAA Council, and was very much a gentleman astronomer. Mike Hendrie writes a personal appreciation of Harold in this issue.

Computers and technology change so fast these days – the DTP package I am using to set this newsletter is many generations past the original – that I have included a handy list of sites on the World-Wide Web (WWW) which have resources on comets on the Internet. I hope these will be of use and will help to continue the endless voyage through cyberspace called *surfing*!

Prospects for (known) comets aren't too good for the remainder of 1995, but nevertheless 6P (d'Arrest) may come brighten to be seen with moderate instruments in late July and early August.

Finally, I must mention that I am moving to a new (permanent) job in late September situated in Bristol. In addition to the new work, I will have a significant study commitment for the next three years to pass more examinations and gain a professional qualification which will be invaluable in today's job market.

This means that I am stepping down as editor of the section newsletter and will be reducing my amateur involvement in astronomy generally for a few years. I do hope, however, to make use of the odd clear night and watch for meteors, do some binocular astronomy or join a local society's observing evening. I have a lot to look forward to, in particular a new part of the country for me.

In my first editorial, I expressed a desire to attract articles on "*all* aspects of cometary astronomy from history through current observations to future prospects". Looking back over these issues of *The Comet's Tale*, I think I have succeeded in that aim, not at all easy when the event of a lifetime – the impact of SL9 with Jupiter in the third week of 1994 July – could have stolen the show. Many thanks must be expressed to all contributors, and to you, the readers, for the encouragement that has made this job so enjoyable.

I look forward to seeing some of you again in the future. Sincere good wishes.

James Lancashire

Correction: Mike Hendrie wishes to add that in his obituary of Michael Candy (1928-1994): "For the record, Mike Candy left the UK for Pert in 1969, not 1967 as I stated in the last newsletter; also he discovered comet 1961 II on Boxing Day, December 26, 1960, not the 28. I have prepared a more detailed appraisal of Candy's life and work for the *Journal*."

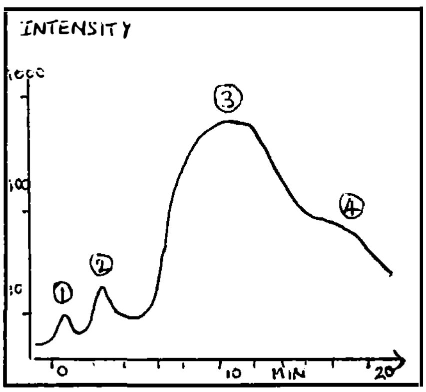
Jupiter/SL9 meeting in Cambridge

continued from page 1

Lunch had been prepared by the CUAS committee, and allowed the perusal of displays by the BAA, the Comet and Jupiter Sections, and the Japan Amateur Astronomers' Convention. Rosemary Naylor from 'Earth and Sky' had a stall, including a proof copy of the new book on Jupiter by John Rogers due out next year. Many people also went on a tour of the telescopes and facilities at the Institute of Astronomy.

Mark Kidger (Tenerife) then opened the afternoon session by talking about fireball observations from Tenerife, giving a feeling for events during impact week when, on each night, the site had seven telescopes in action. A wide-field camera was used and, although Jupiter's disc formed only a small part of the image, the existing equatorial zone and auroral caps stood out against the black planet. The impacts were impressive: impact L reached 7.5^m in visual and -0.5^m in IR . Dr Kidger concluded by mentioning the tremendous media interest in the events: his observations were piped live to two national television channels in Spain, the lecture theatre was crammed with 3000 people over five hours before each impact and the small control room had seventeen packed in space normally for four!

Steven Miller (UCL) spoke next about the professional observations and science of the impacts. Galileo had a direct view of the impacts, but curiously Hubble and Earth-based observations detected the impacts slightly earlier. The general form of each impact IR light-curve was: (1) a short flash as the main nucleus entered Jupiter's atmosphere; (2) the real fireball rising above the limb; (3) a rapid rise 6 min after impact to the very bright 'main event'; and (4) a decline checked slightly as the site rotated into direct view. The ejected material in the plume crashed back down onto the atmosphere with maximum heating at 10–12 min and spanning in IR about 45,000 km of the surface, far greater than at other wavelengths. Dr Miller concluded by saying that over the weeks since impact, material has spread in longitude and also in latitude, enabling the N-S wind speeds to be calculated for the first time.



General form of the IR lightcurve for the impacts: see text for details (1)–(4)

Peter Andrews (RGO, Cambridge) then spoke about fireball observations from La Palma. The Jacobus Kapteyn Telescope in visible light saw the plume of L (the largest impact) projecting over Jupiter's limb, whilst the Isaac Newton Telescope detected sodium (peaking 5 min earlier than other elements), iron, magnesium, and calcium, all of which must have originated in the comet rather than Jupiter. All the emission lines were at the *lowest possible* excitation, implying cool plume material collapsing back onto the planet, quite unlike meteors entering the Earth's atmosphere.

In the time before tea, two BAA members recounted their experiences. First, **Richard McKim,** BAA President, spoke about his first visit to California, using a different telescope each night. He showed his drawings made during impact week and continued on his return to the UK until mid-August. Then **Derek Hatch** showed results from his Astrophysics 6-inch refractor connected by Plossl eyepiece projection to a CCD video camera without its lens; many dark impact sites could be seen on his video.

Tea and biscuits were then provided by CUAS, and the opportunity was taken to reflect on personal experiences from impact week and to discuss some issues arising from the talks so far.

Seiji Kimura (Tokyo) then spoke about the visible impact scars as observed from Japan. He generously provided a handout giving a compilation of Japanese amateur work. Sixty people had attended a conference in Japan at which the work of fifteen Japanese observers was presented. He requested BAA contributions to ensure coverage at all Jovian longitudes. Mr Kimura showed using strip maps how the remarkable dark spots had appeared and evolved, becoming a continuous new belt which remained visible into 1995.

John Rogers (BAA Jupiter Section Director) then spoke about BAA observations and the development of the visible impact scars. Reports had been received by the BAA from the UK, India, Japan and the US. The sites were bright at methane wavelengths but dark visually, implying that they comprised a layer of high altitude, dark, absorbing material. The black core was the site of the explosion and the arc was settled ejected material; the sites tended to be darker visually about a day after impact. The (anticyclonic) white ovals seemed to attract dark material northward from nearby impact sites. Over a longer period, BAA members tracked the dark clouds as the impacts were a unique chance to study high-level Jovian clouds; drift rates were consistent with System III, although this is also the normal windspeed at the impact latitude. Dr Rogers concluded by talking about the impact belt which had encircled the planet by October and which was also seen by BAA members in December and January, although it has subsequently faded rapidly.

Chris Trayner (Leeds) then spoke about the Tunguska event, when on 1908 June 30 (Gregorian) at 07^h14^m local time (00^h14^m UT) a 10^9–10^{10} kg bolide flew at ~40 km s^{-1} into the atmosphere over Siberia and exploded at 8 km altitude, knocking down 2000 km^2 of forest but not leaving a crater. Local reports mention deaths of reindeer and houses collapsing. Dr Trayner said that details of the event could be estimated only to order of magnitude. Nevertheless, it illustrates what has happened when the Earth – not Jupiter – is involved in celestial billiards.

The day closed with high-level discussion on some controversial points. The BAA President thanked Paul McLaughlin and CUAS for organizing a successful and enjoyable day. Dr John Rogers also deserves thanks for contacting speakers. Around a hundred people were in attendance. With clearish skies, the Directors of Mars and Saturn sections stayed to observe Mars with the telescopes, but cloud had arrived before the occultation of Spica.

Section news from the Director

Dear Section member,

Things seem to have been very quiet since I left for the Antarctic. The change to the new naming scheme for comets took place on January 1 and this has either discouraged all the comet hunters or offended the heavens as only one has been found since then. Periodic comets with well known orbits are now individually numbered, rather like the asteroids, and a full list appears elsewhere in the newsletter. Shoemaker-Levy 9 does not receive a number however, as it was destroyed before it could return to perihelion. Comets which have been recovered, which might have received a year letter under the old scheme include 57P (du Toit-Neujmin-Delporte) and 58P (Jackson-Neujmin), so the gap is perhaps not as bad as it might seem.

Whilst I was away I was able to enter most of the remaining archival observations up to the mid-1970s, when observations began to be submitted to the *ICQ*. I also completed formatting the data from 1991 and 1992 which I had scanned from TA. All this material has now been sent to the *ICQ*. There are still a lot more observations that could be entered to complete our record until 1990, if anyone has the time and facilities to do so. I hope to publish reports on the periodic comets observed between 1955 and 1990 in a series of papers in the Journal. There are also some parabolic comets which were well observed (e.g. Bennett, Kohoutek, Kobayashi-Berger-Milon, etc) which could be written up as papers for the Journal – anyone interested please contact me.

I heard the sad news about **Harold Ridley** whilst I was away in the Antarctic. I have all his section files and photographic observations and hope to continue with his much valued prospects for comets series. A personal memory from Mike Hendrie appears elsewhere in this newsletter and a full obituary will appear in the *BAA Journal*. Another death that has recently occurred is that of **Ray Littleton**, who was a proponent of the flying gravel bank model of cometary structure. The well-known team of Carolyn and Eugene Shoemaker, David Levy and Henry Holt has finally concluded their observing program at Palomar, so no more Shoemaker-Levy comets are likely to be discovered with the 18" Schmidt camera. Estimates suggest that their famous comet was exceptional as it could be 2000 years before another comet hits Jupiter.

The **section guide** to observing comets is now nearly complete and will be going to press in early July. The text will be on display at the Exhibition meeting and last minute suggestions for changes may be included in the final version. Another way to get up to date comet information is via the world wide web and I have set up a page for the comet section on `http://www.ast.cam.ac.uk/~jds/` I don't propose to put the full text of the guide there, only sufficient information to help observers; there are also links to other pages with comet information. The BAA also has a page, which has been set up by Starbase 1 and this is available from `http://www.emoticon.com/emoticon/astro`

Since the last newsletter observations or contributions have been received from the following BAA members:

Robert Bullen, Werner Hasubick, Guy Hurst, James Lancashire, Jonathan Shanklin, Nick James, Bob Neville, Alex Vincent, and also from Alexander Baransky, John Bortle, Eric Broens, Matyas Csukas, Alfons Diepvens, Bjorn Granslo, Graham Keitch, Atilla Kosa-Kiss, Martin Lehky, Herman Mikuz, Antonio Milani, John Sanford, John Seach, David Seargent, Chris Spratt, Graham Wolf and Vittorio Zanotta;

and of comets:

8P (Tuttle), 9P (Tempel 1), 16P (Brooks 2), 19P (Borrelly), 29P (Schwassmann-Wachmann 1), 44P (Reinmuth 2), 51P (Harrington), 65P (Gunn), 77P (Longmore), C/1993 Q1 (Mueller), C/1993 Y1 (McNaught-Russell), C/1994 G1 (Takamizawa-Levy), C/1994 J2 (Takamizawa), C/1994 N1 (Nakamura-Nishimura-Machholz), P/1994 P1 (Machholz 2) and C/1994 T1 (Machholz).

Comet **19P (Borrelly)**, was followed until early April having reached a maximum brightness of around 8^m in November/December, around 1^m fainter than predicted by *ICQ*. The analysis suggests that the magnitude equation given in the last issue was correct with $H_1 = 7.3^m$ and $K_1 = 14^m$. It showed an interesting anti-tail as it crossed through the nodal plane, which was well shown in many CCD images. **C/1994 T1 (Machholz)** peaked at around 10^m in late November, though there is a large spread in early December with some observers making it as bright as 8.7^m and others as faint as 11.8^m, but otherwise giving it a similar physical description. The last visual observations were made in early January when it was 12^m, though Mikuz was able to observe it with his CCD camera in early February when it had faded to 15^m.

Prospects for the next six months are not particularly good, with comet **6P (d'Arrest)** likely to be the brightest on display and it is unlikely to be brighter than 11^m. Some sources suggest that it could reach 6.5^m in early August, however it has yet to be observed visually, although it should be around 14^m according to these predictions. CCD observations made it 16.7^m on June 1, suggesting that it won't be observed this time round unless it brightens very rapidly. **58P (Jackson-Neujmin)** could reach 11.5^m in September according to *ICQ* predictions and this is a more favourable return than at its discovery in 1936 when it reached 12^m. **29P (Schwassmann-Wachmann 1)** will emerge from conjunction in October and is worth following by those equipped with CCD cameras as it is frequently in outburst at around 13^m. Finally **18P (Perrine-Mrkos)** may reach 13^m towards the end of the year, though it has yet to be observed visually by the section and hasn't been seen since 1968. Southern observers may be able to follow **71P (Clark)** which is currently 12^m.

I will probably be visiting the Antarctic again from mid November to late January. During this time I can still be contacted by e-mail, but postal mail will have to wait until my return. Observations should go to Guy Hurst as usual and any urgent postal correspondence to James Lancashire.

Finally, thanks must go to James Lancashire for his sterling work in preparing the newsletter over the past couple of years. The professional standard he has achieved will be very hard to follow. He is moving to a new job in Bristol, but I hope he will get the opportunity to continue observing comets.

Jonathan Shanklin

Harold Ridley (1919–1995) – *a personal appreciation by Michael Hendrie*

AS MOST readers will know we lost one of our most earnest and talented supporters in February of this year, with the death of Harold Ridley. I was asked by Council to write an obituary article about Harold for the *Journal* which I hope will give a view of his life both in astronomy and outside. This should appear in the August number. But as I have been asked to write something for the Newsletter as well, I offer a few personal thoughts about Harold's interest and work on comets, and how I came to be associated with it.

I joined the BAA in 1951 and the Comet Section soon after. Harold became Director of the Meteor Section in 1954 and in 1955 I photographed a Lyrid and sent him a print. In writing back from his home in Barnes he mentioned that until 1951 he had been teaching in the Westcliff-on-Sea area and had been in digs for two years barely a mile from where I was and had been living. My brother, then at university, so it turned out had sold him deck chair tickets on the beach at Chalkwell during the summer vacation before any of us had met! So started a long association and friendship that was to continue without a break until our last telephone conversation the evening before he died.

At Barnes Harold did not have an observatory but used fixed cameras for meteor photography and spectrography. With these he did valuable and pioneering work on meteor spectrography especially. His teaching work and running the Meteor Section kept him quite busy. He was of course always interested in comets: indeed it is difficult to study one without the other and without asteroids as well.

I had been assisting Dr R.L.Waterfield at his observatory at Silwood Park near Ascot from time to time since 1956 and in 1960 April comet Burnham 1960 II turned up after he had made arrangements to be away for two or three weeks. He asked me if I would take the keys to the observatory and darkroom and see what I could get while he was away. Having only primitive equipment myself at that time I readily agreed to take a weeks leave but said that as it was a fast-moving comet, four hands would be better than two. Harold agreed to come over and we did have some good nights when useful plates

Harold Ridley at Waterfield's Ascot Observatory, 1960 April. Photo: M. Hendrie

were obtained. I remember we had only 13 hours sleep in 5 nights and showed slides of the comet to the BAA on the afternoon of the day they were obtained. I think we were both inspired to do more and better comet photography. Harold moved to Rogate for 3 years but it was not until his move to Godalming in 1963 that he could begin work on a fixed observatory and make driven exposures. That was really the start of his practical comet work.

There he set up an old BAA 4.5 inch Cooke refractor. The mounting was sound hut the drive had a lot of rather well-worn gearing and he had to make various improvements. micrometers for offsetting the comet's motion were hard to borrow then but he did get the loan of one after a while. He tried various lenses up to about 20-inches focal length and obtained some fine views of the sky and comets. He completely blacked out his garage, had water, sinks and drains installed and built benches all round until he had a very useful darkroom: the car stayed under a car-port.

When Harold retired from teaching in 1979 he looked for a part of the country that with less traffic and darker skies. Eventually he found a suitable south-facing bungalow at East Chinnock about 5 miles from Crewkerne. Situated up a single track lane about a mile from the village it had a beautiful view across miles of farmland towards the south and very dark skies. He never tired of that view by day or night. As a keen gardener he was able to develop the garden too. A small room once used to house a generator was converted into a darkroom.

Harold set out to obtain the best possible images and obtained an excellent new mounting and drive from AE Optics to which he added a BAA 6-inch refractor tube assembly and various cameras. His last lens was a Zeiss f/7 of about 49-inches focal length (which I understand is now doing service in the restored, by Glyn Marsh, Mond astrograph formerly at the Norman Lockyer observatory).

In 1968 Reggie Waterfield had moved from Ascot to Woolston near Wincanton and I went down there two or three times a year to help out. I was fortunate to be there when comet Bennett 1970 II was at its peak. I always took ... *contd*

Harold Ridley *(contd)*

a complete tool kit with me as there was often an electrical problem with the micrometer lights and not infrequently a micrometer to be re-webbed. As East Chinnock was only about 22 miles from Woolston, Harold often received telephone calls, often late in the evening, asking him to drive over on the chance that it would still be clear by the time he arrived. Sometimes Harold felt that he would rather use his own equipment and sometimes he just felt he would rather not drive nearly 50 miles, but I think he usually went and provided much assistance over several years until Waterfield's death in 1986. (I see that the assistance that Harold gave Reggie Waterfield was not something that I mentioned in the official obituary and I am glad to have a second opportunity to mention it here).

Harold was very interested in the relation of comets and meteor streams and in and long-term changes in comets' brightness and activity. He kept files on all the periodic comets and others too, and liked to prepare his *Prospects* for the next year or two ahead. This involved him in a great amount of work which the short, pithy summaries that he published did not disclose. He also went to considerable trouble to get good measures of his astrometric plates. Both he and I had some experience of Waterfield's measuring machine and methods, I and others then measured some of Harold's plates until he took on board the BAA Zeiss measuring machine that occupied nearly a quarter of his study.

Harold lived with his sister Mollie from Barnes days until her death in 1988. He told me he had emphysema in 1986 but he may have known earlier. It did not really affect him too much until about 1992 but he decided to carry on and do as much as he could while he still had the strength and mobility. Eventually of course he had to give up observing, his last photograph was of nova Cassiopeia 1993 on 1995 December 21. He spent several spells in Yeovil and Crewkerne hospitals between spells at home where he looked after himself with increasing difficulty. He never complained about his illness and said he was lucky to have been able to observe and live as he wished for so long.

Michael Hendrie

The Blasynge Sterre of 1472

Richard Butterwick of the Cambridge University Astronomical Society discovered a reference to a comet in a manuscript by John Warkworth, who was Master of Peterhouse in 1472, in the college library. It describes observations of the comet of 1472 and Richard provides the following transcription [his editorial comments are in brackets]:

"And in the same xj. yere of the Kynge [eleven, and similarly for all future numbers], in the begynnynge of Januarij, there apperyd the moste mervelous blasynge sterre that hade bene seyne. It aroose in the southe este, at ij. of the cloke at mydnyghte, and so contynuede a xij. nyghtes; and it arose ester and ester, tille it aroose fulle este; and rather, and rather [earlier and earlier]; and so when it roose playne este, it rose at x. of cloke in the nyght, and kept his cours flamynge westwarde overe Englonde; and it hadde a white flaume of fyre fervently brennynge, and it flammede endlonges fro the est to the weste, and not upryght, and a grete hole therin, wherof the flawme came oute of. And aftyre a vj. or vij. dayes, it aroose north-est, and so bakkere and bakkere; and so enduryd a xiiij nyghtes, fulle lytelle chaungynge, goynge from the north-este to the weste, and some tyme it wulde seme aquenchede out, and sodanly it brent fervently ageyne. And thenne it was at one tyme playne northe, and thenne it compassede round aboute the lodesterre [Pole Star], for in the evynynge the blase went ageyns the southe, and in the mornynge playne northe, and thenne afterwarde west, and so more west, flaumyng up ryghte; and so the sterre contynduede iiij. wekys, tylle the xx. day of Feveryere; and whenne it appered yest in the fyrmament, thenne it lasted alle the nyghte, somewhat discendyng with a grettere smoke one the heyre. And some menne seyde that the blassynges of the seide sterre was of a myle length. And a xij. dayes afore the vanyschynge therof, it appereryd in the evynynge, and was downe anone within two oures, and evyr of a colour pale stedfast; and it kept his course rysynge west in the northe, and so every nyght, it apperide lasse and lasse tylle it was as lytelle as a hesylle styke [Hazel stick]; and so at the laste it waneschede aaaway the xx. day of Februarij. And somee menne saide that this sterre was seene ij. or iij. oures afore the sunne rysynge in Decembre, iiij. days before Crystynmasse, in the south-west; so by that reasoune it compassed rounde abowte alle the erthe, alle way chaungynge his cours, as is afore reherside."

I have investigated the orbit, observing circumstances and other observations of the comet. The comet was discovered on 25th December 1471, when 4^m, just south of the Virgo/Libra border and passed near to Spica. By mid January 1472 it was in Bootes and had a tail 30° long. On the 21st it was visible in broad daylight and passed within 0.07 AU of the Earth, covering 40° in a day. It moved through Cepheus, Cassiopeia and Andromeda and was last seen, in Pisces, on the 21st of February.

In Europe it was observed by Toscanelli from January 8th and by Regiomontanus from the 13th until the end of February. It was also observed by Hagasi ab Hauk, who seems to be otherwise unknown. It was well observed in China, they wrote:

"In the 7th year of the same epoch, 12th moon, on the day Kea Seuh (1472 Jan 16), a comet was seen in Teen Teen. It pointed towards the west. It suddenly went to the north. It passed through Yew She Te. It swept Shang Tseang in Tae Wei Yuen, and also Hing Chin, Tae Tsze, and Tsung Kwan. The tail pointed directly to the west. It swept across Tae Wei Yuen and Lang Wei. On the day Ke Maou (Jan 21st) the luminous envelope had lengthened greatly. It extended from east to west across the heavens. It went northwards about 28 degrees. It passed near Teen Tsang and swept Pih Tow, San Kung and Tae Yang. It entered Tsze Wei Yuen and is said to have been seen in full daylight...... It gradually faded, and it was some time before it finally disappeared."

Halley computed the comet's orbit, though his results were not particularly accurate. Modern determinations of the orbital elements allow us to compute an accurate ephemeris of the comet. It would have become visible in the morning sky in mid December 1471 and slowly brightened, rising earlier each night. When discovered it rose just after midnight, though the view would have been rather spoilt by the full moon. It steadily approached the Earth, brightening as it did so. It reached 2^m in early January, 0^m in mid month and peaked at -4^m on the 22nd. From January 20th it was an evening object, and slowly faded, remaining at negative magnitude and decreasing in elongation from the sun until the end of February when it became too close to the sun to be seen.

Jonathan Shanklin

Hubble detects comets beyond Neptune

NASA's Hubble Space Telescope has detected a long-sought population of comets dwelling at the icy fringe of the solar system. The observation, which is the astronomical equivalent to finding the proverbial needle-in-haystack, bolsters proof for a primordial comet reservoir just beyond Neptune, currently the farthest planet from the Sun.

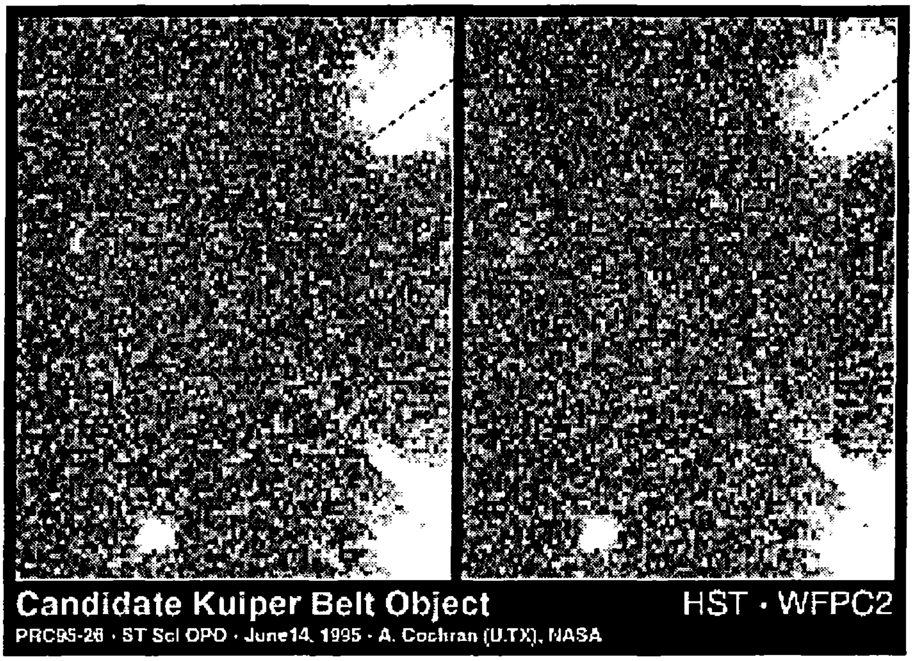
Based on the Hubble observations, a team of astronomers consisting of Anita Cochran of the University of Texas, Austin, TX, Hal Levison and Alan Stern of Southwest Research Institute, San Antonio, TX branch office in Boulder, CO, and Martin Duncan of Queen's University, Ontario, Canada, estimate the belt contains at least 200 million comets, which have remained essentially unchanged since the birth of the solar system 4.5 billion years ago.

"For the first time, we have a direct handle on the population of comets in this outer region. The solar system just got a lot more interesting," said Cochran. "We now know where these short-period comets formed, and we now have a context for their role in the solar system's evolution."

The existence of a comet-belt encircling our solar system – like the rings which wrap around Saturn – was first hypothesized more than 40 years ago by astronomer Gerard Kuiper. The so-named Kuiper Belt remained theory and conjecture until 1992, when ground-based telescopes began detecting about 20 large icy objects ranging from 60 to 200 miles in diameter. The planet Pluto is considered by astronomers to be the largest member of the Kuiper Belt region. However, researchers had to wait for Hubble Space Telescope's high spatial resolution and sensitivity before they could search for an underlying population of much smaller bodies assumed to be present – just as there are more pebbles on the beach than boulders.

"This is a striking example of what Hubble can do well," said Cochran. "We can at last identify small comet-sized objects that are just a few miles across, about the size of New York's Manhattan Island. "Cochran discussed her team's findings at a 11:00 a.m. news conference June 14, at the 186th meeting of the American Astronomical Society in Pittsburgh, PA.

The team believes this apparently closes the mystery of the source of the short period comets, that orbit the Sun in less than 200 years, including such members as comet Encke, Giacobini-Zinner, and the infamous comet Shoemaker-Levy 9 that collided with the planet Jupiter in July, 1994. The comet-disk lies just beyond Neptune and might stretch 500 times farther from the Sun than Earth. This is 100 times closer to Earth than the hypothesized Oort cloud, commonly thought to be a vast repository of comets that were tossed out of the early solar system. Despite their close proximity, the Kuiper belt comets don't pose any greater threat of colliding with Earth than comets that come from much farther out, said experts.



The comet nuclei are the primordial building blocks that condensed out of the cloud of gas, dust and ices that collapsed to form the Sun. "Knowing where comets come from will help constrain models for the formation of the solar system and tells us something new about where we came from," Cochran emphasized.

"The Kuiper Belt is the best laboratory in the solar system for studying how planets formed," said Levison. "We believe we are seeing a region of the solar system where the accumulation of planets fizzled out."

The icy nuclei are too far away to have the characteristic shell (coma) and tail of gasses and dust that are a comet's trademarks, when it swings close enough to the Sun to warm up and sublimate. Detecting these bodies in their "deep-freeze" state, at the dim horizon of the solar system, pushed Hubble Space Telescope to its performance limits. "Imagine trying to see something the size of a mountain, draped in black velvet, located four billion miles away," said Stern.

The team used Hubble's Wide Field Planetary Camera 2 (WFPC 2) to observe a selected region of the sky in the constellation Taurus, that had few faint stars and galaxies that would confuse the search. The detection is based purely on a statistical approach, because the objects being discovered are so faint.

The team plans to continue searching for more objects. They have already collected more images with Hubble. These additional images allow them to better quantify the number and sizes of comets in the Kuiper belt. They also will apply for more Hubble observing time in the future to probe the structure of the Kuiper belt.

Press release courtesy of Ron Baalke

New designations for periodic comets

Number	Name
50P	Arend
49P	Arend-Rigaux
47P	Ashbrook-Jackson
3D	Biela
85P	Boethin
19P	Borrelly
16P	Brooks 2
5D	Brorsen
23P	Brorsen-Metcalf
87P	Bus
101P	Chernykh
95P	Chiron
67P	Churyumov-Gerasimenko
108P	Ciffreo
71P	Clark
32P	Comas Sola
27P	Crommelin
6P	d'Arrest
33P	Daniel
54P	de Vico-Swift
72P	Denning-Fujikawa
66P	du Toit
79P	du Toit-Hartley
57P	du Toit-Neujmin-Delporte
2P	Encke
4P	Faye
15P	Finlay
37P	Forbes
34P	Gale
90P	Gehrels 1
78P	Gehrels 2
82P	Gehrels 3
21P	Giacobini-Zinner
84P	Giclas
26P	Grigg-Skjellerup
65P	Gunn
1P	Halley
51P	Harrington
52P	Harrington-Abell
100P	Hartley 1
103P	Hartley 2
110P	Hartley 3
117P	Helin-Roman-Alu 1
111P	Helin-Roman-Crockett
35P	Herschel-Rigollet
17P	Holmes
45P	Honda-Mrkos-Pajdusakova
88P	Howell
58P	Jackson-Neujmin
48P	Johnson
59P	Kearns-Kwee
68P	Klemola
75P	Kohoutek
70P	Kojima
22P	Kopff
99P	Kowal 1
104P	Kowal 2
77P	Longmore
93P	Lovas 1
96P	Machholz 1

Number	Name
115P	Maury
97P	Metcalf-Brewington
28P	Neujmin 1
25D	Neujmin 2
42P	Neujmin 3
13P	Olbers
39P	Oterma
18P	Perrine-Mrkos
80P	Peters-Hartley
12P	Pons-Brooks
7P	Pons-Winnecke
30P	Reinmuth 1
44P	Reinmuth 2
83P	Russell 1
89P	Russell 2
91P	Russell 3
94P	Russell 4
92P	Sanguin
24P	Schaumasse
106P	Schuster
29P	Schwassmann-Wachmann 1
31P	Schwassmann-Wachmann 2
73P	Schwassmann-Wachmann 3
61P	Shajn-Schaldach
102P	Shoemaker 1
105P	Singer Brewster
56P	Slaughter-Burnham
74P	Smirnova-Chernykh
113P	Spitaler
38P	Stephan-Oterma
64P	Swift-Gehrels
109P	Swift-Tuttle
98P	Takamizawa
69P	Taylor
9P	Tempel 1
10P	Tempel 2
11D	Tempel-Swift
55P	Tempel-Tuttle
62P	Tsuchinshan 1
60P	Tsuchinshan 2
8P	Tuttle
41P	Tuttle-Giacobini-Kresak
112P	Urata-Niijima
40P	Vaisala 1
53P	Van Biesbroeck
76P	West-Kohoutek-Ikemura
20D	Westphal
36P	Whipple
63P	Wild 1
81P	Wild 2
86P	Wild 3
116P	Wild 4
107P	Wilson-Harrington
46P	Wirtanen
114P	Wiseman-Skiff
14P	Wolf
43P	Wolf-Harrington

Computer update

WITH THE continued expansion of the Internet and global resources available to a PC/modem combination, I provide a set of useful starting points to astronomy in general and comets in particular. Note the rather strange locations which must be typed exactly as they appear – do not type spaces across line continuations!

BAA Comet Section (Jon Shanklin):
`http://www.ast.cam.ac.uk/~jds/`

Charles Morris's US homepage:
`http://encke.jpl.nasa.gov/index.html`

Comet SL9 Home Page (JPL):
`http://newproducts.jpl.nasa.gov/sl9/sl9.html`

Comet SL9 Impact Home Page (SEDS):
`http://seds.lpl.arizona.edu/sl9/sl9.html`

Comet Shoemaker-Levy 9 (NSSDC):
`http://nssdc.gsfc.nasa.gov/planetary/comet.html`

Comets and Meteor Showers (Kronk):
`http://wums.wustl.edu/~kronk/index.htm`

Welcome to Cambridge Astronomy:
`http://www.ast.cam.ac.uk/`

NASA Information Services via World Wide Web:
`http://hypatia.gsfc.nasa.gov/NASA_homepage.html`

Space Telescope Science Institute:
`gopher://stsci.edu/00/html/top.html-bak`

Astronomical Internet Resources:
`http://stsci.edu/net-resources.html`

Welcome to the Planets:
`http://stardust.jpl.nasa.gov/planets/index.htm`

The Nine Planets:
`ftp://ftp.netcom.com/pub/billa/nineplanets/nineplanets.html`

UK Amateur Astronomy:
`http://www.emoticon.com/emoticon/astro/`

Happy surfing on the Internet Superhighway!

James Lancashire

Bright comets since 1750

In *Earth, Moon and Planets* Vol. 66 No.2 (1994), Kidger investigates the statistics behind the amateur astronomer's complaint of the lack of bright comets. [It's certainly something I moan about! – *Ed.*] He examines bright naked eye apparitions since 1750 and finds 97 such comets, giving an average of one bright comet per 2.5 yr.

The distribution of intervals between bright comets follows Poisson (i.e. random) statistics. This means that there is a 2/3 probability of a bright comet within 2.5 yr of the most recent spectacle. However, if the distribution is *random* then there is a 1/3 chance that the next bright comet will be more than 2.5 yr away, 1/20 of being more than 5 yr away and 1/400 that we will have to wait more than 7.5 yr! Thus our current 9 yr interval should be statistically rare, but that is no comfort to the observer! (The significance of 2.5, 5 and 7.5 yr is that they are the mean interval, twice the mean and three times the mean, respectively.)

The statistics show lots of very short intervals between bright comets but very few very long intervals. In fact, 50% of bright comets have been followed by another within a year, 75% within 3 yr and 96% within 8 yr.

The statistics also fail to support the observer's feeling that there were more naked-eye comets way back in the past, although this century does have a comparative lack of very bright comets. The past quarter-century also has two of the longest intervals between bright comets: between Comet West (1976) and Comet Halley (1986), and the subsequent interval to the present.

Using 10-yr samples and a five-point (i.e. 50-yr) running mean, Kidger shows that the past century has been rather average in its number of bright comets, although this followed something of a 'golden age' during the decade of the 1880s which had 12 bright comets.

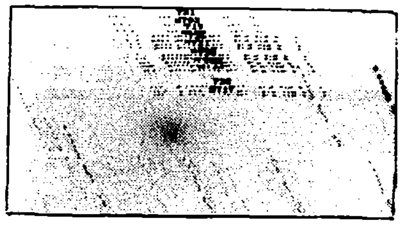
Finally, there is an analysis of possible perturbations by the Kuiper belt or Planet X, but there is no significant evidence for either of these.

Perhaps the best things is still to cross one's fingers!

James Lancashire

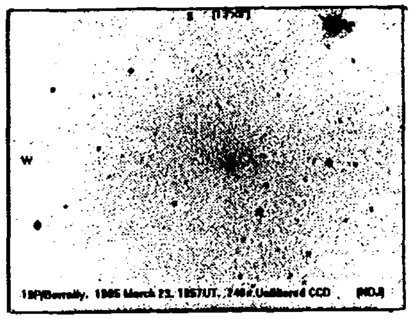
Images

1994m (Nakamura-Nishimra-Mahholz)



Bob Neville's multiple CCD images (16 x 20 s) stacked with the cometary nucleus as common frame point. Date: 1994 Aug 28

19P (Borrelly)

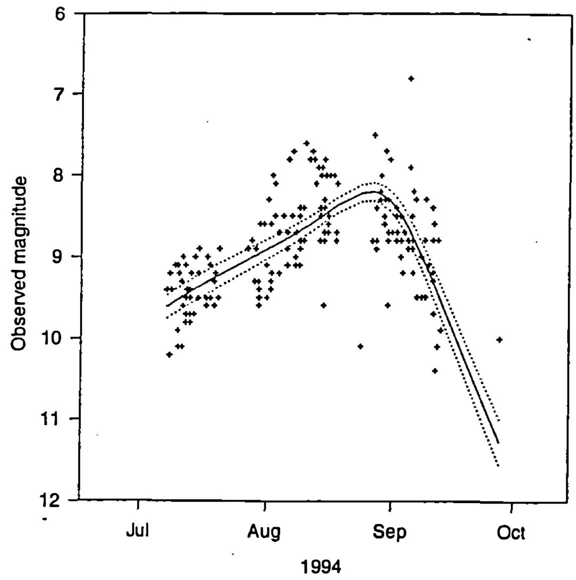


CCD image by Nick James taken on 1995 March 23 at 1957 UT. Exposure is 240 s. In the original image, there is a broad tail extending from the comet nucleus to the SE (upper right) which is difficult to reproduce here. The comet was about 13^m visually

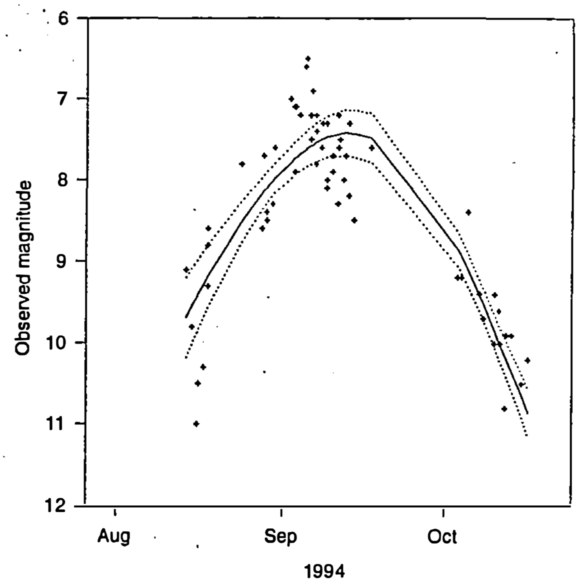
Lightcurves

follow overleaf...

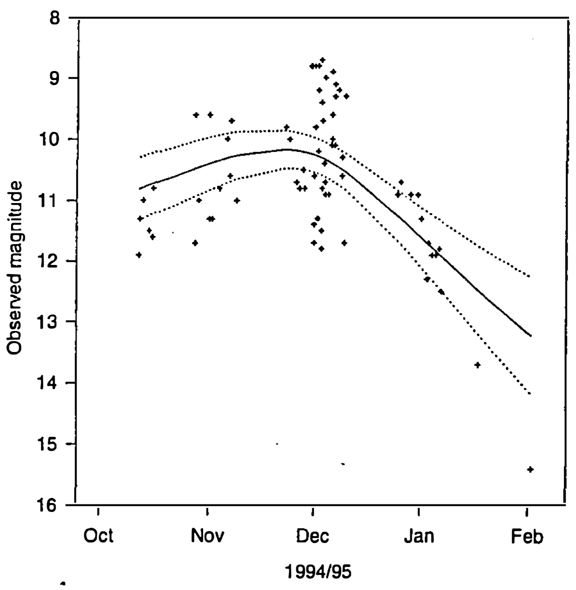
Comet C/1994 N1 (Nakamura-Nishimura-Machholz)



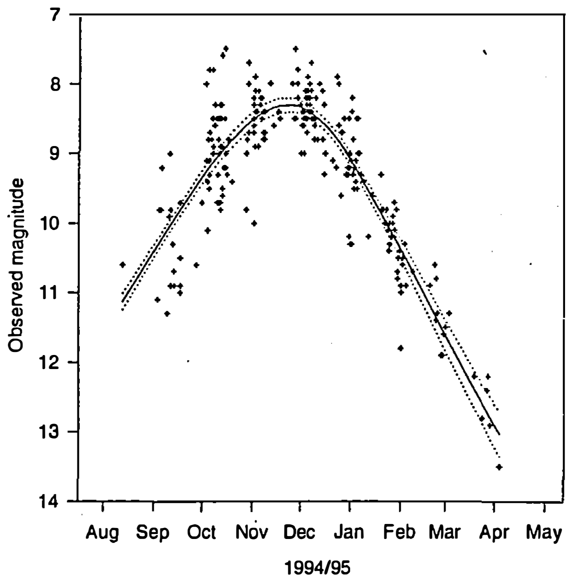
Comet P/1994 P1 (Machholz 2)



Comet C/1994 T1 (Machholz)



Comet 19P (Borrelly)



Review of comet observations for 1994 November – 1995 May

In addition to the Director's report and lightcurves based on observations from BAA members, I present a review of comets over the winter and spring, with information gleaned from IAU circulars 6106–6177 and *The Astronomer* (1994 November – 1995 May). Note that the figures quoted are rounded off from their original published accuracy. Full reports on some comets will appear elsewhere in due course.

Comets with names printed in ***bold italic type*** have ephemerides and charts printed later in this supplement. Please use the new comet report form for your observations!

29P (Schwassmann - Wachmann 1): CCD mag 14–15, with flares to mag 13 in mid Jan and late Feb.

44P (Reinmuth 2): mag 13 in Oct.

C/1994 G1 (Takamizawa-Levy): secondary nucleus observed on April 5, 6.

19P (Borrelly): mag 8 in Nov, with fan-shaped anti-tail in mid Nov; fading to mag 9 during Dec with some observers reporting a double tail; continued fading to mag 10 during Jan, mag 11 by mid Feb, mag 12 by end Feb and mag 13 at end Mar.

P/1994 P1 (Machholz 2): mag 10 in October.

C/1994 T1 (Machholz): brightened to mag 10 in Nov and Dec; faded to mag 11 by early Jan, mag 12 in late Jan and mag 13 in Feb.

22P (Kopff): rec'd at mag 22.

71P (Clark): recovered at mag 17; mag 13 in mid Apr, brightening to mag 12 by mid May.

116P (Wild 4): rec'd at mag 20.

73P (Schwassmann-Wachmann 3): recovered at mag 22.

P/1994 X1 (McNaught-Russell): discovered at mag 17 in mid Dec, well after it perihelion on 1994 Sept 6, with inclination 29° and period 15 yr.

41P (Tuttle - Giacobini - Kresak): recovered at mag 22.

P/1989 T2 (Helin-Roman-Alu): observed all round orbit, mag 20 at end Jan.

P/1995 A1 (Jedicke): discovered at mag 19 in early Jan, perihelion was on 1993 Mar 20! Eccentricity is 0.35, inclination 23° and period 14 yr.

65P (Gunn): CCD mag 16 in early Feb.

D/1931 R1 = 84P (Giclas): IAUC 6161 gave details of a mag 15 comet recently found on a plate taken by Clyde Tombaugh in 1931 September, for which an elliptical orbit was calculated. The elements are compatible with the known comet 84P (Giclas).

7P (Pons-Winnecke): mag 20 in Jan.

6P (d'Arrest): CCD mag 17 in early Jun.

58P (Jackson-Neujmin): CCD mag 21 in mid May.

57P (du Toit - Neujmin - Delporte): CCD mag 21 in late May.

James Lancashire

Comet ephemerides for 6P (d'Arrest), 58P (Jackson-Neujmin), 18P (Perrine-Mrkos), 29P (Schwassmann-Wachmann 1) [CCD] & 71P (Clark) [southern hemisphere]

Computed by Jonathan Shanklin.

Comet ephemerides are for the UK (actually Cambridge: long. 0.1° E, lat. 52.2° N) and give the following:–

- Name of comet
- Orbital elements (**epoch 2000**)
- Magnitude formula

Conditions for the comet to be observable. This is a rough indication only. The sun must be 13° or more below the horizon (i.e. sky is dark) and the comet a distance above the horizon depending on its predicted brightness.

A bright comet may be visible outside these limits. Equally a faint comet in poor skies may be invisible!

- Month, year. **All times are in Greenwich Mean Astronomical Time (GMAT)**, i.e. the day is the day on which the night starts. To convert to UT (GMT) add 12 hours. If the value is greater than 24, add 1 to the day and subtract 24 from the hour. If necessary, convert to local time. Strictly, ephemeris time is used which is currently some 60 seconds ahead of UT.

- Column headings:

a) Double-date format. **Time in GMAT.**

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are for **epoch 1950**).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of observability subject to the constraints in line 7. The comet may be visible outside this period.

h) Elongation from the sun in degrees.

Ephemerides follow

Ephemeris for **6P (d'Arrest)**

Omega=178.0540 OMEGA=138.9870 i= 19.5230 q= 1.345880 a= 3.486916
e=0.614020 P= 6.511 T= 1995 July 27.3660 Epoch= 2000
Magnitudes calculated from m=10.1+5.0*Log(d)+20.0*Log(r)+0.000*Beta

July 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	22 4.4	7.57	11.6	0.54	1.38	15.28	11.07 to 13.17	121
2/ 3	12.0	22 7.2	7.45	11.5	0.54	1.38	15.27	11.06 to 13.19	121
3/ 4	12.0	22 10.1	7.31	11.5	0.53	1.37	15.26	11.05 to 13.21	122
4/ 5	12.0	22 13.0	7.17	11.4	0.52	1.37	15.25	11.03 to 13.23	122
5/ 6	12.0	22 15.9	7.02	11.4	0.52	1.37	15.24	11.03 to 13.25	123
6/ 7	12.0	22 18.8	6.46	11.4	0.51	1.37	15.23	11.02 to 13.27	123
7/ 8	12.0	22 21.7	6.29	11.3	0.51	1.36	15.22	11.01 to 13.29	124
8/ 9	12.0	22 24.6	6.11	11.3	0.50	1.36	15.21	11.01 to 13.31	124
9/10	12.0	22 27.5	5.52	11.3	0.50	1.36	15.20	11.00 to 13.33	125
10/11	12.0	22 30.5	5.32	11.2	0.49	1.36	15.19	11.00 to 13.36	125
11/12	12.0	22 33.4	5.11	11.2	0.49	1.36	15.18	10.60 to 13.38	125
12/13	12.0	22 36.3	4.49	11.2	0.48	1.36	15.17	10.60 to 13.40	126
13/14	12.0	22 39.3	4.26	11.1	0.48	1.35	15.16	11.00 to 13.43	126
14/15	12.0	22 42.2	4.02	11.1	0.47	1.35	15.15	11.00 to 13.45	127
15/16	12.0	22 45.2	3.37	11.1	0.47	1.35	15.14	11.01 to 13.48	127
16/17	12.0	22 48.1	3.11	11.0	0.46	1.35	15.13	11.02 to 13.50	128
17/18	12.0	22 51.1	2.44	11.0	0.46	1.35	15.12	11.02 to 13.53	129
18/19	12.0	22 54.0	2.16	11.0	0.45	1.35	15.11	11.03 to 13.56	129
19/20	12.0	22 56.9	1.47	11.0	0.45	1.35	15.10	11.04 to 13.58	130
20/21	12.0	22 59.8	1.17	10.9	0.45	1.35	15.09	11.05 to 14.01	130
21/22	12.0	23 2.8	0.46	10.9	0.44	1.35	15.08	11.07 to 14.03	131
22/23	12.0	23 5.7	0.14	10.9	0.44	1.35	15.07	11.08 to 14.06	131
23/24	12.0	23 8.5	-0.19	10.9	0.44	1.35	15.05	11.10 to 14.09	132
24/25	12.0	23 11.4	-0.53	10.9	0.43	1.35	15.04	11.12 to 14.11	132
25/26	12.0	23 14.3	-1.27	10.8	0.43	1.35	15.03	11.14 to 14.14	133
26/27	12.0	23 17.1	-2.03	10.8	0.43	1.35	15.02	11.16 to 14.17	134
27/28	12.0	23 19.9	-2.40	10.8	0.42	1.35	15.01	11.18 to 14.19	134
28/29	12.0	23 22.7	-3.17	10.8	0.42	1.35	14.60	11.21 to 14.22	135
29/30	12.0	23 25.5	-3.55	10.8	0.42	1.35	14.59	11.23 to 14.24	135
30/31	12.0	23 28.2	-4.34	10.8	0.42	1.35	14.58	11.26 to 14.27	136
31/32	12.0	23 31.0	-5.13	10.8	0.42	1.35	14.56	11.29 to 14.30	136

August 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	23 33.6	-5.53	10.8	0.41	1.35	14.55	11.32 to 14.32	137
2/ 3	12.0	23 36.3	-6.34	10.8	0.41	1.35	14.54	11.36 to 14.35	137
3/ 4	12.0	23 38.9	-7.15	10.8	0.41	1.35	14.53	11.39 to 14.37	138
4/ 5	12.0	23 41.5	-7.57	10.8	0.41	1.35	14.51	11.43 to 14.40	139
5/ 6	12.0	23 44.1	-8.39	10.8	0.41	1.35	14.50	11.47 to 14.42	139
6/ 7	12.0	23 46.6	-9.22	10.8	0.41	1.35	14.48	11.51 to 14.45	140
7/ 8	12.0	23 49.1	-10.05	10.8	0.41	1.35	14.47	11.56 to 14.47	140
8/ 9	12.0	23 51.5	-10.48	10.8	0.41	1.35	14.45	12.01 to 14.50	141
9/10	12.0	23 53.9	-11.31	10.8	0.41	1.36	14.44	12.06 to 14.52	141
10/11	12.0	23 56.3	-12.15	10.8	0.41	1.36	14.42	12.11 to 14.55	142
11/12	12.0	23 58.6	-12.58	10.8	0.41	1.36	14.41	12.17 to 14.57	142
12/13	12.0	0 0.8	-13.42	10.8	0.41	1.36	14.39	12.24 to 14.60	143
13/14	12.0	0 3.0	-14.25	10.8	0.41	1.36	14.37	12.30 to 15.02	143
14/15	12.0	0 5.2	-15.09	10.8	0.41	1.36	14.35	12.38 to 15.04	143
15/16	12.0	0 7.3	-15.52	10.9	0.41	1.37	14.34	12.47 to 15.07	144
16/17	12.0	0 9.3	-16.35	10.9	0.41	1.37	14.32	12.56 to 15.09	144
17/18	12.0	0 11.3	-17.17	10.9	0.41	1.37	14.30	13.07 to 15.11	145
18/19	12.0	0 13.3	-17.59	10.9	0.41	1.37	14.28	13.21 to 15.14	145
19/20	12.0	0 15.2	-18.41	10.9	0.41	1.37	14.26	13.41 to 15.11	145
20/21	12.0	0 17.0	-19.23	11.0	0.42	1.38	14.24	Not Observable	146
21/22	12.0	0 18.7	-20.04	11.0	0.42	1.38	14.21	Not Observable	146

Ephemeris for **58P (Jackson-Neujmin)**

Omega=200.3470 OMEGA=160.7180 i= 13.4780 q= 1.381130 a= 4.079304
e=0.661430 P= 8.239 T= 1995 October 6.6190 Epoch= 2000
Magnitudes calculated from m=11.0+5.0*Log(d)+15.0*Log(r)+0.000*Beta

August 1995 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	21 24.6	1.43	12.8	0.59	1.58	12.46	9.59 to 14.32	158
2/ 3	12.0	21 25.0	1.33	12.8	0.59	1.57	12.42	9.54 to 14.35	159
3/ 4	12.0	21 25.3	1.21	12.7	0.58	1.57	12.39	9.49 to 14.37	159
4/ 5	12.0	21 25.7	1.09	12.7	0.57	1.56	12.35	9.44 to 14.40	160
5/ 6	12.0	21 26.1	0.56	12.6	0.56	1.56	12.32	9.40 to 14.42	161
6/ 7	12.0	21 26.5	0.43	12.6	0.56	1.55	12.28	9.35 to 14.45	162
7/ 8	12.0	21 26.9	0.29	12.6	0.55	1.55	12.25	9.31 to 14.47	162
8/ 9	12.0	21 27.3	0.14	12.5	0.54	1.54	12.21	9.27 to 14.50	163
9/10	12.0	21 27.7	-0.02	12.5	0.54	1.54	12.18	9.23 to 14.52	164
10/11	12.0	21 28.1	-0.18	12.4	0.53	1.53	12.14	9.19 to 14.55	164
11/12	12.0	21 28.5	-0.35	12.4	0.53	1.53	12.11	9.15 to 14.57	165
12/13	12.0	21 28.9	-0.53	12.3	0.52	1.52	12.07	9.12 to 14.60	166
13/14	12.0	21 29.4	-1.12	12.3	0.51	1.52	12.04	9.08 to 14.59	166
14/15	12.0	21 29.8	-1.31	12.2	0.51	1.51	12.00	9.05 to 14.55	167
15/16	12.0	21 30.2	-1.51	12.2	0.50	1.51	11.57	9.02 to 14.51	168
16/17	12.0	21 30.7	-2.11	12.1	0.50	1.50	11.53	8.59 to 14.47	168
17/18	12.0	21 31.2	-2.33	12.1	0.49	1.50	11.50	8.56 to 14.43	168
18/19	12.0	21 31.7	-2.55	12.1	0.49	1.50	11.46	8.54 to 14.38	169
19/20	12.0	21 32.2	-3.18	12.0	0.48	1.49	11.43	8.51 to 14.34	169
20/21	12.0	21 32.7	-3.41	12.0	0.48	1.49	11.39	8.49 to 14.29	169
21/22	12.0	21 33.2	-4.05	12.0	0.48	1.48	11.36	8.47 to 14.25	170
22/23	12.0	21 33.8	-4.30	11.9	0.47	1.48	11.32	8.45 to 14.20	170
23/24	12.0	21 34.3	-4.55	11.9	0.47	1.47	11.29	8.44 to 14.15	169
24/25	12.0	21 34.9	-5.21	11.8	0.46	1.47	11.26	8.42 to 14.10	169
25/26	12.0	21 35.6	-5.47	11.8	0.46	1.47	11.22	8.41 to 14.04	169
26/27	12.0	21 36.2	-6.14	11.8	0.46	1.46	11.19	8.40 to 13.59	169
27/28	12.0	21 36.9	-6.42	11.7	0.45	1.46	11.16	8.39 to 13.53	168
28/29	12.0	21 37.6	-7.10	11.7	0.45	1.45	11.13	8.38 to 13.47	168
29/30	12.0	21 38.4	-7.38	11.7	0.45	1.45	11.10	8.38 to 13.41	167
30/31	12.0	21 39.1	-8.07	11.7	0.45	1.45	11.06	8.37 to 13.35	167
31/32	12.0	21 39.9	-8.36	11.6	0.44	1.44	11.03	8.37 to 13.29	166

September 1995 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	21 40.8	-9.05	11.6	0.44	1.44	11.00	8.38 to 13.23	165
2/ 3	12.0	21 41.7	-9.35	11.6	0.44	1.44	10.57	8.38 to 13.16	165
3/ 4	12.0	21 42.6	-10.04	11.6	0.44	1.43	10.54	8.39 to 13.09	164
4/ 5	12.0	21 43.6	-10.34	11.5	0.44	1.43	10.51	8.40 to 13.02	163
5/ 6	12.0	21 44.6	-11.05	11.5	0.43	1.43	10.48	8.41 to 12.55	162
6/ 7	12.0	21 45.6	-11.35	11.5	0.43	1.43	10.45	8.43 to 12.48	161
7/ 8	12.0	21 46.7	-12.05	11.5	0.43	1.42	10.42	8.45 to 12.40	161
8/ 9	12.0	21 47.8	-12.35	11.5	0.43	1.42	10.40	8.47 to 12.32	160
9/10	12.0	21 49.0	-13.05	11.4	0.43	1.42	10.37	8.50 to 12.24	159
10/11	12.0	21 50.2	-13.36	11.4	0.43	1.41	10.34	8.53 to 12.16	158
11/12	12.0	21 51.4	-14.06	11.4	0.43	1.41	10.31	8.56 to 12.07	157
12/13	12.0	21 52.7	-14.35	11.4	0.43	1.41	10.29	9.00 to 11.57	156
13/14	12.0	21 54.1	-15.05	11.4	0.43	1.41	10.26	9.05 to 11.47	155
14/15	12.0	21 55.5	-15.34	11.4	0.43	1.40	10.24	9.11 to 11.36	154
15/16	12.0	21 56.9	-16.03	11.4	0.43	1.40	10.21	9.18 to 11.25	154
16/17	12.0	21 58.4	-16.32	11.4	0.43	1.40	10.19	9.26 to 11.11	153
17/18	12.0	21 59.9	-16.60	11.4	0.43	1.40	10.16	9.38 to 10.55	152
18/19	12.0	22 1.5	-17.28	11.3	0.43	1.40	10.14	10.00 to 10.28	151
19/20	12.0	22 3.1	-17.55	11.3	0.43	1.40	10.12	Not Observable	150
20/21	12.0	22 4.8	-18.22	11.3	0.43	1.39	10.09	Not Observable	149
21/22	12.0	22 6.5	-18.48	11.3	0.43	1.39	10.07	Not Observable	148

Ephemeris for **18P (Perrine-Mrkos)**

Omega=166.5420 OMEGA=240.6290 i= 17.8320 q= 1.292930 a= 3.577065
e=0.638550 P= 6.765 T= 1995 December 6.0490 Epoch= 2000
Magnitudes calculated from m=11.5+5.0*Log(d)+20.0*Log(r)+0.000*Beta

November 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	22 2.0	18.47	12.9	0.57	1.36	7.21	5.54 to 11.44	117
2/ 3	12.0	22 4.1	18.27	12.9	0.57	1.35	7.19	5.52 to 11.42	117
3/ 4	12.0	22 6.3	18.08	12.9	0.57	1.35	7.17	5.50 to 11.40	117
4/ 5	12.0	22 8.6	17.48	12.9	0.57	1.35	7.15	5.49 to 11.38	116
5/ 6	12.0	22 11.0	17.28	12.8	0.57	1.34	7.14	5.47 to 11.35	116
6/ 7	12.0	22 13.4	17.08	12.8	0.57	1.34	7.12	5.46 to 11.33	115
7/ 8	12.0	22 15.9	16.48	12.8	0.57	1.34	7.11	5.44 to 11.31	115
8/ 9	12.0	22 18.4	16.28	12.8	0.57	1.33	7.09	5.43 to 11.29	115
9/10	12.0	22 21.1	16.08	12.8	0.57	1.33	7.08	5.41 to 11.27	114
10/11	12.0	22 23.7	15.48	12.7	0.57	1.33	7.07	5.40 to 11.25	114
11/12	12.0	22 26.5	15.29	12.7	0.57	1.33	7.06	5.39 to 11.23	114
12/13	12.0	22 29.2	15.09	12.7	0.57	1.32	7.05	5.37 to 11.20	113
13/14	12.0	22 32.1	14.49	12.7	0.57	1.32	7.03	5.36 to 11.18	113
14/15	12.0	22 35.0	14.30	12.7	0.57	1.32	7.02	5.35 to 11.16	113
15/16	12.0	22 38.0	14.10	12.7	0.57	1.32	7.01	5.34 to 11.14	113
16/17	12.0	22 41.0	13.51	12.6	0.57	1.31	7.01	5.33 to 11.12	112
17/18	12.0	22 44.0	13.32	12.6	0.57	1.31	6.60	5.32 to 11.10	112
18/19	12.0	22 47.2	13.13	12.6	0.57	1.31	6.59	5.30 to 11.08	112
19/20	12.0	22 50.3	12.54	12.6	0.57	1.31	6.58	5.29 to 11.06	111
20/21	12.0	22 53.6	12.35	12.6	0.57	1.31	6.57	5.28 to 11.04	111
21/22	12.0	22 56.8	12.16	12.6	0.57	1.30	6.57	5.28 to 11.02	111
22/23	12.0	23 0.1	11.58	12.6	0.57	1.30	6.56	5.27 to 11.00	110
23/24	12.0	23 3.5	11.39	12.6	0.57	1.30	6.55	5.26 to 10.58	110
24/25	12.0	23 6.9	11.21	12.6	0.57	1.30	6.55	5.25 to 10.56	110
25/26	12.0	23 10.4	11.04	12.6	0.57	1.30	6.54	5.24 to 10.54	110
26/27	12.0	23 13.8	10.46	12.6	0.58	1.30	6.54	5.24 to 10.52	109
27/28	12.0	23 17.4	10.29	12.6	0.58	1.30	6.54	5.23 to 10.50	109
28/29	12.0	23 20.9	10.12	12.6	0.58	1.30	6.53	5.22 to 10.48	109
29/30	12.0	23 24.5	9.55	12.6	0.58	1.29	6.53	5.22 to 10.46	109
30/31	12.0	23 28.2	9.38	12.6	0.58	1.29	6.53	5.21 to 10.44	108

December 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	23 31.8	9.22	12.6	0.58	1.29	6.52	5.21 to 10.42	108
2/ 3	12.0	23 35.5	9.06	12.6	0.59	1.29	6.52	5.20 to 10.40	108
3/ 4	12.0	23 39.2	8.50	12.6	0.59	1.29	6.52	5.20 to 10.39	108
4/ 5	12.0	23 43.0	8.35	12.6	0.59	1.29	6.52	5.20 to 10.37	108
5/ 6	12.0	23 46.8	8.20	12.6	0.59	1.29	6.51	5.19 to 10.34	107
6/ 7	12.0	23 50.5	8.05	12.6	0.60	1.29	6.51	5.19 to 10.32	107
7/ 8	12.0	23 54.3	7.51	12.6	0.60	1.29	6.51	5.19 to 10.30	107
8/ 9	12.0	23 58.2	7.37	12.6	0.60	1.29	6.51	5.19 to 10.28	107
9/10	12.0	0 2.0	7.23	12.6	0.60	1.29	6.51	5.19 to 10.26	107
10/11	12.0	0 5.9	7.10	12.7	0.61	1.29	6.51	5.19 to 10.24	106
11/12	12.0	0 9.7	6.57	12.7	0.61	1.29	6.51	5.19 to 10.22	106
12/13	12.0	0 13.6	6.44	12.7	0.61	1.30	6.51	5.19 to 10.20	106
13/14	12.0	0 17.5	6.32	12.7	0.62	1.30	6.51	5.19 to 10.18	106
14/15	12.0	0 21.4	6.20	12.7	0.62	1.30	6.51	5.19 to 10.15	106
15/16	12.0	0 25.3	6.09	12.8	0.63	1.30	6.51	5.19 to 10.13	105
16/17	12.0	0 29.2	5.58	12.8	0.63	1.30	6.51	5.19 to 10.11	105
17/18	12.0	0 33.1	5.47	12.8	0.63	1.30	6.51	5.20 to 10.09	105
18/19	12.0	0 37.0	5.37	12.8	0.64	1.30	6.51	5.20 to 10.06	105
19/20	12.0	0 40.9	5.27	12.8	0.64	1.30	6.50	5.20 to 10.04	105
20/21	12.0	0 44.8	5.17	12.9	0.65	1.31	6.50	5.21 to 10.01	104
21/22	12.0	0 48.7	5.08	12.9	0.65	1.31	6.50	5.21 to 9.59	104
22/23	12.0	0 52.6	4.60	12.9	0.66	1.31	6.50	5.22 to 9.56	104

Ephemeris for **29P (Schwassmann-Wachmann 1)**

Omega= 46.4000 OMEGA=312.8230 i= 9.3840 q= 5.752980 a= 6.015685
e=0.043670 P= 14.755 T= 1989 September 10.5410 Epoch= 2000
Magnitudes calculated from m= 6.0+5.0*Log(d)+10.0*Log(r)+0.000*Beta

October 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 19.3	7.54	18.2	7.05	6.24	21.40	Not Observable	34
2/ 3	12.0	10 19.9	7.49	18.2	7.04	6.24	21.37	Not Observable	35
3/ 4	12.0	10 20.5	7.45	18.2	7.03	6.24	21.34	Not Observable	36
4/ 5	12.0	10 21.1	7.41	18.2	7.02	6.24	21.30	Not Observable	36
5/ 6	12.0	10 21.7	7.37	18.2	7.01	6.24	21.27	Not Observable	37
6/ 7	12.0	10 22.3	7.32	18.2	7.00	6.24	21.24	Not Observable	38
7/ 8	12.0	10 22.9	7.28	18.2	6.99	6.24	21.20	Not Observable	39
8/ 9	12.0	10 23.5	7.24	18.2	6.98	6.24	21.17	16.51 to 16.53	40
9/10	12.0	10 24.1	7.20	18.2	6.97	6.24	21.14	16.48 to 16.55	41
10/11	12.0	10 24.7	7.15	18.2	6.96	6.24	21.10	16.45 to 16.57	41
11/12	12.0	10 25.3	7.11	18.2	6.95	6.24	21.07	16.42 to 16.58	42
12/13	12.0	10 25.8	7.07	18.2	6.94	6.24	21.04	16.39 to 16.60	43
13/14	12.0	10 26.4	7.03	18.2	6.92	6.24	21.00	16.36 to 17.02	44
14/15	12.0	10 27.0	6.59	18.2	6.91	6.24	20.57	16.33 to 17.03	45
15/16	12.0	10 27.5	6.55	18.1	6.90	6.24	20.53	16.30 to 17.05	46
16/17	12.0	10 28.1	6.51	18.1	6.89	6.24	20.50	16.27 to 17.07	46
17/18	12.0	10 28.6	6.46	18.1	6.88	6.24	20.47	16.24 to 17.08	47
18/19	12.0	10 29.2	6.42	18.1	6.87	6.24	20.43	16.21 to 17.10	48
19/20	12.0	10 29.7	6.38	18.1	6.85	6.24	20.40	16.18 to 17.12	49
20/21	12.0	10 30.3	6.34	18.1	6.84	6.24	20.36	16.15 to 17.13	50
21/22	12.0	10 30.8	6.30	18.1	6.83	6.24	20.33	16.12 to 17.15	51
22/23	12.0	10 31.3	6.26	18.1	6.82	6.24	20.30	16.09 to 17.17	51
23/24	12.0	10 31.8	6.22	18.1	6.80	6.24	20.26	16.06 to 17.18	52
24/25	12.0	10 32.3	6.18	18.1	6.79	6.24	20.23	16.03 to 17.20	53
25/26	12.0	10 32.8	6.15	18.1	6.78	6.24	20.19	16.00 to 17.22	54
26/27	12.0	10 33.3	6.11	18.1	6.76	6.24	20.16	15.57 to 17.23	55
27/28	12.0	10 33.8	6.07	18.1	6.75	6.24	20.12	15.54 to 17.25	56
28/29	12.0	10 34.3	6.03	18.1	6.74	6.25	20.09	15.51 to 17.26	57
29/30	12.0	10 34.8	5.59	18.1	6.72	6.25	20.05	15.48 to 17.28	57
30/31	12.0	10 35.3	5.55	18.1	6.71	6.25	20.02	15.44 to 17.30	58
31/32	12.0	10 35.8	5.52	18.1	6.70	6.25	19.59	15.41 to 17.31	59

November 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 36.2	5.48	18.1	6.68	6.25	19.55	15.38 to 17.33	60
2/ 3	12.0	10 36.7	5.44	18.1	6.67	6.25	19.52	15.35 to 17.34	61
3/ 4	12.0	10 37.1	5.41	18.1	6.65	6.25	19.48	15.32 to 17.36	62
4/ 5	12.0	10 37.6	5.37	18.1	6.64	6.25	19.45	15.29 to 17.38	63
5/ 6	12.0	10 38.0	5.33	18.1	6.62	6.25	19.41	15.26 to 17.39	64
6/ 7	12.0	10 38.4	5.30	18.1	6.61	6.25	19.38	15.22 to 17.41	64
7/ 8	12.0	10 38.8	5.26	18.1	6.60	6.25	19.34	15.19 to 17.42	65
8/ 9	12.0	10 39.3	5.23	18.0	6.58	6.25	19.30	15.16 to 17.44	66
9/10	12.0	10 39.7	5.19	18.0	6.57	6.25	19.27	15.13 to 17.46	67
10/11	12.0	10 40.1	5.16	18.0	6.55	6.25	19.23	15.10 to 17.47	68
11/12	12.0	10 40.5	5.12	18.0	6.54	6.25	19.20	15.06 to 17.49	69
12/13	12.0	10 40.8	5.09	18.0	6.52	6.25	19.16	15.03 to 17.50	70
13/14	12.0	10 41.2	5.06	18.0	6.51	6.25	19.13	14.60 to 17.52	71
14/15	12.0	10 41.6	5.02	18.0	6.49	6.25	19.09	14.57 to 17.53	72
15/16	12.0	10 42.0	4.59	18.0	6.47	6.25	19.06	14.53 to 17.55	72
16/17	12.0	10 42.3	4.56	18.0	6.46	6.25	19.02	14.50 to 17.56	73
17/18	12.0	10 42.7	4.53	18.0	6.44	6.25	18.58	14.47 to 17.58	74
18/19	12.0	10 43.0	4.50	18.0	6.43	6.25	18.55	14.43 to 17.59	75
19/20	12.0	10 43.3	4.47	18.0	6.41	6.25	18.51	14.40 to 18.01	76
20/21	12.0	10 43.6	4.44	18.0	6.40	6.25	18.48	14.37 to 18.02	77
21/22	12.0	10 44.0	4.41	18.0	6.38	6.25	18.44	14.33 to 18.03	78

*Ephemeris for **29P (Schwassmann-Wachmann 1)*** *(contd)*

Omega= 46.4000 OMEGA=312.8230 i= 9.3840 q= 5.752980 a= 6.015685
e=0.043670 P= 14.755 T= 1989 September 10.5410 Epoch= 2000
Magnitudes calculated from m= 6.0+5.0*Log(d)+10.0*Log(r)+0.000*Beta

22/23	12.0	10 44.3	4.38	18.0	6.36	6.25	18.40	14.30 to 18.05	79
23/24	12.0	10 44.6	4.35	18.0	6.35	6.25	18.37	14.27 to 18.06	80
24/25	12.0	10 44.8	4.32	18.0	6.33	6.25	18.33	14.23 to 18.08	81
25/26	12.0	10 45.1	4.29	18.0	6.32	6.25	18.29	14.20 to 18.09	82
26/27	12.0	10 45.4	4.26	18.0	6.30	6.25	18.26	14.17 to 18.10	83
27/28	12.0	10 45.7	4.23	17.9	6.28	6.25	18.22	14.13 to 18.12	83
28/29	12.0	10 45.9	4.21	17.9	6.27	6.25	18.18	14.10 to 18.13	84
29/30	12.0	10 46.2	4.18	17.9	6.25	6.25	18.15	14.06 to 18.14	85
30/31	12.0	10 46.4	4.15	17.9	6.24	6.25	18.11	14.03 to 18.15	86

December 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 46.6	4.13	17.9	6.22	6.25	18.07	13.59 to 18.17	87
2/ 3	12.0	10 46.8	4.10	17.9	6.20	6.25	18.03	13.56 to 18.18	88
3/ 4	12.0	10 47.0	4.08	17.9	6.19	6.25	17.60	13.52 to 18.19	89
4/ 5	12.0	10 47.2	4.06	17.9	6.17	6.25	17.56	13.49 to 18.20	90
5/ 6	12.0	10 47.4	4.03	17.9	6.15	6.25	17.52	13.45 to 18.21	91
6/ 7	12.0	10 47.6	4.01	17.9	6.14	6.25	17.48	13.42 to 18.22	92
7/ 8	12.0	10 47.8	3.59	17.9	6.12	6.25	17.45	13.38 to 18.23	93
8/ 9	12.0	10 47.9	3.56	17.9	6.11	6.25	17.41	13.35 to 18.24	94
9/10	12.0	10 48.1	3.54	17.9	6.09	6.25	17.37	13.31 to 18.25	95
10/11	12.0	10 48.2	3.52	17.9	6.07	6.25	17.33	13.27 to 18.26	96
11/12	12.0	10 48.3	3.50	17.9	6.06	6.25	17.29	13.24 to 18.27	97
12/13	12.0	10 48.5	3.48	17.9	6.04	6.25	17.26	13.20 to 18.28	98
13/14	12.0	10 48.6	3.46	17.9	6.03	6.25	17.22	13.16 to 18.29	99
14/15	12.0	10 48.7	3.44	17.9	6.01	6.25	17.18	13.13 to 18.30	100
15/16	12.0	10 48.8	3.43	17.8	5.99	6.25	17.14	13.09 to 18.31	101
16/17	12.0	10 48.8	3.41	17.8	5.98	6.25	17.10	13.05 to 18.31	102
17/18	12.0	10 48.9	3.39	17.8	5.96	6.25	17.06	13.02 to 18.32	103
18/19	12.0	10 49.0	3.38	17.8	5.95	6.25	17.02	12.58 to 18.33	104
19/20	12.0	10 49.0	3.36	17.8	5.93	6.25	16.59	12.54 to 18.33	105
20/21	12.0	10 49.1	3.35	17.8	5.91	6.25	16.55	12.50 to 18.34	106
21/22	12.0	10 49.1	3.33	17.8	5.90	6.25	16.51	12.47 to 18.34	107
22/23	12.0	10 49.1	3.32	17.8	5.88	6.25	16.47	12.43 to 18.35	108
23/24	12.0	10 49.1	3.30	17.8	5.87	6.25	16.43	12.39 to 18.35	109
24/25	12.0	10 49.1	3.29	17.8	5.85	6.25	16.39	12.35 to 18.36	110
25/26	12.0	10 49.1	3.28	17.8	5.84	6.25	16.35	12.31 to 18.36	111
26/27	12.0	10 49.1	3.27	17.8	5.82	6.25	16.31	12.28 to 18.36	112
27/28	12.0	10 49.0	3.26	17.8	5.81	6.25	16.27	12.24 to 18.37	113
28/29	12.0	10 49.0	3.25	17.8	5.79	6.25	16.23	12.20 to 18.37	114
29/30	12.0	10 48.9	3.24	17.8	5.78	6.25	16.19	12.16 to 18.37	115
30/31	12.0	10 48.9	3.23	17.8	5.76	6.25	16.15	12.12 to 18.37	116
31/32	12.0	10 48.8	3.22	17.8	5.75	6.25	16.11	12.08 to 18.37	117

Details of P/Clark (71P) on the facing page are for southern hemisphere observers

This ephemeris is for a site on the equator - the comet is not visible from the UK. Times are in local time as the chosen longitude is the Greenwich meridian.

Ephemeris for **71P (Clark)**

Omega=208.8530 OMEGA= 59.7250 i= 9.5050 q= 1.552500 a= 3.117032
e=0.501930 P= 5.503 T= 1995 May 31.0990 Epoch= 2000
Magnitudes calculated from m=10.5+5.0*Log(d)+15.0*Log(r)+0.000*Beta

July 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	20 34.9	-37.54	12.4	0.61	1.58	13.60	10.16 to 17.07	151
2/ 3	12.0	20 35.1	-38.06	12.4	0.61	1.59	13.56	10.13 to 17.07	152
3/ 4	12.0	20 35.3	-38.17	12.5	0.61	1.59	13.52	10.10 to 17.08	152
4/ 5	12.0	20 35.4	-38.29	12.5	0.61	1.59	13.48	10.07 to 17.08	153
5/ 6	12.0	20 35.5	-38.40	12.5	0.62	1.59	13.44	10.04 to 17.08	154
6/ 7	12.0	20 35.6	-38.50	12.5	0.62	1.59	13.41	10.01 to 17.08	154
7/ 8	12.0	20 35.6	-39.01	12.5	0.62	1.60	13.37	9.57 to 17.09	155
8/ 9	12.0	20 35.6	-39.11	12.5	0.62	1.60	13.33	9.54 to 17.09	155
9/10	12.0	20 35.5	-39.21	12.5	0.62	1.60	13.29	9.51 to 17.06	155
10/11	12.0	20 35.5	-39.30	12.5	0.62	1.60	13.25	9.48 to 17.01	156
11/12	12.0	20 35.4	-39.40	12.5	0.62	1.61	13.21	9.45 to 16.56	156
12/13	12.0	20 35.2	-39.48	12.6	0.62	1.61	13.17	9.42 to 16.51	157
13/14	12.0	20 35.0	-39.57	12.6	0.62	1.61	13.12	9.38 to 16.46	157
14/15	12.0	20 34.8	-40.05	12.6	0.63	1.61	13.08	9.35 to 16.41	157
15/16	12.0	20 34.6	-40.13	12.6	0.63	1.62	13.04	9.32 to 16.36	158
16/17	12.0	20 34.4	-40.20	12.6	0.63	1.62	12.60	9.29 to 16.31	158
17/18	12.0	20 34.1	-40.27	12.7	0.63	1.62	12.56	9.26 to 16.26	158
18/19	12.0	20 33.8	-40.33	12.7	0.64	1.62	12.52	9.22 to 16.21	158
19/20	12.0	20 33.5	-40.39	12.7	0.64	1.63	12.47	9.19 to 16.15	158
20/21	12.0	20 33.2	-40.45	12.7	0.64	1.63	12.43	9.16 to 16.10	159
21/22	12.0	20 32.8	-40.50	12.7	0.64	1.63	12.39	9.13 to 16.05	159
22/23	12.0	20 32.5	-40.55	12.8	0.65	1.64	12.34	9.10 to 15.59	159
23/24	12.0	20 32.1	-40.59	12.8	0.65	1.64	12.30	9.06 to 15.54	159
24/25	12.0	20 31.8	-41.03	12.8	0.65	1.64	12.26	9.03 to 15.49	159
25/26	12.0	20 31.4	-41.06	12.8	0.66	1.64	12.22	8.60 to 15.43	158
26/27	12.0	20 31.0	-41.09	12.9	0.66	1.65	12.17	8.57 to 15.38	158
27/28	12.0	20 30.6	-41.11	12.9	0.66	1.65	12.13	8.54 to 15.32	158
28/29	12.0	20 30.3	-41.13	12.9	0.67	1.65	12.09	8.51 to 15.27	158
29/30	12.0	20 29.9	-41.15	12.9	0.67	1.66	12.04	8.47 to 15.21	158
30/31	12.0	20 29.5	-41.16	13.0	0.68	1.66	11.60	8.44 to 15.16	157
31/32	12.0	20 29.2	-41.17	13.0	0.68	1.66	11.56	8.41 to 15.10	157

August 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	20 28.8	-41.17	13.0	0.69	1.67	11.51	8.38 to 15.05	157
2/ 3	12.0	20 28.5	-41.17	13.0	0.69	1.67	11.47	8.35 to 14.59	156
3/ 4	12.0	20 28.2	-41.16	13.1	0.70	1.67	11.43	8.32 to 14.54	156
4/ 5	12.0	20 27.9	-41.15	13.1	0.70	1.68	11.39	8.29 to 14.48	155
5/ 6	12.0	20 27.6	-41.13	13.1	0.71	1.68	11.34	8.26 to 14.43	155
6/ 7	12.0	20 27.3	-41.11	13.2	0.71	1.68	11.30	8.23 to 14.37	154
7/ 8	12.0	20 27.1	-41.09	13.2	0.72	1.69	11.26	8.20 to 14.32	154
8/ 9	12.0	20 26.8	-41.06	13.2	0.72	1.69	11.22	8.17 to 14.26	153
9/10	12.0	20 26.6	-41.03	13.3	0.73	1.70	11.18	8.14 to 14.21	153
10/11	12.0	20 26.4	-40.59	13.3	0.74	1.70	11.14	8.12 to 14.15	152
11/12	12.0	20 26.3	-40.55	13.3	0.74	1.70	11.09	8.09 to 14.10	152
12/13	12.0	20 26.1	-40.51	13.4	0.75	1.71	11.05	8.06 to 14.05	151
13/14	12.0	20 26.0	-40.46	13.4	0.76	1.71	11.01	8.03 to 13.59	150

Comet 6P (d'Arrest)

Voyager II Sky Chart

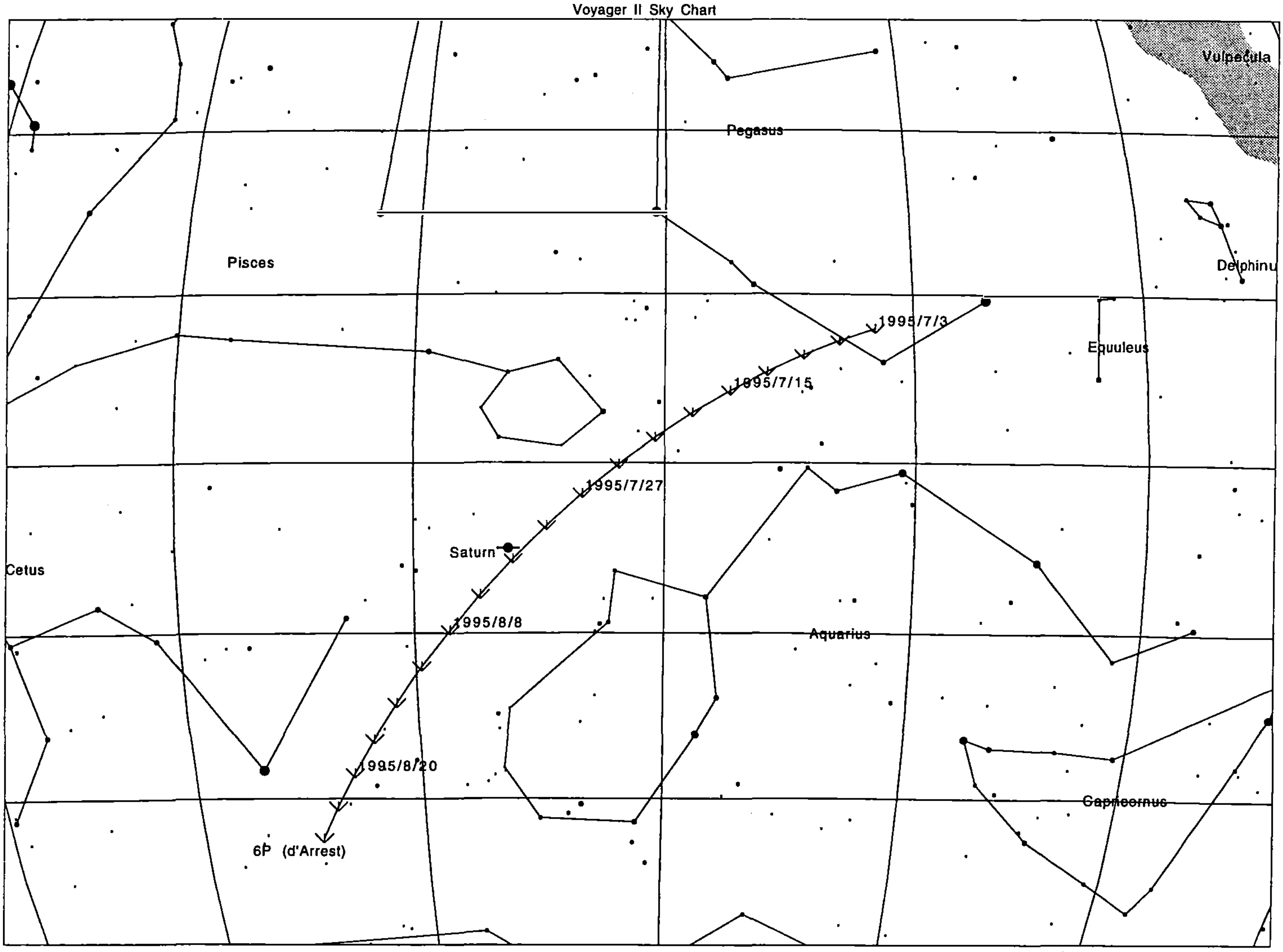
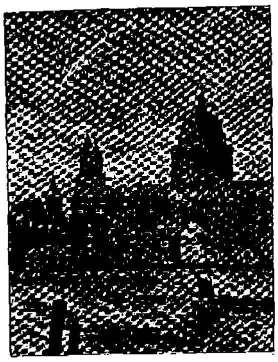


Chart Center: 23h 05.6m -01° 06' Universal Time: 1995/8/26 00:00 LMT: 00:00 Location: 0° 10' W 51° 30' N London



THE COMET'S TALE

Newsletter of the **Comet Section** of the **British Astronomical Association** 1995 November

Volume 2 No 2 (Issue 4)

Comet 1995 O1 (Hale-Bopp) promises to be spectacular

Jonathan Shanklin

Many people have been saying for some time that we are overdue for a bright comet. This could be it, though whilst we do have a good idea of where it will be, comets are notorious for not brightening as predicted. I will be issuing detailed observing instructions when the comet emerges from solar conjunction next year and by that time we should have a much better idea of its likely brightness. We will also be having a section meeting specifically devoted to the comet. The orbit predicts that it will be circumpolar from the UK at the time of perihelion in April 1997 and the indications are that it will be a bright naked eye object.

What we are certain of is that the wild speculations by the press are wrong. They picked up some remarks on the internet and amplified them more than a little. It is not 1000 miles across (it may be 100 km, but more likely only 25 km) and it is not going to hit the earth (it gets no closer than 1.32 AU). I am sure that we will soon hear that it is a reincarnation of comet Halley and has been sent back to warn us of impending disaster.

The comet was discovered accidently by two independent American amateurs who were looking at globular cluster M70 in Sagittarius. Alan Hale of Cloudcroft, New Mexico, has actually spent around 400 hours hunting for comets without success, but he found this one by chance at 11 pm local time on July 22nd. He was using a Meade DS-16 0.41-m reflector and knew instantly that he had discovered a comet as he had observed M70 only a month earlier.

Thomas Bopp of Glenfield, Arizona was observing Messier objects with a group of friends in the Arizona desert near Stanfield, some 90 miles from his home. At the time he was using a 0.44-m Dobsonian belonging to Jim Stevens but only owns a small spotting scope himself. He sighted the comet half an hour after Hale; after waiting to see if the new object moved he had to drive all the way back home before he could report the discovery to the CBAT. A third discoverer, Gerry Rattley of Gilbert, Arizona reported it a couple of days later, but by this time the IAU circular had gone out.

The initial orbit was rather uncertain, but suggested that the comet was still beyond the orbit of Jupiter, unheard of for an amateur discovery. Further observations refined the orbit and enabled Rob McNaught to search old UK Schmidt plates, and he picked up the comet on a plate taken on 1993 April 27, when it was 18^m. He couldn't find the comet on an earlier plate taken on 1991 September 1, though it should have been only a magnitude fainter and within the plate limit.

Some early CCD observations by Warren Offutt of Cloudcroft, New Mexico (which seems to be a haven for comet observers) showed that the coma was shrinking and Zdenek Sekanina suggests that this may represent a spiral coma similar to that seen in 29P/Schwassmann-Wachmann after an outburst. This comet orbits the sun at around 6 AU and is normally 17^m, but undergoes outbursts to 11^m. If comet 1995 O1 does undergo similar outbursts it could explain McNaught's failure to find the comet on the earlier plate. Further observations in late August, late September and mid October have shown a spiral jet emanating from the nucleus. Sekanina has modelled this and suggests that the source switches on at local noon, emission rises to a peak and then ceases at local sunset. Emission velocities of the dust are 30 - 50 ms^{-1}. The recurrence period is around 18 days, but the rotation state is complex and he has assumed a rotation period of around eight days.

At the moment the comet is too far south to be easily observed from the UK (though it can be seen from more southerly latitudes until the autumn). It should be picked up from the UK in April next year, possibly reaching naked eye visibility by autumn 1996. After perihelion the solar elongation rapidly decreases, but Northern hemisphere observers should be able to follow it till mid May 1997. After conjunction it becomes a southern hemisphere object, but could remain visible for at least another year.

What will we see ? There are some similarities in the orbit and apparent absolute magnitude to that of comet C/1811 F1 which became a spectacular naked eye object with a tail covering 70°; at one time a second tail lay at right angles to the primary (see article by Gary Kronk).

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Section news from the Director

Dear Section member,

The summer has been quite a busy time for me: I have been very busy at work getting ready for the coming Antarctic season, section work has taken time and I have done a lot of observing. In addition I have other hobbies including cricket, bell-ringing and ice-hockey to keep me occupied. The long hot spell saw a lot of clear nights and in August I managed a string of 11 consecutive meteor watches. In part I was encouraged in this by a realisation that the Observatories in Cambridge were now just too light polluted for satisfactory observing and I needed somewhere better. I found a site about 15 kilometres east of Cambridge which has quite dark skies, indeed in recent weeks the zodiacal cone has been easily visible, with the band and gegenschein also glimpsed. The dark skies, although not quite as dark as the Antarctic, have certainly rejuvenated my enthusiasm for meteor watching. Finding a dark sky site is something to consider when observing comets as well as their debris - the nebulous outer coma and filamentary tail will not be seen in a site affected by light pollution.

After the lull in the first half of the year considerable activity has happened in the field of cometary recoveries and discoveries. The major discovery is comet 1995 O1 (Hale-Bopp) which promises to be a spectacular object in late 1996 and early 1997. More details are given elsewhere in the newsletter, but I think we need to plan in more detail what we will be able to do in observing this comet. I am therefore arranging a section meeting on 1996 June 8 at the Institute of Astronomy in Cambridge. This will be an all day meeting and I will give more details in the next newsletter. Anyone who would like to speak at this meeting should contact me.

The section guide to observing comets is now with Don Miles and I am checking the proofs. It is quite a lengthy booklet and will be around 48 pages long. I have aimed to include everything that is needed for visual observation of comets, with small sections on comet hunting and photography. It should certainly be ready by the time 1995 O1 emerges from solar conjunction and may be ready before the end of the year. The normal selling price will be £2.00 from the BAA office, however section members can send me a C5 stamped and addressed envelope, together with a small contribution towards the cost in the form of stamps. Note however that I will be away until mid February.

Since the last newsletter observations or contributions have been received from the following BAA members: Sally Beaumont, Werner Hasubick, Guy Hurst, Nick James, Brian Manning, Martin Mobberley, Stewart Moore, Roy Panther, Jonathan Shanklin, David Strange, Tony Tanti, Melvyn Taylor, Alex Vincent, and also from John Aldridge, Alexander Baransky, Sandro Baroni, Stefan Beck, John Bortle, Eric Broens, Paul Camilleri, Haakon Dahle, Jose Guilherme de S. Aguiar, Stephen Getliffe, Bjorn Granslo, Roberto Haver, Francisco Hernandez, Graham Keitch, Mark Kidger, Atilla Kosa-Kiss, Romualdo Lourencon, Herman Mikuz, Antonio Milani, Arto Oksanen, David Seargent, Chris Spratt, Graham Wolf and Vittorio Zanotta of comets: 6P/d'Arrest, 19P/Borrelly, 41P/Tuttle-Giacobini-Kresak, 58P/Jackson-Neujmin, 71P/Clark, 73P/Schwassmann-Wachmann 3, 116P/Wild 4, C/1995 O1 (Hale-Bopp), C/1995 Q1 (Bradfield) and P/1995 S1 (de Vico).

I will be visiting the Antarctic again from mid November to mid February. During this time I can still be contacted by e-mail at faraday@vc.nbs.ac.uk; please put "For the attention of Jonathan Shanklin" on the first line. Postal mail addressed to Cambridge will have to wait until my return, but for those wanting a reply from the Antarctic I have given a postal address; however be warned that the postman doesn't visit very often! Observations should go to Guy Hurst as usual and any urgent postal queries to James Lancashire.

Finally I am pleased to announce that Alex Vincent has been awarded the 1995 Keedy prize. He is a regular contributor of slides of comets and also sent a good photo of the "ex comet" on Jupiter. Thanks to David Keedy for making this award possible. Please send me any nominations for the 1996 award.

Jonathan Shanklin

Comet 1995 O1 (Hale-Bopp)

Continued from page 1

In 1811, however, street lights hadn't been invented and gas lighting was only just coming into fashion, so they had much darker skies than we have now. The comet was well observed by Herschel, who measured a bluish planetary disc 700 km in diameter, but which disappeared under higher magnification. This great comet was thought to have produced a good vintage "comet wine" and also foretold the war between Napoleon and Russia.

The earth passes about 0.1 AU inside the comet's orbit on January 3/4, 123 days before the comet or 242 days after it. Although this might give a meteor shower, it is unlikely; calculations by Brian Marsden give a theoretical radiant of $15^h\ 36^m$ +32°.

Isao Sato reports on the internet that the moon will occult Hale-Bopp on May 8.44, 1996. The event will be seen from the north American continent except for Alaska and Canada. The age of the moon is 20.5 days and the brightness of the comet will be about 7.5^m at 4.5 AU from the sun.

The favourable phenomenon is the reappearance from the dark limb in the night. It will be seen from the west part of the United States, Mexico, Belize, Guatemala, Honduras, and San Salvador. Many famous observatories including Palomar, Kitt Peak, Lowell and Tonantzintla are located in this region.

Lunar occultation of the comet could reveal the fine structure of the coma. The duration of the event is about 0.1 second if the nucleus diameter is 100km. Therefore high speed photometry will reveal the diameter of the nucleus and the brightness distribution of the coma and tail. Spectroscopic photometry will reveal the distribution of some materials in the comet.

Let's hope that C/1995 O1 lives up to expectations and gives us an object of awesome beauty to view and perhaps a good vintage to go with it.

Comet 1811 F1 (Flaugergues or Great Comet)

Gary W. Kronk

Honore Flaugergues (Viviers) discovered this comet in the evening sky on March 25, 1811, in Argo Navis. On March 26, he estimated the position as RA=8h 01.7m, DEC=-29° 03'. The orbit indicates the comet was discovered at an elongation of 115° and was situated 2.73 AU from the sun and 2.16 AU from Earth. The comet was then low in the south and was moving northward and brightening. On April 8, the moon was full. Jean Louis Pons (Marseille, France) independently discovered this comet in the evening sky in Argo Navis on April 11.82. On April 11.87, Pons determined the position as RA=7h 49m 13.6s, DEC=-19° 58' 10".

William J. Burchell was situated in Cape Town (South Africa) from late 1810 until mid 1811. On the evening of June 2, 1811, an earthquake hit the region and Burchell wrote in his journal that many of the people "coupled the comet, which had been seen every night since the 12th of the foregoing month, and the earthquake together, and drew from this two-fold portentous sign, the certain prognostics of the annihilation of the Cape."

The comet passed 9.4° from the sun on July 31, and then began to move away from the sun and continue to brighten.

On August 18 and 21, Olbers searched for the comet in the evening sky, but found nothing. On August 22.08, Olbers recovered the comet close to the horizon and near 20 Leo Minoris. He said it was visible before 20 Leo Minoris [according to SC2000.0, the magnitude of this star is 5.36] and seemed as bright as Alpha Leo Minoris [according to SC2000.0, the magnitude of this star is 3.83]. Olbers estimated the position as RA=9h 50.7m, DEC=+33° 15'. On August 22.83, Friedrich Wilhelm Bessel (Konigsberg, now Kaliningrad, USSR) independently recovered the comet in the evening sky when only 4° above the horizon. He determined the position as RA=9h 53m 22.35s, DEC=+33° 33' 04.1".

On September 1, Alexander Ross (a member of the John Jacob Astor expedition travelling down the Columbia River) "observed, for the first time, about 20° above the horizon, and almost due west, a very brilliant comet, with a tail about 10° long. The Indians at once said it was placed there by the Good Spirit which they called *Skom-malt-squisses* to announce to them the glad tidings of our arrival; and the omen impressed them with a reverential awe for us, implying that we had been sent to them by the Good Spirit, or Great Mother of Life." On September 2, the moon was full. William Herschel (Glasgow) observed the comet with a 14-foot focal length reflector, but noted that its low altitude, moonlight, and hazy sky made it appear "like a very brilliant nebula, gradually brighter in a large place about the middle." He could detect no tail. On September 8, Simeon Perkins (Liverpool, Nova Scotia) wrote, "at Evening I observe a Comet or Some New appearance of a Star that has an appearance of a Light tail or Blaze it was Nearly in the N.N.W. about one Hour high at 8 o'clock and Set further Northward about [text missing] there was a thin Cloud or haize about it So that I could Not discern the Body of the Star by the Naked Eye but I looked with a Glass and Saw it and an appearance of Light but could not discern any tail or Blaze. It has been observed by Several people for two or three Evenings past." On September 9, Herschel (Alnwick) saw the comet with a refractor at a magnification of 65x and noted, "the planetary disk-like appearance seen with the naked eye, was transformed into a bright cometic nebula, in which, with this power, no nucleus could be perceived." He estimated the conspicuous tail as 9° or 10° long and noted a "very considerable" curvature. On September 13, Perkins and his daughters "were up at 3 o'Clock to observe a remarkable Star which they had been told rose towards morning they say it had the same appearance as that which it Seen in the Evening and as the motion of that when we See it in the Evening as it is Setting is to the Eastward. I conclude it is the Same it Sets by Nine So it is 5 or 6 Hours under the Horison." On September 18, Herschel (Glasgow) observed with a 10-foot focal length reflector and noted that the star-like head took on the appearance of a globular nebula when viewed at 110x. He estimated that its diameter was about 5 or 6 arcmin, "of which one or two minutes about the centre were nearly of equal brightness." He added that the tail was 11° or 12° long and remarked "that towards the end of the tail its curvature had the appearance as if, with respect to the motion of the comet, that part of the tail were left a little behind the head." In addition, "The appearance of the nebulosity...perfectly resembled the milky nebulosity of the nebula in the constellation of Orion, in places where the brightness of the one was equal to that of the other." With a night glass with a field of view of 4° 41', Herschel noted the tail was accompanied by a stream on each side. He noted "that the two streams or branches arising from the sides of the head scattered a considerable portion of their light as they proceeded towards the end of the tail, and were at last so much diluted that the while of the farthest part of the tail, contained only scattered light." According to a note in the Codex PΘrez, a comet was seen in the northeast. It was referred to as "God's sign." [The Codex PΘrez was compiled during the first half of the 19th century by Juan Pφo PΘrez of the Yucatan. PΘrez, born on July 11, 1798, would only have been 13 years old and since most of the notes of the Codex PΘrez predate his birth, the comet was probably seen and recorded by someone else in the region. It was probably in the morning sky-GWK]. On September 29, Herschel observed with a 10-foot focal length reflector and noted the head was 3' 00" across.

On October 2, the moon was full. On October 6, Herschel observed with a 20-foot focal length reflector and noted the head was 3' 45" across, while a fainter outer coma was estimated as 15' across. He added that the tail was about 25° long. On October 11, Olbers said the tail was 13° long. On October 12, Herschel estimated that the tail was 17° long. He added, "its breadth in the broadest part was 6 3/4 degrees, and about 5 or 6 degrees from the head it began to be a little contracted." Herschel observed with his night glass and remarked "that the two streams remained sufficiently condensed in their diverging course to be distinguished for a length of about six degrees, after which their scattered light began to be pretty equally spread over the tail." On October 14, Herschel estimated the tail length as 17.5°. On October 15, Herschel commented, "in a very clear atmosphere, I found the tail to cover a space of 23 1/2 degrees in length." He added that his night glass showed the preceding branch of the tail was 7° 01' long, while the following was only 4° 41' long. On October 16, the comet was nearest Earth (1.221 AU). Herschel noted a well-defined luminous point in the centre of the coma and measured its diameter as 0.79". He added, "that part of the head which was towards the sun was a little brighter and broader than that towards the tail, so that the planetary disk or point was a little eccentric." On October 17, Herschel found the bright point within the coma to have been "a little beyond the centre." He added that "the tail appeared to be more curved than it had been at any time before." On October 19, Herschel examined the comet with a 10-foot focal length telescope. At a magnification of 169x, he noted the bright point within the coma was 1.39 arcsec across. At 600x, he estimated it was between 0.68 and 1.06 arcsec across.

After reaching a maximum elongation of 67° on October 31, the comet began moving back towards twilight.

On November 3, Herschel observed with his night glass and noted, "The two branches were nearly of an equal length." On November 4, Burchell (near the Vaal River about 50 miles west of present day Kimberley, South Africa) wrote, "as I lay waiting for sleep, and amusing myself in observing the constellations above my head, I noticed a faint nebulous star of the third magnitude, which I had not been used to see in that part of the heavens. Looking at it more attentively, it appeared plainly to be a comet." He said it was located in the tail of Aquila and formed a right triangle with Alpha Cygni and Alpha Lyrae. Herschel found the nucleus "more eccentric than I had ever seen it before" and showed a slight disk in the 10-foot focal length reflector with a magnification of 289x. On November 5, Herschel estimated the tail was not longer than 12.5°. He added that the preceding stream was 5° 16' long, while the following was 4° 41' long. On November 9, Herschel noted, "The two branches might still be seen to extend full 4 degrees, but their light was much scattered." He added, "The tail of the comet being very near the milky-way, the appearance of the one compared to that of the other, in places where no stars can be seen in the milky-way, was perfectly alike." He estimated the tail's length as 10°. In the 10-foot focal length reflector, Herschel saw the nucleus "imperfectly" with a magnification of 169x, but "it was more visible" with a magnification of 240x; however, "the nebulosity of the envelope overpowered its light already so much that no good observations could be made of it." On November 10, Herschel obtained only a glimpse of the nucleus in a 10-foot focal length reflector and noted it was as eccentrically placed as on the 4th. He added that the preceding branch was 5° 16' long, while the following one was 3° 31' long. On November 13, Herschel could no longer see the nucleus. He did not that the following stream was now longer and 4° 06' long, while the preceding stream was 3° 31' long. On November 14, Herschel found both streams equal in length and 3° 31' long. On November 15, Herschel noted the following stream was 4° 06' long, while the preceding was 3° 31' long. On November 16, Herschel noted the tail was about 7.5° long to the naked eye and found the following stream 3° 48' long, while the preceding was 3° 13' long. On November 19, Herschel found the two streams to be of equal length and 4° 23' long. The tail was estimated as 6° 10' long.

On December 2, Herschel noted the tail was "hardly 5 degrees long and of a very feeble light." He said the streams were both 3° 12' long. He added, "they joined more to the sides than the vertex, and had lost their former vivid appearance; their colour being changed into that of scattered light." On December 9, Herschel wrote that the tail length had changed little since the 2nd. He noted, "The branches were already so much scattered that observations of them could no longer be made with any accuracy." On December 14, Herschel wrote that the tail "still remained as before, but the end of it was much fainter."

On January 2, 1912, Herschel commented that the comet "could only be distinguished from a bright globular nebula by the scattered light of its tail, which was still 2° 20' long."

The comet passed 9.5° from the sun on February 17.

Don Jose Joaquin de Ferrer (Havana, Cuba) began looking for the comet in early July. He used the 4.5-foot focal length refractor, "but I could not discover it on account of the little light it had at that time." However, while using a "night-perspective" on July 11.31, Ferrer spotted the comet at a position of RA=22h 09.2m, DEC=-18° 46'. The "night-perspective" had an objective 4-inches in diameter and a magnification of only 5x. The subsequent field of view was given as 5°. Ferrer wrote "some stars of the 10th and 12th magnitude surrounded" the comet. He added, "the extremity of its nucleus was in contact with one of these stars, and its centre 2' towards the south, and in the same right ascension." He continued, "The comet appeared as a very slight vapour, its tail opposed to the sun scarcely looked 10' in length." The comet was again observed by Ferrer on July 13 and July 14, but he was not able to determine an accurate position. He even tried using a 12-inch "repeating-circle," but whenever the threads were illuminated, the comet would disappear. Ferrer last saw the comet on July 15.31, and noted it was "in contact with a star of 10th magnitude."

The comet was last detected on August 17, by Vincent Wisniewski. It was then at an elongation of 167°.

During June 1813, Ferrer said he "used all attention to discover the nucleus of this comet" with a 4.5-foot focal length refractor, "yet never could perceive more than a luminous point from time to time, which can no how be supposed to arise from defect of clearness of sky in the Isle of Cuba." He concluded "it is beyond a doubt that the diameters of these bodies [referring to comets 1807, 1811 I, and 1813 II] are exceedingly small, and we much fear therefore that the greater part of those who have observed them have confounded the nucleus with the nebula...." Ferrer specifically noted Herschel's observation of October 16 and wrote "not to mention the difficulty of measuring such small quantities, radiation must augment considerably the luminous disc."

[Extracted from the unpublished Cometography, volume 2, copyright 1995 by Gary W Kronk

Comet Prospects for 1996

For the first time for several years the prospects for observing comets in the coming year are better than average. There is comet 1995 O1 (Hale-Bopp) and a good return of comet 22P/Kopff. Ephemerides for new and currently observable comets are published in the *Circulars* and comet section Newsletter, with predictions for returns in the Handbook[1]. Details of how to obtain the section booklet on comet observing[2] are given elsewhere in the newsletter.

1995 O1 (Hale-Bopp)
What promises to be the brightest comet for many years should be recovered in the UK in the morning sky in April as it moves slowly northwards in Sagittarius. Based on relatively conservative magnitude predictions it will be around 9^m-10^m, and steadily brightens to 8^m as it moves towards opposition in Scutum in early July. Its slow motion northwards and westwards continues throughout the summer and autumn till late September, when it is in Ophiuchus. Eastward motion resumes and by November it should reach naked eye visibility, still in Ophiuchus. At year's end it has entered Serpens, with a brief period of visibility in both dusk and dawn sky. Now 4^m-5^m it may have a short tail, pointing north. Fig 1 shows the comet's path from April 15 to June 23.

29P/Schwassmann-Wachmann 1
This annual comet has frequent outbursts and seems to be more often active than not, though it rarely gets brighter than 12^m. It is at opposition in late February in Sextans and should be observable until late May. It is then in conjunction until early November and it will be observable in Virgo for the rest of the year. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity.

45P/Honda-Mrkos-Pajdusakova
P/Honda-Mrkos-Pajdusakova, which has a period of around 5.3 years, will be making its 9th observed return since discovery in 1948 (it was missed in 1959). The comet won't be visible from the northern hemisphere until late January, when it may be picked up in binoculars in the morning sky in Serpens/Ophiuchus as it fades rapidly from 8^m. It moves north and westwards reaching 13^m by the end of February when it is in Coma.

67P/Churymov-Gerasimenko
This comet has already been recovered and is making its 5th return since discovery in 1969. At a good apparition, such as in 1982, when it was well observed by the comet section, it can reach 9^m. This time it gets no closer than 0.9 AU, but may be observable until February in the evening sky, moving from Pisces to Aries, though it is unlikely to get brighter than 12^m.

22P/Kopff
P/Kopff has already been recovered and is making its 14th observed return since its discovery in 1906 (it was missed at its first return in 1912). This apparition is about as favourable as possible with the comet reaching perihelion on July 2nd and opposition 9 days later, when it is 0.6 AU from the earth at a declination of -19°. It should become visible in the morning sky in mid April at around 11^m. It brightens steadily and should be at least 9^m by June, with some predictions making it as bright as 7^m. It remains at a similar magnitude throughout June and July, but begins to fade and move south in August and will probably be lost to view from the UK around mid month. Fig 1 shows comet's path from May 27 to August 25.

65P/Gunn
P/Gunn is too far south, lying near the ecliptic in Scorpius, for easy observation from the UK, but is well placed for more favourably located observers. It reaches opposition in May and perihelion is a couple of months later, though at best it is only 12^m. The comet was discovered in 1970 after a perturbation by Jupiter in 1965 had reduced the perihelion distance from 3.39 to 2.44 AU. In 1980 two prediscovery images were

found on Palomar plates taken in 1954. The comet can be followed all round the orbit as it has a relatively low eccentricity of 0.32.

P/1983 M1 (IRAS)
P/IRAS, discovered by the Infra-Red Astronomy Satellite, is returning for the first time. It should be picked up by southern hemisphere observers in Tucana in August when it is 12^m. It is brightest in October, but doesn't move far enough north to be seen from the UK until November when it has faded to 11^m. It should then be possible to follow it until the end of the year as it moves through Capricornus, Aquarius and Pegasus.

Two comets that reach perihelion in 1997 will become visible at the end of the year. 46P/Wirtanen will be in the evening sky in Capricornus at 13^m, though not visible from the UK until the end of January 1997. 81P/Wild 2 is in Cancer and brightens from 13^m to 12^m in December as it approaches opposition in January 1997. Further details of both these comets will be given in the prospects for 1997.

A number of fainter comets have favourable returns and may be of interest to CCD observers. These include 95P/Chiron (opposition March/April, 15^m), 116P/Wild 4 (opposition January, 14^m), 119P/Parker-Hartley (opposition January 1997, 15^m) and P/1989 E2 (Shoemaker-Holt 2) (opposition February 1997, 13^m). Ephemerides for all these can be found on the comet section WWW page.

Several other comets return to perihelion during 1996, however they are unlikely to become bright enough to observe or are poorly placed. These include: 7P/Pons-Winnecke, 32P/Comas Sola, 57P/du Toit-Neujmin-Delporte, 72P/Denning-Fujikawa, 96P/Machholz 1 and P/1991 F1 (Mrkos) which have unfavourable returns and 111P/Helin-Roman-Crockett, P/1987 U2 (Mueller 1), P/1989 E3 (West-Hartley) and P/1991 R2 (Spacewatch) which are intrinsically faint or distant comets. D/1978 C2 (Tritton) was not observed at its last return.

Details of the date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 for each comet are given below.

1997 includes favourable returns of comets 2P/Encke, 43P/Wolf-Harrington, 46P/Wirtanen, 78P/Gehrels 2, 81P/Wild 2, and 100P/Hartley 1. The return of 2P/Encke is a good one for the southern hemisphere, but it will not be visible from the UK. At the end of the year, 55P/Tempel-Tuttle, the parent comet of the Leonids may become visible. The highlight of the year should be comet 1995 O1 (Hale-Bopp) which is predicted to reach peak brightness in late March, when it may have a tail stretching to the pole.

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Jonathan Shanklin

Comets reaching perihelion in 1996

Comet	T	q	P	N	H1	K1
7P/Pons-Winnecke	Jan 02.5	1.26	6.37	20	10.0	15
67P/Churyumov-Gerasimenko	Jan 17.7	1.30	6.59	4	9.5	10
95P/Chiron	Feb 14.8	8.45	50.7	3		
57P/du Toit-Neujmin-Delporte	Mar 05.6	1.72	6.39	4	12.5	15
P/1987 U2 (Mueller 1)	Apr 25.5	2.74	8.41	1	12.0	10
P/1989 E3 (West-Hartley)	May 12.0	2.13	7.59	1	11.5	10
72P/Denning-Fujikawa	May 29.8	0.79	9.03	2	15.5	25
32P/Comas Sola	Jun 10.5	1.85	8.83	8	6.5	20
119P/Parker-Hartley	Jun 26.0	3.05	8.89	1	9.0	8
22P/Kopff	Jul 02.2	1.58	6.45	13	3.0	26
P/1991 R2 (Spacewatch)	Jul 16.9	1.54	5.56	1	13.5	15
65P/Gunn	Jul 24.4	2.46	6.83	5	5.0	15
P/1989 E2 (Shoemaker-Holt 2)	Aug 20.2	2.66	8.05	1	4.5	15
116P/Wild 4	Aug 31.2	1.99	6.16	1	5.0	20
96P/Machholz 1	Oct 15.1	0.12	5.24	2	13.0	12
P/1983 M1 (IRAS)	Oct 31.7	1.70	13.3	1	6.0	20
111P/Helin-Roman-Crockett	Oct 31.8	3.49	8.16	1	5.0	20
D/1978 C2 (Tritton)	Nov 05.0	1.44	6.34	1	13.0	20
P/1991 F1 (Mrkos)	Nov 09.0	1.41	5.64	1	12.5	20

Note: $m_1 = H1 + 5.0 * \log(d) + K1 * \log(r)$

Review of comet observations for 1995 June - 1995 October

The information in this report is a synopsis of material gleaned from IAU circulars 6177 - 6253 and The Astronomer (1995 June - 1995 October). Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. Note that the figures quoted are rounded off from their original published accuracy. A full report of the comets seen during the year will be published in the Journal in due course. For the latest information see the section www page.

My rather gloomy predictions for comet 6P/d'Arrest proved wrong and it reached 8^m in early August, although the large coma was of low surface brightness and quite hard to see. Mikuz was able to pick it up with his CCD camera at the end of May when it was 17^m. Visually, it brightened very rapidly from 13^m at the end of June to around $8\text{-}9^m$ at the beginning of August. Observation from the UK rapidly became harder as it moved south and it was not observed after the end of August. The light curve is quite different to that of most comets and it seems to switch on at 1.41 AU and continue at almost constant brightness after perihelion.

19P/Borrelly was observed with the Hubble Space Telescope. The team making the observations suggest that the nucleus is an oblate spheroid of 8.3 x 3.3 km and rotates with a period of 24.7 hours.

29P/Schwassmann-Wachmann 1 emerged from conjunction in October and was observed to be in outburst on October 20/21 at 13.3^m. It is worth following by those equipped with CCD cameras as it is frequently in outburst at around 13th mag.

41P/Tuttle-Giacobini-Kresak went into outburst in mid August, reaching about 8^m on the 17th before fading to 10^m by the end of the month.

58P/Jackson-Neujmin was rather fainter than I predicted, reaching 15^m in early August and 12^m by mid September.

71P/Clark was well placed for observation for observers located further south than the UK and reached $11\text{-}12^m$.

73P/Schwassmann-Wachmann 3 was reported at 13^m in mid August. In October it underwent an outburst, reaching naked eye brightness with a 1.5° long dust tail.

81P/Wild 2 was observed at mag 22 in late August.

P/1995 M1 (Shoemaker-Levy 4) = 118P was recovered by Jim Scotti with the Spacewatch telescope.

P/1995 M2 (Parker-Hartley) = 119P was also recovered by Scotti.

1995 O1 (Hale-Bopp). Details of the discovery and prospects are given in the front page article. David Strange obtained CCD images of the comet on July 28th and Melvyn Taylor made a visual sighting from Yorkshire on August 26th. I attempted an observation on September 28th, but could only see field stars of a comparable magnitude to the comet.

1995 O2 (Mueller 1) = 120P was another recovery by Jim Scotti with the Spacewatch telescope.

1995 Q1 (Bradfield) is William Bradfield's seventeenth comet and was 6^m, with a 3° tail when discovered. It moved into solar conjunction and became visible in the morning sky from the UK after perihelion, but faded and did not show a tail. Initially well condensed, it became more diffuse and larger in size as it faded. The light curve is relatively flat and the observations so far available suggest that it is fading as 5 log r.

1995 Q2 (Hartley-Drinkwater) was discovered on a UK Schmidt plate at 14^m, but faded after discovery.

P/1995 Q3 (Shoemaker-Holt 2) = 121P was recovered by Jim Scotti with the Spacewatch telescope at mag 21.

P/1995 S1 (de Vico) = 122P. Comet 1995 S1 turned out to be P/de Vico which has a period of around 75 years and was last seen in 1846. It was missed in 1922, although it was well placed in the evening sky and 7^m during April that year. This suggests that perhaps the completeness of the records of near naked eye comets in past years is not quite as good as we thought it was. It is one of the best comets for several years, with a well condensed coma and a tail 2° long. Observations so far show a reasonably well behaved light curve which fits that used in the ephemeris quite well.

P/1995 S2 (West-Hartley) = 123P was recovered by Jim Scotti and Tom Gehrels with the Spacewatch telescope.

P/1995 S3 (Mrkos) = 124P was recovered by C W Hergenrother at Kitt Peak and amateur Warren Offutt of Cloudcroft, New Mexico using a CCD on his 0.6-m reflector.

DeepSpace Version 5.12 for MS DOS.

David Chandler Company, 1995. $136 (CD ROM), $96 (disk), $7 (Shareware).

I obtained a review copy of this software in response to an advert appearing in Sky & Tel which suggests that it is the premier software for comet observers. The software arrives in a nicely packaged box and comes complete with a comprehensive manual. Installation is straightforward and the full version takes up around 14 MB on the hard disc; a shareware version is also available which takes up less than 4 MB. The program is DOS based and rather to my surprise has no mouse support. In addition to the Guide Star Catalogue the CD-ROM has the NASA Skymap stellar database, the Saguaro astronomy club deepsky database, the JPL asteroid and comet database and comet elements from the CBAT 9th comet catalogue.

The user interface has a clunky feel to it when compared to many windows based programs. The package has been designed with a US market in mind; far southern latitudes cause problems for the almanac computation (though admittedly not many observers go to Antarctica) and in particular the printer support assumes US page dimensions of 8.5" x 11", rather than the international A4. There are ways round the resulting clipping, but you need some knowledge of postscript or a certain amount of trial and error. The computation was reasonably fast on my 386 PC with math co-processor, but it rather annoyingly recomputes positions for the moon and planets each time it redraws a map. There is no find facility and zooming and centering are clumsy due to the lack of mouse support. The program can produce a daily almanac which is very useful for planning observing sessions, though it is a pity that user limits for twighlight and minimum altitude cannot be set.

The comet elements are very easy to access and update and also enable you to investigate observing circumstances, particularly useful in checking out what might be seen for comet 1995 O1 in comparison to great comets of the past. You can plot tracks of comets, complete with tail orientation, or asteroids across the sky or with respect to the horizon and in a variety of projections. Particularly nice is the all sky projection which, for example, can be used to provide very handy finder charts for meteor showers, though it is not possible to add user labels. You can also produce ephemerides, but with both ephemerides and tracks the start point is the present date and the online ephemeris has no page hold.

The software also has many educational uses and comes bundled with several other products, such as one to compute times of minima for Algol and a demonstration version of one to plot planetary motions. It lacks the polish of many competing products, but the author responds to queries quickly and is contactable via e-mail. For the moment I would recommend obtaining the shareware version, but program development in response to market pressure should enable it to live up to its claims.

The Legacy of Comet Shoemaker-Levy 9

Jacqueline Mitton

Comet SL9 may no longer be with us but the data acquired before its demise is still the basis of an active industry. Papers presented at the 27th Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society, which took place in Hawaii between 9 and 13 October 1995, threw light on the pre-breakup history and activity of the comet, but unleashed confusion and disagreement about its structure and what it may be telling us about the nature of comets in general.

Re-interpreting history

Integration back in time before the breakup of SL9 in July 1992 should, in principle, reveal how long it had been orbiting Jupiter, how it was captured and what kind of heliocentric orbit it was in prior to capture. In practice, however, it is not possible to produce definitive answers because of the chaotic nature of the problem. Small errors in the orbital elements used to start with are magnified by the comet's previous close approaches to Jupiter, so a whole range of possible histories could have resulted in the orbit finally observed.

To tackle the problem statistically, Paul Chodas and Don Yeomans of JPL worked back in time starting with a random set of 1000 different orbital elements, all within the known uncertainties of SL9's observed orbit. They included the gravitational effects of the Sun, the planets, the Galilean satellites and the oblateness of Jupiter. Each integration was continued until the point was reached where the 'test' comet was no longer in orbit around Jupiter. Its heliocentric orbital elements at that point were recorded.

The results indicate convincingly that the most likely time of capture was the year 1929, plus or minus 9 years. It is very unlikely that capture took place later than 1960. (Is it significant that Gene Shoemaker was born in 1928, and Carolyn in 1929, some wondered?).

The statistics regarding the heliocentric orbit immediately before capture indicate that SL9 was a typical Jupiter family comet, with orbital inclination less than 6 degrees and a low eccentricity, no more than 0.3. Its orbit could have been entirely inside Jupiter's, with capture occurring around aphelion, or entirely outside Jupiter's, with capture near perihelion. The interior orbit turned out to be three times more likely. The most likely pre-capture orbit had an aphelion near 4.7 AU and eccentricity of about 0.1. Chodas and Yeomans noted that this orbit would have taken the comet through Jupiter's ring just before breakup.

Breaking up is hard to do

Erik Asphaug (NASA Ames) and Willy Benz (University of Arizona), looked at the tidal forces that acted on SL9 and the implications for the structural strength of the comet. They came to the startling conclusion that its strength was minuscule. If in their theoretical models they set the comet's strength as high as one millionth that of ice, they could not get it to break into more than two pieces. The implication that comets may be extremely loose aggregations of material was challenged by some at the meeting, who saw it as 'a step backwards' in understanding comets. The SL9 phenomenon seems to have reopened an old debate about the nature of comet nuclei.

Assuming that crater chains seen on Ganymede and Callisto are the results of the impacts of fragmented comets, William McKinnon, Paul Schenk and Erik Asphaug studied the geometry of crater chains to deduce the density of the original comets. They came out with answers around 0.5 to 1 g per cubic cm, and a scenario consistent with the notion that comets are structurally very weak.

The dusty answer

Hubble Space Telescope images of SL9 after opposition (29 April 1994) showed no dust feature in the anti-sunward direction. This was interpreted by many as meaning that the fragments were not actively producing dust. However, Joseph Hahn, Terrence Rettig (Notre Dame University) and Michael Mumma (NASA GSFC) say that the photometry on images taken in January and March 1994 suggests the opposite. The profiles are consistent with an active comet surrounded by a dust coma disturbed by radiation pressure. Later images, from June and July, show two dust tails, one aligned towards Jupiter and one pointing away.

These researchers constructed a mathematical model of dust production by the comet fragments, including the effects of radiation pressure together with solar and jovian gravity. They discovered that the absence of an anti-sunward feature to the east of the fragments after opposition is not evidence against dust-producing activity. It turns out that, for sufficiently large dust grains (larger than about 10 microns), the combination of their velocity and the viewing geometry results in dust being seen only on the west side. The outflow velocity was estimated to be 0.4 m/s.

Larger grains (500 microns and up) were also present and their contribution was pronounced in the June and July observations, the smaller grains being confined to the 'leading' tail.

David Levy reflects on what we learned from Comet SL9

Invited to give the media his 'top ten' points on what we learned from Comet SL9, he came up with a list, dramatically and eloquently revealed in reverse order. Here is the summary of what he said:

10. Small comets can make big black marks!

9. Had it hit Earth, there would have been at least a two-month global dust cloud.
8. Comets are extremely fragile.
7. If it was so fragile, how did it manage to hold together such a vast observing program!
6. If impacts have such a dramatic role in shaping the solar system, why can't politicians balance the national budget!
5. The resolving power of a small telescope can become front-page news (as it did on 14th July 1994).
4. There are too few searches going on to determine whether Earth's 'number' is on some comet or asteroid.
3. Earth is a lonely, vulnerable planet.
2. Comets may in the past have deposited organic material which formed the basis for life.
1. The age-old allure of comets is as great as ever.

Notes from Journals

The following snippets are from a variety of sources, though many come from the internet:

Crater mystery - from "Earth Week" Sept 30.

Scientists in Brazil's northeastern state of Piaui are baffled by a crater that was punched into the tropical rain forest shortly after witnesses reported seeing a bright light streak across the sky. Researchers are uncertain whether the crater, 5 metres wide and 10 metres deep, was left by a meteorite or a piece of a comet. Physicist Paulo Frota of the University of Piaui believes it was caused by a block of ice from a comet because the surrounding vegetation is not burned and the crater's rim is not raised.

Although large blocks of ice have been reported falling from the sky, none have been confirmed to have extra terrestrial origin. In this case the reported dimensions of the crater seem inconsistent with an impact origin. No details are given of the geology of the region, but a sink-hole would seem a more likely explanation.

The 1930 August 13 'Brazilian Tunguska event' - from *The Observatory, 1995 October*

Mark Bailey et al report on an article written by a Catholic missionary which appeared in the papal newspaper in 1931. The missionary reports on three fireballs which exploded over the upper reaches of the Amazon and terrified the local inhabitants. The authors of the paper suggest that the effects reported are similar to those seen during the Tunguska event and point out that the timing coincides with the Perseid meteor shower.

Some follow-up postings on the internet from Duncan Steel note that the date is similar to the Wyoming/Montana fireball of 1972 August 12. He also reports of another similar event that occurred over Guyana on 1935 December 11, possibly covering a larger area than the Tunguska event (See also *The Sky*, 1939 September, pp 8-10). The date of this event ties in with the Geminid meteor shower.

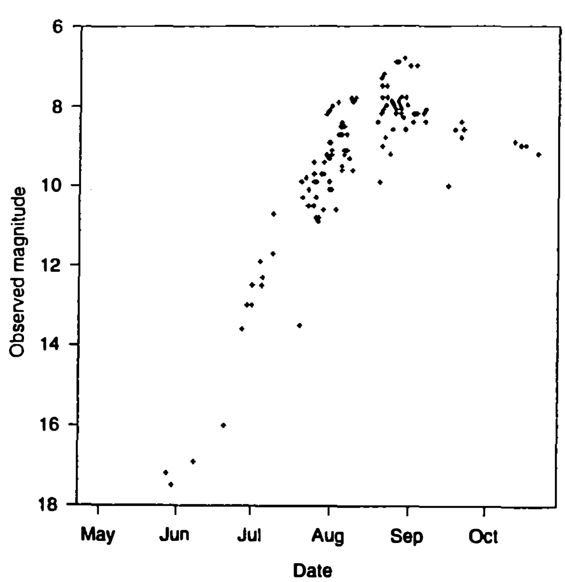
STARDUST

NASA scientists and engineers are designing a STARDUST spacecraft for launch in February 1999. One of the Discovery Program satellites, it would be scheduled to rendezvous with comet 81P/Wild 2 in December 2003 and return cometary material to Earth for analysis. It is also hoped that the spacecraft could recover grains from an interstellar dust stream that is bringing material into the solar system. Further information on the project is available on the www at http://pdc.jpl.nasa.gov/stardust/home.html

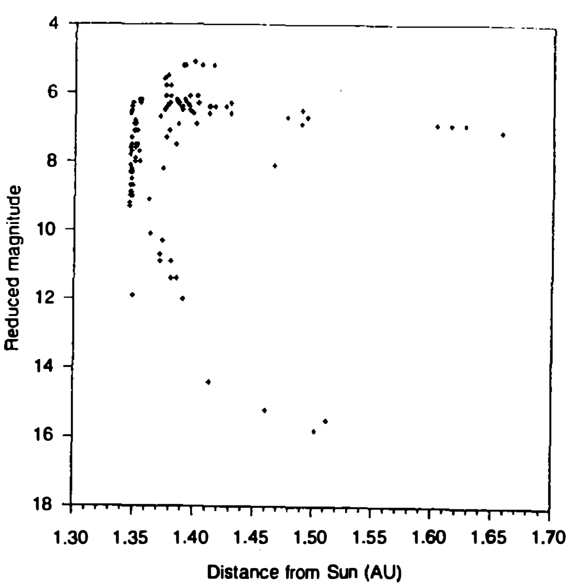
Comet 81P/Wild 2 has a moderately favourable return in 1997 when it will reach 10.5^m. From the UK it should become visible in December 1996 and remain visible until June 1997. More details on this and European comet missions will appear in the next issue.

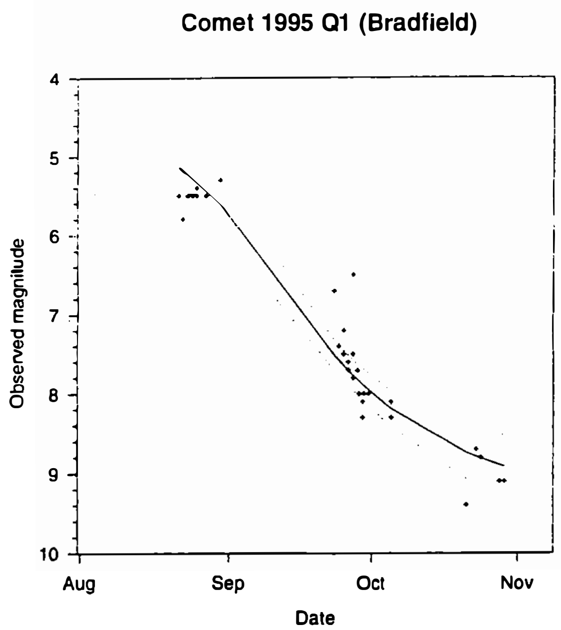
Light Curves

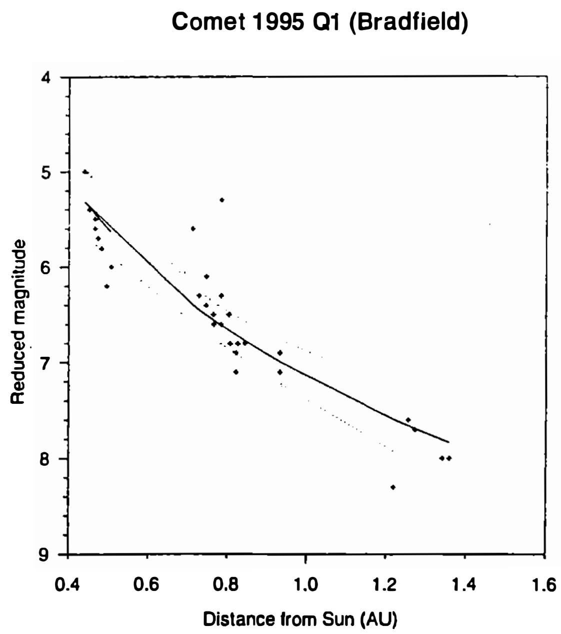
Comet 6P/d'Arrest

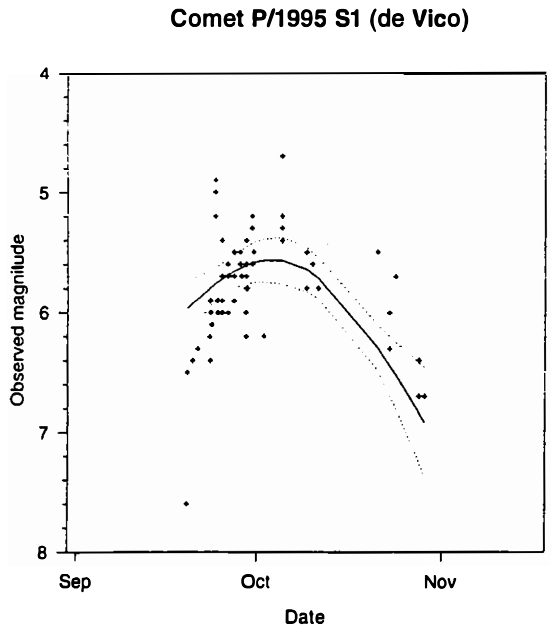


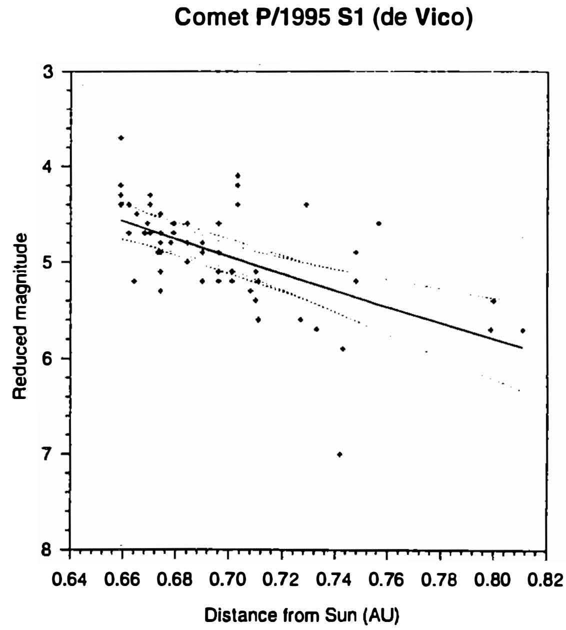
Comet 6P/d'Arrest




Comet 1995 Q1 (Bradfield)
Observed magnitude
4
5
6
7
8
9
10
Aug
Sep
Oct
Nov
Date


Comet 1995 Q1 (Bradfield)
Reduced magnitude
4
5
6
7
8
9
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Distance from Sun (AU)


Comet P/1995 S1 (de Vico)
Observed magnitude
4
5
6
7
8
Sep
Oct
Nov
Date


Comet P/1995 S1 (de Vico)
Reduced magnitude
3
4
5
6
7
8
0.64
0.66
0.68
0.70
0.72
0.74
0.76
0.78
0.80
0.82
Distance from Sun (AU)

Introduction

We have received few drawings of comets in recent years, so I have introduced a new observing blank to encourage observers to make drawings. Good drawings will be used to illustrate future section reports in the Journal. A copy of the blank and the section report form are on the last two pages of this supplement; please let me know if you need more copies of them.

Ephemerides are given for comets:

- 22P/Kopff,
- 29P/Schwassmann-Wachmann 1 (a target for CCD observers),
- 45P/Honda-Mrkos-Pajdusakova, (Southern hemisphere in December, UK for January and February)
- 65P/Gunn, (Southern hemisphere only)
- 67P/Churymov-Gerasimenko,
- 73P/Schwassmann-Wachmann 3, (Equator in November and early December, UK from mid December and January)
- P/1995 S1 (de Vico),
- C/1995 O1 (Hale-Bopp),
- C/1995 Q1 (Bradfield)

Comet 22P/Kopff will form a summer project next year as it has a good return and I hope that we will be able to obtain full coverage of it.

Comet Ephemerides

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are taken from the IAU circulars or the latest IAU/CBAT/MPC comet catalogue.
- Magnitude formula

Where the comet is invisible from the UK other locations may be used; these will either be the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. All times are in Greenwich Mean Astronomical Time (GMAT), i.e. the day is the day on which the night starts. To convert to UT (GMT) add 12 hours. If the value is greater than 24, add 1 to the day and subtract 24 from the hour. If necessary, convert to local time. Strictly ephemeris time is used which is currently some 60 seconds ahead of UT.

- Column headings:

a) Double-date format. Time in GMAT. 12.0 is midnight UT.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are for epoch 1950).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun in degrees.

Ephemerides follow

Ephemeris for **22P/Kopff**

```
Omega=162.8460 OMEGA=120.9160 i=  4.7210 q= 1.579530 a=  3.463122
e=0.543900  P=    6.445  T= 1996 July       2.2330     Equinox= 2000
Magnitudes calculated from m= 3.0+5.0*Log(d)+25.0*Log(r)+0.000*Beta
```

March 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 32.3	-16.20	11.5	1.67	1.97	17.55	Not Observable	92
2/ 3	12.0	16 34.3	-16.22	11.5	1.66	1.97	17.53	Not Observable	93
3/ 4	12.0	16 36.3	-16.25	11.4	1.64	1.96	17.51	Not Observable	93
4/ 5	12.0	16 38.3	-16.27	11.4	1.63	1.96	17.49	Not Observable	94
5/ 6	12.0	16 40.4	-16.29	11.3	1.61	1.95	17.47	Not Observable	94
6/ 7	12.0	16 42.4	-16.31	11.3	1.60	1.95	17.45	Not Observable	95
7/ 8	12.0	16 44.4	-16.33	11.2	1.58	1.94	17.43	17.03 to 17.10	95
8/ 9	12.0	16 46.4	-16.35	11.2	1.57	1.94	17.41	16.54 to 17.08	96

9/10	12.0	16 48.4	-16.37	11.1	1.55	1.93	17.39	16.46 to 17.05	96
10/11	12.0	16 50.4	-16.39	11.1	1.54	1.93	17.37	16.39 to 17.03	97
11/12	12.0	16 52.4	-16.40	11.0	1.52	1.92	17.35	16.32 to 17.00	97
12/13	12.0	16 54.4	-16.42	11.0	1.51	1.92	17.33	16.26 to 16.58	98
13/14	12.0	16 56.3	-16.43	10.9	1.49	1.91	17.31	16.19 to 16.56	98
14/15	12.0	16 58.3	-16.44	10.9	1.48	1.91	17.30	16.13 to 16.53	99
15/16	12.0	17 0.3	-16.46	10.8	1.47	1.90	17.28	16.08 to 16.51	99
16/17	12.0	17 2.3	-16.47	10.8	1.45	1.90	17.26	16.02 to 16.48	100
17/18	12.0	17 4.3	-16.48	10.7	1.44	1.89	17.24	15.57 to 16.46	100
18/19	12.0	17 6.3	-16.48	10.7	1.42	1.89	17.22	15.51 to 16.43	101
19/20	12.0	17 8.3	-16.49	10.6	1.41	1.88	17.20	15.46 to 16.41	101
20/21	12.0	17 10.2	-16.50	10.6	1.40	1.88	17.18	15.41 to 16.38	102
21/22	12.0	17 12.2	-16.51	10.5	1.38	1.87	17.16	15.36 to 16.35	102
22/23	12.0	17 14.2	-16.51	10.5	1.37	1.87	17.14	15.31 to 16.33	103
23/24	12.0	17 16.1	-16.51	10.4	1.36	1.86	17.12	15.26 to 16.30	103
24/25	12.0	17 18.1	-16.52	10.4	1.34	1.86	17.10	15.22 to 16.28	104
25/26	12.0	17 20.1	-16.52	10.3	1.33	1.85	17.08	15.17 to 16.25	104
26/27	12.0	17 22.0	-16.52	10.3	1.32	1.85	17.06	15.12 to 16.22	105
27/28	12.0	17 24.0	-16.52	10.2	1.30	1.84	17.04	15.08 to 16.20	106
28/29	12.0	17 25.9	-16.52	10.2	1.29	1.84	17.02	15.03 to 16.17	106
29/30	12.0	17 27.8	-16.52	10.1	1.28	1.83	16.60	14.59 to 16.14	107
30/31	12.0	17 29.8	-16.52	10.1	1.26	1.83	16.58	14.54 to 16.12	107
31/32	12.0	17 31.7	-16.51	10.0	1.25	1.82	16.56	14.50 to 16.09	108

April 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	17 33.6	-16.51	10.0	1.24	1.82	16.54	14.46 to 16.06	108
2/ 3	12.0	17 35.5	-16.51	9.9	1.23	1.81	16.52	14.41 to 16.04	109
3/ 4	12.0	17 37.4	-16.50	9.9	1.21	1.81	16.50	14.37 to 16.01	109
4/ 5	12.0	17 39.3	-16.49	9.8	1.20	1.80	16.48	14.33 to 15.58	110
5/ 6	12.0	17 41.2	-16.49	9.8	1.19	1.80	16.46	14.29 to 15.55	110
6/ 7	12.0	17 43.1	-16.48	9.7	1.18	1.79	16.44	14.25 to 15.53	111
7/ 8	12.0	17 45.0	-16.47	9.7	1.16	1.79	16.42	14.20 to 15.50	111
8/ 9	12.0	17 46.8	-16.46	9.6	1.15	1.79	16.39	14.16 to 15.47	112
9/10	12.0	17 48.7	-16.45	9.6	1.14	1.78	16.37	14.12 to 15.44	112
10/11	12.0	17 50.5	-16.44	9.5	1.13	1.78	16.35	14.08 to 15.41	113
11/12	12.0	17 52.4	-16.43	9.5	1.12	1.77	16.33	14.04 to 15.39	113
12/13	12.0	17 54.2	-16.42	9.4	1.11	1.77	16.31	14.00 to 15.36	114
13/14	12.0	17 56.0	-16.40	9.4	1.09	1.76	16.29	13.56 to 15.33	114
14/15	12.0	17 57.9	-16.39	9.3	1.08	1.76	16.27	13.52 to 15.30	115
15/16	12.0	17 59.7	-16.38	9.3	1.07	1.76	16.25	13.48 to 15.27	116
16/17	12.0	18 1.4	-16.36	9.2	1.06	1.75	16.23	13.45 to 15.25	116
17/18	12.0	18 3.2	-16.35	9.2	1.05	1.75	16.20	13.41 to 15.22	117
18/19	12.0	18 5.0	-16.34	9.1	1.04	1.74	16.18	13.37 to 15.19	117
19/20	12.0	18 6.7	-16.32	9.1	1.03	1.74	16.16	13.33 to 15.16	118
20/21	12.0	18 8.5	-16.30	9.0	1.02	1.74	16.14	13.29 to 15.13	118
21/22	12.0	18 10.2	-16.29	9.0	1.01	1.73	16.12	13.25 to 15.10	119
22/23	12.0	18 11.9	-16.27	8.9	1.00	1.73	16.09	13.21 to 15.07	119
23/24	12.0	18 13.6	-16.26	8.9	0.98	1.72	16.07	13.18 to 15.05	120
24/25	12.0	18 15.3	-16.24	8.8	0.97	1.72	16.05	13.14 to 15.02	120
25/26	12.0	18 17.0	-16.22	8.8	0.96	1.72	16.03	13.10 to 14.59	121
26/27	12.0	18 18.7	-16.21	8.7	0.95	1.71	16.00	13.06 to 14.56	122
27/28	12.0	18 20.3	-16.19	8.7	0.94	1.71	15.58	13.03 to 14.53	122
28/29	12.0	18 21.9	-16.17	8.6	0.93	1.70	15.56	12.59 to 14.50	123
29/30	12.0	18 23.5	-16.16	8.6	0.92	1.70	15.53	12.55 to 14.47	123
30/31	12.0	18 25.1	-16.14	8.6	0.91	1.70	15.51	12.52 to 14.44	124

May 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	18 26.7	-16.12	8.5	0.91	1.69	15.49	12.48 to 14.42	124
2/ 3	12.0	18 28.3	-16.11	8.5	0.90	1.69	15.46	12.44 to 14.39	125
3/ 4	12.0	18 29.8	-16.09	8.4	0.89	1.69	15.44	12.40 to 14.36	126
4/ 5	12.0	18 31.4	-16.08	8.4	0.88	1.68	15.41	12.37 to 14.33	126
5/ 6	12.0	18 32.9	-16.06	8.3	0.87	1.68	15.39	12.33 to 14.30	127
6/ 7	12.0	18 34.4	-16.04	8.3	0.86	1.68	15.37	12.30 to 14.27	127
7/ 8	12.0	18 35.9	-16.03	8.2	0.85	1.67	15.34	12.26 to 14.24	128
8/ 9	12.0	18 37.3	-16.02	8.2	0.84	1.67	15.32	12.22 to 14.21	129

9/10	12.0	18 38.8	-16.00	8.2	0.83	1.67	15.29	12.19 to 14.18	129
10/11	12.0	18 40.2	-15.59	8.1	0.82	1.66	15.27	12.15 to 14.15	130
11/12	12.0	18 41.6	-15.58	8.1	0.82	1.66	15.24	12.11 to 14.13	130
12/13	12.0	18 42.9	-15.56	8.0	0.81	1.66	15.21	12.08 to 14.10	131
13/14	12.0	18 44.3	-15.55	8.0	0.80	1.65	15.19	12.04 to 14.07	132
14/15	12.0	18 45.6	-15.54	7.9	0.79	1.65	15.16	12.01 to 14.04	132
15/16	12.0	18 46.9	-15.53	7.9	0.78	1.65	15.14	11.57 to 14.01	133
16/17	12.0	18 48.2	-15.53	7.9	0.78	1.65	15.11	11.54 to 13.58	134
17/18	12.0	18 49.5	-15.52	7.8	0.77	1.64	15.08	11.50 to 13.55	134
18/19	12.0	18 50.7	-15.51	7.8	0.76	1.64	15.06	11.47 to 13.53	135
19/20	12.0	18 51.9	-15.51	7.7	0.75	1.64	15.03	11.43 to 13.50	136
20/21	12.0	18 53.1	-15.50	7.7	0.75	1.64	15.00	11.39 to 13.47	136
21/22	12.0	18 54.2	-15.50	7.7	0.74	1.63	14.57	11.36 to 13.44	137
22/23	12.0	18 55.4	-15.50	7.6	0.73	1.63	14.54	11.32 to 13.41	138
23/24	12.0	18 56.5	-15.50	7.6	0.73	1.63	14.52	11.29 to 13.38	138
24/25	12.0	18 57.6	-15.50	7.6	0.72	1.63	14.49	11.26 to 13.36	139
25/26	12.0	18 58.6	-15.50	7.5	0.71	1.62	14.46	11.22 to 13.33	140
26/27	12.0	18 59.7	-15.51	7.5	0.71	1.62	14.43	11.19 to 13.30	140
27/28	12.0	19 0.7	-15.51	7.5	0.70	1.62	14.40	11.15 to 13.27	141
28/29	12.0	19 1.6	-15.52	7.4	0.69	1.62	14.37	11.12 to 13.25	142
29/30	12.0	19 2.6	-15.53	7.4	0.69	1.61	14.34	11.08 to 13.22	143
30/31	12.0	19 3.5	-15.54	7.4	0.68	1.61	14.31	11.05 to 13.19	143
31/32	12.0	19 4.4	-15.55	7.3	0.68	1.61	14.28	11.01 to 13.17	144

Ephemeris for **29P/Schwassmann-Wachmann 1**

Omega= 46.4000 OMEGA=312.8230 i= 9.3840 q= 5.752980 a= 6.015685
e=0.043670 P= 14.755 T= 1989 September 10.5410 Equinox= 2000
Magnitudes calculated from m= 6.0+5.0*Log(d)+10.0*Log(r)+0.000*Beta

November 1995 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 36.2	5.48	18.1	6.68	6.25	19.55	15.40 to 17.34	60
3/ 4	12.0	10 37.1	5.41	18.1	6.65	6.25	19.48	15.34 to 17.37	62
5/ 6	12.0	10 38.0	5.33	18.1	6.62	6.25	19.41	15.28 to 17.40	64
7/ 8	12.0	10 38.8	5.26	18.1	6.60	6.25	19.34	15.21 to 17.44	65
9/10	12.0	10 39.7	5.19	18.0	6.57	6.25	19.27	15.15 to 17.47	67
11/12	12.0	10 40.5	5.12	18.0	6.54	6.25	19.20	15.09 to 17.50	69
13/14	12.0	10 41.2	5.06	18.0	6.51	6.25	19.13	15.02 to 17.53	71
15/16	12.0	10 42.0	4.59	18.0	6.47	6.25	19.06	14.56 to 17.56	72
17/18	12.0	10 42.7	4.53	18.0	6.44	6.25	18.59	14.49 to 17.59	74
19/20	12.0	10 43.3	4.47	18.0	6.41	6.25	18.52	14.42 to 18.02	76
21/22	12.0	10 44.0	4.41	18.0	6.38	6.25	18.44	14.36 to 18.05	78
23/24	12.0	10 44.6	4.35	18.0	6.35	6.25	18.37	14.29 to 18.08	80
25/26	12.0	10 45.1	4.29	18.0	6.32	6.25	18.30	14.22 to 18.11	82
27/28	12.0	10 45.7	4.23	17.9	6.28	6.25	18.22	14.15 to 18.14	83
29/30	12.0	10 46.2	4.18	17.9	6.25	6.25	18.15	14.09 to 18.16	85

December 1995 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 46.6	4.13	17.9	6.22	6.25	18.08	14.02 to 18.19	87
3/ 4	12.0	10 47.0	4.08	17.9	6.19	6.25	18.00	13.55 to 18.21	89
5/ 6	12.0	10 47.4	4.03	17.9	6.15	6.25	17.53	13.48 to 18.24	91
7/ 8	12.0	10 47.8	3.59	17.9	6.12	6.25	17.45	13.41 to 18.26	93
9/10	12.0	10 48.1	3.54	17.9	6.09	6.25	17.37	13.33 to 18.28	95
11/12	12.0	10 48.3	3.50	17.9	6.06	6.25	17.30	13.26 to 18.30	97
13/14	12.0	10 48.6	3.46	17.9	6.03	6.25	17.22	13.19 to 18.31	99
15/16	12.0	10 48.8	3.43	17.8	5.99	6.25	17.14	13.12 to 18.33	101
17/18	12.0	10 48.9	3.39	17.8	5.96	6.25	17.07	13.04 to 18.34	103
19/20	12.0	10 49.0	3.36	17.8	5.93	6.25	16.59	12.57 to 18.36	105
21/22	12.0	10 49.1	3.33	17.8	5.90	6.25	16.51	12.49 to 18.37	107
23/24	12.0	10 49.1	3.30	17.8	5.87	6.25	16.43	12.42 to 18.38	109
25/26	12.0	10 49.1	3.28	17.8	5.84	6.25	16.35	12.34 to 18.39	111
27/28	12.0	10 49.0	3.26	17.8	5.81	6.25	16.27	12.26 to 18.39	113
29/30	12.0	10 48.9	3.24	17.8	5.78	6.25	16.19	12.18 to 18.39	115

31/32	12.0	10 48.8	3.22	17.8	5.75	6.25	16.11	12.11 to 18.40	117

January 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 48.7	3.21	17.8	5.73	6.25	16.07	12.07 to 18.40	118
3/ 4	12.0	10 48.5	3.20	17.7	5.71	6.25	15.59	11.59 to 18.40	120
5/ 6	12.0	10 48.3	3.19	17.7	5.68	6.25	15.51	11.51 to 18.39	122
7/ 8	12.0	10 48.0	3.18	17.7	5.65	6.25	15.43	11.43 to 18.39	124
9/10	12.0	10 47.7	3.17	17.7	5.62	6.25	15.35	11.34 to 18.38	126
11/12	12.0	10 47.3	3.17	17.7	5.60	6.25	15.27	11.26 to 18.37	128
13/14	12.0	10 46.9	3.17	17.7	5.57	6.26	15.18	11.18 to 18.36	130
15/16	12.0	10 46.5	3.17	17.7	5.55	6.26	15.10	11.10 to 18.35	133
17/18	12.0	10 46.0	3.17	17.7	5.52	6.26	15.02	11.01 to 18.34	135
19/20	12.0	10 45.5	3.18	17.7	5.50	6.26	14.53	10.53 to 18.32	137
21/22	12.0	10 44.9	3.19	17.7	5.48	6.26	14.45	10.44 to 18.30	139
23/24	12.0	10 44.4	3.20	17.6	5.46	6.26	14.36	10.36 to 18.28	141
25/26	12.0	10 43.7	3.21	17.6	5.44	6.26	14.28	10.27 to 18.26	143
27/28	12.0	10 43.1	3.23	17.6	5.42	6.26	14.19	10.18 to 18.20	145
29/30	12.0	10 42.4	3.25	17.6	5.40	6.26	14.11	10.10 to 18.12	148
31/32	12.0	10 41.7	3.27	17.6	5.39	6.26	14.02	10.01 to 18.03	150

February 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 41.4	3.28	17.6	5.38	6.26	13.58	9.56 to 17.59	151
3/ 4	12.0	10 40.6	3.30	17.6	5.36	6.26	13.49	9.48 to 17.51	153
5/ 6	12.0	10 39.8	3.32	17.6	5.35	6.26	13.41	9.39 to 17.42	155
7/ 8	12.0	10 39.0	3.35	17.6	5.34	6.26	13.32	9.30 to 17.34	157
9/10	12.0	10 38.2	3.38	17.6	5.32	6.26	13.23	9.21 to 17.26	160
11/12	12.0	10 37.4	3.41	17.6	5.31	6.26	13.14	9.12 to 17.17	162
13/14	12.0	10 36.6	3.44	17.6	5.30	6.26	13.06	9.03 to 17.09	164
15/16	12.0	10 35.7	3.47	17.6	5.30	6.26	12.57	8.54 to 17.00	166
17/18	12.0	10 34.8	3.51	17.6	5.29	6.26	12.48	8.44 to 16.52	168
19/20	12.0	10 33.9	3.54	17.6	5.28	6.26	12.39	8.35 to 16.44	170
21/22	12.0	10 33.0	3.58	17.6	5.28	6.26	12.31	8.26 to 16.35	172
23/24	12.0	10 32.1	4.02	17.6	5.28	6.26	12.22	8.17 to 16.27	174
25/26	12.0	10 31.2	4.06	17.6	5.27	6.26	12.13	8.08 to 16.18	175
27/28	12.0	10 30.3	4.10	17.6	5.27	6.26	12.04	7.59 to 16.10	175
29/30	12.0	10 29.4	4.14	17.6	5.27	6.26	11.56	7.50 to 16.02	174

March 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 29.0	4.16	17.6	5.27	6.26	11.51	7.45 to 15.57	174
3/ 4	12.0	10 28.1	4.20	17.6	5.28	6.26	11.42	7.36 to 15.49	172
5/ 6	12.0	10 27.2	4.24	17.6	5.28	6.26	11.34	7.27 to 15.41	170
7/ 8	12.0	10 26.4	4.28	17.6	5.29	6.26	11.25	7.17 to 15.32	169
9/10	12.0	10 25.5	4.32	17.6	5.29	6.26	11.16	7.15 to 15.24	166
11/12	12.0	10 24.6	4.36	17.6	5.30	6.26	11.07	7.19 to 15.16	164
13/14	12.0	10 23.8	4.40	17.6	5.31	6.26	10.59	7.23 to 15.07	162
15/16	12.0	10 23.0	4.44	17.6	5.32	6.26	10.50	7.27 to 14.59	160
17/18	12.0	10 22.2	4.48	17.6	5.33	6.26	10.41	7.31 to 14.51	158
19/20	12.0	10 21.4	4.52	17.6	5.34	6.26	10.33	7.35 to 14.42	156
21/22	12.0	10 20.7	4.55	17.6	5.35	6.26	10.24	7.39 to 14.34	154
23/24	12.0	10 20.0	4.59	17.6	5.37	6.26	10.15	7.43 to 14.26	152
25/26	12.0	10 19.3	5.03	17.6	5.38	6.26	10.07	7.47 to 14.18	149
27/28	12.0	10 18.6	5.06	17.6	5.40	6.26	9.58	7.51 to 14.09	147
29/30	12.0	10 18.0	5.10	17.6	5.42	6.26	9.50	7.55 to 14.01	145
31/32	12.0	10 17.4	5.13	17.6	5.44	6.26	9.41	7.59 to 13.53	143

April 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 17.1	5.14	17.6	5.45	6.26	9.37	8.01 to 13.49	142
3/ 4	12.0	10 16.5	5.17	17.7	5.47	6.26	9.29	8.05 to 13.41	140
5/ 6	12.0	10 16.0	5.20	17.7	5.49	6.26	9.20	8.10 to 13.33	138
7/ 8	12.0	10 15.5	5.23	17.7	5.51	6.26	9.12	8.14 to 13.25	136
9/10	12.0	10 15.1	5.26	17.7	5.53	6.26	9.03	8.19 to 13.17	134

11/12	12.0	10 14.7	5.28	17.7	5.55	6.26	8.55	8.23 to 13.08	132
13/14	12.0	10 14.3	5.30	17.7	5.58	6.26	8.47	8.28 to 13.00	130
15/16	12.0	10 14.0	5.32	17.7	5.60	6.27	8.39	8.32 to 12.52	128
17/18	12.0	10 13.7	5.34	17.7	5.63	6.27	8.31	8.37 to 12.44	126
19/20	12.0	10 13.4	5.36	17.7	5.65	6.27	8.22	8.42 to 12.36	124
21/22	12.0	10 13.2	5.37	17.7	5.68	6.27	8.14	8.47 to 12.28	122
23/24	12.0	10 13.1	5.39	17.8	5.71	6.27	8.06	8.52 to 12.21	120
25/26	12.0	10 12.9	5.40	17.8	5.74	6.27	7.58	8.57 to 12.13	118
27/28	12.0	10 12.8	5.41	17.8	5.76	6.27	7.50	9.02 to 12.05	116
29/30	12.0	10 12.8	5.41	17.8	5.79	6.27	7.42	9.07 to 11.57	114

May 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	10 12.8	5.42	17.8	5.82	6.27	7.34	9.12 to 11.49	112
3/ 4	12.0	10 12.8	5.42	17.8	5.85	6.27	7.27	9.18 to 11.41	110
5/ 6	12.0	10 12.9	5.42	17.8	5.88	6.27	7.19	9.23 to 11.33	108
7/ 8	12.0	10 13.0	5.42	17.8	5.91	6.27	7.11	9.29 to 11.26	106
9/10	12.0	10 13.1	5.42	17.8	5.94	6.27	7.03	9.34 to 11.18	104
11/12	12.0	10 13.3	5.41	17.9	5.97	6.27	6.56	9.40 to 11.10	102
13/14	12.0	10 13.5	5.40	17.9	6.01	6.27	6.48	9.46 to 11.02	100
15/16	12.0	10 13.8	5.39	17.9	6.04	6.27	6.40	9.52 to 10.55	99
17/18	12.0	10 14.1	5.38	17.9	6.07	6.27	6.33	9.57 to 10.47	97
19/20	12.0	10 14.5	5.37	17.9	6.10	6.27	6.25	10.03 to 10.39	95
21/22	12.0	10 14.8	5.35	17.9	6.13	6.27	6.18	10.09 to 10.32	93
23/24	12.0	10 15.2	5.33	17.9	6.16	6.27	6.10	10.15 to 10.24	91
25/26	12.0	10 15.7	5.31	17.9	6.20	6.27	6.03	Not Observable	89
27/28	12.0	10 16.2	5.29	17.9	6.23	6.27	5.55	Not Observable	88
29/30	12.0	10 16.7	5.26	18.0	6.26	6.27	5.48	Not Observable	86
31/32	12.0	10 17.2	5.23	18.0	6.29	6.27	5.41	Not Observable	84

Ephemeris for **45P/Honda-Mrkos-Pajdusakova** for the **Southern Hemisphere**

Omega=326.0570 OMEGA= 89.1670 i= 4.2510 q= 0.531950 a= 3.027432
e=0.824290 P= 5.268 T= 1995 December 25.9310 Equinox= 2000
Magnitudes calculated from m=13.5+5.0*Log(d)+20.0*Log(r)+0.000*Beta

December 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	19 21.0	-24.53	11.0	1.12	0.73	2.42	Not Observable	40
2/ 3	12.0	19 24.0	-24.47	10.8	1.10	0.71	2.41	Not Observable	39
3/ 4	12.0	19 27.1	-24.41	10.6	1.09	0.70	2.41	Not Observable	39
4/ 5	12.0	19 30.2	-24.34	10.4	1.07	0.69	2.40	Not Observable	39
5/ 6	12.0	19 33.3	-24.28	10.2	1.05	0.67	2.39	8.37 to 8.37	38
6/ 7	12.0	19 36.4	-24.21	10.0	1.04	0.66	2.38	8.38 to 8.40	38
7/ 8	12.0	19 39.5	-24.13	9.8	1.02	0.65	2.37	8.39 to 8.42	38
8/ 9	12.0	19 42.6	-24.06	9.6	1.00	0.64	2.36	8.40 to 8.44	38
9/10	12.0	19 45.7	-23.58	9.4	0.98	0.63	2.35	8.41 to 8.46	37
10/11	12.0	19 48.7	-23.49	9.2	0.96	0.62	2.34	8.42 to 8.48	37
11/12	12.0	19 51.7	-23.41	9.0	0.94	0.61	2.34	8.43 to 8.49	37
12/13	12.0	19 54.7	-23.32	8.9	0.92	0.60	2.33	8.44 to 8.51	36
13/14	12.0	19 57.6	-23.23	8.7	0.90	0.59	2.32	8.45 to 8.52	36
14/15	12.0	20 0.4	-23.13	8.5	0.88	0.58	2.30	8.46 to 8.52	36
15/16	12.0	20 3.2	-23.03	8.3	0.86	0.57	2.29	8.47 to 8.53	35
16/17	12.0	20 5.9	-22.53	8.2	0.84	0.56	2.28	8.48 to 8.53	35
17/18	12.0	20 8.5	-22.43	8.0	0.82	0.56	2.27	8.48 to 8.53	35
18/19	12.0	20 11.0	-22.33	7.9	0.80	0.55	2.25	8.49 to 8.53	34
19/20	12.0	20 13.4	-22.22	7.7	0.78	0.55	2.24	8.50 to 8.52	34
20/21	12.0	20 15.6	-22.12	7.6	0.76	0.54	2.22	8.50 to 8.51	33
21/22	12.0	20 17.7	-22.01	7.5	0.74	0.54	2.20	Not Observable	33
22/23	12.0	20 19.6	-21.50	7.4	0.72	0.54	2.18	Not Observable	32
23/24	12.0	20 21.3	-21.39	7.3	0.70	0.53	2.16	Not Observable	32
24/25	12.0	20 22.8	-21.28	7.2	0.68	0.53	2.13	Not Observable	31
25/26	12.0	20 24.1	-21.17	7.1	0.66	0.53	2.11	Not Observable	30

Ephemeris for **45P/Honda-Mrkos-Pajdusakova** for the **UK**

January 1996				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
21/22	12.0	18 54.2	-14.19	8.0	0.23	0.77	22.54	Not Observable	19
22/23	12.0	18 44.7	-13.42	8.1	0.22	0.78	22.41	Not Observable	23
23/24	12.0	18 34.6	-13.01	8.2	0.22	0.80	22.27	Not Observable	26
24/25	12.0	18 24.0	-12.16	8.3	0.21	0.81	22.12	Not Observable	30
25/26	12.0	18 12.9	-11.26	8.3	0.20	0.82	21.57	18.16 to 18.26	33
26/27	12.0	18 1.2	-10.33	8.4	0.20	0.84	21.41	17.56 to 18.25	37
27/28	12.0	17 49.0	-9.35	8.5	0.19	0.85	21.25	17.35 to 18.24	41
28/29	12.0	17 36.3	-8.32	8.6	0.19	0.87	21.09	17.13 to 18.23	46
29/30	12.0	17 23.1	-7.26	8.7	0.18	0.88	20.52	16.51 to 18.21	50
30/31	12.0	17 9.6	-6.15	8.8	0.18	0.89	20.34	16.27 to 18.20	55
31/32	12.0	16 55.7	-5.01	8.9	0.17	0.91	20.16	16.04 to 18.19	59

February 1996				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 41.5	-3.44	9.0	0.17	0.92	19.58	15.40 to 18.17	64
2/ 3	12.0	16 27.1	-2.24	9.1	0.17	0.94	19.40	15.16 to 18.16	69
3/ 4	12.0	16 12.7	-1.04	9.2	0.17	0.95	19.21	14.53 to 18.15	74
4/ 5	12.0	15 58.2	0.18	9.4	0.17	0.97	19.03	14.29 to 18.13	78
5/ 6	12.0	15 43.8	1.38	9.5	0.17	0.98	18.44	14.06 to 18.12	83
6/ 7	12.0	15 29.5	2.58	9.6	0.17	0.99	18.26	13.44 to 18.10	88
7/ 8	12.0	15 15.5	4.15	9.8	0.17	1.01	18.08	13.22 to 18.08	92
8/ 9	12.0	15 1.8	5.29	9.9	0.18	1.02	17.51	13.01 to 18.07	97
9/10	12.0	14 48.5	6.40	10.1	0.18	1.04	17.33	12.41 to 18.05	101
10/11	12.0	14 35.6	7.47	10.3	0.18	1.05	17.16	12.23 to 18.04	106
11/12	12.0	14 23.2	8.49	10.4	0.19	1.07	17.00	12.05 to 18.02	110
12/13	12.0	14 11.2	9.48	10.6	0.19	1.08	16.44	11.49 to 18.00	114
13/14	12.0	13 59.7	10.42	10.8	0.20	1.09	16.29	11.33 to 17.58	118
14/15	12.0	13 48.8	11.31	11.0	0.21	1.11	16.14	11.19 to 17.56	122
15/16	12.0	13 38.4	12.17	11.1	0.21	1.12	15.60	11.06 to 17.55	125
16/17	12.0	13 28.5	12.58	11.3	0.22	1.14	15.46	10.54 to 17.53	128
17/18	12.0	13 19.0	13.36	11.5	0.23	1.15	15.32	10.43 to 17.51	132
18/19	12.0	13 10.1	14.10	11.7	0.23	1.17	15.19	10.33 to 17.49	135
19/20	12.0	13 1.7	14.41	11.9	0.24	1.18	15.07	10.24 to 17.47	138
20/21	12.0	12 53.6	15.08	12.0	0.25	1.19	14.55	10.17 to 17.45	141
21/22	12.0	12 46.1	15.33	12.2	0.26	1.21	14.44	10.10 to 17.43	143
22/23	12.0	12 38.9	15.55	12.4	0.27	1.22	14.33	10.04 to 17.41	146

Ephemeris for **65P/Gunn** for the **Southern Hemisphere**

Omega=196.8620 OMEGA= 68.5180 i= 10.3820 q= 2.461840 a= 3.598077
e=0.315790 P= 6.825 T= 1996 July 24.5770 Equinox= 2000
Magnitudes calculated from m= 5.0+5.0*Log(d)+15.0*Log(r)+0.000*Beta

April 1996				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 45.9	-18.37	12.5	1.91	2.56	16.06	11.25 to 17.12	119
2/ 3	12.0	16 46.3	-18.40	12.5	1.90	2.56	16.03	11.21 to 17.13	120
3/ 4	12.0	16 46.7	-18.44	12.5	1.89	2.55	15.59	11.17 to 17.14	121
4/ 5	12.0	16 47.1	-18.47	12.5	1.88	2.55	15.56	11.12 to 17.15	122
5/ 6	12.0	16 47.4	-18.50	12.5	1.86	2.55	15.52	11.08 to 17.16	123
6/ 7	12.0	16 47.7	-18.53	12.4	1.85	2.55	15.48	11.04 to 17.17	124
7/ 8	12.0	16 48.0	-18.57	12.4	1.84	2.55	15.45	10.59 to 17.18	125
8/ 9	12.0	16 48.3	-18.60	12.4	1.83	2.55	15.41	10.55 to 17.19	126
9/10	12.0	16 48.5	-19.03	12.4	1.82	2.54	15.37	10.51 to 17.20	127
10/11	12.0	16 48.7	-19.06	12.4	1.81	2.54	15.33	10.46 to 17.21	128
11/12	12.0	16 48.9	-19.10	12.3	1.79	2.54	15.30	10.42 to 17.22	128
12/13	12.0	16 49.0	-19.13	12.3	1.78	2.54	15.26	10.37 to 17.23	129
13/14	12.0	16 49.1	-19.16	12.3	1.77	2.54	15.22	10.33 to 17.24	130
14/15	12.0	16 49.2	-19.20	12.3	1.76	2.54	15.18	10.28 to 17.25	131
15/16	12.0	16 49.3	-19.23	12.3	1.75	2.54	15.14	10.23 to 17.26	132

16/17	12.0	16 49.3	-19.26	12.3	1.74	2.53	15.10	10.19 to 17.27	133
17/18	12.0	16 49.3	-19.30	12.2	1.73	2.53	15.06	10.14 to 17.28	134
18/19	12.0	16 49.3	-19.33	12.2	1.72	2.53	15.03	10.10 to 17.29	135
19/20	12.0	16 49.3	-19.36	12.2	1.71	2.53	14.59	10.05 to 17.29	136
20/21	12.0	16 49.2	-19.40	12.2	1.70	2.53	14.55	10.00 to 17.30	137
21/22	12.0	16 49.1	-19.43	12.2	1.69	2.53	14.50	9.55 to 17.31	138
22/23	12.0	16 48.9	-19.46	12.2	1.68	2.53	14.46	9.51 to 17.32	139
23/24	12.0	16 48.8	-19.50	12.1	1.67	2.52	14.42	9.46 to 17.33	140
24/25	12.0	16 48.6	-19.53	12.1	1.66	2.52	14.38	9.41 to 17.34	141
25/26	12.0	16 48.4	-19.57	12.1	1.65	2.52	14.34	9.36 to 17.35	142
26/27	12.0	16 48.1	-20.00	12.1	1.64	2.52	14.30	9.32 to 17.36	143
27/28	12.0	16 47.9	-20.04	12.1	1.63	2.52	14.26	9.27 to 17.37	144
28/29	12.0	16 47.6	-20.07	12.1	1.62	2.52	14.21	9.22 to 17.38	145
29/30	12.0	16 47.2	-20.11	12.1	1.62	2.52	14.17	9.17 to 17.38	146
30/31	12.0	16 46.9	-20.14	12.0	1.61	2.52	14.13	9.12 to 17.39	147

May	1996			Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 46.5	-20.18	12.0	1.60	2.51	14.09	9.07 to 17.40	148
2/ 3	12.0	16 46.1	-20.21	12.0	1.59	2.51	14.04	9.02 to 17.41	149
3/ 4	12.0	16 45.7	-20.25	12.0	1.58	2.51	13.60	8.57 to 17.42	150
4/ 5	12.0	16 45.2	-20.28	12.0	1.58	2.51	13.55	8.52 to 17.43	152
5/ 6	12.0	16 44.8	-20.32	12.0	1.57	2.51	13.51	8.48 to 17.44	153
6/ 7	12.0	16 44.3	-20.36	12.0	1.56	2.51	13.47	8.43 to 17.44	154
7/ 8	12.0	16 43.8	-20.39	11.9	1.56	2.51	13.42	8.38 to 17.45	155
8/ 9	12.0	16 43.2	-20.43	11.9	1.55	2.51	13.38	8.33 to 17.46	156
9/10	12.0	16 42.6	-20.46	11.9	1.54	2.51	13.33	8.27 to 17.47	157
10/11	12.0	16 42.0	-20.50	11.9	1.54	2.50	13.29	8.22 to 17.48	158
11/12	12.0	16 41.4	-20.54	11.9	1.53	2.50	13.24	8.17 to 17.49	159
12/13	12.0	16 40.8	-20.57	11.9	1.53	2.50	13.19	8.12 to 17.49	160
13/14	12.0	16 40.1	-21.01	11.9	1.52	2.50	13.15	8.07 to 17.50	161
14/15	12.0	16 39.5	-21.04	11.9	1.52	2.50	13.10	8.02 to 17.51	163
15/16	12.0	16 38.8	-21.08	11.9	1.51	2.50	13.06	7.57 to 17.52	164
16/17	12.0	16 38.1	-21.12	11.9	1.51	2.50	13.01	7.52 to 17.53	165
17/18	12.0	16 37.4	-21.15	11.8	1.50	2.50	12.56	7.47 to 17.53	166
18/19	12.0	16 36.6	-21.19	11.8	1.50	2.50	12.52	7.42 to 17.54	167
19/20	12.0	16 35.9	-21.22	11.8	1.50	2.49	12.47	7.37 to 17.55	168
20/21	12.0	16 35.1	-21.26	11.8	1.49	2.49	12.42	7.32 to 17.53	169
21/22	12.0	16 34.3	-21.29	11.8	1.49	2.49	12.37	7.26 to 17.48	170
22/23	12.0	16 33.5	-21.33	11.8	1.49	2.49	12.33	7.21 to 17.44	172
23/24	12.0	16 32.7	-21.37	11.8	1.48	2.49	12.28	7.16 to 17.40	173
24/25	12.0	16 31.9	-21.40	11.8	1.48	2.49	12.23	7.11 to 17.35	174
25/26	12.0	16 31.1	-21.44	11.8	1.48	2.49	12.18	7.06 to 17.31	175
26/27	12.0	16 30.3	-21.47	11.8	1.48	2.49	12.14	7.01 to 17.27	176
27/28	12.0	16 29.4	-21.51	11.8	1.47	2.49	12.09	6.56 to 17.22	177
28/29	12.0	16 28.6	-21.54	11.8	1.47	2.49	12.04	6.51 to 17.18	178
29/30	12.0	16 27.8	-21.58	11.8	1.47	2.49	11.59	6.46 to 17.13	179
30/31	12.0	16 26.9	-22.01	11.8	1.47	2.48	11.55	6.41 to 17.09	179
31/32	12.0	16 26.1	-22.05	11.8	1.47	2.48	11.50	6.36 to 17.04	178

Ephemeris for **67P/Churyumov-Gerasimenko**

Omega= 11.3890 OMEGA= 51.0060 i= 7.1130 q= 1.300030 a= 3.514925
e=0.630140 P= 6.590 T= 1996 January 17.6650 Equinox= 2000
Magnitudes calculated from m=10.5+5.0*Log(d)+10.0*Log(r)+0.000*Beta

December	1995			Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	22 53.4	-11.55	12.0	0.99	1.41	6.14	5.19 to 7.24	91
2/ 3	12.0	22 55.2	-11.35	12.0	0.99	1.41	6.12	5.19 to 7.29	91
3/ 4	12.0	22 57.1	-11.14	12.0	0.99	1.40	6.10	5.19 to 7.34	90
4/ 5	12.0	22 59.0	-10.54	11.9	0.99	1.40	6.08	5.18 to 7.38	90
5/ 6	12.0	23 0.9	-10.33	11.9	0.99	1.40	6.06	5.18 to 7.42	90
6/ 7	12.0	23 2.8	-10.12	11.9	1.00	1.39	6.04	5.18 to 7.46	89

7/ 8	12.0	23 4.8	-9.51	11.9	1.00	1.39	6.02	5.17 to 7.49	89
8/ 9	12.0	23 6.9	-9.29	11.9	1.00	1.38	6.00	5.17 to 7.53	88
9/10	12.0	23 8.9	-9.08	11.9	1.00	1.38	5.58	5.17 to 7.56	88
10/11	12.0	23 11.0	-8.46	11.9	1.00	1.37	5.56	5.17 to 7.59	88
11/12	12.0	23 13.1	-8.24	11.9	1.01	1.37	5.55	5.17 to 8.02	87
12/13	12.0	23 15.2	-8.02	11.9	1.01	1.37	5.53	5.17 to 8.04	87
13/14	12.0	23 17.4	-7.39	11.9	1.01	1.36	5.51	5.17 to 8.07	86
14/15	12.0	23 19.6	-7.16	11.9	1.01	1.36	5.49	5.17 to 8.09	86
15/16	12.0	23 21.8	-6.53	11.9	1.01	1.36	5.48	5.17 to 8.12	86
16/17	12.0	23 24.1	-6.30	11.8	1.01	1.35	5.46	5.18 to 8.14	85
17/18	12.0	23 26.3	-6.07	11.8	1.02	1.35	5.44	5.18 to 8.16	85
18/19	12.0	23 28.6	-5.43	11.8	1.02	1.35	5.43	5.18 to 8.19	85
19/20	12.0	23 31.0	-5.19	11.8	1.02	1.34	5.41	5.19 to 8.21	84
20/21	12.0	23 33.3	-4.55	11.8	1.02	1.34	5.39	5.19 to 8.23	84
21/22	12.0	23 35.7	-4.31	11.8	1.02	1.34	5.38	5.19 to 8.25	84
22/23	12.0	23 38.1	-4.07	11.8	1.03	1.34	5.36	5.20 to 8.27	83
23/24	12.0	23 40.6	-3.42	11.8	1.03	1.33	5.35	5.21 to 8.29	83
24/25	12.0	23 43.0	-3.18	11.8	1.03	1.33	5.33	5.21 to 8.31	83
25/26	12.0	23 45.5	-2.53	11.8	1.03	1.33	5.32	5.22 to 8.33	82
26/27	12.0	23 48.1	-2.28	11.8	1.03	1.33	5.30	5.22 to 8.35	82
27/28	12.0	23 50.6	-2.03	11.8	1.03	1.32	5.29	5.23 to 8.37	82
28/29	12.0	23 53.2	-1.37	11.8	1.04	1.32	5.28	5.24 to 8.39	82
29/30	12.0	23 55.8	-1.12	11.8	1.04	1.32	5.26	5.25 to 8.40	81
30/31	12.0	23 58.4	-0.46	11.8	1.04	1.32	5.25	5.26 to 8.42	81
31/32	12.0	0 1.0	-0.20	11.8	1.04	1.32	5.24	5.26 to 8.44	81

January 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	0 3.7	0.05	11.8	1.04	1.31	5.22	5.27 to 8.46	81
2/ 3	12.0	0 6.4	0.31	11.8	1.05	1.31	5.21	5.28 to 8.48	80
3/ 4	12.0	0 9.1	0.58	11.8	1.05	1.31	5.20	5.29 to 8.49	80
4/ 5	12.0	0 11.8	1.24	11.8	1.05	1.31	5.19	5.30 to 8.51	80
5/ 6	12.0	0 14.6	1.50	11.8	1.05	1.31	5.18	5.31 to 8.53	80
6/ 7	12.0	0 17.4	2.17	11.8	1.06	1.31	5.16	5.33 to 8.54	80
7/ 8	12.0	0 20.2	2.43	11.8	1.06	1.31	5.15	5.34 to 8.56	79
8/ 9	12.0	0 23.0	3.10	11.8	1.06	1.30	5.14	5.35 to 8.58	79
9/10	12.0	0 25.9	3.36	11.8	1.06	1.30	5.13	5.36 to 8.59	79
10/11	12.0	0 28.8	4.03	11.8	1.07	1.30	5.12	5.37 to 9.01	79
11/12	12.0	0 31.7	4.30	11.8	1.07	1.30	5.11	5.39 to 9.02	79
12/13	12.0	0 34.6	4.57	11.8	1.07	1.30	5.10	5.40 to 9.04	78
13/14	12.0	0 37.6	5.23	11.8	1.07	1.30	5.09	5.41 to 9.05	78
14/15	12.0	0 40.5	5.50	11.8	1.08	1.30	5.08	5.42 to 9.07	78
15/16	12.0	0 43.5	6.17	11.8	1.08	1.30	5.07	5.44 to 9.08	78
16/17	12.0	0 46.6	6.44	11.8	1.08	1.30	5.06	5.45 to 9.10	78
17/18	12.0	0 49.6	7.11	11.8	1.09	1.30	5.05	5.47 to 9.11	78
18/19	12.0	0 52.7	7.38	11.8	1.09	1.30	5.04	5.48 to 9.13	78
19/20	12.0	0 55.7	8.05	11.8	1.09	1.30	5.03	5.49 to 9.14	77
20/21	12.0	0 58.9	8.32	11.8	1.09	1.30	5.03	5.51 to 9.16	77
21/22	12.0	1 2.0	8.58	11.8	1.10	1.30	5.02	5.52 to 9.17	77
22/23	12.0	1 5.1	9.25	11.9	1.10	1.30	5.01	5.54 to 9.18	77
23/24	12.0	1 8.3	9.52	11.9	1.10	1.30	5.00	5.55 to 9.20	77
24/25	12.0	1 11.5	10.18	11.9	1.11	1.30	4.60	5.57 to 9.21	77
25/26	12.0	1 14.7	10.45	11.9	1.11	1.30	4.59	5.59 to 9.22	77
26/27	12.0	1 18.0	11.11	11.9	1.12	1.30	4.58	6.00 to 9.24	77
27/28	12.0	1 21.2	11.38	11.9	1.12	1.31	4.57	6.02 to 9.25	76
28/29	12.0	1 24.5	12.04	11.9	1.12	1.31	4.57	6.03 to 9.26	76
29/30	12.0	1 27.8	12.30	11.9	1.13	1.31	4.56	6.05 to 9.28	76
30/31	12.0	1 31.1	12.56	11.9	1.13	1.31	4.56	6.07 to 9.29	76
31/32	12.0	1 34.5	13.22	12.0	1.14	1.31	4.55	6.08 to 9.30	76

February 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	1 37.8	13.47	12.0	1.14	1.31	4.54	6.10 to 9.31	76
2/ 3	12.0	1 41.2	14.13	12.0	1.14	1.31	4.54	6.11 to 9.32	76
3/ 4	12.0	1 44.6	14.38	12.0	1.15	1.32	4.53	6.13 to 9.34	76
4/ 5	12.0	1 48.0	15.03	12.0	1.15	1.32	4.53	6.15 to 9.35	76
5/ 6	12.0	1 51.4	15.28	12.0	1.16	1.32	4.52	6.16 to 9.36	76

6/ 7	12.0	1 54.9	15.52	12.0	1.16	1.32	4.52	6.18 to 9.37	75
7/ 8	12.0	1 58.3	16.17	12.1	1.17	1.32	4.51	6.20 to 9.38	75
8/ 9	12.0	2 1.8	16.41	12.1	1.17	1.33	4.51	6.22 to 9.39	75
9/10	12.0	2 5.3	17.05	12.1	1.18	1.33	4.50	6.23 to 9.40	75
10/11	12.0	2 8.9	17.29	12.1	1.18	1.33	4.50	6.25 to 9.41	75
11/12	12.0	2 12.4	17.52	12.1	1.19	1.33	4.50	6.27 to 9.42	75
12/13	12.0	2 15.9	18.15	12.1	1.19	1.34	4.49	6.28 to 9.43	75
13/14	12.0	2 19.5	18.38	12.2	1.20	1.34	4.49	6.30 to 9.43	75
14/15	12.0	2 23.1	19.00	12.2	1.21	1.34	4.49	6.32 to 9.44	75
15/16	12.0	2 26.7	19.23	12.2	1.21	1.35	4.48	6.34 to 9.45	75
16/17	12.0	2 30.3	19.45	12.2	1.22	1.35	4.48	6.36 to 9.46	75
17/18	12.0	2 33.9	20.06	12.2	1.22	1.35	4.48	6.37 to 9.46	75
18/19	12.0	2 37.6	20.28	12.3	1.23	1.36	4.47	6.39 to 9.47	74
19/20	12.0	2 41.2	20.48	12.3	1.24	1.36	4.47	6.41 to 9.48	74
20/21	12.0	2 44.9	21.09	12.3	1.24	1.36	4.47	6.43 to 9.48	74
21/22	12.0	2 48.6	21.29	12.3	1.25	1.37	4.46	6.44 to 9.49	74
22/23	12.0	2 52.3	21.49	12.4	1.26	1.37	4.46	6.46 to 9.49	74
23/24	12.0	2 56.0	22.09	12.4	1.26	1.37	4.46	6.48 to 9.50	74
24/25	12.0	2 59.7	22.28	12.4	1.27	1.38	4.46	6.50 to 9.50	74
25/26	12.0	3 3.4	22.47	12.4	1.28	1.38	4.46	6.52 to 9.51	74
26/27	12.0	3 7.1	23.05	12.5	1.28	1.39	4.45	6.53 to 9.51	74
27/28	12.0	3 10.9	23.23	12.5	1.29	1.39	4.45	6.55 to 9.51	74
28/29	12.0	3 14.6	23.41	12.5	1.30	1.39	4.45	6.57 to 9.51	74
29/30	12.0	3 18.4	23.58	12.5	1.31	1.40	4.45	6.59 to 9.52	74

Ephemeris for **73P/Schwassmann-Wachmann 3** for the **Equator**

Omega=198.7760 OMEGA= 69.9470 i= 11.4230 q= 0.932800 a= 3.056356
e=0.694800 P= 5.343 T= 1995 September 22.7620 Equinox= 2000
Magnitudes calculated from m= 5.0+5.0*Log(d)+15.0*Log(r)

November 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	18 7.2	-32.10	6.3	1.35	1.10	3.27	6.37 to 8.57	54
2/ 3	12.0	18 13.1	-32.14	6.3	1.35	1.11	3.29	6.37 to 8.58	54
3/ 4	12.0	18 18.9	-32.17	6.4	1.36	1.12	3.31	6.37 to 8.60	54
4/ 5	12.0	18 24.7	-32.19	6.4	1.36	1.12	3.33	6.38 to 9.01	54
5/ 6	12.0	18 30.5	-32.20	6.5	1.37	1.13	3.35	6.38 to 9.03	55
6/ 7	12.0	18 36.2	-32.19	6.5	1.37	1.14	3.36	6.38 to 9.04	55
7/ 8	12.0	18 41.9	-32.18	6.6	1.38	1.15	3.38	6.38 to 9.06	55
8/ 9	12.0	18 47.6	-32.16	6.6	1.38	1.15	3.40	6.38 to 9.07	55
9/10	12.0	18 53.2	-32.13	6.7	1.39	1.16	3.41	6.38 to 9.08	55
10/11	12.0	18 58.8	-32.09	6.8	1.40	1.17	3.43	6.38 to 9.09	56
11/12	12.0	19 4.4	-32.05	6.8	1.40	1.18	3.45	6.39 to 9.11	56
12/13	12.0	19 9.9	-31.59	6.9	1.41	1.19	3.46	6.39 to 9.12	56
13/14	12.0	19 15.3	-31.53	6.9	1.42	1.20	3.48	6.39 to 9.13	56
14/15	12.0	19 20.7	-31.46	7.0	1.43	1.20	3.49	6.39 to 9.14	56
15/16	12.0	19 26.1	-31.38	7.0	1.44	1.21	3.51	6.40 to 9.15	56
16/17	12.0	19 31.3	-31.29	7.1	1.44	1.22	3.52	6.40 to 9.16	57
17/18	12.0	19 36.6	-31.20	7.2	1.45	1.23	3.53	6.40 to 9.17	57
18/19	12.0	19 41.7	-31.09	7.2	1.46	1.24	3.54	6.40 to 9.17	57
19/20	12.0	19 46.9	-30.59	7.3	1.47	1.25	3.56	6.41 to 9.18	57
20/21	12.0	19 51.9	-30.47	7.3	1.48	1.26	3.57	6.41 to 9.19	57
21/22	12.0	19 56.9	-30.35	7.4	1.49	1.27	3.58	6.41 to 9.19	57
22/23	12.0	20 1.8	-30.23	7.5	1.50	1.27	3.59	6.42 to 9.20	57
23/24	12.0	20 6.7	-30.10	7.5	1.51	1.28	3.60	6.42 to 9.20	57
24/25	12.0	20 11.5	-29.56	7.6	1.52	1.29	4.00	6.42 to 9.21	57
25/26	12.0	20 16.3	-29.42	7.6	1.53	1.30	4.01	6.43 to 9.21	57
26/27	12.0	20 20.9	-29.27	7.7	1.54	1.31	4.02	6.43 to 9.21	58
27/28	12.0	20 25.5	-29.12	7.8	1.55	1.32	4.03	6.44 to 9.22	58
28/29	12.0	20 30.1	-28.57	7.8	1.56	1.33	4.03	6.44 to 9.22	58
29/30	12.0	20 34.6	-28.41	7.9	1.57	1.34	4.04	6.44 to 9.22	58
30/31	12.0	20 39.0	-28.25	7.9	1.59	1.35	4.04	6.45 to 9.22	58

December 1995				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	20 43.4	-28.09	8.0	1.60	1.36	4.05	6.45 to 9.22	58
2/ 3	12.0	20 47.7	-27.52	8.1	1.61	1.37	4.05	6.46 to 9.22	58
3/ 4	12.0	20 51.9	-27.35	8.1	1.62	1.37	4.05	6.46 to 9.21	58
4/ 5	12.0	20 56.1	-27.17	8.2	1.63	1.38	4.06	6.47 to 9.21	58
5/ 6	12.0	21 0.2	-26.60	8.2	1.65	1.39	4.06	6.47 to 9.21	58
6/ 7	12.0	21 4.3	-26.42	8.3	1.66	1.40	4.06	6.47 to 9.20	57
7/ 8	12.0	21 8.3	-26.24	8.4	1.67	1.41	4.06	6.48 to 9.20	57
8/ 9	12.0	21 12.3	-26.05	8.4	1.69	1.42	4.06	6.48 to 9.19	57
9/10	12.0	21 16.2	-25.47	8.5	1.70	1.43	4.06	6.49 to 9.19	57
10/11	12.0	21 20.0	-25.28	8.5	1.71	1.44	4.06	6.49 to 9.18	57
11/12	12.0	21 23.8	-25.09	8.6	1.73	1.45	4.06	6.50 to 9.17	57
12/13	12.0	21 27.5	-24.50	8.7	1.74	1.46	4.05	6.50 to 9.17	57
13/14	12.0	21 31.2	-24.31	8.7	1.75	1.47	4.05	6.51 to 9.16	57
14/15	12.0	21 34.8	-24.12	8.8	1.77	1.48	4.05	6.51 to 9.15	57
15/16	12.0	21 38.4	-23.53	8.8	1.78	1.49	4.04	6.52 to 9.14	57

Ephemeris for **73P/Schwassmann-Wachmann 3** from the **UK**

December 1995				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
10/11	12.0	21 20.0	-25.28	8.5	1.71	1.44	4.06	Not Observable	57
11/12	12.0	21 23.8	-25.09	8.6	1.73	1.45	4.06	Not Observable	57
12/13	12.0	21 27.5	-24.50	8.7	1.74	1.46	4.05	Not Observable	57
13/14	12.0	21 31.2	-24.31	8.7	1.75	1.47	4.05	Not Observable	57
14/15	12.0	21 34.8	-24.12	8.8	1.77	1.48	4.05	5.17 to 5.19	57
15/16	12.0	21 38.4	-23.53	8.8	1.78	1.49	4.04	5.17 to 5.22	57
16/17	12.0	21 41.9	-23.34	8.9	1.79	1.50	4.04	5.18 to 5.25	56
17/18	12.0	21 45.4	-23.14	9.0	1.81	1.51	4.03	5.18 to 5.28	56
18/19	12.0	21 48.8	-22.55	9.0	1.82	1.52	4.03	5.18 to 5.30	56
19/20	12.0	21 52.2	-22.35	9.1	1.84	1.53	4.02	5.19 to 5.32	56
20/21	12.0	21 55.6	-22.16	9.1	1.85	1.53	4.02	5.19 to 5.35	56
21/22	12.0	21 58.9	-21.56	9.2	1.87	1.54	4.01	5.19 to 5.37	56
22/23	12.0	22 2.1	-21.37	9.2	1.88	1.55	4.00	5.20 to 5.39	55
23/24	12.0	22 5.3	-21.17	9.3	1.90	1.56	3.60	5.21 to 5.40	55
24/25	12.0	22 8.5	-20.58	9.4	1.91	1.57	3.59	5.21 to 5.42	55
25/26	12.0	22 11.6	-20.38	9.4	1.93	1.58	3.58	5.22 to 5.43	55
26/27	12.0	22 14.7	-20.18	9.5	1.94	1.59	3.57	5.22 to 5.45	55
27/28	12.0	22 17.8	-19.59	9.5	1.96	1.60	3.56	5.23 to 5.46	54
28/29	12.0	22 20.8	-19.39	9.6	1.97	1.61	3.55	5.24 to 5.47	54
29/30	12.0	22 23.8	-19.20	9.6	1.99	1.62	3.54	5.25 to 5.48	54
30/31	12.0	22 26.7	-19.01	9.7	2.01	1.63	3.53	5.26 to 5.49	54
31/32	12.0	22 29.6	-18.41	9.7	2.02	1.64	3.52	5.26 to 5.50	53

January 1996				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	22 32.5	-18.22	9.8	2.04	1.65	3.51	5.27 to 5.51	53
2/ 3	12.0	22 35.4	-18.03	9.9	2.05	1.66	3.50	5.28 to 5.51	53
3/ 4	12.0	22 38.2	-17.43	9.9	2.07	1.67	3.49	5.29 to 5.52	53
4/ 5	12.0	22 41.0	-17.24	10.0	2.09	1.68	3.48	5.30 to 5.52	52
5/ 6	12.0	22 43.7	-17.05	10.0	2.10	1.69	3.47	5.31 to 5.52	52
6/ 7	12.0	22 46.4	-16.46	10.1	2.12	1.70	3.45	5.33 to 5.53	52
7/ 8	12.0	22 49.1	-16.27	10.1	2.13	1.71	3.44	5.34 to 5.53	52
8/ 9	12.0	22 51.8	-16.08	10.2	2.15	1.71	3.43	5.35 to 5.53	51
9/10	12.0	22 54.4	-15.49	10.2	2.17	1.72	3.42	5.36 to 5.53	51
10/11	12.0	22 57.0	-15.31	10.3	2.18	1.73	3.40	5.37 to 5.53	51
11/12	12.0	22 59.6	-15.12	10.3	2.20	1.74	3.39	5.39 to 5.53	50
12/13	12.0	23 2.1	-14.54	10.4	2.22	1.75	3.37	5.40 to 5.52	50
13/14	12.0	23 4.7	-14.35	10.4	2.23	1.76	3.36	5.41 to 5.52	50
14/15	12.0	23 7.2	-14.17	10.5	2.25	1.77	3.35	5.42 to 5.52	49
15/16	12.0	23 9.6	-13.58	10.5	2.26	1.78	3.33	5.44 to 5.51	49
16/17	12.0	23 12.1	-13.40	10.6	2.28	1.79	3.32	5.45 to 5.51	49
17/18	12.0	23 14.5	-13.22	10.6	2.30	1.80	3.30	5.47 to 5.50	48
18/19	12.0	23 16.9	-13.04	10.7	2.31	1.81	3.29	5.48 to 5.50	48

19/20	12.0	23 19.3	-12.46	10.7	2.33	1.82	3.27	Not Observable	48
20/21	12.0	23 21.7	-12.28	10.8	2.35	1.83	3.25	Not Observable	47
21/22	12.0	23 24.0	-12.11	10.8	2.36	1.84	3.24	Not Observable	47
22/23	12.0	23 26.4	-11.53	10.9	2.38	1.85	3.22	Not Observable	46

Ephemeris for comet **P/1995 S1 (de Vico)**

Omega= 12.9710 OMEGA= 79.6210 i= 85.3980 q= 0.658960 a= 17.680708
e=0.962730 P= 74.345 T= 1995 October 6.0230 Equinox= 2000
Magnitudes calculated from m= 8.0+5.0*Log(d)+15.0*Log(r)+0.000*Beta

November 1995 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
2/ 3	12.0	14 40.6	30.60	7.5	1.19	0.87	23.55	5.52 to 7.58	
								15.53 to 17.36	46
3/ 4	12.0	14 47.5	30.45	7.6	1.21	0.88	23.58	5.50 to 7.57	
								15.60 to 17.37	46
4/ 5	12.0	14 54.0	30.30	7.7	1.23	0.89	0.01	5.48 to 7.55	
								16.07 to 17.39	46
5/ 6	12.0	15 0.4	30.13	7.8	1.25	0.91	0.03	5.47 to 7.54	
								16.13 to 17.40	46
6/ 7	12.0	15 6.5	29.56	8.0	1.27	0.92	0.06	5.45 to 7.51	
								16.20 to 17.42	46
7/ 8	12.0	15 12.5	29.38	8.1	1.29	0.93	0.08	5.44 to 7.49	
								16.26 to 17.44	46
8/ 9	12.0	15 18.2	29.19	8.2	1.31	0.95	0.09	5.42 to 7.46	
								16.32 to 17.45	46
9/10	12.0	15 23.6	29.01	8.3	1.33	0.96	0.11	5.41 to 7.43	
								16.38 to 17.47	46
10/11	12.0	15 28.9	28.41	8.5	1.35	0.97	0.12	5.39 to 7.40	
								16.44 to 17.49	46
11/12	12.0	15 34.1	28.22	8.6	1.37	0.99	0.13	5.38 to 7.37	
								16.50 to 17.50	46
12/13	12.0	15 39.0	28.02	8.7	1.39	1.00	0.14	5.37 to 7.33	
								16.55 to 17.52	46
13/14	12.0	15 43.8	27.43	8.8	1.41	1.02	0.15	5.35 to 7.30	
								17.01 to 17.53	46
14/15	12.0	15 48.4	27.23	9.0	1.43	1.03	0.16	5.34 to 7.26	
								17.06 to 17.55	46
15/16	12.0	15 52.8	27.04	9.1	1.45	1.04	0.16	5.33 to 7.22	
								17.11 to 17.56	46
16/17	12.0	15 57.1	26.45	9.2	1.47	1.06	0.17	5.32 to 7.18	
								17.16 to 17.58	46
17/18	12.0	16 1.2	26.25	9.3	1.49	1.07	0.17	5.31 to 7.13	
								17.20 to 17.59	46
18/19	12.0	16 5.3	26.06	9.4	1.51	1.09	0.17	5.29 to 7.09	
								17.25 to 18.01	46
19/20	12.0	16 9.2	25.48	9.5	1.53	1.10	0.17	5.28 to 7.05	
								17.29 to 18.02	46
20/21	12.0	16 12.9	25.29	9.7	1.55	1.11	0.17	5.27 to 7.00	
								17.33 to 18.04	46
21/22	12.0	16 16.6	25.11	9.8	1.57	1.13	0.16	5.26 to 6.55	
								17.37 to 18.05	46
22/23	12.0	16 20.1	24.53	9.9	1.59	1.14	0.16	5.26 to 6.51	
								17.41 to 18.07	46
23/24	12.0	16 23.6	24.36	10.0	1.61	1.16	0.16	5.25 to 6.46	
								17.45 to 18.08	45
24/25	12.0	16 26.9	24.18	10.1	1.63	1.17	0.15	5.24 to 6.41	
								17.49 to 18.10	45
25/26	12.0	16 30.1	24.01	10.2	1.65	1.19	0.14	5.23 to 6.36	
								17.52 to 18.11	45
26/27	12.0	16 33.3	23.45	10.3	1.67	1.20	0.13	5.22 to 6.31	
								17.56 to 18.12	45
27/28	12.0	16 36.4	23.29	10.4	1.69	1.22	0.13	5.22 to 6.26	
								17.59 to 18.14	45
28/29	12.0	16 39.3	23.13	10.5	1.71	1.23	0.12	5.21 to 6.21	

								18.02 to 18.15	45
29/30	12.0	16 42.3	22.57	10.6	1.73	1.24	0.11	5.20 to 6.16	
								18.05 to 18.16	45
30/31	12.0	16 45.1	22.42	10.7	1.75	1.26	0.10	5.20 to 6.11	
								18.08 to 18.18	45

December 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 47.8	22.28	10.8	1.77	1.27	0.08	5.19 to 6.05	
								18.11 to 18.19	44
2/ 3	12.0	16 50.5	22.13	10.9	1.79	1.29	0.07	5.19 to 5.60	
								18.14 to 18.20	44
3/ 4	12.0	16 53.2	21.59	11.0	1.81	1.30	0.06	5.19 to 5.55	
								18.17 to 18.21	44
4/ 5	12.0	16 55.7	21.46	11.1	1.83	1.32	0.04	5.18 to 5.49	
								18.20 to 18.22	44
5/ 6	12.0	16 58.2	21.33	11.2	1.85	1.33	0.03	5.18 to 5.44	
								18.22 to 18.24	44
6/ 7	12.0	17 0.7	21.20	11.3	1.87	1.35	0.01	5.18 to 5.38	44
7/ 8	12.0	17 3.0	21.07	11.4	1.89	1.36	23.60	5.17 to 5.33	44
8/ 9	12.0	17 5.4	20.55	11.5	1.91	1.38	23.58	5.17 to 5.27	44
9/10	12.0	17 7.7	20.43	11.6	1.93	1.39	23.57	5.17 to 5.22	44
10/11	12.0	17 9.9	20.32	11.7	1.95	1.40	23.55	Not Observable	43
11/12	12.0	17 12.1	20.21	11.7	1.96	1.42	23.53	Not Observable	43
12/13	12.0	17 14.2	20.10	11.8	1.98	1.43	23.51	Not Observable	43
13/14	12.0	17 16.3	19.60	11.9	2.00	1.45	23.50	Not Observable	43
14/15	12.0	17 18.4	19.50	12.0	2.02	1.46	23.48	Not Observable	43

Ephemeris for **1995 O1 (Hale-Bopp)**

Omega=130.3750 OMEGA=282.4720 i= 88.8920 q= 0.917550 a=298.876221
e=0.996930 P= 5166.983 T= 1997 March 31.9090 Equinox= 2000
Magnitudes calculated from m= 0.0+5.0*Log(d)+ 7.5*Log(r)+0.000*Beta

April 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
9/10	12.0	19 41.6	-19.05	8.5	4.73	4.77	18.30	Not Observable	86
10/11	12.0	19 41.7	-19.01	8.4	4.71	4.76	18.26	Not Observable	87
11/12	12.0	19 41.9	-18.56	8.4	4.68	4.75	18.23	Not Observable	88
12/13	12.0	19 42.0	-18.52	8.4	4.65	4.74	18.19	Not Observable	89
13/14	12.0	19 42.1	-18.47	8.4	4.62	4.73	18.15	Not Observable	90
14/15	12.0	19 42.1	-18.43	8.4	4.60	4.72	18.11	15.29 to 15.30	91
15/16	12.0	19 42.2	-18.38	8.3	4.57	4.71	18.07	15.24 to 15.27	91
16/17	12.0	19 42.3	-18.34	8.3	4.54	4.70	18.03	15.19 to 15.25	92
17/18	12.0	19 42.3	-18.29	8.3	4.52	4.69	17.59	15.14 to 15.22	93
18/19	12.0	19 42.3	-18.25	8.3	4.49	4.68	17.55	15.09 to 15.19	94
19/20	12.0	19 42.3	-18.20	8.3	4.46	4.67	17.52	15.03 to 15.16	95
20/21	12.0	19 42.3	-18.15	8.2	4.44	4.66	17.48	14.58 to 15.13	96
21/22	12.0	19 42.3	-18.11	8.2	4.41	4.65	17.44	14.53 to 15.10	97
22/23	12.0	19 42.2	-18.06	8.2	4.38	4.64	17.40	14.48 to 15.07	98
23/24	12.0	19 42.2	-18.02	8.2	4.36	4.62	17.36	14.43 to 15.05	99
24/25	12.0	19 42.1	-17.57	8.2	4.33	4.61	17.32	14.38 to 15.02	100
25/26	12.0	19 42.0	-17.52	8.1	4.30	4.60	17.28	14.32 to 14.59	101
26/27	12.0	19 41.9	-17.47	8.1	4.28	4.59	17.24	14.27 to 14.56	102
27/28	12.0	19 41.8	-17.43	8.1	4.25	4.58	17.19	14.22 to 14.53	103
28/29	12.0	19 41.6	-17.38	8.1	4.22	4.57	17.15	14.17 to 14.50	104
29/30	12.0	19 41.5	-17.33	8.1	4.20	4.56	17.11	14.11 to 14.47	105
30/31	12.0	19 41.3	-17.28	8.0	4.17	4.55	17.07	14.06 to 14.44	106

May 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	19 41.1	-17.24	8.0	4.14	4.54	17.03	14.01 to 14.42	107
2/ 3	12.0	19 40.9	-17.19	8.0	4.12	4.53	16.59	13.56 to 14.39	108

3/ 4	12.0	19 40.7	-17.14	8.0	4.09	4.52	16.55	13.50 to 14.36	109
4/ 5	12.0	19 40.4	-17.09	8.0	4.07	4.51	16.51	13.45 to 14.33	110
5/ 6	12.0	19 40.2	-17.04	7.9	4.04	4.50	16.46	13.40 to 14.30	111
6/ 7	12.0	19 39.9	-16.59	7.9	4.01	4.49	16.42	13.34 to 14.27	112
7/ 8	12.0	19 39.6	-16.55	7.9	3.99	4.48	16.38	13.29 to 14.24	113
8/ 9	12.0	19 39.2	-16.50	7.9	3.96	4.47	16.34	13.24 to 14.21	114
9/10	12.0	19 38.9	-16.45	7.8	3.94	4.46	16.29	13.18 to 14.18	115
10/11	12.0	19 38.5	-16.40	7.8	3.91	4.45	16.25	13.13 to 14.15	116
11/12	12.0	19 38.1	-16.35	7.8	3.89	4.44	16.21	13.07 to 14.13	117
12/13	12.0	19 37.7	-16.30	7.8	3.86	4.43	16.16	13.02 to 14.10	118
13/14	12.0	19 37.3	-16.25	7.8	3.84	4.42	16.12	12.57 to 14.07	119
14/15	12.0	19 36.9	-16.20	7.7	3.81	4.41	16.08	12.51 to 14.04	120
15/16	12.0	19 36.4	-16.15	7.7	3.79	4.40	16.03	12.46 to 14.01	121
16/17	12.0	19 35.9	-16.10	7.7	3.76	4.39	15.59	12.40 to 13.58	122
17/18	12.0	19 35.4	-16.04	7.7	3.74	4.38	15.54	12.35 to 13.55	124
18/19	12.0	19 34.9	-15.59	7.7	3.72	4.37	15.50	12.29 to 13.53	125
19/20	12.0	19 34.3	-15.54	7.6	3.69	4.36	15.45	12.24 to 13.50	126
20/21	12.0	19 33.8	-15.49	7.6	3.67	4.35	15.41	12.18 to 13.47	127
21/22	12.0	19 33.2	-15.44	7.6	3.64	4.34	15.36	12.12 to 13.44	128
22/23	12.0	19 32.6	-15.39	7.6	3.62	4.33	15.32	12.07 to 13.41	129
23/24	12.0	19 31.9	-15.33	7.5	3.60	4.32	15.27	12.01 to 13.38	130
24/25	12.0	19 31.3	-15.28	7.5	3.57	4.31	15.22	11.56 to 13.36	131
25/26	12.0	19 30.6	-15.23	7.5	3.55	4.30	15.18	11.50 to 13.33	132
26/27	12.0	19 29.9	-15.18	7.5	3.53	4.29	15.13	11.44 to 13.30	133
27/28	12.0	19 29.2	-15.12	7.5	3.51	4.28	15.09	11.38 to 13.27	134
28/29	12.0	19 28.4	-15.07	7.4	3.49	4.27	15.04	11.33 to 13.25	135
29/30	12.0	19 27.7	-15.02	7.4	3.46	4.26	14.59	11.27 to 13.22	137
30/31	12.0	19 26.9	-14.56	7.4	3.44	4.25	14.54	11.21 to 13.19	138
31/32	12.0	19 26.1	-14.51	7.4	3.42	4.24	14.50	11.16 to 13.17	139

Ephemeris for **1995 Q1 (Bradfield)**

Omega=331.0510 OMEGA=178.0410 i=147.3860 q= 0.436810 a=**********
e=1.000000 P=********* T= 1995 August 31.3920 Equinox= 2000
Magnitudes calculated from m= 7.5+5.0*Log(d)+ 9.0*Log(r)+0.000*Beta

November 1995 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
6/ 7	12.0	10 56.5	50.50	9.6	1.26	1.51	19.56	5.45 to 7.29 8.23 to 17.42	83
7/ 8	12.0	10 55.2	51.53	9.6	1.26	1.53	19.51	5.44 to 17.44	85
8/ 9	12.0	10 53.9	52.56	9.7	1.25	1.54	19.46	5.42 to 17.45	86
9/10	12.0	10 52.4	54.01	9.7	1.24	1.56	19.40	5.41 to 17.47	88
10/11	12.0	10 50.7	55.07	9.7	1.24	1.58	19.35	5.39 to 17.49	89
11/12	12.0	10 48.9	56.13	9.8	1.23	1.59	19.29	5.38 to 17.50	91
12/13	12.0	10 46.9	57.20	9.8	1.23	1.61	19.23	5.37 to 17.52	92
13/14	12.0	10 44.7	58.28	9.8	1.22	1.62	19.17	5.35 to 17.53	94
14/15	12.0	10 42.2	59.36	9.9	1.22	1.64	19.11	5.34 to 17.55	95
15/16	12.0	10 39.5	60.45	9.9	1.22	1.66	19.04	5.33 to 17.56	97
16/17	12.0	10 36.4	61.54	9.9	1.21	1.67	18.57	5.32 to 17.58	98
17/18	12.0	10 33.0	63.04	10.0	1.21	1.69	18.50	5.31 to 17.59	100
18/19	12.0	10 29.3	64.14	10.0	1.21	1.71	18.42	5.29 to 18.01	101
19/20	12.0	10 25.0	65.23	10.0	1.21	1.72	18.34	5.28 to 18.02	103
20/21	12.0	10 20.3	66.33	10.1	1.21	1.74	18.26	5.27 to 18.04	104
21/22	12.0	10 15.0	67.42	10.1	1.21	1.75	18.16	5.26 to 18.05	106
22/23	12.0	10 9.0	68.51	10.1	1.21	1.77	18.07	5.26 to 18.07	107
23/24	12.0	10 2.3	69.59	10.2	1.21	1.79	17.56	5.25 to 18.08	108
24/25	12.0	9 54.7	71.05	10.2	1.21	1.80	17.45	5.24 to 18.10	110
25/26	12.0	9 46.0	72.11	10.3	1.21	1.82	17.32	5.23 to 18.11	111
26/27	12.0	9 36.2	73.14	10.3	1.22	1.83	17.19	5.22 to 18.12	112
27/28	12.0	9 25.0	74.15	10.3	1.22	1.85	17.04	5.22 to 18.14	113
28/29	12.0	9 12.2	75.13	10.4	1.22	1.86	16.47	5.21 to 18.15	115
29/30	12.0	8 57.7	76.08	10.4	1.23	1.88	16.29	5.20 to 18.16	116
30/31	12.0	8 41.2	76.58	10.5	1.23	1.89	16.09	5.20 to 18.18	117

December 1995				Times in GMAT					
Day	Time	R.A. B1950 Dec		Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	8 22.6	77.43	10.5	1.24	1.91	15.47	5.19 to 18.19	118
2/ 3	12.0	8 1.8	78.22	10.5	1.25	1.93	15.23	5.19 to 18.20	119
3/ 4	12.0	7 38.8	78.55	10.6	1.26	1.94	14.56	5.19 to 18.21	120
4/ 5	12.0	7 14.0	79.19	10.6	1.26	1.96	14.28	5.18 to 18.22	120
5/ 6	12.0	6 47.8	79.35	10.7	1.27	1.97	13.58	5.18 to 18.24	121
6/ 7	12.0	6 20.9	79.42	10.7	1.28	1.99	13.28	5.18 to 18.25	122
7/ 8	12.0	5 54.1	79.40	10.8	1.29	2.00	12.57	5.17 to 18.26	123
8/ 9	12.0	5 28.1	79.29	10.8	1.30	2.02	12.27	5.17 to 18.27	123
9/10	12.0	5 3.8	79.11	10.9	1.31	2.03	11.58	5.17 to 18.28	124
10/11	12.0	4 41.3	78.46	10.9	1.33	2.05	11.32	5.17 to 18.29	124
11/12	12.0	4 21.1	78.16	11.0	1.34	2.06	11.07	5.17 to 18.30	124
12/13	12.0	4 3.0	77.40	11.0	1.35	2.08	10.45	5.17 to 18.31	125
13/14	12.0	3 47.1	77.01	11.1	1.37	2.09	10.24	5.17 to 18.31	125
14/15	12.0	3 33.1	76.19	11.1	1.38	2.11	10.06	5.17 to 18.32	125
15/16	12.0	3 20.8	75.35	11.2	1.40	2.12	9.50	5.17 to 18.33	125
16/17	12.0	3 10.0	74.49	11.2	1.41	2.14	9.35	5.18 to 18.34	125
17/18	12.0	3 0.5	74.02	11.3	1.43	2.15	9.21	5.18 to 18.34	125
18/19	12.0	2 52.2	73.15	11.3	1.45	2.17	9.09	5.18 to 18.35	125
19/20	12.0	2 44.9	72.27	11.4	1.46	2.18	8.57	5.19 to 18.36	125
20/21	12.0	2 38.5	71.39	11.4	1.48	2.20	8.47	5.19 to 18.36	125
21/22	12.0	2 32.8	70.52	11.5	1.50	2.21	8.37	5.19 to 18.37	124
22/23	12.0	2 27.8	70.05	11.5	1.52	2.23	8.28	5.20 to 18.37	124
23/24	12.0	2 23.3	69.18	11.6	1.54	2.24	8.19	5.21 to 18.38	124
24/25	12.0	2 19.3	68.32	11.6	1.56	2.26	8.11	5.21 to 18.38	123
25/26	12.0	2 15.8	67.46	11.7	1.58	2.27	8.04	5.22 to 18.39	123
26/27	12.0	2 12.7	67.01	11.7	1.60	2.28	7.56	5.22 to 18.39	123
27/28	12.0	2 9.9	66.17	11.8	1.62	2.30	7.50	5.23 to 18.39	122
28/29	12.0	2 7.4	65.34	11.9	1.64	2.31	7.43	5.24 to 18.39	121
29/30	12.0	2 5.2	64.52	11.9	1.66	2.33	7.37	5.25 to 18.39	121
30/31	12.0	2 3.2	64.10	12.0	1.69	2.34	7.31	5.26 to 18.40	120
31/32	12.0	2 1.4	63.30	12.0	1.71	2.36	7.25	5.26 to 18.40	120

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. Please report both the comet magnitude and the coma diameter if possible.

MM
Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag
If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet.

Ref
Source or catalogue for comparison stars. The most common ones are AA (AAVSO atlas), VB (BAA VS chart), HS (Hubble catalogue), SC (Sky Catalogue 2000).

Sky
Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel
Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments
Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20.95) and your observing location (eg Cambridge) at the top of the form. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow. Space at the bottom of the form can be used for a description of the observation.

BAA Comet Section Observing Blank

Observer..........................

Comet.............................

Date 19 / /

Location..........................

Instrument.......magnification......

Scale: circle is.........arc minutes

Please indicate the north point on the drawing

Comments ....

....

....

....

....

....

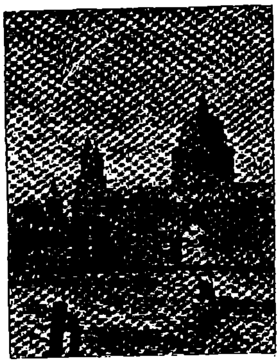
....

BAA Comet Section Visual Observation Report Form

Observer..........................   Comet......................

Year...........   Location......................

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail Length	Tail PA	Sky [illegible]	Ref [illegible]	Comments



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association 1996 May

Volume 3 No 1 (Issue 5)

Preliminary report on Comet Hyakutake (1996 B2)

Nick James

Comet Hyakutake turned out to be an even more impressive object than expected. Whilst, at the time of writing, it does not look as if the most optimistic perihelion predictions will be attained, the comet was a spectacular sight at Earth close approach. At its closest on March 25 the comet sported a naked-eye tail in excess of 50° from dark sites and rivalled Arcturus as one of the brightest objects in the sky. With binoculars a tremendous amount of intricate detail was visible in the tail and wide-field photographs taken at the time show multiple tail rays.

In early March the comet was still well south of the equator but it was already a naked-eye object at fifth magnitude and binocular observers reported a short tail in pa 280. By March 20, when the comet passed into the northern hemisphere, it had brightened to second magnitude and was a beautiful naked eye sight to those lucky enough to have clear skies. The head was already larger than 1 degree and an ion tail of up to 20° had been reported by some observers.

Unfortunately, weather conditions over the UK during early to mid-March ranged from patchy to downright dreadful. The most favoured parts of the country were the south-west and the south coast but even here the weather was not good. The poor forcasts forced several BAA members to leave the country. John Rogers fled the "miasmic swamp" of his native East Anglia for the sunnier climes of southern Spain. Mike Maunder was conveniently on an observatory tour in Tenerife and Martin Mobberley, Glyn Marsh and the author left at short notice for Tenerife courtesy of Mark Kidger at the Instituto Astrofisica de Canarias.

Spectra from the IUE satellite reported in IAUC 6355 indicated that Hyakutake's molecule production rate was significantly higher than for Halley. A number of emission lines were seen and the most important were those for C_2, CS, CO_2^+, NH, C, O, CO and S. The IUE results indicated that water production reached a temporary maximum around closest approach (IAUC 6370) as small pieces broke off the nucleus exposing fresh surfaces. The Hubble Space Telescope (HST) tracked these small fragments as they moved away from the nucleus at around 11.5m/s.

On the nights around closest approach the comet put on a spectacular show which left most observers short of adjectives. On March 25 the magnitude reached 0 and the tail streched from Ursa Major, through Bootes and possibly as far as the bowl of Virgo. The tail was very bright for an ion tail and it showed multiple rays which changed in form over periods measured in minutes. No significant dust tail activity was seen at this time.

Radar contact with the comet was achived by the Goldstone X-Band (8.5GHz) dish on March 24. A few dozen 480kW pulses were directed towards the comet and the echos were received 107 seconds later. Steve Ostro of JPL reported that the radar results implied a very small nucleus of 1-3km. The inability of the HST to image an extended nucleus despite a pixel resolution of 7.5km tends to confirm the radar observations although they are still preliminary. Earlier, on March 19-20 high resolution optical observations by the NTT at La Silla with a resolution of 18km/pixel had shown that the dense central gas and dust condensation had a diameter of 70km but these observations did not resolve the nucleus.

At the end of March as the Moon waxed to full the weather cleared and UK observers had many opportunities to view the comet. By this time it was still spectacular but the best of the show was over. At the beginning of April the comet had faded to around second magnitude. An impressive movie of the central condensation was made by Terry Platt on April 1. He used an SXL8 camera to take a short exposure of the nuclear region at half hourly intervals from 1940 to 2340. This movie clearly shows the nuclear rotation and the overal impression is rather similar to water jets from a rotating garden sprinkler. Observations from Pic-du-Midi had indicated a most likely nucleus rotation period of around 6.2hr. This is around eight times faster than Halley's.

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Section news from the Director

Dear Section member,

First my apologies that this is a rather thinner Tale than usual. Comet Hyakutake (1996 B2) has generated an enormous amount of correspondence leaving little time to prepare this newsletter, which needed to come out before the section meeting. Comet Hyakutake has presented us with a number of problems in observing a comet that we haven't encountered before and it seems quite likely that Hale-Bopp will be even brighter. We will be discussing these problems and the lessons learnt at the section meeting and I hope to see many of you on the day. Anyone who would like to speak or show slides, overheads or other material at the meeting should contact me, preferably by the beginning of June.

I made some early observations of comet 1996 B2 from the Falkland Islands which suggested that it was brightening rapidly, and it continued to brighten rapidly until within 1.5 AU of the Sun. Once it passed by the Earth it seems to have gone into an even more passive mode. My return to the UK in mid February coincided with a large crop of comets and a change in the weather and over February 21 I was able to observe 6 comets. Unfortunately the weather didn't oblige at the critical time of the closest approach, but a few section members sought better locations abroad and had good views.

Section members will be sorry to hear of the death of Richard Glynn of Okehampton, Devon. A long standing member of the Association he made occasional observations of the brighter comets. The earliest observations from him in the section archives are of comet 1957 P1 (Mrkos) and when I last spoke with him in October he was hoping to observe 1995 S1 (de Vico).

Former section director Michael Hendrie has agreed to act as photographic advisor. He has been taking comet photographs and carrying out astrometric observations for many years. If you have queries about photography please write to him, remembering to enclose an sae.

The section guide to observing comets is now available. It is a 48 page booklet which I hoped would give you all the information you ever needed to observe a comet. I have aimed to include everything that is needed for visual observation of comets, with small sections on comet hunting and photography. The normal selling price will be £2.25 from the BAA office, however section members can send me a C5 size stamped and addressed envelope, together with a small contribution towards the cost in the form of stamps.

I hadn't quite bargained for a very bright comet and I will need to add some extras to the booklet when it is reprinted. One point concerns magnitude estimates for large bright comets. It is very important to defocus sufficiently and a good technique is to use reversed binoculars with one eye and direct vision with the other. 7x50B will give a reduction of 4.2 mags, 10x80B 5.0 mags etc. I used this technique for observing the eclipsed moon last month, though must confess to not having used it in anger on the comet. Another point concerns the measurement of the position angle of the tail: the angle is measured with respect to lines of right ascension NOT with respect to the horizon or direction of the zenith.

Since the last newsletter observations or contributions have been received from the following BAA members:

James Abott, Sally Beaumont, Paul Bispham, Denis Buczynski, Robert Bullen, Peter Butler, David Clegg, Emilio Colombo, Paul Doherty, John Fletcher, Michael Foulkes, James Fraser, Werner Hasubick, Alan Heath, Mark Herbert, Guy Hurst, Nick James, Albert Jones, Joe Kaplonek, Paul Keenan, Norman Kiernan, Ron Livesey, John Mackey, Nick Martin, Richard McKim, Howard Miles, Martin Mobberley, David Moore, Neil Morrison, Brian O'Halloran, Ornulf Midstkogen, Gabriel Oksa, Alexei Pace, Roy Panther, Simon Pierson, Gary Poyner, John Rogers, Jonathan Shanklin, John Smith, David Storey, David Strange, Tony Tanti, Melvyn Taylor, B Topping, Alex Vincent, Richard Walters, James Weightman, Kevin West and Jack Youdale

and also from: Jose Aguiar, John Aldridge, Frank Andrews, Andrew Atterbury, Alexandr Baransky, Sandro Baroni, R Blay, John Bortle, Michael Boschat, Peter Caldwell, Paul Camilleri, Matyas Csukas, Haakon Dahle, Alfons Diepvens, Stephen Getliffe, Bjoern Granslo, Roberto Haver, Trond Hillestad, Andreas Kammerer, Graham Keitch, Mark Kidger, Atilla Kosa-Kiss, Martin Lehky, Romualdo Lourencon, Robert McNaught, Herman Mikuz, Antonio Milani, Charles Morris, Mieczyslaw Paradowski, Andrew Pearce, Ernie Richardson, John Sanford, Oddleiv Skilbrei, Christopher Spratt, Peter Stanley, Steinar Thorvaldsen, Graham Wolf and Vittorio Zanotta.

Comets under observation were: 6P/d'Arrest, 22P/Kopff, 29P/Schwassmann-Wachmann 1, 45P/Honda-Mrkos-Pajdusakova, 58P/Jackson-Neujmin, 67P/Churyumov-Gerasimenko, 73P/Schwassmann-Wachmann 3, 116P/Wild 4, 122P/de Vico, 123P/West-Hartley, C/1995 O1 (Hale-Bopp), C/1995 Q1 (Bradfield), C/1996 Y1 (Hyakutake), C/1996 A1 (Jedicke), C/1996 B1 (Szczepanski) and C/1996 B2 (Hyakutake).

It would be a great help to Guy and myself if observers could include all the details requested on the section report form when they submit observations. Observations submitted by e-mail are much appreciated, especially if they are already in the TA or ICQ format. Observations are not accepted by the ICQ unless all unshaded and lightly shaded items on the form are included.

I look forward to seeing as many of you as possible at the section meeting on June 8th.

Jonathan Shanklin

Provisional Meeting Programme

Comets Hyakutake and Hale-Bopp

Saturday June 8
Institute of Astronomy, Cambridge

10.30	Coffee	
11.00	Jon Shanklin	Introduction
11.10	David Dewhirst	Really Great Comets.
11.40	Jon Shanklin	Visual observing
12.10	Members	
12.30	Lunch	
14.00	Guy Hurst	Submitting observations
14.30	Mike Hendrie	Photography
15.00	Members	
15.30	Tea	
16.00	Nick James	CCD imaging
16.30	Roger O'Brien	Professional observations
17.00	Closing remarks followed by a tour of the Observatories (on request).	

There is an entry charge of £1.00 to cover administration costs, tea, coffee and biscuits. A buffet lunch is available for £4.00 if you book in advance - please send bookings to me.

Some exhibition space is available and observations of comet Hyakutake will be on display. The TA supplement on the comet should be available for purchase. If you would like to exhibit material please let me know in advance. There will be stands by the BAA, CAA, CUAS and TA. I have left plenty of time for discussion so that we can exchange experiences. If you would like to speak do let me know.

Cambridge rail and coach stations are a lengthy walk from the Observatories. The Birmingham train arrives at 10:30, London trains at 09:59, 10:09 and 10.37. The meeting will take place in the Hoyle building of the Institute of Astronomy.

Comet Hyakutake (1996 B2)

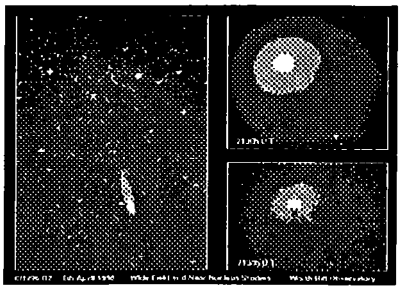
Continued from page 1

One of the most suprising results was obtained by the X-ray satellite ROSAT. Observations of the comet in X-Rays showed levels around 100 times those expected. Possibly solar X-rays were absorbed by molecules in the coma causing them to fluoresce. Alternatively violent collisons between solar wind particles and the coma were causing the X-rays. Much work remains to be done to interpret these observations.

Interestingly on April 9.9 a gamma-ray burster went off close to the position of the comet. If anyone took photographs between 21 and 24 UT that reach to about 9^m they may just have captured it on film. As no bursters have yet been identified with an optical source this is a good opportunity for amateurs to make a significant contribution to science.

By April 10 Hyakutake was within the orbit of Venus and the magnitude had stabilized at around 2.5. Further small fragments had broken from the nucleus but the comet was not brightening as expected. The coma diameter had shrunk to 10' and it now looks unlikely that the comet will be brighter than second magnitude at perihelion.

Brian Marsden computes that Hyakutake's original orbital period was 8,000 years but that after passing through the inner solar system gravitational purturbations had changed this to 14,000 years (IAUC 6359). We shall not see this comet again!



Many images of the comet including Terry Platt's comet movie (in MPEG format) are available on the TA web site at http://www.demon.co.uk/astronomer/comets.html.

NASA and CNES select science investigations for comet lander

Douglas Isbell, Jet Propulsion Laboratory, Press Release

Science investigations designed to image the surface of a comet close up and determine its exact chemical and mineralogical composition have been provisionally selected by NASA and CNES, the French space agency, to be carried out early next century on a comet lander named Champollion.

Slated for launch aboard the International Rosetta Mission, Champollion and a similar comet lander named RoLand, to be provided by a German-led consortium, will be the first spacecraft ever to land on one of these ancient clumps of icy rubble.

Planetary scientists believe that comets were the primary building blocks for the outer planets of the solar system. Cometary bombardment also may have provided a significant fraction of the atmosphere, oceans and organic materials of Earth when it was a young planet.

The overall scientific objective of the Rosetta mission is to produce a global picture of a comet called Wirtanen, including its shape and composition, the nature of the volatiles that it spews out, and the comet surface phenomena that contribute to this process.

The mission is named after the Rosetta Stone, an ancient Egyptian tablet discovered near the town of Rosetta in 1799 that provided a major key to the translation of Egyptian hieroglyphic writing. Jean-Francois Champollion of France, for whom one of the Rosetta mission comet landers is named, played a large part in deciphering it.

"The new knowledge about comets that Rosetta and Champollion promise to return will help us decipher important clues about the earliest stages of the formation of our solar system, just as the Rosetta Stone did with ancient Egyptian hieroglyphics," said Dr. Wesley T. Huntress, Associate Administrator for Space Science, NASA Headquarters, Washington D.C. "The most intriguing potential result from Champollion's investigations is the possible presence of complex organic molecules, which would tell us whether these precursors of life might have been brought to Earth by comets."

Rosetta will be the first spacecraft to orbit a comet. It represents the next major step in cometary science, following several recent reconnaissance flybys of comets by other international spacecraft. Rosetta is the third cornerstone mission in the European Space Agency's long-term space science program called Horizon 2000.

After its scheduled launch aboard an Ariane 5 vehicle in January 2003, the Rosetta spacecraft will perform gravity-assist flybys of Mars and Earth, and then rendezvous with comet Wirtanen in August 2011. It will deploy the Champollion and RoLand surface landers about one year later. Two asteroid flyby encounters also are planned for about halfway through the mission.

The selected Champollion experiments incorporate a number of new technologies, including high-density, three-dimensional electronics, an advanced infrared spectrometer, active pixel imaging sensors with on-chip electronics, an advanced gamma-ray sensor, and a miniaturized, low-power gas chromatograph/mass spectrometer.

A suite of a dozen cameras will provide Earth-bound scientists with their first close-up look at the surface of a comet. One set of cameras, to be provided by Dr. Jean-Pierre Bibring of the Institut d'Astrophysique Spatiale in Orsay, France, will create stereo images of the landscape surrounding the lander. A second camera set supplied by Dr. Roger Yelle of Boston University, Boston, MA, will photograph the surface close to the lander. An even closer look will be generated by a microscope, also supplied by Yelle, which should reveal individual grains in the comet nucleus.

Organic molecules, which may provide clues to the origin of life on Earth, will be identified by a gas chromatograph/mass spectrometer to be contributed by a group led by Dr. Paul Mahaffy of NASA's Goddard Space Flight Center, Greenbelt, MD. Determining the chemical composition of the comet itself is the task of an international consortium headed by Dr. Claude d'Uston of the Centre d'Etude Spatiale des Rayonnements in Toulouse, France. They will use a gamma-ray spectrometer to measure the radiation generated from inside the comet by the cosmic rays that bombard it continuously.

The strength, density and temperature of the comet surface will be measured by probes placed on spikes driven into the surface. These spikes, to be provided by Dr. Thomas Ahrens of the California Institute of Technology, Pasadena, CA, will also serve to anchor the spacecraft firmly to the comet and prevent it from drifting off into space.

The scientific investigators for the provisionally selected instruments are based at 10 U.S. universities, three NASA field centers, three other U.S. laboratories, 10 French institutes, and nine institutes in other countries.

A radio sounding tomographic experiment that would produce a CAT scan-like, three-dimensional image of the comet nucleus is under consideration as an additional Champollion investigation, if financial and technical resources can be made available. It would be provided by Dr. Wlodek Kofman of the Centre d'Etude des Phenomenes Aleatoires et Geophysiques, St. Martin d'Heres, France.

Full confirmation of the Champollion instrument payload is anticipated in about one year, after a formal review and endorsement by the ESA Space Program Committee in February 1996, and verification by NASA and CNES that the selected investigators are able to accommodate changes required to increase instrument collaboration and decrease their costs.

The Champollion project is managed by NASA's Jet Propulsion Laboratory, Pasadena, CA, for the Solar System Exploration Division of NASA's Office of Space Science, Washington, DC, and the CNES Scientific Program Division, Paris. CNES will contribute several key elements of the mission, including its telecommunication subsystem, batteries, spacecraft separation mechanism, and its ground-based control system.

Comet names

Although a standard format for comet names has been adopted by the IAU circulars, this has not actually been ratified by the committee tasked to decide on the issue. The committee has tentatively agreed that comets will continue to be named after their discoverers, but not on how many members of a discovery team will have their names included. Another point still under discussion is should each comet have a unique name? This is currently true for periodic comets but not for non-periodic ones; there are for example two comets Hyakutake. Should these be called Hyakutake 1 and Hyakutake 2 ? The IAU resolution did not specify a style to be used for comet names, so that Comet Hale-Bopp (1995 O1) is just as valid as C/1995 O1 (Hale-Bopp) and is nearer to the traditional format.

The committee is seeking input on these issues from the astronomical community, so if you have any views please let me know and I'll pass them on.

Jonathan Shanklin

Cometary clouds round other stars ?

Alex Vincent

The first star found to have an infra-red excess was Vega in 1983, when it was viewed by IRAS (Infra-Red Astronomy Satellite). The temperature of the material is only 95 Kelvin, but it is sufficient to increase the apparent infra-red output of the star. It is thought that a planetary system is in the process of forming round the star. A number of other stars (notably Fomalhaut) have been found to have a similar excess.

The star Beta Pictoris was the first star to have a possible proto-planetary system detected optically. This star is 78 light years distant and is 68 times more luminous than the sun. The star has a large infra-red excess and the material may be in the form of a disc which extends 500 AU from the star and is seen almost edge on. There is a depleted region extending from 20 to 30 AU from the star.

It is possible that these infra-red excesses could be due to cometary clouds of dust, ice and gas similar to the supposed Oort Cloud surrounding the Sun. The Oort cloud is believed to extend to a distance of up to one light year from the sun. It might appear as a disc shaped infra-red excess when viewed from another stellar system.

Tail length prediction C/1996 B2

Andreas Kammerer

At the International Workshop on Cometary Astronomy in February 1994 I talked about my analysis of visual tail lengths. The analysis showed that there exists a correlation between the heliocentric magnitude and the tail length (see International Comet Quarterly, Oct. 1994, pp. 144-148). [*This formula is used in the ephemerides available on the section web page*].

Applying the formula to comet C/1996 B2 (Hyakutake) I made the following prediction about the development of the visual tail:

Because of severe foreshortening prior to its encounter with earth the tail length will not exceed 5° prior to March 20th. The following days, however, will see a rapid increase - due to diminishing foreshortening and distance - with a maximum on March 27th. For that day I predict a visual tail length of 20°, but it should be of comparable length from March 25th to 28th. The tail however will not be conspicuous. [*As things turned out, the comet was brighter than predicted and hence the tail was longer].* Thereafter, mainly because of the increasing distance from the earth, the tail will shrink and reach a minimum of about 12° around April 5th. After that date it will grow again and gain in brightness. Maximum length will be reached on April 25th/26th. Thereafter foreshortening and increasing distance will cause a rapid shrinkage. The formula predicts the following lengths (0h UT): April 15th: 17°, April 20th: 26°, April 25th: 35°, April 30th: 20°, May 5th: 14°, May 10th: 13°, May 15th: 9°, May 20th: 6°.

The prediction has three important restrictions: First, the formula describes the average(!) tail development of comets. If comet Hyakutake shows high activity or even breaks apart, the visible tail can get much longer. On the other hand, in the case of low activity it will be shorter. Second, the formula depends on the brightness development. The above values are calculated on the basis of the brightness parameters m0=5.5 and n=4 (neglecting a probably greater m0 and smaller n after perihelion, because assuming any different values for this period is no more than a guess). Again, if the comet shows a different brightness development, the tail length will differ from the above values. Third, the formula is well tested only for distances down to about 0.35 AU. Because of its exponential nature, it has to be replaced by another kind of formula (I prefer a parabola) at a distance somewhere between about 0.3 AU and 0.2 AU. Comet Hyakutake will have sun distances of less than 0.3 AU from April 26th to May 7th. For these dates, the given values are therefore not supported by any observations of past comets.

As a result, northern hemisphere observers at about 40°-60° latitude will have the best view (especially around the time of earth passage). To southern hemisphere observers the comet will not be visible in a moderately dark sky prior to about May 7th. By then the tail length will have shortened to only about one third that displayed at the end of April. Only in the case of a splitting of the nucleus and a resulting increase of the absolute brightness of at least 3.5^m would the tail achieve comparable lengths after perihelion.

Review of comet observations for 1995 November - 1996 April

The information in this report is a synopsis of material gleaned from IAU circulars 6254 - 6380 and The Astronomer (1995 November - 1996 March). Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. Note that the figures quoted are rounded off from their original published accuracy. A full report of the comets seen during the year will be published in the Journal in due course. For the latest information see the section www page.

6P/d'Arrest continued to be observed by more favourably located observers after it was lost from view in the UK. It faded from around 8^m at the beginning of September to 11^m at the end of November, steadily becoming more diffuse.

18P/Perrine-Mrkos was not recovered and may have become inert.

22P/Kopff was picked up by CCD observers in mid February and had reached 10^m as I write these notes in mid April. A finding chart for the comet is in the observing supplement.

29P/Schwassmann-Wachmann 1 continued to be active with another outburst starting in mid February and continuing into April. This outburst was quite a bright one and it reached around 11^m. Observing with the Northumberland 0.30-m refractor shortly after the outburst commenced it was a small well condensed object, surprisingly easy to see. The comet is worth following by those equipped with CCD cameras as it seems to be in outburst more often than not.

45P/Honda-Mrkos-Pajdusakova made a brief forray into Northern skies in late January and February and some more southerly observers were also able to observe it in December prior to perihelion. It faded fairly rapidly and became quite large and very diffuse. The observations are fitted by 11.4 + 5 log(Δ) + 11.9 log(r), which generally confirms the faint intrinsic magnitude of the comet, but is a rather smaller value for K1 than normally adopted.

58P/Jackson-Neujmin peaked at around 10.5 in mid November, but was not well placed for UK observation.

67P/Churyumov-Gerasimenko reached around 11^m in mid February. It was a weakly condensed object with a maximum coma diameter of around 3'.

73P/Schwassmann-Wachmann 3 underwent a further outburst in mid November, reaching 7^m. Despite the two outbursts, the overall brightness law is 5.8 + 5 log(Δ) + 7.4 log (r).

116P/Wild 4 reached around 13^m in late February and continued at this brightness into April.

122P/de Vico was lost for most observers after the end of November, when it went into solar conjunction as a 9^m rather diffuse object. However Mikuz picked it up again in January when it had faded considerably to 14.5^m.

123P/West-Hartley was observed by Mikuz and Hasubick in mid February at around 13.5.

C/1995 O1 (Hale-Bopp) was recovered after solar conjuntion and seems to be brightening rapidly. It is now an easy binocular object. The best fit equation to the observations made so far is -3 + 5 log(Δ) + 12 log (r), which would make it a spectacular object at perihelion. However Hyakutake held out similar prospects and then didn't quite live up to them so it is best to wait and see what happens as it approaches the sun. Whatever else it should be an easy object to observe.

C/1995 Q1 (Bradfield) was followed by a few observers into December, when it was a diffuse 11^m object.

C/1995 Y1 (Hyakutake). Yuji Hyakutake of Hayato-machi, Aira-gun, Kagoshima-ken discovered an 11^m comet on December 25 using 25x150 B. The brightness peaked at around 8^m at the end of February. The comet was moderately condensed, with a maximum coma diameter of around 10'. The observations are fitted by $7.6 + 5 \log(\Delta) + 11.4 \log r$

C/1996 A1 (Jedicke). Robert and Victoria Jedicke of the Lunar and Planetary Laboratory, discovered the first comet of the year on January 14 with the Spacewatch telescope at Kitt Peak. At discovery it was 17^m. Although it is a very faint object and won't get much brighter, Mikuz has been able to make a couple of CCD observations putting it at around 16.5^m.

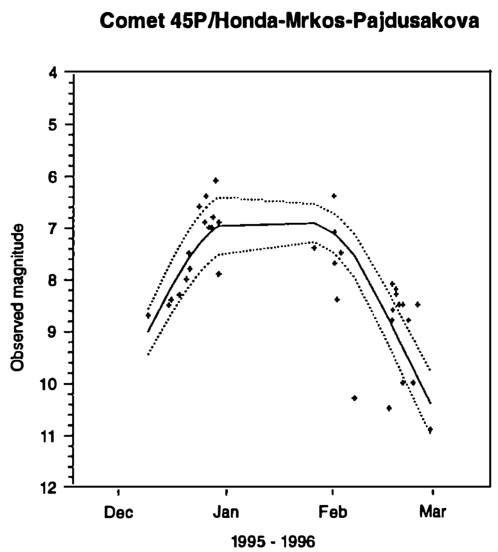
C/1996 B1 (Szczepanski). Edward W Szczepanski of Houston, Texas, U.S.A. photographically discovered a comet on January 27, using a 0.10-m refractor and a 300-mm camera lens on a 50 minute exposure. At discovery it was estimated at 10.5, though visual observations made it a couple of magnitudes brighter. The light curve is not particularly well defined, but can be fitted by $7.8 + 5 \log(\Delta) + 10 \log(r)$. The majority of observers estimate that the brightness peaked at around 8^m at the end of February. The coma became quite large and diffuse, which may explain much of the scatter.

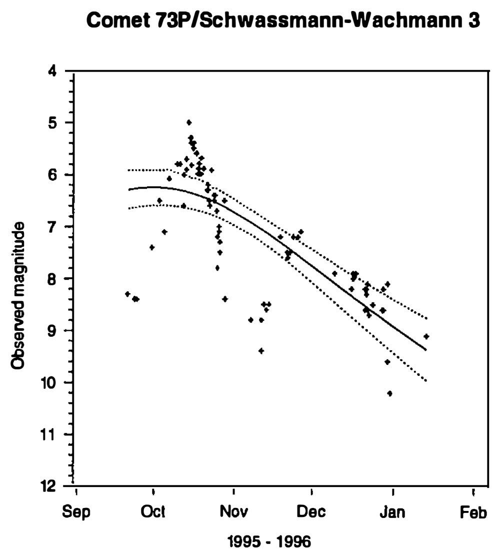
C/1996 B2 (Hyakutake). Yuji Hyakutake made a second visual discovery on January 31. He again used 25x150 B and the comet was initially 11 magnitude. More details are given elsewhere in the Newsletter. The observations so far give a mean light curve of $5.4 + 5 \log(\Delta) + 8 \log(r)$, however the comet was significantly fainter than indicated by this equation when it was discovered and reached a brighter magnitude at closest approach to the Earth. After closest approach the light curve is best fitted by $5.2 + 5 \log(\Delta) + 6 \log(r)$

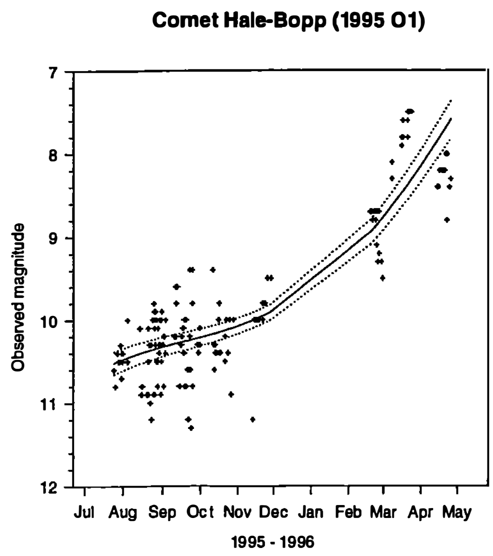
C/1996 E1 (NEAT) was discovered by Eleanor Helin and other members of the Near-Earth-Asteroid Tracking (NEAT) team with the 1-m f2.2 GEODSS telescope at Haleakala. The comet is intrinsically quite faint and is currently about 16^m. It reaches perihelion at 1.4 AU in July, but is not well placed.

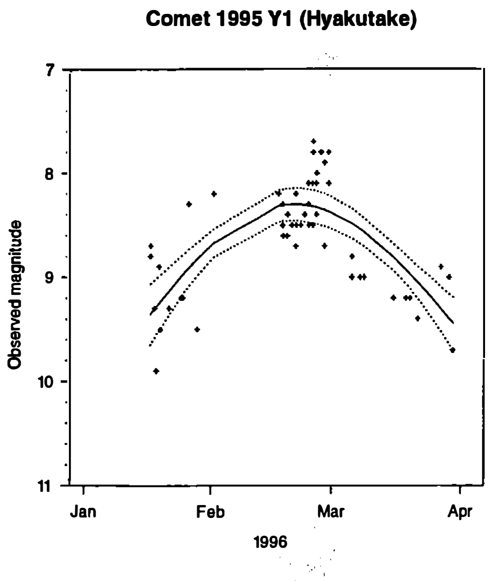
P/1996 F1 (Spacewatch) (125P/Spacewatch) was recovered by Jim Scotti and J Montani with the 0.9-m Spacewatch telescope at Kitt Peak on March 21st. It is not expected to become brighter than 17^m.

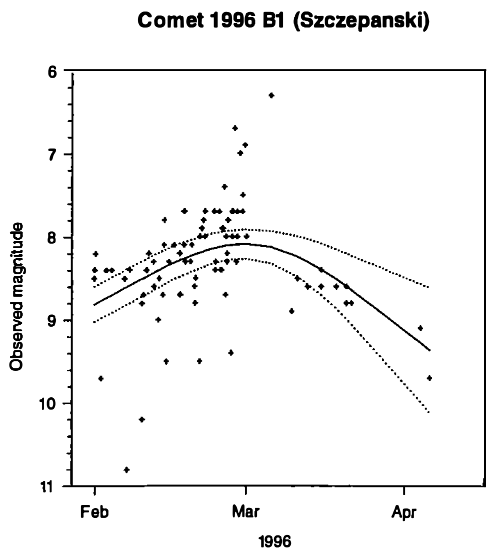
Light Curves

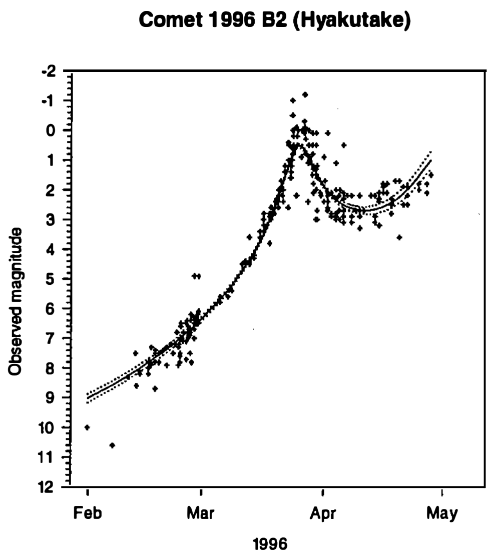





Comet Hale-Bopp (1995 O1)
Observed magnitude
7
8
9
10
11
12
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May
1995 - 1996


Comet 1995 Y1 (Hyakutake)
Observed magnitude
7
8
9
10
11
Jan Feb Mar Apr
1996


Comet 1996 B1 (Szczepanski)
Observed magnitude
6
7
8
9
10
11
Feb Mar Apr
1996


Comet 1996 B2 (Hyakutake)
Observed magnitude
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
Feb Mar Apr May
1996

Introduction

Comet Hyakutake has encouraged members to make a few drawings so do keep sending them in. Observing and drawing features in the inner coma takes practice and as such features are likely to be common in Hale-Bopp, now is the time to start. Good drawings will be used to illustrate future section reports in the Journal and in Memoirs. A copy of the section observing blank and report form are on the last two pages of this supplement; please let me know if you need more copies of them.

Ephemerides are given for comets:

- 22P/Kopff (The ephemeris is for the UK but continues to mid October as it may be observed from more southerly locations)
- 65P/Gunn (Equator only)
- 96P/Machholz 1 (Southern hemisphere only)
- 116P/Wild 4 (Equator only; the comet may be visible from the UK for the first few weeks of May)
- C/Hale-Bopp (1995 O1)
- C/Hyakutake (1996 B2) (Southern hemisphere only)

Current ephemerides are also available on the section web page.

Although comet Hale-Bopp will get the lion's share of attention it is important not to forget the fainter comets. Comet 22P/Kopff has a good return and I hope that members will be able to obtain full coverage of it. A finding chart with selected comparison star magnitudes is given at the end of the supplement.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are from the IAU circulars or comet catalogue or from Don Yeomans of JPL. Apologies to the originators for not making this clear in previous issues.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 35° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. All times are in Greenwich Mean Astronomical Time (GMAT), i.e. the day is the day on which the night starts. To convert to UT (GMT) add 12 hours. If the value is greater than 24, add 1 to the day and subtract 24 from the hour. If necessary, convert to local time. Strictly ephemeris time is used which is currently some 60 seconds ahead of UT.
- Column headings:

a) Double-date format. Time in GMAT. 12.0 is midnight UT.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are for epoch 1950).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun in degrees.

Ephemerides follow

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Ephemeris for 22P/Kopff

Omega=162.8362 OMEGA=120.9141 i=  4.7210 q= 1.579945 a=  3.463318
e=0.543806  P=    6.445  T= 1996 July       2.2569    Equinox= 2000
Magnitudes calculated from m = 3.0 + 5.0*Log(d) + 26.0*Log(r)
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May 1996 Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
				Times in GMAT					
15/16	12.0	18 46.7	-15.53	8.1	0.78	1.65	15.13	12.01 to 14.01	133
16/17	12.0	18 48.0	-15.53	8.1	0.78	1.65	15.11	11.58 to 13.58	134
17/18	12.0	18 49.3	-15.52	8.0	0.77	1.64	15.08	11.54 to 13.55	134
18/19	12.0	18 50.5	-15.51	8.0	0.76	1.64	15.05	11.51 to 13.53	135
19/20	12.0	18 51.7	-15.51	8.0	0.75	1.64	15.03	11.47 to 13.50	136
20/21	12.0	18 52.9	-15.50	7.9	0.75	1.64	14.60	11.43 to 13.47	136
21/22	12.0	18 54.1	-15.50	7.9	0.74	1.63	14.57	11.40 to 13.44	137

22/23	12.0	18 55.2	-15.50	7.8	0.73	1.63	14.54	11.36 to 13.41	138
23/24	12.0	18 56.3	-15.50	7.8	0.73	1.63	14.51	11.33 to 13.38	138
24/25	12.0	18 57.4	-15.50	7.8	0.72	1.63	14.49	11.29 to 13.36	139
25/26	12.0	18 58.4	-15.50	7.7	0.71	1.62	14.46	11.26 to 13.33	140
26/27	12.0	18 59.5	-15.51	7.7	0.71	1.62	14.43	11.22 to 13.30	140
27/28	12.0	19 0.5	-15.51	7.7	0.70	1.62	14.40	11.19 to 13.27	141
28/29	12.0	19 1.4	-15.52	7.6	0.69	1.62	14.37	11.15 to 13.25	142
29/30	12.0	19 2.4	-15.53	7.6	0.69	1.61	14.34	11.12 to 13.22	143
30/31	12.0	19 3.3	-15.54	7.6	0.68	1.61	14.31	11.08 to 13.19	143
31/32	12.0	19 4.2	-15.55	7.5	0.68	1.61	14.28	11.05 to 13.17	144

June	1996			Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	19 5.1	-15.57	7.5	0.67	1.61	14.25	11.01 to 13.14	145
2/ 3	12.0	19 5.9	-15.58	7.5	0.66	1.61	14.22	10.58 to 13.12	146
3/ 4	12.0	19 6.7	-16.00	7.4	0.66	1.61	14.19	10.54 to 13.09	146
4/ 5	12.0	19 7.5	-16.02	7.4	0.65	1.60	14.15	10.51 to 13.07	147
5/ 6	12.0	19 8.2	-16.05	7.4	0.65	1.60	14.12	10.53 to 13.04	148
6/ 7	12.0	19 9.0	-16.07	7.4	0.64	1.60	14.09	10.55 to 13.02	149
7/ 8	12.0	19 9.7	-16.10	7.3	0.64	1.60	14.06	10.58 to 12.60	149
8/ 9	12.0	19 10.3	-16.12	7.3	0.63	1.60	14.02	11.01 to 12.58	150
9/10	12.0	19 11.0	-16.16	7.3	0.63	1.60	13.59	11.03 to 12.56	151
10/11	12.0	19 11.6	-16.19	7.2	0.63	1.59	13.56	11.05 to 12.54	152
11/12	12.0	19 12.2	-16.22	7.2	0.62	1.59	13.52	11.07 to 12.52	153
12/13	12.0	19 12.7	-16.26	7.2	0.62	1.59	13.49	11.09 to 12.50	153
13/14	12.0	19 13.2	-16.30	7.2	0.61	1.59	13.46	11.11 to 12.49	154
14/15	12.0	19 13.7	-16.34	7.2	0.61	1.59	13.42	11.13 to 12.48	155
15/16	12.0	19 14.2	-16.38	7.1	0.61	1.59	13.39	11.15 to 12.47	156
16/17	12.0	19 14.7	-16.43	7.1	0.60	1.59	13.35	11.16 to 12.46	157
17/18	12.0	19 15.1	-16.48	7.1	0.60	1.59	13.32	11.17 to 12.45	158
18/19	12.0	19 15.5	-16.53	7.1	0.60	1.59	13.28	11.18 to 12.45	159
19/20	12.0	19 15.9	-16.58	7.1	0.59	1.58	13.25	11.19 to 12.44	159
20/21	12.0	19 16.2	-17.03	7.0	0.59	1.58	13.21	11.19 to 12.44	160
21/22	12.0	19 16.5	-17.09	7.0	0.59	1.58	13.17	11.19 to 12.45	161
22/23	12.0	19 16.8	-17.15	7.0	0.58	1.58	13.14	11.19 to 12.45	162
23/24	12.0	19 17.1	-17.21	7.0	0.58	1.58	13.10	11.19 to 12.46	163
24/25	12.0	19 17.4	-17.27	7.0	0.58	1.58	13.06	11.18 to 12.47	164
25/26	12.0	19 17.6	-17.34	7.0	0.58	1.58	13.03	11.17 to 12.48	165
26/27	12.0	19 17.8	-17.40	7.0	0.58	1.58	12.59	11.16 to 12.50	166
27/28	12.0	19 18.0	-17.47	7.0	0.57	1.58	12.55	11.15 to 12.52	167
28/29	12.0	19 18.2	-17.54	7.0	0.57	1.58	12.52	11.13 to 12.54	168
29/30	12.0	19 18.4	-18.01	6.9	0.57	1.58	12.48	11.12 to 12.56	168
30/31	12.0	19 18.6	-18.08	6.9	0.57	1.58	12.44	11.10 to 12.58	169

July	1996			Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	19 18.7	-18.16	6.9	0.57	1.58	12.40	11.08 to 12.60	170
2/ 3	12.0	19 18.8	-18.23	6.9	0.57	1.58	12.36	11.06 to 13.02	171
3/ 4	12.0	19 19.0	-18.31	6.9	0.57	1.58	12.33	11.04 to 13.05	172
4/ 5	12.0	19 19.1	-18.39	6.9	0.57	1.58	12.29	11.02 to 13.07	173
5/ 6	12.0	19 19.2	-18.47	6.9	0.57	1.58	12.25	10.59 to 13.10	174
6/ 7	12.0	19 19.3	-18.55	6.9	0.57	1.58	12.21	10.57 to 13.13	175
7/ 8	12.0	19 19.4	-19.03	6.9	0.57	1.58	12.17	10.55 to 13.15	175
8/ 9	12.0	19 19.5	-19.11	6.9	0.57	1.58	12.13	10.52 to 13.18	176
9/10	12.0	19 19.5	-19.19	6.9	0.57	1.58	12.09	10.50 to 13.21	177
10/11	12.0	19 19.6	-19.28	6.9	0.57	1.58	12.06	10.47 to 13.24	177
11/12	12.0	19 19.7	-19.36	7.0	0.57	1.58	12.02	10.45 to 13.27	177
12/13	12.0	19 19.8	-19.44	7.0	0.57	1.58	11.58	10.42 to 13.30	177
13/14	12.0	19 19.9	-19.53	7.0	0.57	1.58	11.54	10.39 to 13.32	177
14/15	12.0	19 20.0	-20.01	7.0	0.57	1.59	11.50	10.37 to 13.35	176
15/16	12.0	19 20.0	-20.10	7.0	0.57	1.59	11.46	10.34 to 13.38	175
16/17	12.0	19 20.1	-20.18	7.0	0.57	1.59	11.43	10.31 to 13.41	174
17/18	12.0	19 20.3	-20.26	7.0	0.57	1.59	11.39	10.28 to 13.44	174
18/19	12.0	19 20.4	-20.35	7.0	0.58	1.59	11.35	10.26 to 13.47	173
19/20	12.0	19 20.5	-20.43	7.0	0.58	1.59	11.31	10.23 to 13.50	172
20/21	12.0	19 20.6	-20.51	7.1	0.58	1.59	11.27	10.20 to 13.53	171
21/22	12.0	19 20.8	-20.59	7.1	0.58	1.59	11.23	10.17 to 13.56	170
22/23	12.0	19 21.0	-21.08	7.1	0.58	1.59	11.20	10.14 to 13.59	169
23/24	12.0	19 21.2	-21.16	7.1	0.59	1.60	11.16	10.11 to 14.00	168
24/25	12.0	19 21.4	-21.24	7.1	0.59	1.60	11.12	10.09 to 13.55	167

25/26	12.0	19 21.6	-21.31	7.2	0.59	1.60	11.08	10.06 to 13.49	166
26/27	12.0	19 21.8	-21.39	7.2	0.60	1.60	11.05	10.03 to 13.44	165
27/28	12.0	19 22.1	-21.47	7.2	0.60	1.60	11.01	9.60 to 13.39	164
28/29	12.0	19 22.4	-21.54	7.2	0.60	1.60	10.57	9.57 to 13.33	164
29/30	12.0	19 22.7	-22.02	7.3	0.61	1.60	10.54	9.54 to 13.28	163
30/31	12.0	19 23.0	-22.09	7.3	0.61	1.61	10.50	9.51 to 13.22	162
31/32	12.0	19 23.4	-22.16	7.3	0.61	1.61	10.47	9.48 to 13.17	161

August 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	19 23.7	-22.23	7.3	0.62	1.61	10.43	9.45 to 13.11	160
2/ 3	12.0	19 24.1	-22.29	7.4	0.62	1.61	10.40	9.43 to 13.06	159
3/ 4	12.0	19 24.6	-22.36	7.4	0.63	1.61	10.36	9.40 to 13.01	158
4/ 5	12.0	19 25.0	-22.42	7.4	0.63	1.62	10.33	9.37 to 12.55	157
5/ 6	12.0	19 25.5	-22.49	7.5	0.64	1.62	10.29	9.34 to 12.50	156
6/ 7	12.0	19 26.0	-22.55	7.5	0.64	1.62	10.26	9.31 to 12.44	156
7/ 8	12.0	19 26.5	-23.01	7.5	0.65	1.62	10.22	9.28 to 12.39	155
8/ 9	12.0	19 27.1	-23.06	7.6	0.65	1.62	10.19	9.25 to 12.34	154
9/10	12.0	19 27.6	-23.12	7.6	0.66	1.63	10.15	9.22 to 12.28	153
10/11	12.0	19 28.2	-23.17	7.6	0.66	1.63	10.12	9.19 to 12.23	152
11/12	12.0	19 28.9	-23.22	7.7	0.67	1.63	10.09	9.16 to 12.18	151
12/13	12.0	19 29.5	-23.27	7.7	0.67	1.63	10.06	9.13 to 12.12	151
13/14	12.0	19 30.2	-23.32	7.7	0.68	1.64	10.02	9.11 to 12.07	150
14/15	12.0	19 31.0	-23.36	7.8	0.69	1.64	9.59	9.08 to 12.02	149
15/16	12.0	19 31.7	-23.40	7.8	0.69	1.64	9.56	9.05 to 11.57	148
16/17	12.0	19 32.5	-23.44	7.8	0.70	1.65	9.53	9.02 to 11.51	147
17/18	12.0	19 33.3	-23.48	7.9	0.71	1.65	9.50	8.59 to 11.46	147
18/19	12.0	19 34.1	-23.52	7.9	0.71	1.65	9.46	8.56 to 11.41	146
19/20	12.0	19 35.0	-23.55	8.0	0.72	1.65	9.43	8.53 to 11.36	145
20/21	12.0	19 35.9	-23.58	8.0	0.73	1.66	9.40	8.50 to 11.30	144
21/22	12.0	19 36.8	-24.01	8.0	0.73	1.66	9.37	8.48 to 11.25	143
22/23	12.0	19 37.7	-24.04	8.1	0.74	1.66	9.34	8.45 to 11.20	143
23/24	12.0	19 38.7	-24.07	8.1	0.75	1.67	9.31	8.42 to 11.15	142
24/25	12.0	19 39.7	-24.09	8.2	0.76	1.67	9.28	8.39 to 11.10	141
25/26	12.0	19 40.7	-24.11	8.2	0.76	1.67	9.25	8.36 to 11.04	140
26/27	12.0	19 41.8	-24.13	8.3	0.77	1.68	9.23	8.33 to 10.59	140
27/28	12.0	19 42.8	-24.15	8.3	0.78	1.68	9.20	8.30 to 10.54	139
28/29	12.0	19 43.9	-24.16	8.4	0.79	1.68	9.17	8.28 to 10.49	138
29/30	12.0	19 45.1	-24.18	8.4	0.80	1.69	9.14	8.25 to 10.44	137
30/31	12.0	19 46.2	-24.19	8.4	0.81	1.69	9.11	8.22 to 10.39	137
31/32	12.0	19 47.4	-24.19	8.5	0.81	1.69	9.08	8.19 to 10.33	136

September 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	19 48.6	-24.20	8.5	0.82	1.70	9.06	8.16 to 10.28	135
2/ 3	12.0	19 49.8	-24.21	8.6	0.83	1.70	9.03	8.14 to 10.23	135
3/ 4	12.0	19 51.0	-24.21	8.6	0.84	1.70	9.00	8.11 to 10.18	134
4/ 5	12.0	19 52.3	-24.21	8.7	0.85	1.71	8.58	8.08 to 10.12	133
5/ 6	12.0	19 53.5	-24.21	8.7	0.86	1.71	8.55	8.05 to 10.07	133
6/ 7	12.0	19 54.8	-24.20	8.8	0.87	1.71	8.52	8.02 to 10.01	132
7/ 8	12.0	19 56.1	-24.20	8.8	0.88	1.72	8.50	7.60 to 9.56	131
8/ 9	12.0	19 57.5	-24.19	8.9	0.89	1.72	8.47	7.57 to 9.50	131
9/10	12.0	19 58.8	-24.18	8.9	0.90	1.73	8.44	7.54 to 9.45	130
10/11	12.0	20 0.2	-24.17	9.0	0.91	1.73	8.42	7.51 to 9.39	129
11/12	12.0	20 1.6	-24.15	9.0	0.92	1.73	8.39	7.49 to 9.33	129
12/13	12.0	20 3.0	-24.14	9.1	0.93	1.74	8.37	7.47 to 9.27	128
13/14	12.0	20 4.4	-24.12	9.1	0.94	1.74	8.34	7.48 to 9.21	127
14/15	12.0	20 5.9	-24.10	9.2	0.95	1.75	8.32	7.49 to 9.14	127
15/16	12.0	20 7.3	-24.08	9.2	0.96	1.75	8.29	7.51 to 9.07	126
16/17	12.0	20 8.8	-24.06	9.3	0.97	1.75	8.27	7.54 to 8.60	125
17/18	12.0	20 10.3	-24.03	9.3	0.98	1.76	8.24	7.57 to 8.51	125
18/19	12.0	20 11.8	-24.01	9.4	0.99	1.76	8.22	8.02 to 8.42	124
19/20	12.0	20 13.3	-23.58	9.4	1.00	1.77	8.19	8.13 to 8.26	123
20/21	12.0	20 14.9	-23.55	9.5	1.01	1.77	8.17	Not Observable	123
21/22	12.0	20 16.4	-23.52	9.5	1.02	1.78	8.15	Not Observable	122
22/23	12.0	20 18.0	-23.48	9.6	1.03	1.78	8.12	Not Observable	122
23/24	12.0	20 19.5	-23.45	9.6	1.05	1.78	8.10	Not Observable	121
24/25	12.0	20 21.1	-23.41	9.7	1.06	1.79	8.08	Not Observable	120
25/26	12.0	20 22.7	-23.38	9.7	1.07	1.79	8.05	Not Observable	120
26/27	12.0	20 24.3	-23.34	9.8	1.08	1.80	8.03	Not Observable	119

27/28	12.0	20 25.9	-23.29	9.8	1.09	1.80	8.00	Not Observable	119
28/29	12.0	20 27.6	-23.25	9.9	1.11	1.81	7.58	Not Observable	118
29/30	12.0	20 29.2	-23.21	9.9	1.12	1.81	7.56	Not Observable	117
30/31	12.0	20 30.8	-23.16	10.0	1.13	1.82	7.54	Not Observable	117

October 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	20 32.5	-23.11	10.1	1.14	1.82	7.51	Not Observable	116
2/ 3	12.0	20 34.1	-23.06	10.1	1.15	1.82	7.49	Not Observable	116
3/ 4	12.0	20 35.8	-23.01	10.2	1.17	1.83	7.47	Not Observable	115
4/ 5	12.0	20 37.5	-22.56	10.2	1.18	1.83	7.44	Not Observable	114
5/ 6	12.0	20 39.2	-22.51	10.3	1.19	1.84	7.42	Not Observable	114
6/ 7	12.0	20 40.9	-22.45	10.3	1.20	1.84	7.40	Not Observable	113
7/ 8	12.0	20 42.5	-22.40	10.4	1.22	1.85	7.38	Not Observable	113
8/ 9	12.0	20 44.3	-22.34	10.4	1.23	1.85	7.35	Not Observable	112
9/10	12.0	20 46.0	-22.28	10.5	1.24	1.86	7.33	Not Observable	111
10/11	12.0	20 47.7	-22.22	10.5	1.26	1.86	7.31	Not Observable	111
11/12	12.0	20 49.4	-22.16	10.6	1.27	1.87	7.29	Not Observable	110
12/13	12.0	20 51.1	-22.10	10.6	1.28	1.87	7.26	Not Observable	110
13/14	12.0	20 52.9	-22.03	10.7	1.30	1.88	7.24	Not Observable	109
14/15	12.0	20 54.6	-21.57	10.7	1.31	1.88	7.22	Not Observable	109
15/16	12.0	20 56.3	-21.50	10.8	1.32	1.89	7.20	Not Observable	108

Ephemeris for **65P/Gunn** for the **Equator**

Omega=196.8462 OMEGA= 68.5191 i= 10.3816 q= 2.462239 a= 3.598139
e=0.315691 P= 6.825 T= 1996 July 24.5700 Equinox= 2000
Magnitudes calculated from m = 5.0 + 5.0*Log(d) + 15.0*Log(r)

May 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
16/17	12.0	16 38.0	-21.11	11.9	1.51	2.50	13.01	8.40 to 17.01	165
18/19	12.0	16 36.6	-21.18	11.8	1.50	2.50	12.52	8.31 to 17.01	167
20/21	12.0	16 35.0	-21.26	11.8	1.49	2.49	12.42	8.21 to 17.01	169
22/23	12.0	16 33.5	-21.33	11.8	1.49	2.49	12.33	8.11 to 16.54	172
24/25	12.0	16 31.9	-21.40	11.8	1.48	2.49	12.23	8.01 to 16.45	174
26/27	12.0	16 30.2	-21.47	11.8	1.48	2.49	12.14	7.52 to 16.36	176
28/29	12.0	16 28.5	-21.54	11.8	1.47	2.49	12.04	7.42 to 16.26	178
30/31	12.0	16 26.9	-22.01	11.8	1.47	2.48	11.55	7.32 to 16.17	179

June 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 25.2	-22.08	11.8	1.47	2.48	11.45	7.23 to 16.07	177
3/ 4	12.0	16 23.5	-22.14	11.8	1.47	2.48	11.35	7.13 to 15.58	175
5/ 6	12.0	16 21.9	-22.21	11.8	1.47	2.48	11.26	7.04 to 15.48	172
7/ 8	12.0	16 20.2	-22.28	11.8	1.47	2.48	11.16	6.56 to 15.38	170
9/10	12.0	16 18.6	-22.35	11.8	1.48	2.48	11.07	6.56 to 15.29	168
11/12	12.0	16 17.0	-22.41	11.8	1.48	2.48	10.57	6.56 to 15.19	166
13/14	12.0	16 15.5	-22.48	11.8	1.48	2.47	10.48	6.57 to 15.10	163
15/16	12.0	16 14.1	-22.54	11.8	1.49	2.47	10.39	6.57 to 15.00	161
17/18	12.0	16 12.7	-23.01	11.8	1.50	2.47	10.29	6.58 to 14.51	159
19/20	12.0	16 11.4	-23.07	11.8	1.50	2.47	10.20	6.58 to 14.41	157
21/22	12.0	16 10.1	-23.14	11.8	1.51	2.47	10.11	6.59 to 14.32	155
23/24	12.0	16 9.0	-23.20	11.8	1.52	2.47	10.02	6.59 to 14.22	152
25/26	12.0	16 7.9	-23.27	11.8	1.53	2.47	9.53	6.60 to 14.13	150
27/28	12.0	16 7.0	-23.33	11.8	1.54	2.47	9.44	6.60 to 14.04	148
29/30	12.0	16 6.2	-23.40	11.8	1.56	2.47	9.36	7.00 to 13.55	146

July 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 5.4	-23.46	11.9	1.57	2.47	9.27	7.01 to 13.46	144
3/ 4	12.0	16 4.8	-23.53	11.9	1.58	2.47	9.18	7.01 to 13.37	142
5/ 6	12.0	16 4.3	-23.59	11.9	1.60	2.46	9.10	7.01 to 13.28	140
7/ 8	12.0	16 3.8	-24.06	11.9	1.61	2.46	9.02	7.01 to 13.19	138
9/10	12.0	16 3.5	-24.13	11.9	1.63	2.46	8.54	7.02 to 13.10	136
11/12	12.0	16 3.4	-24.20	12.0	1.64	2.46	8.45	7.02 to 13.01	134

13/14	12.0	16 3.3	-24.27	12.0	1.66	2.46	8.38	7.02 to 12.53	132
15/16	12.0	16 3.4	-24.34	12.0	1.68	2.46	8.30	7.02 to 12.44	130
17/18	12.0	16 3.5	-24.41	12.0	1.70	2.46	8.22	7.02 to 12.36	129
19/20	12.0	16 3.8	-24.48	12.0	1.72	2.46	8.14	7.02 to 12.28	127
21/22	12.0	16 4.3	-24.55	12.1	1.73	2.46	8.07	7.02 to 12.19	125
23/24	12.0	16 4.8	-25.02	12.1	1.75	2.46	7.60	7.02 to 12.11	123
25/26	12.0	16 5.4	-25.10	12.1	1.77	2.46	7.52	7.02 to 12.03	121
27/28	12.0	16 6.2	-25.17	12.1	1.80	2.46	7.45	7.02 to 11.56	120
29/30	12.0	16 7.1	-25.25	12.2	1.82	2.46	7.38	7.01 to 11.48	118
31/32	12.0	16 8.0	-25.32	12.2	1.84	2.46	7.31	7.01 to 11.40	116

August 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
2/ 3	12.0	16 9.1	-25.40	12.2	1.86	2.46	7.25	7.01 to 11.32	115
4/ 5	12.0	16 10.3	-25.48	12.2	1.88	2.46	7.18	7.00 to 11.25	113
6/ 7	12.0	16 11.6	-25.56	12.3	1.90	2.46	7.11	7.00 to 11.18	112
8/ 9	12.0	16 13.0	-26.03	12.3	1.93	2.46	7.05	6.60 to 11.10	110
10/11	12.0	16 14.5	-26.11	12.3	1.95	2.46	6.58	6.59 to 11.03	108
12/13	12.0	16 16.1	-26.19	12.4	1.97	2.47	6.52	6.59 to 10.56	107
14/15	12.0	16 17.8	-26.27	12.4	2.00	2.47	6.46	6.58 to 10.49	105
16/17	12.0	16 19.6	-26.35	12.4	2.02	2.47	6.40	6.58 to 10.42	104
18/19	12.0	16 21.5	-26.43	12.4	2.04	2.47	6.34	6.57 to 10.35	102
20/21	12.0	16 23.5	-26.51	12.5	2.07	2.47	6.28	6.56 to 10.28	101
22/23	12.0	16 25.6	-26.58	12.5	2.09	2.47	6.22	6.56 to 10.21	99
24/25	12.0	16 27.7	-27.06	12.5	2.12	2.47	6.16	6.55 to 10.15	98
26/27	12.0	16 29.9	-27.14	12.5	2.14	2.47	6.11	6.54 to 10.08	97
28/29	12.0	16 32.2	-27.21	12.6	2.17	2.47	6.05	6.54 to 10.01	95
30/31	12.0	16 34.6	-27.29	12.6	2.19	2.47	5.60	6.53 to 9.55	94

September 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	16 37.1	-27.36	12.6	2.22	2.47	5.54	6.52 to 9.49	92
3/ 4	12.0	16 39.6	-27.44	12.7	2.24	2.48	5.49	6.51 to 9.42	91
5/ 6	12.0	16 42.2	-27.51	12.7	2.27	2.48	5.44	6.51 to 9.36	90
7/ 8	12.0	16 44.9	-27.58	12.7	2.29	2.48	5.39	6.50 to 9.30	88
9/10	12.0	16 47.7	-28.05	12.7	2.32	2.48	5.33	6.49 to 9.24	87
11/12	12.0	16 50.5	-28.12	12.8	2.34	2.48	5.28	6.48 to 9.18	86
13/14	12.0	16 53.4	-28.18	12.8	2.37	2.48	5.23	6.48 to 9.12	85
15/16	12.0	16 56.3	-28.25	12.8	2.39	2.48	5.18	6.47 to 9.06	83
17/18	12.0	16 59.3	-28.31	12.8	2.42	2.49	5.14	6.46 to 8.60	82
19/20	12.0	17 2.4	-28.37	12.9	2.44	2.49	5.09	6.46 to 8.54	81
21/22	12.0	17 5.5	-28.43	12.9	2.47	2.49	5.04	6.45 to 8.48	79
23/24	12.0	17 8.7	-28.49	12.9	2.49	2.49	4.59	6.44 to 8.42	78
25/26	12.0	17 11.9	-28.54	13.0	2.52	2.49	4.55	6.43 to 8.37	77
27/28	12.0	17 15.2	-28.59	13.0	2.54	2.49	4.50	6.43 to 8.31	76
29/30	12.0	17 18.5	-29.04	13.0	2.57	2.50	4.45	6.42 to 8.26	75

October 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	17 21.9	-29.09	13.0	2.60	2.50	4.41	6.42 to 8.20	73
3/ 4	12.0	17 25.3	-29.13	13.1	2.62	2.50	4.36	6.41 to 8.15	72
5/ 6	12.0	17 28.8	-29.17	13.1	2.65	2.50	4.32	6.40 to 8.09	71
7/ 8	12.0	17 32.3	-29.21	13.1	2.67	2.51	4.28	6.40 to 8.04	70
9/10	12.0	17 35.8	-29.25	13.1	2.69	2.51	4.23	6.39 to 7.58	69
11/12	12.0	17 39.4	-29.28	13.2	2.72	2.51	4.19	6.39 to 7.53	67
13/14	12.0	17 43.0	-29.31	13.2	2.74	2.51	4.15	6.39 to 7.48	66
15/16	12.0	17 46.7	-29.33	13.2	2.77	2.51	4.11	6.38 to 7.43	65
17/18	12.0	17 50.4	-29.36	13.2	2.79	2.52	4.06	6.38 to 7.38	64
19/20	12.0	17 54.1	-29.38	13.3	2.82	2.52	4.02	6.38 to 7.32	63
21/22	12.0	17 57.9	-29.39	13.3	2.84	2.52	3.58	6.38 to 7.27	62
23/24	12.0	18 1.7	-29.40	13.3	2.86	2.52	3.54	6.37 to 7.22	60
25/26	12.0	18 5.5	-29.41	13.3	2.89	2.53	3.50	6.37 to 7.17	59
27/28	12.0	18 9.3	-29.42	13.4	2.91	2.53	3.46	6.37 to 7.12	58
29/30	12.0	18 13.2	-29.42	13.4	2.93	2.53	3.42	6.37 to 7.07	57
31/32	12.0	18 17.1	-29.42	13.4	2.96	2.54	3.38	6.37 to 7.03	56

Ephemeris for **96P/Machholz 1** for the **Southern Hemisphere**

Omega= 14.5487 OMEGA= 94.4983 i= 60.0040 q= 0.125874 a= 3.016247
e=0.958268 P= 5.238 T= 1996 October 15.2875 Equinox= 2000
Magnitudes calculated from m = 13.0 + 5.0*Log(d) + 12.0*Log(r)

September 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	12 23.6	-62.19	13.8	0.97	1.18	1.41	6.41 to 6.53	73
2/ 3	12.0	12 24.0	-61.29	13.7	0.97	1.16	1.37	6.42 to 6.54	72
3/ 4	12.0	12 24.4	-60.39	13.6	0.97	1.14	1.33	6.43 to 6.56	71
4/ 5	12.0	12 24.7	-59.49	13.5	0.97	1.12	1.30	6.43 to 6.57	69
5/ 6	12.0	12 25.1	-58.59	13.4	0.96	1.10	1.26	6.44 to 6.57	68
6/ 7	12.0	12 25.5	-58.09	13.3	0.96	1.08	1.23	6.45 to 6.58	67
7/ 8	12.0	12 25.8	-57.19	13.2	0.96	1.06	1.19	6.45 to 6.58	65
8/ 9	12.0	12 26.2	-56.29	13.1	0.96	1.04	1.15	6.46 to 6.58	64
9/10	12.0	12 26.5	-55.39	13.0	0.96	1.02	1.12	6.47 to 6.58	63
10/11	12.0	12 26.8	-54.48	12.9	0.95	1.00	1.08	6.48 to 6.58	61
11/12	12.0	12 27.2	-53.58	12.8	0.95	0.98	1.05	6.48 to 6.58	60
12/13	12.0	12 27.5	-53.07	12.7	0.95	0.96	1.01	6.49 to 6.58	59
13/14	12.0	12 27.7	-52.16	12.6	0.95	0.94	0.57	6.50 to 6.57	57
14/15	12.0	12 28.0	-51.25	12.4	0.95	0.92	0.54	6.50 to 6.57	56
15/16	12.0	12 28.3	-50.33	12.3	0.94	0.90	0.50	6.51 to 6.56	55
16/17	12.0	12 28.5	-49.40	12.2	0.94	0.88	0.46	6.52 to 6.55	53
17/18	12.0	12 28.7	-48.47	12.0	0.94	0.85	0.43	6.53 to 6.54	52
18/19	12.0	12 28.9	-47.53	11.9	0.94	0.83	0.39	Not Observable	51
19/20	12.0	12 29.1	-46.57	11.7	0.93	0.81	0.35	Not Observable	49
20/21	12.0	12 29.2	-46.01	11.6	0.93	0.79	0.31	Not Observable	48
21/22	12.0	12 29.4	-45.04	11.4	0.93	0.76	0.27	Not Observable	46
22/23	12.0	12 29.5	-44.05	11.2	0.92	0.74	0.24	Not Observable	45
23/24	12.0	12 29.5	-43.05	11.1	0.92	0.71	0.20	Not Observable	43
24/25	12.0	12 29.6	-42.03	10.9	0.92	0.69	0.16	Not Observable	42
25/26	12.0	12 29.6	-40.59	10.7	0.92	0.66	0.12	Not Observable	40
26/27	12.0	12 29.6	-39.53	10.5	0.91	0.64	0.08	Not Observable	39
27/28	12.0	12 29.6	-38.44	10.2	0.91	0.61	0.04	Not Observable	37
28/29	12.0	12 29.6	-37.33	10.0	0.91	0.59	23.60	Not Observable	35
29/30	12.0	12 29.6	-36.19	9.8	0.90	0.56	23.56	Not Observable	34
30/31	12.0	12 29.5	-35.01	9.5	0.90	0.53	23.52	Not Observable	32

Ephemeris for **116P/Wild 4** for the **Equator**

Omega=170.7114 OMEGA= 22.0815 i= 3.7199 q= 1.988948 a= 3.360374
e=0.408117 P= 6.160 T= 1996 August 31.1123 Equinox= 2000
Magnitudes calculated from m = 5.9 + 5.0*Log(d) + 15.0*Log(r)

May 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
14/15	12.0	8 25.4	22.05	12.7	2.29	2.15	4.56	6.51 to 8.55	70
15/16	12.0	8 27.1	21.58	12.7	2.30	2.15	4.54	6.51 to 8.53	69
16/17	12.0	8 28.8	21.50	12.7	2.30	2.15	4.52	6.52 to 8.51	68
17/18	12.0	8 30.5	21.43	12.7	2.31	2.15	4.49	6.52 to 8.48	68
18/19	12.0	8 32.3	21.35	12.7	2.32	2.14	4.47	6.52 to 8.46	67
19/20	12.0	8 34.0	21.27	12.7	2.33	2.14	4.45	6.52 to 8.44	67
20/21	12.0	8 35.8	21.19	12.7	2.33	2.14	4.43	6.52 to 8.42	66
21/22	12.0	8 37.6	21.11	12.7	2.34	2.13	4.41	6.52 to 8.40	66
22/23	12.0	8 39.4	21.03	12.7	2.35	2.13	4.39	6.52 to 8.38	65
23/24	12.0	8 41.2	20.55	12.7	2.35	2.13	4.36	6.53 to 8.36	65
24/25	12.0	8 43.0	20.47	12.7	2.36	2.13	4.34	6.53 to 8.34	64
25/26	12.0	8 44.8	20.38	12.7	2.37	2.12	4.32	6.53 to 8.32	64
26/27	12.0	8 46.6	20.30	12.7	2.38	2.12	4.30	6.53 to 8.31	63
27/28	12.0	8 48.4	20.21	12.7	2.38	2.12	4.28	6.53 to 8.29	63
28/29	12.0	8 50.3	20.12	12.7	2.39	2.12	4.26	6.53 to 8.27	62
29/30	12.0	8 52.1	20.03	12.7	2.40	2.11	4.24	6.54 to 8.25	62
30/31	12.0	8 54.0	19.55	12.7	2.40	2.11	4.22	6.54 to 8.23	61
31/32	12.0	8 55.8	19.45	12.7	2.41	2.11	4.19	6.54 to 8.21	61

June 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	8 57.7	19.36	12.7	2.42	2.11	4.17	6.54 to 8.19	60
2/ 3	12.0	8 59.6	19.27	12.7	2.42	2.10	4.15	6.54 to 8.17	60
3/ 4	12.0	9 1.5	19.18	12.7	2.43	2.10	4.13	6.55 to 8.15	59
4/ 5	12.0	9 3.4	19.08	12.7	2.44	2.10	4.11	6.55 to 8.13	59
5/ 6	12.0	9 5.2	18.59	12.7	2.44	2.10	4.09	6.55 to 8.11	58
6/ 7	12.0	9 7.2	18.49	12.7	2.45	2.09	4.07	6.55 to 8.09	58
7/ 8	12.0	9 9.1	18.39	12.7	2.46	2.09	4.05	6.56 to 8.08	57
8/ 9	12.0	9 11.0	18.30	12.7	2.46	2.09	4.03	6.56 to 8.06	57
9/10	12.0	9 12.9	18.20	12.7	2.47	2.09	4.01	6.56 to 8.04	56
10/11	12.0	9 14.8	18.10	12.7	2.48	2.09	3.59	6.56 to 8.02	56
11/12	12.0	9 16.8	17.60	12.7	2.48	2.08	3.57	6.56 to 8.00	55
12/13	12.0	9 18.7	17.49	12.7	2.49	2.08	3.55	6.57 to 7.58	55
13/14	12.0	9 20.7	17.39	12.7	2.50	2.08	3.53	6.57 to 7.56	55
14/15	12.0	9 22.6	17.29	12.7	2.50	2.08	3.51	6.57 to 7.55	54
15/16	12.0	9 24.6	17.18	12.6	2.51	2.07	3.49	6.57 to 7.53	54
16/17	12.0	9 26.5	17.07	12.6	2.51	2.07	3.47	6.58 to 7.51	53
17/18	12.0	9 28.5	16.57	12.6	2.52	2.07	3.45	6.58 to 7.49	53
18/19	12.0	9 30.5	16.46	12.6	2.53	2.07	3.43	6.58 to 7.47	52
19/20	12.0	9 32.5	16.35	12.6	2.53	2.07	3.41	6.58 to 7.46	52
20/21	12.0	9 34.4	16.24	12.6	2.54	2.06	3.39	6.58 to 7.44	51
21/22	12.0	9 36.4	16.13	12.6	2.55	2.06	3.37	6.59 to 7.42	51
22/23	12.0	9 38.4	16.01	12.6	2.55	2.06	3.35	6.59 to 7.40	50
23/24	12.0	9 40.4	15.50	12.6	2.56	2.06	3.33	6.59 to 7.38	50
24/25	12.0	9 42.4	15.39	12.6	2.56	2.06	3.31	6.59 to 7.37	50
25/26	12.0	9 44.4	15.27	12.6	2.57	2.05	3.29	6.60 to 7.35	49
26/27	12.0	9 46.4	15.16	12.6	2.57	2.05	3.27	6.60 to 7.33	49
27/28	12.0	9 48.5	15.04	12.6	2.58	2.05	3.26	6.60 to 7.31	48
28/29	12.0	9 50.5	14.52	12.6	2.59	2.05	3.24	7.00 to 7.29	48
29/30	12.0	9 52.5	14.40	12.6	2.59	2.05	3.22	7.00 to 7.28	47
30/31	12.0	9 54.5	14.28	12.6	2.60	2.04	3.20	7.00 to 7.26	47

Ephemeris for **1995 O1 (Hale-Bopp)**

Omega=130.5947 OMEGA=282.4716 i= 89.4245 q= 0.913959 a=185.575431
e=0.995075 P= 2528.021 T= 1997 April 1.0919 Equinox= 2000
Magnitudes calculated from m = -4.0 + 5.0*Log(d) + 11.5*Log(r)

May 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
14/15	12.0	19 36.7	-16.19	6.3	3.81	4.41	16.07	12.29 to 14.04	120
16/17	12.0	19 35.7	-16.09	6.3	3.76	4.39	15.58	12.18 to 13.58	123
18/19	12.0	19 34.7	-15.59	6.2	3.71	4.37	15.50	12.08 to 13.53	125
20/21	12.0	19 33.6	-15.49	6.2	3.67	4.35	15.41	11.57 to 13.47	127
22/23	12.0	19 32.3	-15.38	6.1	3.62	4.33	15.31	11.46 to 13.41	129
24/25	12.0	19 31.0	-15.28	6.1	3.57	4.31	15.22	11.35 to 13.36	131
26/27	12.0	19 29.7	-15.17	6.0	3.53	4.29	15.13	11.24 to 13.30	133
28/29	12.0	19 28.2	-15.06	6.0	3.48	4.27	15.04	11.12 to 13.25	135
30/31	12.0	19 26.6	-14.56	5.9	3.44	4.24	14.54	11.01 to 13.19	138

June 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	19 25.0	-14.45	5.9	3.40	4.22	14.45	10.50 to 13.14	140
3/ 4	12.0	19 23.2	-14.34	5.8	3.36	4.20	14.35	10.47 to 13.09	142
5/ 6	12.0	19 21.4	-14.23	5.7	3.32	4.18	14.25	10.53 to 13.04	144
7/ 8	12.0	19 19.5	-14.12	5.7	3.28	4.16	14.15	10.58 to 12.60	147
9/10	12.0	19 17.5	-14.00	5.6	3.24	4.14	14.06	11.03 to 12.56	149
11/12	12.0	19 15.4	-13.49	5.6	3.20	4.12	13.56	11.07 to 12.52	151
13/14	12.0	19 13.2	-13.38	5.5	3.17	4.10	13.46	11.11 to 12.49	153
15/16	12.0	19 11.0	-13.26	5.5	3.13	4.08	13.35	11.15 to 12.47	155
17/18	12.0	19 8.7	-13.14	5.4	3.10	4.06	13.25	11.17 to 12.45	158
19/20	12.0	19 6.3	-13.03	5.4	3.07	4.03	13.15	11.19 to 12.44	160
21/22	12.0	19 3.8	-12.51	5.4	3.04	4.01	13.05	11.19 to 12.45	162
23/24	12.0	19 1.3	-12.39	5.3	3.01	3.99	12.54	11.19 to 12.46	164
25/26	12.0	18 58.7	-12.27	5.3	2.98	3.97	12.44	11.17 to 12.48	165

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
27/28	12.0	18 56.0	-12.15	5.2	2.95	3.95	12.33	11.15 to 12.52	167
29/30	12.0	18 53.3	-12.03	5.2	2.93	3.93	12.23	11.12 to 12.56	168

July 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	18 50.6	-11.51	5.1	2.91	3.91	12.12	11.08 to 12.60	169
3/ 4	12.0	18 47.8	-11.39	5.1	2.88	3.89	12.01	11.04 to 13.05	169
5/ 6	12.0	18 45.0	-11.26	5.0	2.86	3.86	11.51	10.59 to 13.10	168
7/ 8	12.0	18 42.1	-11.14	5.0	2.84	3.84	11.40	10.55 to 13.15	167
9/10	12.0	18 39.2	-11.02	5.0	2.83	3.82	11.29	10.50 to 13.21	166
11/12	12.0	18 36.3	-10.50	4.9	2.81	3.80	11.18	10.45 to 13.27	164
13/14	12.0	18 33.4	-10.38	4.9	2.80	3.78	11.07	10.39 to 13.32	162
15/16	12.0	18 30.5	-10.26	4.8	2.78	3.76	10.57	10.34 to 13.38	160
17/18	12.0	18 27.6	-10.14	4.8	2.77	3.73	10.46	10.28 to 13.44	158
19/20	12.0	18 24.7	-10.02	4.8	2.76	3.71	10.35	10.23 to 13.50	156
21/22	12.0	18 21.8	-9.50	4.7	2.76	3.69	10.24	10.17 to 13.56	153
23/24	12.0	18 19.0	-9.39	4.7	2.75	3.67	10.14	10.11 to 14.02	151
25/26	12.0	18 16.2	-9.27	4.7	2.74	3.65	10.03	10.06 to 14.07	149
27/28	12.0	18 13.4	-9.16	4.6	2.74	3.63	9.52	9.60 to 14.13	146
29/30	12.0	18 10.6	-9.05	4.6	2.73	3.60	9.42	9.54 to 14.19	144
31/32	12.0	18 8.0	-8.53	4.6	2.73	3.58	9.31	9.48 to 14.13	141

August 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
2/ 3	12.0	18 5.3	-8.43	4.5	2.73	3.56	9.20	9.43 to 14.04	139
4/ 5	12.0	18 2.8	-8.32	4.5	2.73	3.54	9.10	9.37 to 13.55	136
6/ 7	12.0	18 0.3	-8.22	4.5	2.73	3.51	8.60	9.31 to 13.46	134
8/ 9	12.0	17 57.9	-8.12	4.4	2.74	3.49	8.49	9.25 to 13.36	132
10/11	12.0	17 55.5	-8.02	4.4	2.74	3.47	8.39	9.19 to 13.27	129
12/13	12.0	17 53.2	-7.52	4.4	2.75	3.45	8.29	9.13 to 13.18	127
14/15	12.0	17 51.1	-7.42	4.3	2.75	3.43	8.19	9.08 to 13.09	124
16/17	12.0	17 49.0	-7.33	4.3	2.76	3.40	8.09	9.02 to 13.00	122
18/19	12.0	17 47.0	-7.24	4.3	2.76	3.38	7.59	8.56 to 12.51	120
20/21	12.0	17 45.0	-7.15	4.3	2.77	3.36	7.49	8.50 to 12.43	117
22/23	12.0	17 43.2	-7.07	4.2	2.78	3.34	7.39	8.45 to 12.34	115
24/25	12.0	17 41.5	-6.59	4.2	2.79	3.31	7.30	8.39 to 12.25	113
26/27	12.0	17 39.9	-6.51	4.2	2.80	3.29	7.20	8.33 to 12.17	111
28/29	12.0	17 38.3	-6.43	4.2	2.81	3.27	7.11	8.28 to 12.08	108
30/31	12.0	17 36.9	-6.35	4.1	2.82	3.25	7.02	8.22 to 11.60	106

September 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	17 35.6	-6.28	4.1	2.83	3.22	6.52	8.16 to 11.51	104
3/ 4	12.0	17 34.3	-6.21	4.1	2.84	3.20	6.43	8.11 to 11.43	102
5/ 6	12.0	17 33.2	-6.14	4.0	2.85	3.18	6.34	8.05 to 11.35	100
7/ 8	12.0	17 32.2	-6.07	4.0	2.86	3.15	6.25	7.60 to 11.27	97
9/10	12.0	17 31.2	-6.00	4.0	2.87	3.13	6.17	7.54 to 11.19	95
11/12	12.0	17 30.4	-5.54	4.0	2.88	3.11	6.08	7.49 to 11.11	93
13/14	12.0	17 29.6	-5.47	3.9	2.89	3.08	5.59	7.43 to 11.03	91
15/16	12.0	17 29.0	-5.41	3.9	2.91	3.06	5.51	7.38 to 10.55	89
17/18	12.0	17 28.4	-5.35	3.9	2.92	3.04	5.42	7.33 to 10.47	87
19/20	12.0	17 28.0	-5.29	3.8	2.93	3.01	5.34	7.27 to 10.40	85
21/22	12.0	17 27.6	-5.23	3.8	2.94	2.99	5.26	7.22 to 10.32	83
23/24	12.0	17 27.3	-5.17	3.8	2.95	2.97	5.17	7.17 to 10.25	81
25/26	12.0	17 27.1	-5.11	3.8	2.96	2.94	5.09	7.12 to 10.17	79
27/28	12.0	17 27.0	-5.06	3.7	2.97	2.92	5.01	7.07 to 10.10	78
29/30	12.0	17 27.0	-4.60	3.7	2.98	2.90	4.53	7.02 to 10.03	76

October 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	17 27.1	-4.54	3.7	2.99	2.87	4.46	6.57 to 9.56	74
3/ 4	12.0	17 27.2	-4.48	3.6	3.00	2.85	4.38	6.52 to 9.49	72
5/ 6	12.0	17 27.4	-4.43	3.6	3.00	2.83	4.30	6.47 to 9.42	70
7/ 8	12.0	17 27.7	-4.37	3.5	3.01	2.80	4.23	6.43 to 9.35	68
9/10	12.0	17 28.1	-4.31	3.5	3.02	2.78	4.15	6.38 to 9.28	67
11/12	12.0	17 28.6	-4.25	3.5	3.03	2.76	4.08	6.34 to 9.21	65
13/14	12.0	17 29.1	-4.19	3.4	3.03	2.73	4.00	6.29 to 9.15	63
15/16	12.0	17 29.8	-4.13	3.4	3.04	2.71	3.53	6.25 to 9.08	62

17/18	12.0	17 30.4	-4.07	3.3	3.04	2.68	3.46	6.21 to 9.02	60
19/20	12.0	17 31.2	-4.00	3.3	3.05	2.66	3.39	6.16 to 8.56	58
21/22	12.0	17 32.0	-3.54	3.3	3.05	2.64	3.32	6.12 to 8.49	57
23/24	12.0	17 32.9	-3.47	3.2	3.05	2.61	3.25	6.08 to 8.43	55
25/26	12.0	17 33.9	-3.40	3.2	3.05	2.59	3.18	6.05 to 8.37	54
27/28	12.0	17 34.9	-3.32	3.1	3.05	2.56	3.11	6.01 to 8.31	52
29/30	12.0	17 36.0	-3.25	3.1	3.05	2.54	3.04	5.57 to 8.25	51
31/32	12.0	17 37.2	-3.17	3.0	3.05	2.51	2.57	5.54 to 8.20	49

November 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
2/ 3	12.0	17 38.4	-3.09	3.0	3.05	2.49	2.51	5.50 to 8.14	48
4/ 5	12.0	17 39.7	-3.01	2.9	3.05	2.47	2.44	5.47 to 8.08	46
6/ 7	12.0	17 41.0	-2.52	2.9	3.04	2.44	2.38	5.44 to 8.03	45
8/ 9	12.0	17 42.4	-2.43	2.8	3.04	2.42	2.31	5.41 to 7.57	43
10/11	12.0	17 43.9	-2.34	2.8	3.03	2.39	2.25	5.38 to 7.52	42
12/13	12.0	17 45.4	-2.24	2.7	3.03	2.37	2.18	5.36 to 7.47	41
14/15	12.0	17 47.0	-2.14	2.7	3.02	2.34	2.12	5.33 to 7.42	40
16/17	12.0	17 48.6	-2.04	2.6	3.01	2.32	2.06	5.31 to 7.36	38
18/19	12.0	17 50.3	-1.53	2.5	3.00	2.29	1.60	5.29 to 7.32	37
20/21	12.0	17 52.0	-1.42	2.5	2.99	2.27	1.53	5.27 to 7.27	36
22/23	12.0	17 53.8	-1.30	2.4	2.98	2.24	1.47	5.25 to 7.22	35
24/25	12.0	17 55.7	-1.17	2.3	2.97	2.22	1.41	5.23 to 7.17	34
26/27	12.0	17 57.6	-1.04	2.3	2.95	2.19	1.35	5.22 to 7.13	33
28/29	12.0	17 59.5	-0.51	2.2	2.94	2.17	1.29	5.21 to 7.08	32
30/31	12.0	18 1.5	-0.36	2.1	2.92	2.14	1.23	5.19 to 7.04	31

Ephemeris for **1996 B2 (Hyakutake)** for the **Southern Hemisphere**

Omega=130.1787 OMEGA=188.0453 i=124.9229 q= 0.230201 a=**********
e=0.999887 P=91948.181 T= 1996 May 1.3937 Equinox= 2000
Magnitudes calculated from m = 5.0 + 5.0*Log(d) + 5.0*Log(r)

May 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
15/16	12.0	2 27.7	-1.21	4.0	1.21	0.52	22.54	17.09 to 17.45	25
16/17	12.0	2 29.3	-2.44	4.1	1.20	0.55	22.52	17.04 to 17.46	27
17/18	12.0	2 31.1	-4.05	4.2	1.19	0.57	22.50	16.58 to 17.47	29
18/19	12.0	2 32.9	-5.26	4.3	1.19	0.60	22.47	16.52 to 17.47	30
19/20	12.0	2 34.9	-6.46	4.3	1.18	0.62	22.45	16.47 to 17.48	32
20/21	12.0	2 36.9	-8.06	4.4	1.18	0.65	22.44	16.42 to 17.49	33
21/22	12.0	2 39.0	-9.25	4.5	1.17	0.67	22.42	16.36 to 17.49	35
22/23	12.0	2 41.2	-10.44	4.5	1.16	0.70	22.40	16.31 to 17.50	36
23/24	12.0	2 43.5	-12.03	4.6	1.16	0.72	22.38	16.26 to 17.50	38
24/25	12.0	2 45.8	-13.22	4.7	1.15	0.74	22.37	16.21 to 17.51	39
25/26	12.0	2 48.2	-14.41	4.7	1.15	0.77	22.35	16.16 to 17.52	41
26/27	12.0	2 50.7	-15.60	4.8	1.14	0.79	22.34	16.11 to 17.52	42
27/28	12.0	2 53.3	-17.18	4.8	1.14	0.81	22.32	16.06 to 17.53	44
28/29	12.0	2 55.9	-18.37	4.9	1.13	0.83	22.31	16.01 to 17.53	45
29/30	12.0	2 58.7	-19.56	4.9	1.13	0.86	22.30	15.56 to 17.54	47
30/31	12.0	3 1.5	-21.15	5.0	1.13	0.88	22.28	15.51 to 17.54	48
31/32	12.0	3 4.4	-22.33	5.0	1.12	0.90	22.27	15.46 to 17.55	50

June 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	3 7.3	-23.52	5.1	1.12	0.92	22.26	15.41 to 17.55	51
2/ 3	12.0	3 10.4	-25.11	5.1	1.12	0.95	22.25	15.37 to 17.56	52
3/ 4	12.0	3 13.5	-26.29	5.2	1.12	0.97	22.25	15.32 to 17.56	54
4/ 5	12.0	3 16.7	-27.48	5.2	1.11	0.99	22.24	15.27 to 17.57	55
5/ 6	12.0	3 20.0	-29.06	5.3	1.11	1.01	22.23	15.22 to 17.57	56
6/ 7	12.0	3 23.4	-30.24	5.3	1.11	1.03	22.23	15.17 to 17.58	58
7/ 8	12.0	3 26.9	-31.42	5.3	1.11	1.05	22.22	15.12 to 17.58	59
8/ 9	12.0	3 30.5	-33.00	5.4	1.11	1.07	22.22	15.07 to 17.59	60
9/10	12.0	3 34.2	-34.18	5.4	1.11	1.09	22.22	15.02 to 17.59	62
10/11	12.0	3 38.0	-35.35	5.5	1.11	1.11	22.21	14.57 to 17.60	63
11/12	12.0	3 41.9	-36.51	5.5	1.11	1.14	22.21	14.52 to 17.60	64
12/13	12.0	3 46.0	-38.07	5.6	1.12	1.16	22.21	14.47 to 18.00	65

13/14	12.0	3 50.1	-39.23	5.6	1.12	1.18	22.21	5.60 to 6.01 14.42 to 18.01	67
14/15	12.0	3 54.4	-40.37	5.6	1.12	1.20	22.22	5.60 to 6.07 14.36 to 18.01	68
15/16	12.0	3 58.7	-41.51	5.7	1.13	1.22	22.22	5.60 to 6.13 14.31 to 18.01	69
16/17	12.0	4 3.2	-43.05	5.7	1.13	1.24	22.23	6.00 to 6.20 14.26 to 18.02	70
17/18	12.0	4 7.9	-44.17	5.8	1.13	1.26	22.23	6.00 to 6.27 14.20 to 18.02	71
18/19	12.0	4 12.7	-45.28	5.8	1.14	1.27	22.24	6.00 to 6.34 14.15 to 18.02	72
19/20	12.0	4 17.6	-46.38	5.9	1.15	1.29	22.25	6.01 to 6.41 14.09 to 18.02	73
20/21	12.0	4 22.7	-47.48	5.9	1.15	1.31	22.26	6.01 to 6.49 14.03 to 18.03	74
21/22	12.0	4 27.9	-48.55	5.9	1.16	1.33	22.27	6.01 to 6.58 13.57 to 18.03	75
22/23	12.0	4 33.2	-50.02	6.0	1.17	1.35	22.29	6.01 to 7.07 13.51 to 18.03	76
23/24	12.0	4 38.8	-51.07	6.0	1.17	1.37	22.30	6.01 to 7.16 13.44 to 18.03	77
24/25	12.0	4 44.5	-52.11	6.1	1.18	1.39	22.32	6.02 to 7.26 13.38 to 18.03	78
25/26	12.0	4 50.4	-53.13	6.1	1.19	1.41	22.34	6.02 to 7.37 13.31 to 18.04	79
26/27	12.0	4 56.4	-54.14	6.2	1.20	1.43	22.36	6.02 to 7.48 13.24 to 18.04	80
27/28	12.0	5 2.6	-55.13	6.2	1.21	1.45	22.38	6.03 to 8.00 13.16 to 18.04	81
28/29	12.0	5 9.0	-56.10	6.3	1.22	1.46	22.40	6.03 to 8.13 13.08 to 18.04	81
29/30	12.0	5 15.6	-57.06	6.3	1.23	1.48	22.43	6.03 to 8.27 12.59 to 18.04	82
30/31	12.0	5 22.4	-57.60	6.4	1.24	1.50	22.46	6.04 to 8.43 12.49 to 18.04	83

July	1996			Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	5 29.4	-58.52	6.4	1.25	1.52	22.49	6.04 to 8.59 12.38 to 18.04	83
2/ 3	12.0	5 36.5	-59.42	6.4	1.27	1.54	22.52	6.05 to 9.19 12.25 to 18.04	84
3/ 4	12.0	5 43.9	-60.30	6.5	1.28	1.56	22.55	6.05 to 9.41 12.10 to 18.04	85
4/ 5	12.0	5 51.4	-61.16	6.5	1.29	1.57	22.59	6.05 to 10.10 11.48 to 18.04	85
5/ 6	12.0	5 59.2	-62.00	6.6	1.30	1.59	23.03	6.06 to 18.04	86
6/ 7	12.0	6 7.1	-62.42	6.6	1.32	1.61	23.07	6.06 to 18.03	86
7/ 8	12.0	6 15.2	-63.22	6.7	1.33	1.63	23.11	6.07 to 18.03	87
8/ 9	12.0	6 23.5	-64.00	6.7	1.35	1.64	23.15	6.07 to 18.03	87
9/10	12.0	6 31.9	-64.36	6.8	1.36	1.66	23.19	6.08 to 18.03	87
10/11	12.0	6 40.5	-65.10	6.8	1.38	1.68	23.24	6.08 to 18.03	88
11/12	12.0	6 49.3	-65.42	6.9	1.39	1.70	23.29	6.09 to 18.02	88
12/13	12.0	6 58.2	-66.11	6.9	1.41	1.71	23.34	6.09 to 18.02	88
13/14	12.0	7 7.1	-66.39	7.0	1.43	1.73	23.39	6.10 to 18.02	89
14/15	12.0	7 16.2	-67.04	7.0	1.44	1.75	23.44	6.10 to 18.02	89
15/16	12.0	7 25.4	-67.28	7.1	1.46	1.77	23.49	6.11 to 18.01	89
16/17	12.0	7 34.7	-67.50	7.1	1.48	1.78	23.54	6.11 to 18.01	89
17/18	12.0	7 44.0	-68.09	7.2	1.50	1.80	23.60	6.12 to 18.00	89
18/19	12.0	7 53.3	-68.27	7.2	1.52	1.82	0.05	6.13 to 18.00	89
19/20	12.0	8 2.6	-68.43	7.2	1.53	1.83	0.10	6.13 to 17.60	90
20/21	12.0	8 11.9	-68.57	7.3	1.55	1.85	0.16	6.14 to 17.59	90
21/22	12.0	8 21.2	-69.10	7.3	1.57	1.87	0.21	6.14 to 17.59	90
22/23	12.0	8 30.4	-69.21	7.4	1.59	1.88	0.27	6.15 to 17.58	90
23/24	12.0	8 39.5	-69.30	7.4	1.61	1.90	0.32	6.15 to 17.58	90
24/25	12.0	8 48.6	-69.38	7.5	1.63	1.92	0.37	6.16 to 17.57	90
25/26	12.0	8 57.5	-69.45	7.5	1.65	1.93	0.42	6.17 to 17.56	90
26/27	12.0	9 6.4	-69.50	7.6	1.67	1.95	0.47	6.17 to 17.56	90
27/28	12.0	9 15.0	-69.54	7.6	1.69	1.97	0.52	6.18 to 17.55	89
28/29	12.0	9 23.6	-69.57	7.7	1.71	1.98	0.56	6.19 to 17.54	89

29/30	12.0	9 32.0	-69.58	7.7	1.74	2.00	1.01	6.19 to 17.54	89
30/31	12.0	9 40.2	-69.59	7.7	1.76	2.01	1.05	6.20 to 17.53	89
31/32	12.0	9 48.2	-69.59	7.8	1.78	2.03	1.10	6.20 to 17.52	89

August 1996				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	9 56.1	-69.58	7.8	1.80	2.05	1.14	6.21 to 17.52	89
2/ 3	12.0	10 3.8	-69.56	7.9	1.82	2.06	1.17	6.22 to 17.51	89
3/ 4	12.0	10 11.3	-69.53	7.9	1.84	2.08	1.21	6.22 to 17.50	88
4/ 5	12.0	10 18.6	-69.50	8.0	1.87	2.09	1.25	6.23 to 17.49	88
5/ 6	12.0	10 25.8	-69.46	8.0	1.89	2.11	1.28	6.24 to 17.48	88
6/ 7	12.0	10 32.7	-69.42	8.0	1.91	2.13	1.31	6.24 to 17.47	88
7/ 8	12.0	10 39.5	-69.37	8.1	1.93	2.14	1.34	6.25 to 17.46	87
8/ 9	12.0	10 46.1	-69.32	8.1	1.96	2.16	1.37	6.25 to 17.46	87
9/10	12.0	10 52.5	-69.27	8.2	1.98	2.17	1.39	6.26 to 17.45	87
10/11	12.0	10 58.8	-69.21	8.2	2.00	2.19	1.42	6.27 to 17.44	87
11/12	12.0	11 4.9	-69.15	8.2	2.03	2.20	1.44	6.27 to 17.43	86
12/13	12.0	11 10.8	-69.08	8.3	2.05	2.22	1.46	6.28 to 17.42	86
13/14	12.0	11 16.6	-69.02	8.3	2.07	2.24	1.48	6.29 to 17.41	86
14/15	12.0	11 22.2	-68.55	8.4	2.10	2.25	1.49	6.29 to 17.40	85
15/16	12.0	11 27.7	-68.48	8.4	2.12	2.27	1.51	6.30 to 17.39	85
16/17	12.0	11 33.0	-68.41	8.4	2.14	2.28	1.53	6.31 to 17.38	85
17/18	12.0	11 38.2	-68.34	8.5	2.17	2.30	1.54	6.31 to 17.36	84
18/19	12.0	11 43.3	-68.27	8.5	2.19	2.31	1.55	6.32 to 17.35	84
19/20	12.0	11 48.2	-68.19	8.6	2.21	2.33	1.56	6.33 to 17.34	83
20/21	12.0	11 53.1	-68.12	8.6	2.24	2.34	1.57	6.33 to 17.33	83
21/22	12.0	11 57.8	-68.05	8.6	2.26	2.36	1.58	6.34 to 17.32	83
22/23	12.0	12 2.3	-67.58	8.7	2.29	2.37	1.59	6.35 to 17.31	82
23/24	12.0	12 6.8	-67.51	8.7	2.31	2.39	1.59	6.35 to 17.30	82
24/25	12.0	12 11.2	-67.44	8.7	2.33	2.40	1.60	6.36 to 17.28	81
25/26	12.0	12 15.5	-67.37	8.8	2.36	2.42	1.60	6.37 to 17.27	81
26/27	12.0	12 19.6	-67.30	8.8	2.38	2.43	2.00	6.37 to 17.26	81
27/28	12.0	12 23.7	-67.23	8.8	2.41	2.45	2.00	6.38 to 17.25	80
28/29	12.0	12 27.7	-67.16	8.9	2.43	2.46	2.01	6.39 to 17.23	80
29/30	12.0	12 31.6	-67.09	8.9	2.45	2.48	2.01	6.39 to 17.22	79
30/31	12.0	12 35.5	-67.03	9.0	2.48	2.49	2.00	6.40 to 17.21	79
31/32	12.0	12 39.2	-66.56	9.0	2.50	2.51	2.00	6.41 to 17.20	78

September 1996				Times in GMAT					
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong
1/ 2	12.0	12 42.9	-66.50	9.0	2.53	2.52	2.00	6.41 to 17.18	78
2/ 3	12.0	12 46.5	-66.43	9.1	2.55	2.53	1.60	6.42 to 13.36	
								14.23 to 17.17	78
3/ 4	12.0	12 50.1	-66.37	9.1	2.58	2.55	1.59	6.43 to 13.19	
								14.40 to 17.16	77
4/ 5	12.0	12 53.6	-66.31	9.1	2.60	2.56	1.59	6.43 to 13.07	
								14.51 to 17.14	77
5/ 6	12.0	12 57.0	-66.25	9.2	2.62	2.58	1.59	6.44 to 12.57	
								14.60 to 17.13	76
6/ 7	12.0	13 0.3	-66.20	9.2	2.65	2.59	1.58	6.45 to 12.49	
								15.07 to 17.11	76
7/ 8	12.0	13 3.6	-66.14	9.2	2.67	2.61	1.57	6.45 to 12.41	
								15.14 to 17.10	75
8/ 9	12.0	13 6.9	-66.08	9.2	2.70	2.62	1.57	6.46 to 12.34	
								15.19 to 17.09	75
9/10	12.0	13 10.1	-66.03	9.3	2.72	2.64	1.56	6.47 to 12.28	
								15.24 to 17.07	74
10/11	12.0	13 13.2	-65.58	9.3	2.75	2.65	1.55	6.48 to 12.21	
								15.29 to 17.06	74
11/12	12.0	13 16.3	-65.53	9.3	2.77	2.66	1.54	6.48 to 12.16	
								15.33 to 17.04	73
12/13	12.0	13 19.4	-65.48	9.4	2.79	2.68	1.54	6.49 to 12.10	
								15.37 to 17.03	73
13/14	12.0	13 22.4	-65.43	9.4	2.82	2.69	1.53	6.50 to 12.05	
								15.40 to 17.02	72
14/15	12.0	13 25.4	-65.38	9.4	2.84	2.71	1.52	6.50 to 11.60	
								15.44 to 17.00	72
15/16	12.0	13 28.3	-65.34	9.5	2.87	2.72	1.51	6.51 to 11.55	
								15.46 to 16.59	72
16/17	12.0	13 31.2	-65.29	9.5	2.89	2.73	1.50	6.52 to 11.50	

									15.49 to 16.57	71
17/18	12.0	13	34.0	-65.25	9.5	2.91	2.75	1.49	6.53 to 11.46	
									15.52 to 16.56	71
18/19	12.0	13	36.8	-65.21	9.5	2.94	2.76	1.48	6.53 to 11.41	
									15.54 to 16.54	70
19/20	12.0	13	39.6	-65.17	9.6	2.96	2.78	1.46	6.54 to 11.37	
									15.56 to 16.53	70
20/21	12.0	13	42.4	-65.13	9.6	2.99	2.79	1.45	6.55 to 11.32	
									15.58 to 16.51	69
21/22	12.0	13	45.1	-65.10	9.6	3.01	2.80	1.44	6.56 to 11.28	
									15.60 to 16.50	69
22/23	12.0	13	47.7	-65.06	9.7	3.03	2.82	1.43	6.56 to 11.24	
									16.01 to 16.48	68
23/24	12.0	13	50.4	-65.03	9.7	3.06	2.83	1.41	6.57 to 11.20	
									16.03 to 16.47	68
24/25	12.0	13	53.0	-64.59	9.7	3.08	2.85	1.40	6.58 to 11.16	
									16.04 to 16.45	67
25/26	12.0	13	55.6	-64.56	9.7	3.10	2.86	1.39	6.59 to 11.12	
									16.05 to 16.44	67
26/27	12.0	13	58.2	-64.53	9.8	3.13	2.87	1.37	6.60 to 11.08	
									16.06 to 16.42	66
27/28	12.0	14	0.7	-64.50	9.8	3.15	2.89	1.36	7.00 to 11.05	
									16.07 to 16.41	66
28/29	12.0	14	3.2	-64.48	9.8	3.17	2.90	1.35	7.01 to 11.01	
									16.08 to 16.39	65
29/30	12.0	14	5.7	-64.45	9.8	3.20	2.92	1.33	7.02 to 10.57	
									16.09 to 16.38	65
30/31	12.0	14	8.2	-64.42	9.9	3.22	2.93	1.32	7.03 to 10.54	
									16.10 to 16.36	64

Finder Charts

Page 13 has a finder chart for comets 22P/Kopff (lower) and Hale-Bopp (upper) and page 14 one for Hale-Bopp. Bright stars are labelled with their Bayer/Flamsteed designations. Comparison star magnitudes are handwritten from the AAVSO atlas. The charts were produced using [illegible] software.

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Please report both the comet magnitude and the coma diameter if possible. Submission via e-mail is much appreciated.

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet.

Ref Source or catalogue for comparison stars. The most common ones are AA (AAVSO atlas), VB (BAA VS chart), HS (Hubble catalogue), SC (Sky Catalogue 2000).

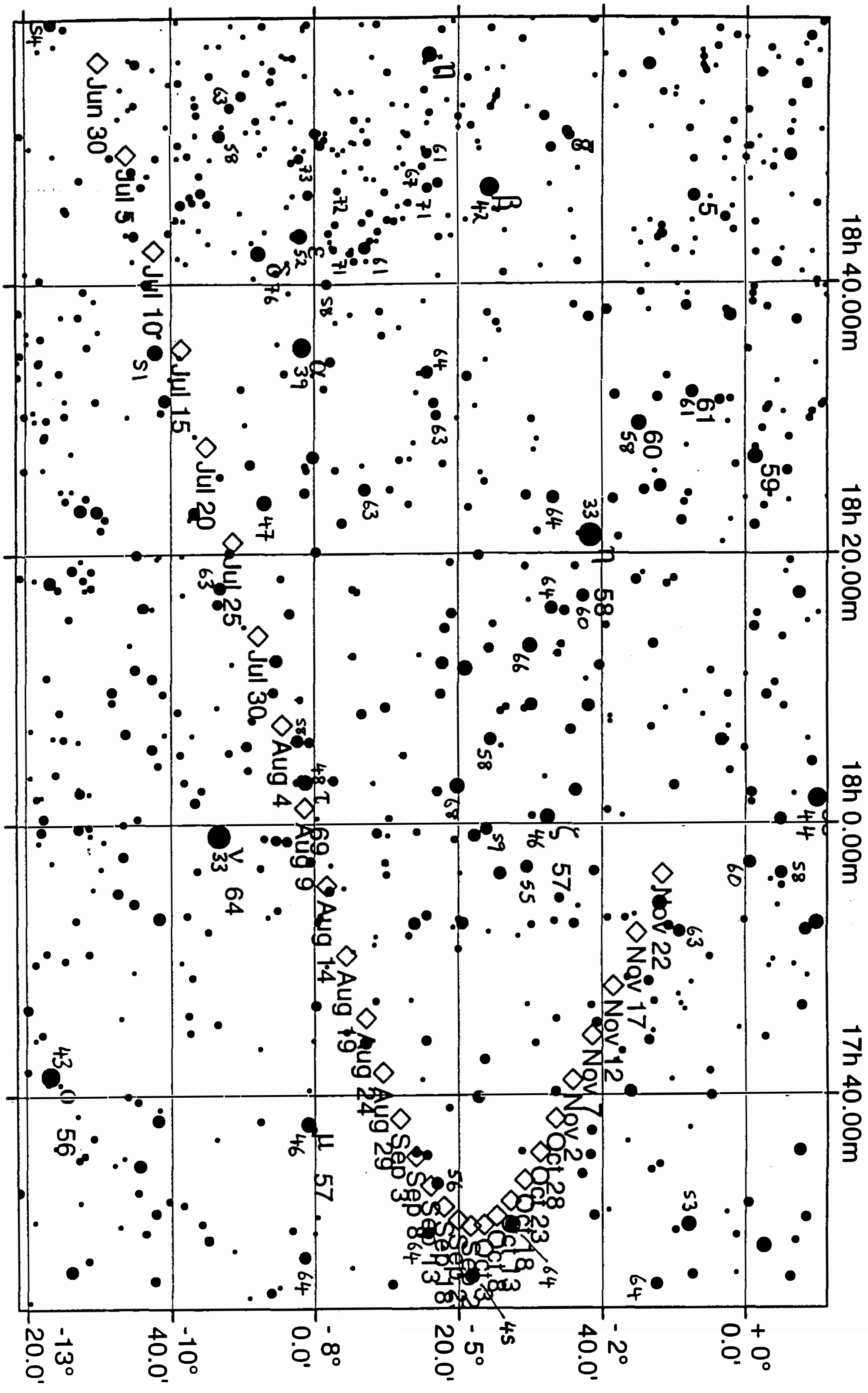
Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

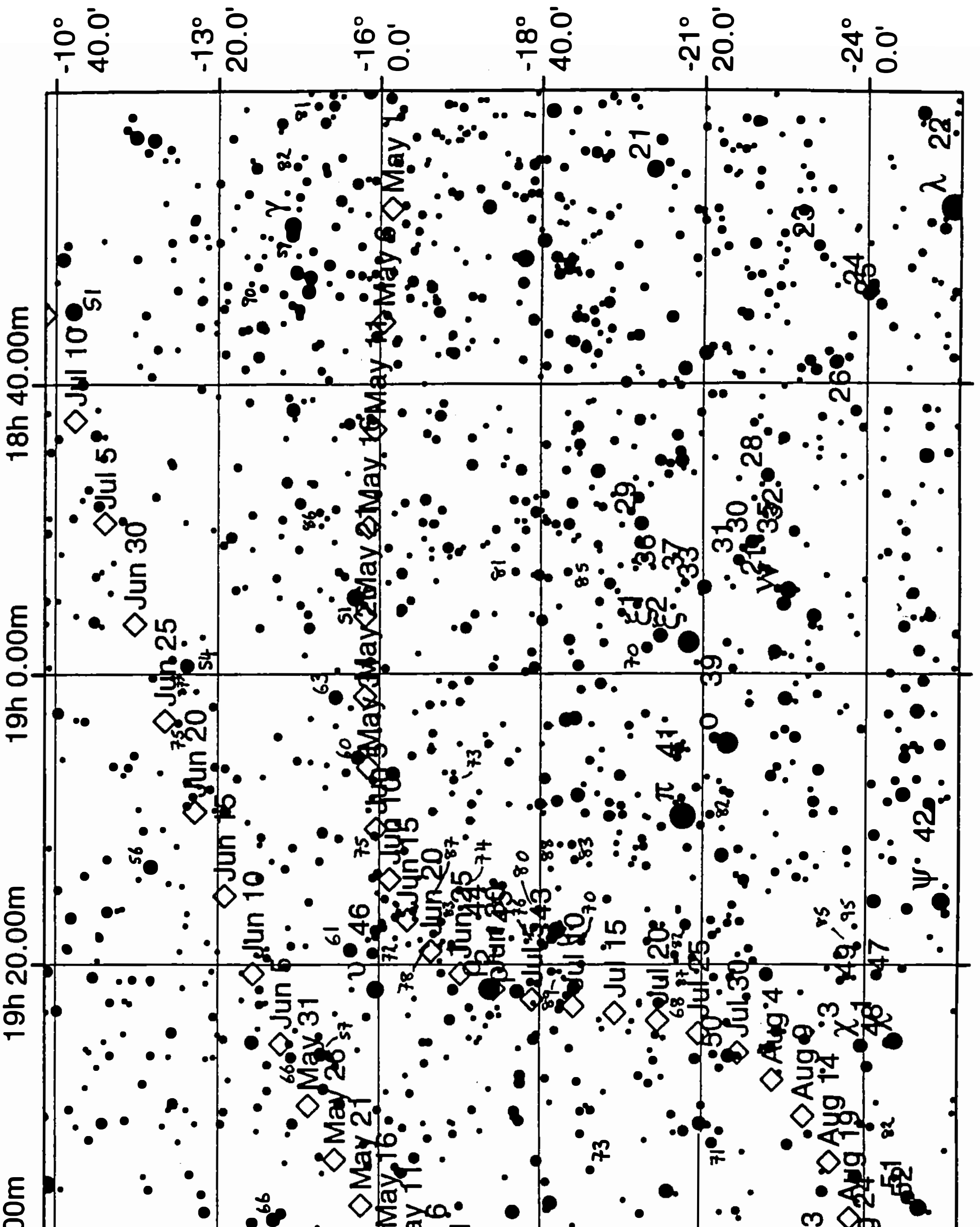
Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (2), Total Mag (6), Ref (3), Tel ap (6), Tel typ (2), f no (6), Tel mag (4), Coma Diam (5), DC (5), Tail len (7), Tail PA (4), 3 spaces, Observer Name. There is an example on the section web page.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20.95) and your observing location (eg Cambridge) at the top of the form. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow. Space at the bottom of the form can be used for a description of the observation.


18h 40.00m
18h 20.00m
18h 0.00m
17h 40.00m
+ 0°
0.0'
- 2°
40.0'
- 5°
20.0'
- 8°
0.0'
-10°
40.0'
-13°
20.0'
Jun 30
Jul 5
Jul 10
Jul 15
Jul 20
Jul 25
Jul 30
Aug 4
Aug 9
Aug 14
Aug 19
Aug 24
Aug 29
Sep 3
Oct 28
Nov 2
Nov 7
Nov 12
Nov 17
Nov 22


-10° 40.0'
-13° 20.0'
-16° 0.0'
-18° 40.0'
-21° 20.0'
-24° 0.0'
18h 40.00m
19h 0.00m
19h 20.00m
19h 40.00m

BAA Comet Section Observing Blank

Observer............................

Comet...............................

Date   19   /   /

Location............................

Scale....................arc minutes

Please indicate the north point on the drawing

Comments

....

....

....

....

....

....

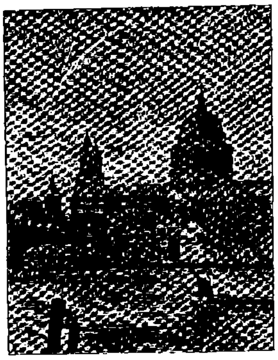
....

BAA Comet Section Visual Observation Report Form

Observer..........................   Comet......................

Year...........   Location......................

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Rel	Comments



THE COMET'S TALE

Newsletter of the **Comet Section** of the **British Astronomical Association** 1996 November

Volume 3 No 2 (Issue 6)

Asteroids, Comets and Meteors 96

Jonathan Shanklin

Asteroids, comets and meteors formed the subject of COSPAR Colloquium 10, held between 1996 July 8 and 12 at Versailles, France. I attended the meeting to find out the latest research on comets and presented a poster on some of the BAA observations of comets Hyakutake and Hale-Bopp. The presentations were mostly given at the Université de Versailles, but plenary sessions were held at the Palais des Congrès near to the famous Château de Versailles of Louis XIV. Many interesting papers were presented, though I missed many others as there were often three sessions running in parallel. These notes represent my views and recollections of the proceedings.

A general consensus is emerging on the nature and origin of comets, asteroids and meteors, but there is still much uncertainty on their composition and the processes involved. Conventional asteroids probably formed where they are today and debris from them form most of the meteorites found on earth. Meteors are largely the debris of periodic comets, but there are some showers which seem to originate from asteroids and others which come from long period comets. Comets probably formed as inhomogenous objects between Jupiter and Neptune; some were perturbed to form what we now see as the Kuiper belt, which contributes the Centaurs (asteroids which cross the orbits of the gas giants, including Chiron and Pluto) and the short period comets; others were perturbed into the Oort cloud which contributes the long period comets.

Comets are generally small, irregular, fragile, inhomogenous bodies that have a range of compositions depending on exactly when and where they accreted. They are of low density and are built in a fractal fashion from smaller building blocks which also have a variety of sizes and compositions. Most of the blocks are likely to be 10 - 100 metres in size and would have collided at speeds of a few metres per second. There are likely to be many voids in their structure, explaining why they may fragment at virtually any time in their orbits. It would be a worthwhile project to monitor all favourably placed periodic comets within a few AU of the sun as an outburst can increase their brightness by up to 10 magnitudes. Most of the nucleus is inert, with only 1 - 10% of the surface area showing typical cometary activity and the rest blanketed by a dark cohesive crust. The majority of comets are 200 - 2000 metres in diameter; Halley at 15 km and Chiron at 90 km are exceptions.

In the comet formation region of the solar nebula, between Jupiter and Neptune, the baby comets formed from a cloud of interstellar grains coated with organics and ices. Drag caused the cometisimals to spiral inwards accreting material with a range of compositions as they did so. They also collided with each other, eventually growing into comets and being perturbed into the Kuiper belt and Oort cloud. There was also a range of temperature in the formation region, probably warmer than 27 K, but colder than 125 K.

Collisions are likely to occur relatively frequently in the Kuiper belt, with around 10 km sized objects produced per year. For a low velocity collision the fragments could spread out over 3 AU putting them into gravitational resonances which could send them into new orbits. The Centaurs are much smaller than the KBOs and are possibly collisional fragments.

Short period comets can be split into Jupiter familly (JF) and Halley type (HT). The JF are generally of small inclination and have perihelion distances (q) that increase with period. There is a faint limit at around H_{10}=12, which suggests that comets get difficult to detect when the gas production rate gets too low. In total there may be several thousand JF comets with q<4 AU and H_{10}<11. The number of JF increase with q, but there are no bright HT with q>1.5 AU which generally have q less than this. This can be explained if new comets suffer an initial rapid fading followed by a period of dormancy (they are out there somewhere!) and then a period of rejuvenation. There may also be a class of comets which fade slowly - Hale-Bopp may be an example. H_{10} values are of interest to professionals for these studies. Magnitude estimates, particularly of fainter comets are therefore important so that they can be computed. Values based on section observations will be published in my annual reports in the Journal.

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Section news from the Director

Dear Section member,

The current large crop of comets have continued to keep me very busy, both with observing and answering all your letters. On one night recently I was able to observe as many as seven comets and I must confess that I wouldn't mind a bit of a lull for a while! Perhaps unsurprisingly most people concentrate on the bright comets, but observations of the fainter ones can be equally usefull. To help both me and Guy please try to send your observations in the correct format.

The Section continues to keep a high profile. Details of the Section meeting and ACM96 are given elsewhere in this issue and we also had a good display at the Exhibition meeting. Section membership has increased significantly over the past few years and now numbers nearly 120. I've given quite a few comet talks to local societies and hopefully this will further increase the number of members and observations.

Nick Martin has made the interesting suggestion of making a movie showing the motion and tail development of comet Hale-Bopp. This will need a reasonable standardisation in format and I'd suggest using a standard 50mm lens on an SLR. I find Fuji 400 slide film very good, but no doubt everyone has their own preferences.

I will be travelling to the Antarctic again this winter, but this time it is a relatively short trip and I'll only be away from November 11 to the end of December. Please send any urgent correspondence to James, or e-mail me at jdsh@south.nbs.ac.uk and I should be able to reply. Post should also reach me reasonably frequently this time, so you can write to me c/o British Antarctic Survey, Rothera Station, Falkland Islands.

I'm in consultation with a company about flights from several UK airports to view Hale-Bopp when it is at its brightest next spring. If they decide to proceed, I hope to get a discount for BAA Members and details will be announced in the *Circulars* or *BAA Newsletter*.

Since the last newsletter observations or contributions have been received from the following BAA members:

James Abott, Sally Beaumont, Paul Bispham, Neil Bone, Graham Boots, Denis Buczynski, Robert Bullen, Franco Canepari, Emilio Colombo, Peter Craven, Eric Dinham, Bev Ewen-Smith, John Fletcher, James Fraser, Mike Gainsford, Cecil Gilbert, Massimo Giuntoli, David Graham, Werner Hasubick, Colin Henshaw, Guy Hurst, Nick James, Albert Jones, John Kemp, Norman Kiernan, James Lancashire, Ron Livesey, John Mackey, Nick Martin, Richard McKim, Haldun Menali, Cliff Meredith, Martin Mobberley, Stewart Moore, Neil Morrison, Detlev Niechoy, Brian O'Halloran, Gabriel Oksa, Roy Panther, Terry Platt, Gary Poyner, Chris Proctor, Paul Richardson, John Rogers, Jonathan Shanklin, James Smith, Enrico Stomeo, David Storey, David Strange, Ajay Talwar, Tony Tanti, Melvyn Taylor, Brian Topping, Frank Ventura, Alex Vincent, Peter Ward and Kevin West.

and also from: Jose Aguiar, Alexandr Baransky, Sandro Baroni, Louis Binder, John Bortle, Reinder Bouma, Stephen Brincat, Peter Caldwell, Paul Camilleri, Mr Carpenter, Mike Collins, Matyas Csukas, Haakon Dahle, Alfons Diepvens, Ignacio Ferrin, David Fideler, Gordon Garrad, Stephen Getliffe, Guus Gilein, Bjoern Granslo, Berhard Haeusler, Roberto Haver, Lars Heen, Doug Heggie, Trond Hillestad, Ken Irving, Andreas Kammerer, Taichi Kat, Graham Keitch, Heinz Kerner, Atilla Kosa-Kiss, Jan Kvaloey, Romualdo Lourencon, Terry Lovejoy, Jean-Claude Merlin, Herman Mikuz, Antonio Milani, Tony O'Sullivan, Rok Palcic, Andrew Pearce, Joao Porto, Ernie Richardson, Oddleiv Skilbrei, Christopher Spratt, Steinar Thorvaldsen, Tony Vanmuster, John Vetterlein, Graham Wolf and Vittorio Zanotta (apologies for any omissions or miss-classifications).

Comets under observation were: 22P/Kopff, 57P/du Toit-Neujmin-Delporte, 116P/Wild 4, C/Hale-Bopp (1995 O1), C/Hyakutake (1996 B2), C/NEAT (1996 E1), C/Brewington (1996 N1), C/Russell-Watson (1996 P2), C/Tabur (1996 Q1) and C/Hergenrother-Spahr (1996 R1).

I look forward to seeing a spectacular display from comet Hale-Bopp next spring and wish you all the best for Christmas and the New Year.

Jonathan Shanklin

ACM 96

Continued from page 1

Planetary perturbations are a bit like games of billiards but gravitational scattering can only move a comet, originally from the Kuiper belt, from one planet to the next, so it is a multistage process. The JF comets come from the Kuiper belt and become extinct on a timescale of around 10^4 years. A Jupiter impact should occur once in 400 years and an earth impact once in 13 My. There should be many more extinct comets than active ones. Its worth monitoring asteroids in cometary type orbits (eg Phaethon [close approach in 1997], Oljato, 6144 1994 EQ3, Hidalgo, Hephaistos etc) in case they outburst.

In polar regions the solar wind blows steadily at 750 kms^{-1}, and in the equatorial region at 450 kms^{-1}. In the intermediate region it can be very gusty. This means that the tails of comets will appear different in polar and equatorial positions. Disconnection events, kinks, rays, knots etc in plasma tails are only likely for comets in equatorial heliocentric latitudes. The disconnection events are associated with the comet crossing the hemispheric current sheet. The March 25th event in 1996 B2 is consistent with this. The long tail lengths reported by some observers around this time are very unlikely to be real. Disconnection events could influence the coma as the energy in one is comparable to that of a terrestrial aurora.

Many papers featured comet Hyakutake, but it was really too soon after the passage of the comet for anything but preliminary results. Radar observations have shown that the nucleus is between one and three km diameter and that it is surrounded by a cloud of centimetre sized pebbles. The hydroxyl distribution in the coma suggests that these pebbles are active. The tail spine seen around the time of perigee may have been produced by fragmentation events, later seen by the HST and Pic du Midi Observatory. Material in the jets was ejected at around 400 ms^{-1}, and their rotation and curvature suggests a nuclear rotation period of around 12 - 13 hours (the apparent period of around 6.5 hours may result from two diametrically opposite jets). The individual jets seem to have emitted material of differing compositions. The X-Ray emission, since found in a number of other comets is compatible with a solar illumination effect, possibly producing bremstrahlung. The composition of the comet suggests it formed at around 65 K.

Comet Hale-Bopp showed major emission events in Aug, Sep and Oct 1995, with a spiral jet rotating clockwise in a sunward direction and a 30 ms^{-1} ejection velocity. The rotation period is between 2 and 8 days and emission starts at local noon, peaks in the afternoon and then declines. It has lost the equivalent of around 1 metre of CO since observations started. Compositionally it shows differences to other comets, but this is probably because of its great distance from the sun. 1995 O1 is unlikely to produce meteors, but its worth watching the expected radiant on January 4th.

Comet SL9 was probably captured in 1929, and was around 1 - 1.5 km in diameter. The Jupiter impactors were all small bodies, 250 - 450 metres in diameter and the plumes were not homogenous. This favours the rubble pile model, with a fragile aggregate of inhomogenous building blocks. Splitting of comets doesn't always give an increase in brightness, suggesting that a new icy surface is not always revealed.

Comet 1P/Halley was brighter post perihelion by a factor of about 2. This can be explained if most C_2 activity from came from the "little" end and the nucleus is in a complex rotational state. The composition of Halley suggests it formed at around 53 K.

2P/Encke may have faded between 1980 and 1993, though this wasn't that obvious in the data presented. A suggestion is that Encke has two active regions, an old one with declining activity, which operates prior to perihelion and a recently activated one present after perihelion.

29P/SW1 shows considerable activity with variation in H_{10}. Prior to 1980 it was mostly about 7, with occasional major outbursts, but rose to around 4 by 1980. After that it faded to around 6, but in 1995 rose to 4 again. The perihelion distance varies with time due to gravitational perturbations and the random activity may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet.

The outburst of 73P/SW3 illustrated comet fragmentation very well. The outburst was first noted from its unusual brightness in radio observations of OH. The calculated active area is much larger than the area of the nucleus, suggesting that an extended source was present. Calculations by Zdenek Sekanina suggest that the events started with the outburst around September 6 - 8, followed by splitting at the end of October and a secondary splitting two weeks later. If the comet had a generally cohesive crust the gravitational pull is less than the force exerted by vapour pressure so it could be blown off. If the observed fragments were part of the comet's crust, then it was between 7 and 50 metres thick. Interestingly at one time it had been a target comet for the Rosetta mission! Nuclear magnitudes following such an outburst can be useful (and were used by Sekanina), but should always use the same telescope and magnification. It is worth monitoring distant periodic comets as you never know when they will outburst.

Many spacecraft are already monitoring comets and others are planned. An interesting result from the European ISO mission is that the dust trail from 22P/Kopff seems to have faded since its discovery by IRAS. This perhaps ties in with the rather fainter magnitude of the comet than predicted for the latest apparition. ISO can only observe slowly moving objects between 60 and 120° elongation from the sun, so it can't observe comets at opposition, nor close earth approachers. Planned missions include Stardust, Rosetta and a JPL multi comet probe. Stardust, due to be launched in 1999 and return in 2006, will use an aerogel to capture dust from comet 81P/Wild 2, and from the interstellar dust stream discovered by the Galileo spacecraft. The European Rosetta mission, due to be launched in 2003 will rendezvous with 46P/Wirtanen at around 3.5 AU in 2011 and go into orbit round it. It will follow it in to perihelion and land probes on the comet which has a fairly good return in early 1997. Astrometry of these target objects is essential for the spacecraft and well within amateur capabilities. Other targets for spacecraft observation are 22P/Kopff, 29P/SW1, 76P/WKI and 90P/Chiron. Chiron has variable activity, as shown by H_{10} and so magnitude measurements (particularly in the V band) are important.

46P/Wirtanen is in a chaotic orbit, and its perihelion distance was much reduced due to aproaches to Jupiter in 1972 and 84. It is around 2 km in diameter and is possibly in an excited rotational state. It has been reported to outburst, but BAA data suggests that it has just been rejuvenated after the perihelion distance was reduced. 81P/Wild 2 is a new comet that made a very close (0.006 AU) approach to Jupiter in 1974. Prior to this it was in a 40 year orbit that had perihelion at 5 AU and aphelion at 25 AU. It is around 4 km in diameter. 46P has typical C_2/CN ratios, but 81P is depleted. Both comets are in low inclination orbits which makes interception easier. 46P/Wirtanen will return in 1997 and 2008 and 81P/Wild 2 in 1997.

The link between comets and meteors is well established, but it seems that some longer period comets may also have meteor showers associated with them. These have a very tight distribution near the orbital path and consequently short periods of activity. Examples of these showers are the Lyrids, which I was fortunate enough to see in outburst from the middle of the Atlantic in 1982 (the associated comet is named Thatcher!), and the Monocerotids which outburst last year. Gravitational perturbations by the giant planets mean that the earth is moving through an area of the solar system not previously visited this century and there is the possibility of surprise outbursts, perhaps one or two per year. It is therefore worth watching minor meteor showers , particularly those associated with long period comets as you might see an outburst. Its also possible that some outbursts are associated with long period comets that are yet to be discovered.

A major focus of the meeting was the nature of the Kuipers, Centaurs and the Near Earth Objects (NEOs). The consensus was that all three groups could be described as cometary; in the first two cases too distant to show much, if any, activity and in the other case being extinct comets, though some are undoubtedly asteroids.

The threat from NEOs to the earth was considered significant, and a Spaceguard project is being set up which will attempt to catalogue all objects that might collide with the earth. Countries and individuals are encouraged to contribute! Several researchers favoured a 35 My or so periodicity in planetary impacts which they suggested had a cometary origin.

There is a class of objects too small to be easily detected during the survey which is being monitored by US Defence satellites as a by-product of tracking missiles. Several objects enter the earth's atmosphere each year; a particularly large one came in over the Pacific last March. The number seen suggests that several Tunguska sized events occur a century; one may have occurred over the South Atlantic in the 1960s.

Most cometary discovery is still by amateurs, however planned asteroid search programmes are likely to pick up all new Jupiter familly comets. They will scan the entire dark sky several times a month to around 19^m. However the twilight zone will still be the province of amateurs.

Jonathan Shanklin

Comet Prospects for 1997

The biggest comet prospect for the coming year is of course Hale-Bopp and on the basis of observations made up to mid 1996, it should be as bright as Jupiter by next spring, with a 40 degree tail. A number of periodic comets also return in 1997 and these should not be forgotten. Comets 46P/Wirtanen and 81P/Wild 2 are targets for spacecraft missions and need to be well observed. Recent theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets as well. Ephemerides for new and currently observable comets are published in the *Circulars*, comet section Newsletters and on the section web page, with predictions for returns in the Handbook[1]. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook[2]; details of subscription to the ICQ are available from the comet section Director. The recently published section booklet on comet observing[3] is available from the BAA office or the Director.

C/Hale-Bopp (1995 O1). It should be impossible to miss this comet! I will say no more here as details will be given from time to time in the *Circulars*, *Journal* and on the section web page. Don't forget that there is a faint chance of a meteor shower from the comet on January 3/4 from $15^h\ 36^m$ +32°.

C/Tabur (1996 Q1) will be fading from its autumn showing, starting the year at around 10^m. It is a morning object and I suspect that only the dedicated observers will follow it. An ephemeris is given in the observing supplement.

2P/Encke. This will be the comet's 58th observed return to perihelion since its discovery by Mechain in 1786. The orbit is quite stable, and with a period of 3.3 years apparitions repeat on a 10 year cycle. This year the comet is best seen from the southern hemisphere as an evening object (it will not be observable from the UK at all). The comet reaches perihelion in late May and should become visible in early June at around 7^m. It brightens a little, and makes a relatively close approach to the earth around July 4, when it is 0.19 AU distant and moves at over 5° per day. It fades fairly rapidly, but is in opposition at the end of the month and is well placed throughout August. There is some evidence for a secular fading, and observations at this favourable return will be important to confirm this. Another suggestion is that Encke has two active regions, an old one with declining activity, which operates prior to perihelion and a recently activated one present after perihelion. The comet is the progenitor of the Taurid meteor complex and may be associated with several Apollo asteroids.

29P/Schwassmann-Wachmann 1. This annual comet has frequent outbursts and seems to be more often active than not, though it rarely gets brighter than 12^m. In early 1996 it was in outburst for several months. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet. This year it is at opposition in late March in Crater and should be observable until June. It is then in conjunction until November and it will be observable in Virgo for the rest of the year. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity.

43P/Wolf-Harrington. This will be the ninth observed return of the comet, which was discovered in 1924, then lost until 1951. The comet is in a chaotic orbit, and made a close approach to Jupiter in 1936 which reduced its perihelion distance from 2.4 to 1.6 AU. At the last return the comet reached 13^m and this time round it could do a little better at 11^m - 12^m. The comet is a morning object and remains at a similar magnitude throughout the apparition. It will emerge from the summer twilight in early August and the solar elongation continues to slowly increase throughout the apparition, but the comet also moves southwards. It will be at its brightest in mid Autumn and should remain visible until the end of the year. Southern hemisphere observers should be able to follow it for a few more months as it approaches opposition and slowly fades.

46P/Wirtanen is in a chaotic orbit, and its perihelion distance was much reduced due to approaches to Jupiter in 1972 and 84. It has been reported to outburst, but BAA data suggests that it has just been rejuvenated after the perihelion distance was reduced. The comet will be a 12^m object in the evening sky at the beginning of the year, but UK observers are unlikely to be able to pick it up until the end of the month. At best it may reach 10^m, but the elongation from the sun is not great and there is only a short observing window in the early evening. It fades after perihelion in March and is likely to be lost in the summer twilight in May. A target for the Rosetta mission, astrometric observations are particularly important, however visual magnitude observations and CCD images should not be neglected. A December perihelion would give a close approach to the Earth, however the present period is exactly 5.5 years so that perihelia alternate between March and September.

81P/Wild 2 is a new comet that made a very close (0.006 AU) approach to Jupiter in 1974. Prior to this it was in a 40 year orbit that had perihelion at 5 AU and aphelion at 25 AU. The Stardust spacecraft is due to visit it in 2004 and recover material for return to earth in 2006. Only a few observations were made at the last return in 1991, when it was 13^m. This return is better and the comet starts the year at around 12^m and nearly at opposition. It is at its brightest between 10^m and 11^m in March and April, but fades a little on its way to perihelion in May as its distance from earth increases. It continues to slowly fade and is likely to be lost in the summer twilight in June.

103P/Hartley 2. In 1982 the comet made a close approach to Jupiter, and it was discovered by Hartley four years later, around nine months after perihelion. It was accidently recovered by T V Kryachko of Majdanak, USSR, on 1991 July 9.85, returning 5.6 days earlier than predicted. It was well observed by the section at this return and observations showed that the brightness peaked around 13 days after perihelion. This return is also a good one and for the northern hemisphere it is likely to be the brightest predicted periodic comet of the year. The comet could be observed as early as July when it should be around 12^m. It is an evening object throughout the apparition and slowly brightens reaching 7^m - 8^m in late December when it is at perihelion. It will then slowly fade, but should remain observable until April. The orbit comes close to that of the Earth and it could produce a meteor shower at the descending node in November. Calculations by Harold Ridley gave a radiant of 19^h56^m +14°, some 5° Nf Altair, with a likely maximum around November 17.

55P/Tempel-Tuttle. At the end of the year the parent comet of the Leonids may become visible. It will be a morning object and brightens rapidly as heads towards a relatively close approach to the earth in mid January, when it may reach 8^m. Intrinsically it is quite a faint comet and by the time it reaches perihelion at the end of February will be over 1 AU from the earth, so it will not put on as good a show as is expected from the meteors it has produced.

1998 also includes favourable returns of comets 21P/Giacobini-Zinner, 88P/Howell, and 93P/Lovas 1. Of these the best is Giacobini-Zinner, the parent comet of the October Draconids, which should reach 9^m in the autumn. Although the comet itself doesn't pass very close to the earth this time, there is still a good chance of a meteor storm on October 9th.

A number of fainter comets may be of interest to CCD observers. The start of the year sees some left overs from 1996 that are still visible. These include: Hyakutake (1996 B2) (Southern hemisphere only), 119P/Parker-Hartley, 121P/Shoemaker-Holt 2, 116P/Wild 4 and P/1983 M1 (IRAS). Fainter comets which have favourable returns in 1997 include: 78P/Gehrels 2 (13^m, November), 95P/Chiron (opposition April, 15^m) and 100P/Hartley 1 (13^m, April). Ephemerides for these can be found on the comet section WWW page. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically.

Several other comets return to perihelion during 1997, however they are unlikely to become bright enough to observe or are poorly placed. These include: 26P/Grigg-Skjellerup and 85P/Boethin which have unfavourable returns and 48P/Johnson, 69P/Taylor, 91P/Russell 3, 94P/Russell 4, 117P/Helin-Roman-Alu 1, 118P/Shoemaker-Levy 4, 127P/Holt-Olmstead, 128P/Shoemaker-Holt 1, P/Helin-Roman-Alu 2 (1989 U1), P/Mueller 2 (1990 R1) and P/Lagerkvist (1996 R2) which are intrinsically faint or distant comets. D/Haneda-Campos (1978 R1) was not observed at its last return.

We have already had two unexpected returns so far this decade (P/Swift-Tuttle and P/de Vico) and maybe a third will be that of comet P/Pons-Gambart. When discovered in 1827 the comet reached 5.5^m and it was later calculated to have a period of 57.5 years, though it has not been seen since. When studying old Chinese records, I Hasegawa noted that a comet observed in China in 1110 had a similar orbit, however this does not help to determine the period. There is a prediction for a return at the end of the year, however this must be regarded as very uncertain. With an inclination of 136°, the orbit is such that the observing circumstances depend very much on the date of perihelion and the comet may pass above or below the earth. At a favourable return a relatively close approach to the earth is possible, but as the comet is not that intrinsically bright it would not be another Hyakutake.

Details of the date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 for each comet are given in the table below.

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Jonathan Shanklin

Comets reaching perihelion in 1997

Comet	T	q	P	N	H1	K1
118P/Shoemaker-Levy 4	Jan 12.2	2.02	6.51	1	12.0	10
P/Lagerkvist (1996 R2)	Jan 18.4	2.62	7.34	0	11.0	10
94P/Russell 4	Feb 03.5	2.23	6.58	2	9.0	15
127P/Holt-Olmstead (1996 S1)	Feb 06.7	2.15	6.33	1	11.0	15
46P/Wirtanen	Mar 14.1	1.06	5.46	7	8.5	15
117P/Helin-Roman-Alu 1	Mar 26.9	3.71	9.57	1	2.5	20
C/Hale-Bopp (1995 O1)	Apr 01.1	0.91		0	-0.5	7
C/Jedicke (1996 A1)	Apr 17.6	2.47		0	6.5	10
85P/Boethin	Apr 17.7	1.16	11.6	2	6.5	20
81P/Wild 2	May 06.6	1.58	6.39	3	7.0	15
2P/Encke	May 23.6	0.22	3.28	57	9.5	7
100P/Hartley 1	May 28.5	1.82	6.02	2	9.0	15
78P/Gehrels 2	Aug 07.1	2.00	7.20	3	5.5	20
D/Haneda-Campos (1978 R1)	Aug 15.8	1.27	6.39	1	13.0	25
26P/Grigg-Skjellerup	Aug 30.3	1.00	5.11	17	12.0	40
43P/Wolf-Harrington	Sep 29.2	1.58	6.46	8	6.5	15
48P/Johnson	Oct 31.8	2.31	6.97	7	10.0	15
P/Helin-Roman-Alu 2 (1989 U1)	Nov 10.7	1.91	8.24	1	11.5	15
91P/Russell 3	Nov 19.2	2.51	7.49	2	7.5	15
128P/Shoemaker-Holt 1 (1996 S2)	Nov 20.3	3.05	9.51	1	8.5	10
P/Mueller 2 (1990 R1)	Nov 22.5	2.41	7.05	1	11.0	10
69P/Taylor	Dec 12.3	1.95	6.97	4	9.5	30
103P/Hartley 2	Dec 21.9	1.03	6.39	2	8.5	10

Note: $m_1 = H1 + 5.0 * \log(d) + K1 * \log(r)$

Report of the Comet Section meeting

James Lancashire

A meting of the Section was held on Saturday, 1996 June 8 at the Institute of Astronomy, Cambridge. Jonathan Shanklin, BAA comet section director, welcomed everyone to the meeting which he hoped would provide a forum to swap experiences of comet Hyakutake and look forward to comet Hale-Bopp. He mentioned a long-term date for our diaries: an International Comet Workshop to be held in Cambridge after the eclipse in 1999. He then presented the 1995 David Keedy award for outstanding contribution to the BAA comet section to Alex Vincent for his monthly packages of slides covering almost all comets brighter than about mag 10. Dr Richard McKim then took the chair and recommended the forthcoming BAA Exhibition Meeting before introducing the first speaker.

Dr David Dewhirst (Institute of Astronomy, Cambridge) spoke about "Really great comets". He mentioned the popular notion of a 'golden age' until the late 1800s when comets had heads the size of the full moon and tails stretching halfway across the sky (either 45° or 90° depending on the writer). How did Hyakutake compare with these really great comets? There is clearly some difficulty in using modern photographs in comparison with visual records, particularly since early observers did not use modern defocusing methods and standard magnitude reference stars. Dr Dewhirst then discussed the criteria for 'great' comets, following George Chambers in 'The story of the comets'.

Requirements for a great comet include some or all of:
(1) Naked-eye for at least a few weeks in a dark sky, so this excludes a daylight comet, very bright but within a few degrees of the Sun (although such comets may become 'great').
(2) For a week or so the head of the comet has total m_v of +1 or brighter.
(3) The tail if short (5°) is of high surface brightness (compared to the Milky Way) or may be fainter if longer.
(4) With a modest telescope, the head is bright enough to reveal fine structure such as hoods, arcs and jets.
(5) With a modest telescope, the brightness is sufficient for colour judgments, e.g. yellowish nucleus, blue-white coma and inner tail.

Great comets

Year	Name	Head	Tail	Comments
17th century: 7 comets				
1607	P/Halley		10°	
1618 Aug	Kepler's	'a small cloud'	15°	bluish-white (telescope)
1618 Nov	Great		40° when head below horizon	
1661	Great			structure in head (Hevelius)
1680	Southern		60°	'tailed star in twilight'
1682	P/Halley		10°	
1689	Great		20° when head below horizon	
18th century: 3 comets				
1744	de Chèseaux	'Sirius', -2^m then 'Venus', -4^m	15°-25°-90° multiple tails	comet 25° below horizon naked eye Dec-Mar
1759	P/Halley	$\sim 0^m$	25°	a 'great' return
1769	Messier		40°-90°	(*) Aug-Oct

(*) ".. but so faint at its extremity that when Venus rose above the horizon, its light shortened the tail by several degrees" (Pingre)

Year	Name	Head	Tail	Comments
19th century: 11 comets				
1811 I	Great	0^m, 20' dia	20°-70°	naked eye Apr-Jan
1819 II	Great	$+1^m$	8°	
1835 III	P/Halley	$+1^m$	30°	
1843 I	Great March	'Jupiter', -1^m	70°	head -7^m near Sun
1858 VI	Donati	'Arcturus', 0^m	35°-70°	'scimitar' dust tail
1861 II	Tebbutt's	'Saturn', 0^m	up to 100°	naked eye Aug-Nov
1874 III	Coggia's	0^m	60°	hoods in coma
1880 I	Gt Southern	cf.47Tuc, 3.5^m	50°	wholly southern sky
1881 III	Tebbutt's	$+1^m$	20°	
1882 II	Gt September	-4^m to 0^m, -10^m at Sun's limb	>20° through October, 'brilliant' 0.5° tail	
1887 I	Gt Southern	no head!	30°-50°	very bright, only 2 weeks

NB-Chambers especially noted the comets of 1811, 1843, 1858 and 1882

Year	Name	Head	Tail	Comments
20th century: 4 comets (to 1996 June)				
1901 I	Great	'Sirius', -1.5^m	10°-30°	head +1.5 at discovery near Sun
1910 I	'Daylight' or Great January	-4^m fading to $+2^m$	brilliant tail 1° when 5° from Sun, then 30°+	
1910 II	P/Halley	$+1^m$	50°-90°	best in southern sky
1996	Hyakutake	0^m, dia 1.5°	30°+	naked eye for ~9 weeks

Dr Dewhirst concluded by saying that sky brightness affects the image and appearance of comets very significantly. This and their unreliable nature had given rise to the following advice: "If you must bet, bet on horses and not on comets."

In a question, Dennis Buczynski asked about the omission of comets West (1976) and IRAS-Araki-Alcock (1983) from the list of great comets. Dr Dewhirst said that although these comets were spectacular he did not think they satisfied all criteria to be 'great'.

Jonathan Shanklin spoke next on "Visual observing". He recommended the comet section's Observing Guide as a comprehensive source of information. Hale-Bopp had become a naked eye object to southern hemisphere observers. Although its lightcurve was based only between 8-4 AU, Hale-Bopp should still be a very prominent object for several months in late 1996 and early 1997. Comet Hyakutake was discovered with 25x100 binoculars. The comet had faded after closest Earth approach but the lightcurve was well-behaved in heliocentric terms. Magnitude estimates showed a large scatter at closest approach which Jonathan thought was due to the large apparent diameter. Dark adaption of at least 15 minutes is essential for the eye to become fully sensitive to wavelengths of cometary molecules, for example C_2 around 500nm. Jonathan said that some comparison star magnitudes may be in error. On the AAVSO charts, the underlined magnitudes have been determined photo-electrically and are more reliable; otherwise a sketch of the comet with field stars can be sent to Jonathan for reduction.

Tail length can be predicted from cometary brightness, for example 60° for Donati, 20° for Hyakutake and 40° for Hale-Bopp. The position angle of the tail must be measured close to the head and round from north with respect to right ascension and not horizon - again a sketch will clarify. Disconnection events are best recorded photographically, although Hyakutake had some naked eye events showing sudden changes in the interplanetary magnetic field. The shape of the tail itself is difficult to predict.

Hyakutake's coma reached 2° and Donati's 0.5°, with Hale-Bopp's predicted to be 0.5°. Jonathan mentioned that instruments were difficult to defocus beyond 0.5° and suggested using reversed binoculars (7x50 or lower magnification in preference to 12x80) for one eye to reduce the comet to a point and using the other (naked) eye for comparison stars. (This is explained further elsewhere in this issue). Jonathan mentioned the difficulties in estimating degree of condensation (DC) but said a sketch was in the section guide. Jets in the coma were in the sunward direction, but Hyakutake had shown an anti-solar jet which must have been material in the plane of the comet. Such structure is best in long-focus refractors and can be used to estimate nucleus rotation.

Jonathan concluded by encouraging observers to view Hale-Bopp and attempt comet 22P/Kopff in the summer twilight and amongst the Milky Way in Sagittarius at low declination.

Dr Dewhirst said that the eye was better than photography for detecting fine structure, unless special unsharp masking techniques were used.

In a members session, Jonathan Shanklin spoke about preparing and making observations. A tripod is useful for binoculars and observing charts (either photocopies or computer software plots) can be protected from the damp nights in transparent plastic pockets. Jonathan also invested recently in an LED torch which has given a good red light, but remember to keep spare/recharged batteries. Also try to use the night's double date. The observing session can be planned by checking the section newsletter's ephemeris for visibility of comets. Stars on VSS charts can also be used as comparisons for magnitude estimates (eg R Sct for Kopff and Hale-Bopp, although extinction corrections need to be applied). Watches should be set to GMT!!

Dr McKim then read a short note from George Alcock who unfortunately could not attend the meeting but sent his good wishes to those present. George had observered over 60 comets in his lifetime but he thought that Hyakutake, although bright, had been the blandest!

Over lunch prepared by CUAS members there was time to chat to fellow observers and look at displays by the comet section of both UK and international work. 'The Astronomer', Earth & Sky, the BAA and CUAS had stalls, and Dr Dewhirst had a collection of old books and charts with comet engravings from the IoA Library. A small party also toured the IoA and telescopes.

Guy Hurst opened the afternoon session on "Submitting observations". He said that reports on Hyakutake had filled 50 pages of 'The Astronomer' magazine (TA) and a colour special had been published (available at the meeting). He encouraged observers to submit monthly reports promptly (e-mail to guy@tahq.demon.co.uk) since the deadline is the 5th of the following month. He mentioned problems in getting started with making accurate estimates but said that advice could be offered on this once observers had confidence to submit results. Scatter is taken in account in analysis, although TA specialises in publication of preliminary results. Guy mentioned that a gamma ray burster had been detected near Hyakutake on 1996 April 9 and encouraged anyone taking photographs or CCD images on that date to check for an optical counterpart. There was a concluding discussion on reporting times in UT and to use the double-date format for clarity. Jim Hysom recalled that he had missed a lunar eclipse around midnight by exactly one day through such confusion!

Glyn Marsh spoke next on "Comet photography" and suggested the use of long exposures with large aperture war-surplus lenses readily available. The 35mm SLR camera, however, could be used in a similar fashion to normal photography and Glyn noted that Hyakutake had provided the ideal opportunity for many observers to try astronomical work. A simple 'barn-door' or Scotch mount can track for several minutes, although skyglow and the object's altitude need to be considered when deciding exposure times. Glyn had been inspired by EE Barnard, one of the pioneers of long-exposure wide-field astrophotography who had started with a portrait lens and moved onto other lenses. Glyn showed his own photographs of comets Halley (in 1986) and Austin (1989) and Hyakutake (1996) taken from sites in Preston, Tenerife, the US and Johannesburg. He has a permanent site for the late Alan Young's refurbished Mond astrograph.

Several observers then discussed guiding methods to track a comet against the star background. Details can be enhanced by copying the negatives to bring out coma size and tail structure. Bob Neville suggested scanning images then processing on computer to enhance detail and Nick James suggested using a PhotoCD, although this uses only 256 greyscales.

In another members session, Dr John Rogers said he had fled the UK snow, cloud and fog to visit Spain for 4 days during Hyakutake's closest approach in the region of Arcturus. He had seen the Gegenschein one night and photographed a disconnection event in the comet's tail, measuring the speed of this event as 44 km/s, close to known values. He had estimated tail length as up to 27°. On his return to the UK, Dr Rogers had seen the tail brighten through clouds as the comet passed near Polaris, and shorted to about 13° in April.

Nick James had joined Martin Mobberley and Glyn Marsh in NE Tenerife, away from the tourist lights. They photographed a 30° tail on a 4 minute exposure, guided since the comet had moved 6 arcmin! His slides showed rays, gaseous patches, disconnection events and fine details comparable to Schmidt plates. Martin

Mobberley showed slides capturing a blue-green coma from carbon-2 with the tail being ionised water and carbon monoxide. Changes in the tail were seen from night to the next, and even over 30 minutes during closest approach.

Nick Martin had attempted some stereo photographs separated by 30 minutes from Ayrshire. At closest approach, the change in viewing angle over such short times made this technique feasible. Although suitable projection equipment was not available at the meeting the images were viewed at the BAA Exhibition meeting.

Rob Hayes had been at the COAA (Portugal) using the 0.5m for 10 minute exposures. Pierre Girard in Milton Keynes saw the comet close to NGC 1502 (a line of stars) and his slides revealed the coma's spine and hood, and fanned tail on longer exposures. David Briggs from Portsmouth showed images of a spine and parabolic hood when the comet was near Polaris.

After tea, Nick James spoke about "CCD imaging of comets". He wanted a quantitative approach to astrometry (for orbit computation), photometry (using filters) spectroscopy (using an objective prism or grating) and physical properties (composition, rotation rates and solar wind studies). CCDs have a relatively small field, therefore good for the inner coma, and adjacent fields can be fitted together to obtain a larger image. The spectral response is wideband so filters must be used to isolate the gas and dust tails: 515 nm for C_2 (in the coma), 620 nm for ionised water (ion tail) and 647 nm (dust tail), or use standard V and R band. Herman Mikuz uses narrow filters with 10 nm FWHM. The lens must be suitable for the far red.

```
Images                   Process             Computer operations
------                   -------             -------------------

original----------------------> + [add]  ------> [divide] ---> [align & stack]
                                  -                 ^
dark frames(*)--------> median  -----^              |
                                                    |
flat frames(*)--------> median  ----> + [add] ---------
                                        -
bias frames(*)--------> median  ----------^
```

(*) NB 10 of each to improve signal:noise ratio

Coma:
- do not saturate original images (use short exposure times)
- take multiple frames and add
- 12-bit analogue-to-digital represents 4096 colours
- a good print might have 64 levels of colour!
- therefore need to transform to 64 levels
- use unsharp masking or radial graded mask to enhance detail

Tail:
- long guided exposure v short stacked exposures: long is better to reduce read-out noise
- filtered v unfiltered
- processing with masks (radial but beware spurious processing effects)

Nick concluded by saying that CCDs have led to an exchange of scientific results with professional astronomers, although this is still possible with good photographic results. Denis Buczynski mentioned that photometry needs care to avoid increasing the sky background level when making coma estimates.

Roger O'Brien then concluded the session by talking about "Professional observations". The Infrared Space Observatory could not track Hyakutake either because of the comet's speed or near perihelion, although it had observed water everywhere in preliminary studies. NASA's Infrared Telescope had detected methane and (for the first time) ethane, which may help to map the distribution of material from the early solar system. A video of SOHO's solar images showed the rapid motion of Hyakutake near perihelion and the coma's twisting/rotation. ROSAT had detected x-rays, mostly on the sunward side suggesting either dust particle interaction with the solar wind or ionised gas in the coma via bremsstrahlung radiation. Roger concluded with observations from Mill Hill (UCL) showing ionised water through a very narrow band filter to miss most of London' light pollution.

Dr McKim brought the successful meeting to close. Jonathan Shanklin said he had been overwhelmed by 500 observations of Hyakutake, with 250 already received of Hale-Bopp! He expressed thanks to Dr Dewhirst and the IoA for use of the facilities and to CUAS for help with refreshments. He urged all observers to make use of clear skies and would assist section members with advice on any queries they might have.

Tales from the Past

This is a new section which gives a few excerpts from past BAA Journals and RAS Monthly Notices

150 Years Ago: Monthly Notices reported observations of Biela's comet which had split into two and underwent an outburst. The comets were seen at the subsequent return but not again, however a spectacular meteor shower was seen in 1872. Also under observation was a new periodic comet discovered by Brorsen at Kiel. The comet was put into its discovery orbit after a close approach to Jupiter in 1842. At its 1879 return it underwent an unexpected fading of three magnitudes and hasn't been seen since. The King of Denmark offered a Comet Medal (worth 20 Dutch ducats in gold) for the best discussion of Tycho's observations of the comet of 1585. In a paper by the Astronomer Royal, discussing the discovery of Neptune, a letter from Professor James Challis quotes "I delayed [examining or mapping the observations] chiefly because I was making a grand effort to reduce the vast number of comet observations which I have accumulated."

100 Years Ago: Volume 6 of the BAA Journal reported that a spectrum of Swift's comet, observed on 1896 April 28 was found to consist of three bright bands due to carbon, there being practically no continuous spectrum. The comet was very bright in early May and numerous observations were reported. At the May meeting Mr S H R Salmon reported an occultation of a 9^m star by the comet. Capt. Noble commented that Arcturus had seemed brighter when Donati's comet had passed over it. Giacobini discovered a periodic comet at Nice Observatory, but it has not been seen since the discovery apparition. A paper by Karl Schwarzchild in AN3361 looked at the stability of the motion of comets captured by Jupiter. He concluded that such comets would not remain permanent members of the solar system and future perturbations would sooner or later eject them. A new publication just out was Prof. Holetschek's work on the brightness of comets and their tails. He found that if a comet exceeds 4^m it will generally display a conspicuous naked eye tail especially if the perihelion distance is small. The annual report noted that comets Swift, Perrine and possibly Faye had been observed. Mr S A Saunders was reported as having made an independent discovery of a comet.

50 Years Ago: Observations of comet Timmers were reported at several meetings, with various orbits being calculated. Another comet, Pajdusakova-Rotbart-Weber was thought by some to be identical to comet Schmidt 1862 N1, but Dr M Davidson the Director of the Comet Section was doubtful. Members were looking forward to a meteor shower from comet Giacobini-Zinner.

Photographing Comet Hale-Bopp

Michael Hendrie

In the BAA Memoir *Halley's Comet - the 1986 Apparition* I mentioned what were probably the first BAA attempted observations of a comet by CCD. I also ventured the opinion that photography seemed likely to remain for some time to come the most convenient way of doing cometary astrometry. In less than 10 years CCD has largely taken over from photography in this field and in recording detail in the heads of comets. I did not foresee how quickly the whole CCD hardware/software package would develop and come within the means of so many amateurs.

However, photography still has many advocates: there is nothing quite like a good comet photograph and for extensive comet tails it is still best. Photography can be inexpensive too: bright comets can be photographed with almost any OLD camera (see below). These notes are directed towards readers who are not regular comet photographers but would like to obtain some permanent record of the event. Regular comet photographers will already know what they intend to do. We should all re-read the excellent Comet Section publication *Observing Guide to Comets*, so most of the ground covered there will not be covered again here.

At the simplest level a short exposure can be made with a camera fixed to a sturdy tripod. To obtain sharp images of stars and comets, trailing due to the Earth's rotation must be kept to a minimum. The scale of a photograph is proportional to the focal length and is given by 206265/focal length so for 300mm fl the scale would be 688 arcsec/mm. It is found from experiment that trailing will be acceptable for most purposes if it is kept to no more than 15 arcsec for a 300mm fl lens or 90 arcsec for a 50mm lens.

As the Earth's rotation causes an equatorial star to move 1 degree in 4 minutes or 15 arcsec in 1 second of time, an exposure of 6 seconds is indicated for a 50mm lens: in practice this rule of thumb is usually relaxed to 10 seconds maximum exposure for an unguided 50mm lens. Double the focal length and one should halve the exposure. Knowing this one may, if one wishes, choose to accept some trailing of the images and make slightly longer exposures. During March and early April the declination of the comet passes 40 degrees where the diurnal motion of the sky is nearer 11 arcsec per second, allowing exposures to be increased by a third with no extra trailing. The motion of the comet relative to the stars is always much less than that due to the Earth's rotation and can be ignored for photographs taken with stationary cameras.

Table 1

Assumed accuracy required in guiding 300mm lens: 15 arcsec.

Comet's motion from ephemeris:	arcsec/hr	length of exposure step 50mm fl	300mm fl
1997 Jan 13	80	ignore	10 min
Feb 17	160	30 min	5 min
Mar 9	240	20 min	4 min
Apr 15	200	25 min	4.5 min

(exposure steps rounded to intervals)

Once exposures exceed the 10-15 seconds, or longer focal length lenses or telescopes are used, it will be necessary to follow the Earth's rotation. At this point the motion of the comet relative to the stars may have to be to taken into account or a blurred comet will appear amongst now sharp star images. Table 1 shows when this is necessary and when it can be ignored. When comet Hale-Bopp's motion is greatest in mid-March a 50mm lens could be driven at the sidereal rate for 15-20 minutes without the comet trailing but with a 300mm lens this would be reduced to 4 minutes.

The easiest way to follow the stars (take 'driven' exposures) is to attach a small camera to an equatorial telescope. There are even simpler methods where no equatorial mounting is available such as the Scotch (or hinge) mount which is easily constructed. It is possible to guide an equatorial telescope through the slow motions (ie without a clock or motor drive) as I used to do for an hour or more in my early days, but many small telescope slow motions are too course and make the telescope move in jumps. With a little ingenuity this can often be improved.

Most equatorial telescopes with mechanical drives will still need to be guided to make sure the camera is fixed exactly upon the same part of the comet. Do not be tempted to add too large or heavy a camera on to the guide telescope or it will become wobbly and fine control will be lost. A small sharp picture is better than a large blurred one. As normal shutters and range of focussing are not needed one can build a camera, essentially a box with a lens at one end and roll or sheet ('cut film') at the other. However, the lenses available for everyday photography from reliable makers are mostly so good that a roll-film camera with a standard or telephoto lens will give good results with much less effort and experimentation.

While almost any camera can be used, a single lens reflex with a lens of about f/2 is most convenient. This is where the OLD comes in. Many modern 'point and shoot' cameras, amazing as they may be, are too automated for our purpose making a time exposure of seconds or minutes difficult (draining the battery by holding the shutter open) or impossible (popping off the flash). The older semi-manual SLR's such as Nikon, Pentax, Praktica etc with 'bulb' settings can still be bought second-hand (though this may not always be so) and many of us have two or three in which different films can be kept at the ready. Operate the shutter with a cable release to avoid vibration, and choose a cable that can be locked to hold the shutter open: these are readily available in the high street. A lens hood will help to keep off stray light and defer the onset of dewing of optics.

With a bright comet, like Hale-Bopp is expected to be, it is often possible to guide on the head of the comet itself. An eyepiece with cross-hairs or engraved reticle is needed. These can be bought or wires (webs) fitted into an eyepiece barrel at the focus, a positive type such as a Ramsden or Plossl is easiest to arrange. While a high power gives greater control it may be difficult to use because of the smaller field and larger comet 'nucleus' image: a power of about 80 - 100x should be adequate with small cameras. Keep the image bisected by the cross-wires throughout the exposure using the drive/slow motions. One can defocus the comet's head a bit if it helps and keep the disc divided into four equal quarters.

If the comet's head proves unsuitable, as is often the case being too fuzzy, too large, too faint, irregular in shape etc one must guide on a nearby star. With a comet of small extent this should be as near the head as possible, as the images are usually best near the centre of the field of view of the camera. With a long tail one can guide from say a third to halfway back along the tail to get more tail in the picture but make sure you have not lost the head from the frame. If one needs to allow for the comet's own motion there are several options requiring further equipment. The old tried and tested method is to use a position angle micrometer eyepiece and guide on a star, moving the star along the web to compensate for the comet's motion. Then one can use a moveable film holder, hand or computer driven to keep pace with the moving comet image while guiding on a star: however this is not an option using a 35mm camera mounted piggyback. Lastly one can guide through the telescope's slow motions, really only practical with a computer controlled instrument. All these methods need extra equipment: see 'further reading'.

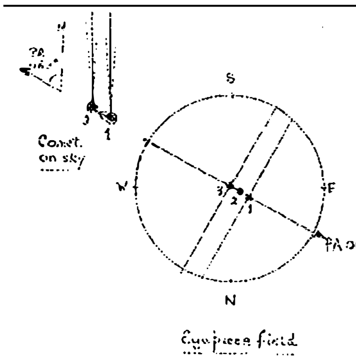
A compromise which can work with a short focal length camera is to use an eyepiece with two or more fixed webs and move the guide star between the webs at suitable intervals of time. Having fixed the webs in place their angular distance apart can be found by timing an equatorial star from one to another remembering that 15 arcsec equals 1 second of time. A simple position angle circle is needed, attached to the eyepiece to set the direction of motion of the comet. Assuming that the telescope image is inverted (south at the top of the eyepiece field) the rule is, move the star in the eyepiece in the same direction as the comet is moving on the sky.

Table 2

Film scale and sky covered (degrees)

Focal length mm	Scale "/mm	Scale /inch	Film format 24x36mm	Film format 60x60mm	Film format 100x125mm
30	6900	48	45x70	-	-
55	3750	26	25x37	65x65	-
80	2580	18	18x27	42x42	-
135	1530	11	10x15	25x25	44x55
660	313	2.2	2.1x3.3	5.3x5.3	9x11
2000	103	0.7	0.7x1.0	1.6x1.6	2.8x3.5

Table 2 shows the area of sky covered on films of different formats by lenses of several focal lengths. Shorter focal length means lower resolution, but the sky is the (financial) limit once one starts seeking the very best possible results together with a large scale. Here we are trying to obtain a personal record, probably using what is already available.



In the inverted field, the guide star is made to move from positions 1 to 3 by moving the telescope (and attached camera) by the slow motions in the direction of the arrow. This compensates for the comet's motion towards pa 63° on the sky. The effect is to superimpose the three comet images, minimising the trailing.

If you wanted to guide to 15 arcsec on a 300mm lens when the comet's motion was 240 arcsec/hr you would have to make 16 steps (effectively 16 exposures though without closing the shutter) per hour or one every 3.75 minutes, perhaps rounded to 4 minutes for convenience. If the webs were found to be 50 arcsec apart you could move the comet along every 4 minutes by eye estimation: ie on 1st web, midway between webs and on 2nd web. The 3 four minute exposures give 50 arcsec motion in 12 minutes against the required 45 arcsec. The guiding error would probably not be noticeable and would enable you to triple the exposure without much trailing.

Given an exposure of a few seconds for a fixed camera, more will be recorded in the time on a fast film. The fastest films are usually rather grainy and the finest grain films rather slow. In the black and white 35mm and roll-film range a speed of ASA 400 is probably a good compromise eg Ilford HP5 or Kodak T-Max 400. Kodak Technical Pan is slow unless hypered but has very fine grain. T-Max and Technical Pan are also available in 100x125mm (4x5 inch) flat film.

There are too many colour print and slide films to mention, the choice depending on the end use of printing or projection. Very fast colour films (eg ASA 1600) should enable good pictures to be taken with short exposures. I have not tried any of these so cannot recommend any one brand. Whatever you choose, try out a few of rolls on the night sky well before the event, see how they compare and what sort of a job the processing people make of them. If you do not have access to a dark room it is easier to get colour developed and printed than it is black and white. A wise tip is to take a conventional scene on the first and last frames so that the processor does not write the film off as a blank failure.

Summary

1. Choose your instruments in good time. You are more likely to get some good pictures with a small, fixed camera than a large wobbly, poorly guided one. If in doubt choose a smaller, lighter camera, but use a substantial tripod or support for it.

2. Decide where you intend to observe from having regard to trees, lights etc and make some exposures under conditions of dark sky, twilight, and moonlight similar to those you expect during the morning and evening apparitions of comet Hale-Bopp. Photograph stars at similar declinations to where the comet will be. Vary the exposures starting with the values shown in Table 1 and increasing them to see the effect of trailing, fogging etc.

3. B & W films will show sky fogging in grey of course but colour film may show quite strong coloured skyfog: if this tint will spoil your comet picture try another make of film. For reasons explained above it is usually best with a fixed camera to use the lens at full aperture and keep exposures short rather than stop down to improve the off-axis images. With a driven camera and a bright comet where exposure time is less critical the effect of reducing the aperture by a stop is worth checking out beforehand.

4. Always keep detailed notes of your exposures. You need at least the time to a minute or two, centre of field being photographed, film type and camera setting (eg f/2), length of exposure to a second and notes on sky conditions, lighting etc. This will enable you to make a well-considered guess as to exposure for the conditions when photographing the comet.

5. Ideally one should make several exposures of slightly different lengths on the comet but often conditions leave us with much less time than we hoped for. If the weather is poor next March - April you could find weeks of potential opportunities reduced to just a few minutes on a couple of dates. Then you will need to make the best of it and that is when planning and preparation pays off. Some of the most memorable comet photographs have been short exposures taken with ordinary cameras with standard (50 - 55mm) lenses. These can include the dawn or dusk skyline and perhaps foreground objects in silhouette. Such photographs most nearly resemble the naked eye views we like to recall.

Further reading

1. 'Observing Guide to Comets', J. D. Shanklin, Official BAA Comet Section handbook on observing and reporting observations.

2. 'Practical Amateur Astronomy', Lutterworth Press, 1968, chapter on Observation of Comets, M. J. Hendrie. See guiding on moving comets.

3. 'The photography of comets' H. B. Ridley, JBAA 1984, 95, 1, p8. General overview the essentials of comet photography, films, lenses, guiding etc.

4. 'An amateurs computerised camera for the automatic tracking of comets', R. W. Arbour, JBAA, 1985, 96,1,p12.

5. 'Astronomy from Towns & Suburbs', R. Scagell, Observers Handbook series, Philips, 1994. Very good guide to observing and photographing the night sky from difficult locations, suggestions on colour films etc.

6. 'Halley's Comet - the 1986 Apparition', M. J. Hendrie, BAA Memoir **43** part 2, 1991. Includes photographs of some members' equipment and photographs, results, bibliography etc.

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up. We are a little short of space, so some are held over till the next issue.

Journal for the History of Astronomy, Vol 27, Pt 2, May 1996. The Earliest Comet Photographs. J. M. Pasachoff, R. J. M. Olson & M. L. Hazen.
An interesting report on the first photographs of comet Donati 1858 L1 by Usherwood (England) and Bond (USA). The next comet to be photographed and the first for which plates are still extant was Tebutt 1881 K1, which showed the tail rather blurred and 1882 R1 by Gill at the Cape which clearly shows the tail. Somewhat spoilt by an American slant on who took the first photograph.

Scientific American, May 1996.
The Kuiper Belt. Jane Luu and David Jewitt.
The latest information on the Kuiper Belt.

Nature, Vol 383, 1996 October 3.
Spectroscopic evidence for insterstellar ices in comet Hyakutake. William M Irvine, et al.
One of the first of what I suspect will be many papers detailing observations of comet Hyakutake. This paper presents evidence that the ratio of HNC (hydrogen isocyanide) to HCN (hydrogen cyanide) in the comet was indicative of that from interstellar clouds and quite different to that expected from that of the outer solar nebula. The authors suggest that interstellar grains were incorporated directly into the comet's nucleus. Although only mentioned in the abstract of the paper, the NASA press release headlines the paper 'UMass Astronomers Report Comets May Have Introduced Interstellar Chemicals to Earth'. No doubt they will discover Fred Hoyle's theory that comets spread influenza next (or maybe that's what those Martian microbes are....).

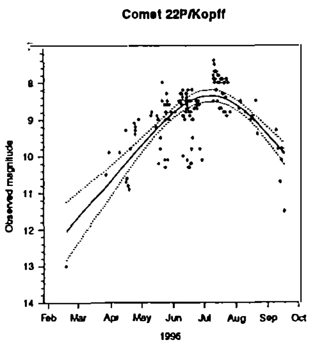
Nature, Vol 383, 1996 October 10.
NASA pulls plug on comet collaboration. Tony Reichhardt
NASA have pulled out of a project to build one of two landers for the European Rosetta spacecraft. ESA are naturally not amused, particularly as NASA pulled out of a similar agreement on the Ulysses spacecraft. NASA intend to spend the money on their own spacecraft, which might reach its target before Rosetta. NASA have yet to launch a spacecraft to study a comet.

Jonathan Shanklin

Review of comet observations for 1996 May - 1996 October

The information in this report is a synopsis of material gleaned from IAU circulars 6381 - 6495 and The Astronomer (1996 April - 1996 October). Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. Note that the figures quoted are rounded off from their original published accuracy. A full report of the comets seen during the year will be published in the Journal in due course. My apologies to those who have submitted images for not including any of them here - I hope to do so in the next edition.

22P/Kopff never quite lived up to expectations and peaked at around 8^m in the summer. It was generally a diffuse object. An analysis of the data gives a light curve of 7.5 + 5 log d + 10 log r, but this is very indeterminate.

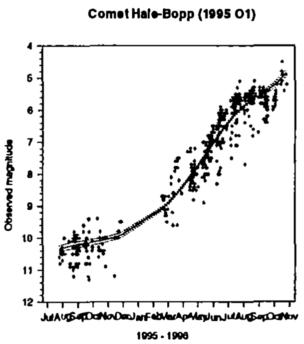


57P/du Toit-Neujmin-Delporte outburst some five months after perihelion to reach 12^m, nearly 7 mag brighter than predicted.

65P/Gunn reached around 13th mag, but was too far south for easy observation from the UK.

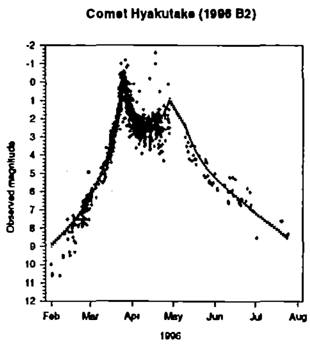
96P/Machholz 1 was not well placed for observation, but a few observations from the southern hemisphere were reported on IAUC.

116P/Wild 4 was lost in the twilight of early May as it approached conjunction.



C/1995 O1 (Hale-Bopp) has not brightened quite as rapidly as the early post conjunction observations suggested, but it is showing considerable activity in the inner coma. There seem to be several active areas and its possible that the brightening rate changes as these come into being, age and die. It is now an easy binocular object and just visible to the naked eye under good conditions. The best fit equation to the observations made so far is -0.5 + 5 log(Δ) + 7.5 log (r); it should be somewhere between Saturn and Jupiter in brightness when at its best.

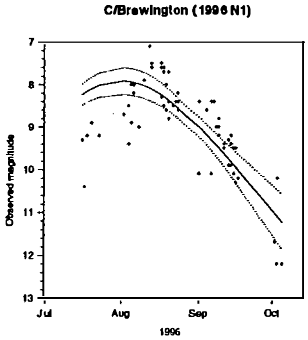
C/1996 B2 (Hyakutake) moved into the southern hemisphere after perihelion and has now faded from view. Nick James is writing a full paper on the comet for the Journal, but a preliminary analysis of the light curve shows that it behaved remarkably evenly over the course of the apparation. The observations give a mean light curve of 5.4 + 5 log(Δ) + 8 log (r).



C/1996 E1 (NEAT) proved to be another comet that was a bit brighter than indicated by initial observations with a large telescope. It was never very easy to see but reached 12^m and passed close to the pole.

C/Evans-Drinkwater (1996 J1) was discovered by Robert Evans and Michael Drinkwater (a former PhD student at the Institute of Astronomy in Cambridge) on UK Schmidt plates taken on May 10. Initially reported as 16^m, visual observations made it 13.5^m and it could reach 9th mag at perihelion. It is unlikely to be observed visually from the UK as it is poorly placed throughout the apparition.

C/Brewington (1996 N1) was 10^m when discovered visually by Howard Brewington of Cloudcroft, New Mexico on July 4. The observations fit a light curve of 9.0 + 5 log d + 10 log r, though this is indeterminate and the comet seems to have begun an outburst shortly before discovery.

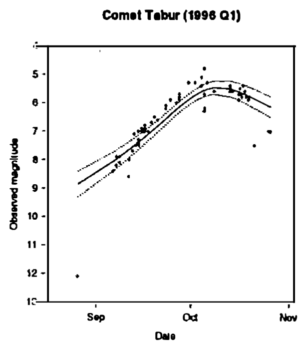


P/Elst-Pizarro (1996 N2) was discovered by Eric W Elst on an ESO 1-m Schmidt plate taken by Guido Pizzaro on July 14. This 17^m object is rather unusual in that it has an orbit resembling that of a main belt asteroid. However, it has a thin tail so that it must be classed as a comet, though it seems to have been produced in a recent outburst, which continued over a period of weeks or months prior to discovery. Previously assigned an asteroidal designation, it may receive a permanent cometary number.

126P/IRAS (1996 P1) was recovered at 13^m by Rob McNaught on a UK Schmidt plate taken by Q A Parker on August 8. For most of the apparition it is a southern hemisphere object, but will become visible from the north late in the year.

C/Russell-Watson (1996 P2) was 13^m when discovered by Ken Russell on UK Schmidt plates taken by Fred Watson on August 12. Although the initial orbit was suggested to be similar to that of P/Shoemaker 4 (1994 J3), subsequent observations have not shown the orbit to be elliptical. It was well past perihelion and faded.

C/Tabur (1996 Q1) was visually discovered by Vello Tabur of Wanniassa, Australian Capital Territory on August 19 at 10^m. It brightened rapidly and moved north, becoming an easy target for northern hemisphere observers. It appeared to have a short anti-tail when it passed through the nodal plane. The orbit is very similar to that of comet Liller 1988 A1, which reached perihelion on 1988 Mar 31. It seems likely that the two comets separated at their last perihelion passage, about 2900 years ago. Highly variable X-ray emission has been detected from the comet, suggesting that it is not caused by interaction with the solar wind. This variation may be related to the apparent rapid visual variation reported in Hyakutake by several observers. Over the past few days it seems to have faded considerably and may have fragmented (reports from Carpenter, Shanklin & Yoshida).



C/Hergenrother-Spahr (1996 R1) was discovered by Carl W Hergenrother on a film taken by Timothy B Spahr with the 0.41-m Schmidt of the University of Arizona on September 7. Reported at 14^m at discovery, it brightened a little to reach 12^m.

P/Lagerkvist (1996 R2) was discovered by Claes-Ingvar Lagerkvist on an ESO Schmidt plate taken on September 10. 17^m at discovery, it is a faint periodic comet and is unlikely to be observed visually.

127P/Holt-Olmstead (1996 S1) was recovered at 20^m by Jim Scotti with the Spacewatch Telescope at Kitt Peak on September 19.

128P/Shoemaker-Holt 1 (1996 S2) was recovered at 21^m by Jim Scotti with the Spacewatch Telescope at Kitt Peak on September 19. Interestingly the comet seems to have split and two nuclei are visible.

129P/Shoemaker-Levy 3 (1996 U1) was recovered Alain Maury, M Lundstrom and G Hahn of the Institut fur Planetenerkundung, DLR Forschungerszentrum, Berlin during the OCA-DLR Asteroid Survey using the 0.9-m Schmidt camera and CCD at Causssols. The comet was 19^m, and still over a year from perihelion, though in fact it won't get that much brighter than it is now.

A final object to note is the asteroid 1996 PW which has a near parabolic orbit, but no sign of a coma. Should it develop one it will be given a cometary designation. These recently discovered transitional objects are increasingly blurring the division between comets and asteroids.

For the latest information on discoveries and the brightness of comets see the section www page: http://www.ast.cam.ac.uk/~jds

Introduction

Comet Hale-Bopp is already showing many features in the inner coma and these are likely to become more complex as the comet brightens. Observing and drawing these features takes practice, so now is the time to start. Good drawings will be used to illustrate future section reports in the Journal and in Memoirs. A copy of the section observing blank and report form are on the last two pages of this supplement; please let me know if you need more copies of them.

Ephemerides are given for comets:

- 29P/Schwassmann-Wachmann 1
- 46P/Wirtanen
- 81P/Wild 2
- 126P/IRAS
- C/Hale-Bopp (1995 O1)
- C/Tabur (1996 Q1) (Note that the magnitudes for this comet may be highly inaccurate.)

Current ephemerides are also available on the section web page.

Although comet Hale-Bopp will get the lion's share of attention it is important not to forget the fainter comets. 29P/Schwassmann-Wachmann 1 is prone to outburst and should be observed every new moon if possible. 46P/Wirtanen and 81P/Wild 2 are targets for spacecraft, so observations are particularly needed.

Comet Hale-Bopp may become brighter than Saturn, though unlike comet Hyakutake, its coma diameter is unlikely to exceed 40' because the comet remains relatively distant from the earth. This will mean that total magnitude estimates are a little easier to make, however there will be a dearth of comparison stars once it exceeds 0^m. The magnitude of bright or large comets can be estimated using the following technique: Use reversed binoculars with one eye and direct vision with the other and make the estimate exactly as for a variable star. The reversed binoculars will reduce the comet's apparent magnitude by an amount depending on the magnification as shown in the table, though this does require the magnification to be known quite accurately. Code this type of observation as method K.

Magnification	2	4	6	7	8
Reduction	1.5	3.0	3.9	4.2	4.5

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are from the IAU circulars or comet catalogue or from Don Yeomans of JPL.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 35° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. All times are in Greenwich Mean Astronomical Time (GMAT), i.e. the day is the day on which the night starts. To convert to UT (GMT) add 12 hours. If the value is greater than 24, add 1 to the day and subtract 24 from the hour. If necessary, convert to local time. Strictly ephemeris time is used which is currently some 60 seconds ahead of UT.
- Column headings:

a) Double-date format. Time in GMAT. 12.0 is midnight UT.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are for epoch 1950).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for **29P/Schwassmann-Wachmann 1**

Omega= 46.2413 OMEGA=312.8269 i= 9.3850 q= 5.748458 a= 6.013396
e=0.044058 P= 14.746 T= 1989 September 9.6357 Equinox= 2000
Magnitudes calculated from m= 2.0+5.0*Log(d)+10.0*Log(r)

November 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	11 46.9	-4.36	14.2	7.00	6.28	21.03	Not Observable	41	63	63	0	287	0	0
2/ 3	12.0	11 47.5	-4.41	14.2	6.99	6.28	20.60	Not Observable	42	51	53	0	287	3	-1
3/ 4	12.0	11 48.0	-4.46	14.2	6.97	6.28	20.56	Not Observable	42	40	44	0	287	3	-1
4/ 5	12.0	11 48.6	-4.50	14.2	6.96	6.28	20.53	Not Observable	43	28	34	0	288	3	-1
5/ 6	12.0	11 49.1	-4.55	14.2	6.95	6.28	20.50	Not Observable	44	17	26	0	288	3	-1
6/ 7	12.0	11 49.7	-4.60	14.2	6.94	6.28	20.46	17.42 to 17.43	45	6	17	0	288	3	-1
7/ 8	12.0	11 50.2	-5.04	14.2	6.93	6.28	20.43	17.39 to 17.45	46	10	10	0	288	3	-1
8/ 9	12.0	11 50.8	-5.09	14.2	6.92	6.28	20.39	17.36 to 17.47	47	21	5	0	288	3	-1
9/10	12.0	11 51.3	-5.13	14.2	6.91	6.28	20.36	17.33 to 17.48	47	34	1	0	288	3	-1
10/11	12.0	11 51.8	-5.18	14.2	6.89	6.28	20.33	17.30 to 17.50	48	47	0	0	288	3	-1
11/12	12.0	11 52.4	-5.22	14.2	6.88	6.28	20.29	17.27 to 17.51	49	61	0	0	289	3	-1
12/13	12.0	11 52.9	-5.27	14.2	6.87	6.28	20.26	17.25 to 17.53	50	74	4	0	289	3	-1
13/14	12.0	11 53.4	-5.31	14.2	6.86	6.28	20.22	17.22 to 17.54	51	88	9	0	289	3	-1
14/15	12.0	11 53.9	-5.36	14.2	6.84	6.28	20.19	17.19 to 17.56	52	102	17	0	289	3	-1
15/16	12.0	11 54.4	-5.40	14.2	6.83	6.28	20.15	17.16 to 17.58	53	116	27	0	289	3	-1
16/17	12.0	11 54.9	-5.45	14.1	6.82	6.28	20.12	17.13 to 17.59	53	130	38	0	289	3	-1
17/18	12.0	11 55.4	-5.49	14.1	6.80	6.28	20.09	17.10 to 18.01	54	144	49	0	289	3	-1
18/19	12.0	11 55.9	-5.53	14.1	6.79	6.28	20.05	17.08 to 18.02	55	158	61	0	289	3	-1
19/20	12.0	11 56.3	-5.58	14.1	6.78	6.28	20.02	17.05 to 18.04	56	171	72	0	290	2	-1
20/21	12.0	11 56.8	-6.02	14.1	6.76	6.28	19.58	17.02 to 18.05	57	172	81	0	290	2	-1
21/22	12.0	11 57.3	-6.06	14.1	6.75	6.28	19.55	16.59 to 18.06	58	160	89	0	290	2	-1
22/23	12.0	11 57.7	-6.11	14.1	6.74	6.28	19.51	16.56 to 18.08	59	147	95	0	290	2	-1
23/24	12.0	11 58.2	-6.15	14.1	6.72	6.28	19.48	16.53 to 18.09	59	133	99	0	290	2	-1
24/25	12.0	11 58.7	-6.19	14.1	6.71	6.28	19.44	16.50 to 18.11	60	121	100	0	290	2	-1
25/26	12.0	11 59.1	-6.23	14.1	6.69	6.28	19.41	16.47 to 18.12	61	108	100	0	290	2	-1
26/27	12.0	11 59.5	-6.27	14.1	6.68	6.28	19.37	16.44 to 18.13	62	95	97	0	290	2	-1
27/28	12.0	11 60.0	-6.31	14.1	6.66	6.28	19.34	16.41 to 18.15	63	83	92	0	291	2	-1
28/29	12.0	12 0.4	-6.35	14.1	6.65	6.28	19.30	16.38 to 18.16	64	71	86	0	291	2	-1
29/30	12.0	12 0.8	-6.39	14.1	6.64	6.28	19.27	16.35 to 18.17	65	59	79	0	291	2	-1
30/31	12.0	12 1.2	-6.43	14.1	6.62	6.28	19.23	16.32 to 18.19	66	48	71	0	291	2	-1

December 1996 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	12 1.6	-6.47	14.1	6.61	6.28	19.20	16.29 to 18.20	66	36	62	0	291	2	-1
2/ 3	12.0	12 2.0	-6.51	14.1	6.59	6.28	19.16	16.26 to 18.21	67	25	52	0	291	2	-1
3/ 4	12.0	12 2.4	-6.55	14.1	6.58	6.28	19.12	16.23 to 18.22	68	13	43	0	291	2	-1
4/ 5	12.0	12 2.8	-6.59	14.1	6.56	6.28	19.09	16.20 to 18.23	69	6	33	0	291	2	-1
5/ 6	12.0	12 3.1	-7.03	14.1	6.54	6.28	19.05	16.17 to 18.24	70	14	24	0	291	2	-1
6/ 7	12.0	12 3.5	-7.07	14.1	6.53	6.28	19.02	16.14 to 18.25	71	26	16	0	291	2	-1
7/ 8	12.0	12 3.9	-7.10	14.0	6.51	6.28	18.58	16.11 to 18.26	72	38	9	0	292	2	-1
8/ 9	12.0	12 4.2	-7.14	14.0	6.50	6.28	18.55	16.08 to 18.27	73	52	3	0	292	2	-1
9/10	12.0	12 4.5	-7.18	14.0	6.48	6.28	18.51	16.05 to 18.28	74	66	0	0	292	2	-1
10/11	12.0	12 4.9	-7.21	14.0	6.47	6.28	18.47	16.02 to 18.29	75	80	0	0	292	2	-1
11/12	12.0	12 5.2	-7.25	14.0	6.45	6.28	18.44	15.59 to 18.30	76	94	2	0	292	2	-1
12/13	12.0	12 5.5	-7.29	14.0	6.44	6.28	18.40	15.56 to 18.31	76	109	7	0	292	1	-1
13/14	12.0	12 5.8	-7.32	14.0	6.42	6.28	18.36	15.53 to 18.32	77	123	14	0	292	1	-1
14/15	12.0	12 6.1	-7.35	14.0	6.40	6.28	18.33	15.50 to 18.33	78	137	23	0	292	1	-1
15/16	12.0	12 6.4	-7.39	14.0	6.39	6.28	18.29	15.46 to 18.34	79	151	34	0	292	1	-1
16/17	12.0	12 6.7	-7.42	14.0	6.37	6.28	18.26	15.43 to 18.34	80	165	46	0	292	1	-1
17/18	12.0	12 7.0	-7.46	14.0	6.36	6.28	18.22	15.40 to 18.35	81	174	57	0	293	1	-1
18/19	12.0	12 7.2	-7.49	14.0	6.34	6.28	18.18	15.37 to 18.36	82	165	68	0	293	1	-1
19/20	12.0	12 7.5	-7.52	14.0	6.32	6.28	18.14	15.34 to 18.36	83	152	77	0	293	1	-1
20/21	12.0	12 7.8	-7.55	14.0	6.31	6.28	18.11	15.30 to 18.37	84	140	86	0	293	1	-1
21/22	12.0	12 8.0	-7.58	14.0	6.29	6.28	18.07	15.27 to 18.37	85	127	92	0	293	1	-1
22/23	12.0	12 8.2	-8.01	14.0	6.27	6.28	18.03	15.24 to 18.38	86	114	97	0	293	1	-1
23/24	12.0	12 8.4	-8.04	14.0	6.26	6.28	17.60	15.21 to 18.38	87	102	100	0	293	1	-1
24/25	12.0	12 8.7	-8.07	14.0	6.24	6.28	17.56	15.17 to 18.38	88	90	100	0	293	1	-1
25/26	12.0	12 8.9	-8.10	13.9	6.23	6.28	17.52	15.14 to 18.39	89	78	99	0	293	1	-1
26/27	12.0	12 9.1	-8.13	13.9	6.21	6.28	17.48	15.11 to 18.39	90	66	96	0	294	1	-1
27/28	12.0	12 9.2	-8.16	13.9	6.19	6.28	17.45	15.07 to 18.39	90	54	92	0	294	1	-1
28/29	12.0	12 9.4	-8.19	13.9	6.18	6.28	17.41	15.04 to 18.39	91	42	85	0	294	1	-1
29/30	12.0	12 9.6	-8.22	13.9	6.16	6.28	17.37	15.01 to 18.40	92	31	78	0	294	1	-1
30/31	12.0	12 9.7	-8.24	13.9	6.14	6.28	17.33	14.57 to 18.40	93	19	70	0	294	0	-1
31/32	12.0	12 9.9	-8.27	13.9	6.13	6.28	17.30	14.54 to 18.40	94	9	61	0	294	0	-1

January 1997 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	12 10.0	-8.29	13.9	6.11	6.28	17.26	14.51 to 18.40	95	9	51	0	294	0	-1
2/ 3	12.0	12 10.1	-8.32	13.9	6.10	6.28	17.22	14.47 to 18.40	96	19	41	0	294	0	-1
3/ 4	12.0	12 10.3	-8.34	13.9	6.08	6.28	17.18	14.44 to 18.40	97	32	31	0	294	0	-1
4/ 5	12.0	12 10.4	-8.37	13.9	6.06	6.28	17.14	14.40 to 18.39	98	44	22	0	295	0	0
5/ 6	12.0	12 10.5	-8.39	13.9	6.05	6.28	17.10	14.37 to 18.39	99	58	13	0	295	0	0
6/ 7	12.0	12 10.6	-8.41	13.9	6.03	6.28	17.07	14.33 to 18.39	100	72	6	0	295	0	0
7/ 8	12.0	12 10.6	-8.43	13.9	6.01	6.28	17.03	14.30 to 18.39	101	86	2	0	295	0	0
8/ 9	12.0	12 10.7	-8.46	13.9	6.00	6.28	16.59	14.26 to 18.38	102	101	0	0	295	0	0
9/10	12.0	12 10.8	-8.48	13.9	5.98	6.28	16.55	14.23 to 18.38	103	116	0	0	295	0	0
10/11	12.0	12 10.8	-8.50	13.9	5.97	6.28	16.51	14.19 to 18.37	104	130	4	0	295	0	0
11/12	12.0	12 10.8	-8.52	13.9	5.95	6.28	16.47	14.15 to 18.37	105	145	11	0	295	0	0
12/13	12.0	12 10.9	-8.54	13.8	5.94	6.28	16.43	14.12 to 18.36	106	159	20	0	296	0	0
13/14	12.0	12 10.9	-8.55	13.8	5.92	6.28	16.39	14.08 to 18.36	107	171	30	0	296	0	0
14/15	12.0	12 10.9	-8.57	13.8	5.90	6.28	16.35	14.04 to 18.35	108	168	41	0	296	0	0
15/16	12.0	12 10.9	-8.59	13.8	5.89	6.28	16.31	14.01 to 18.35	109	156	52	0	296	0	0
16/17	12.0	12 10.9	-9.00	13.8	5.87	6.28	16.27	13.57 to 18.34	110	143	63	0	296	0	0
17/18	12.0	12 10.8	-9.02	13.8	5.86	6.28	16.24	13.53 to 18.33	111	131	73	0	296	0	0
18/19	12.0	12 10.8	-9.04	13.8	5.84	6.28	16.20	13.50 to 18.32	112	118	81	0	297	0	0
19/20	12.0	12 10.8	-9.05	13.8	5.83	6.28	16.16	13.46 to 18.31	113	106	88	0	297	0	0

20/21	12.0	12 10.7	-9.06	13.8	5.81	6.28	16.12	13.42 to 18.30	114	94	94	0	297	0	0
21/22	12.0	12 10.6	-9.08	13.8	5.80	6.28	16.08	13.38 to 18.30	115	82	98	0	297	0	0
22/23	12.0	12 10.6	-9.09	13.8	5.78	6.28	16.04	13.35 to 18.29	116	70	100	0	297	0	0
23/24	12.0	12 10.5	-9.10	13.8	5.77	6.28	15.59	13.31 to 18.28	117	58	100	0	297	0	0
24/25	12.0	12 10.4	-9.11	13.8	5.75	6.28	15.55	13.27 to 18.24	118	46	99	0	298	0	0
25/26	12.0	12 10.3	-9.12	13.8	5.74	6.28	15.51	13.23 to 18.20	119	34	96	0	298	0	0
26/27	12.0	12 10.2	-9.13	13.8	5.73	6.28	15.47	13.19 to 18.16	120	23	91	0	298	0	0
27/28	12.0	12 10.0	-9.14	13.8	5.71	6.28	15.43	13.15 to 18.11	121	13	84	0	298	0	0
28/29	12.0	12 9.9	-9.15	13.8	5.70	6.28	15.39	13.11 to 18.07	122	8	77	0	298	0	0
29/30	12.0	12 9.8	-9.16	13.8	5.68	6.28	15.35	13.07 to 18.03	123	16	68	0	299	0	0
30/31	12.0	12 9.6	-9.16	13.7	5.67	6.28	15.31	13.03 to 17.59	124	28	58	0	299	0	0
31/32	12.0	12 9.4	-9.17	13.7	5.66	6.28	15.27	12.59 to 17.55	125	40	48	0	299	-1	0

February 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	12 9.3	-9.17	13.7	5.64	6.28	15.23	12.55 to 17.50	126	53	38	0	299	-1	0
2/ 3	12.0	12 9.1	-9.18	13.7	5.63	6.28	15.19	12.51 to 17.46	127	66	27	0	299	-1	0
3/ 4	12.0	12 8.9	-9.18	13.7	5.62	6.28	15.15	12.47 to 17.42	128	80	18	0	300	-1	0
4/ 5	12.0	12 8.7	-9.19	13.7	5.61	6.28	15.10	12.43 to 17.38	129	94	10	0	300	-1	0
5/ 6	12.0	12 8.5	-9.19	13.7	5.59	6.28	15.06	12.39 to 17.34	130	109	4	0	300	-1	0
6/ 7	12.0	12 8.2	-9.19	13.7	5.58	6.28	15.02	12.35 to 17.29	132	124	0	0	301	-1	0
7/ 8	12.0	12 8.0	-9.19	13.7	5.57	6.28	14.58	12.31 to 17.25	133	139	0	0	301	-1	0
8/ 9	12.0	12 7.8	-9.19	13.7	5.56	6.28	14.54	12.26 to 17.21	134	154	2	0	301	-1	0
9/10	12.0	12 7.5	-9.19	13.7	5.55	6.28	14.50	12.22 to 17.17	135	167	8	0	301	-1	0
10/11	12.0	12 7.3	-9.19	13.7	5.53	6.28	14.45	12.18 to 17.13	136	170	16	0	302	-1	0
11/12	12.0	12 7.0	-9.19	13.7	5.52	6.28	14.41	12.14 to 17.08	137	159	25	0	302	-1	0
12/13	12.0	12 6.7	-9.19	13.7	5.51	6.28	14.37	12.09 to 17.04	138	146	36	0	302	-1	0
13/14	12.0	12 6.4	-9.18	13.7	5.50	6.28	14.33	12.05 to 17.00	139	133	46	0	303	-1	0
14/15	12.0	12 6.1	-9.18	13.7	5.49	6.28	14.28	12.01 to 16.56	140	120	57	0	303	-1	0
15/16	12.0	12 5.8	-9.17	13.7	5.48	6.28	14.24	11.57 to 16.52	141	108	67	0	304	-1	0
16/17	12.0	12 5.5	-9.17	13.7	5.47	6.28	14.20	11.52 to 16.48	142	95	76	0	304	-1	0
17/18	12.0	12 5.2	-9.16	13.7	5.46	6.28	14.16	11.48 to 16.43	143	83	84	0	304	-1	0
18/19	12.0	12 4.9	-9.16	13.7	5.45	6.28	14.11	11.43 to 16.39	144	71	90	0	305	-1	0
19/20	12.0	12 4.6	-9.15	13.7	5.44	6.28	14.07	11.39 to 16.35	145	60	95	0	305	-2	0
20/21	12.0	12 4.2	-9.14	13.7	5.43	6.28	14.03	11.35 to 16.31	146	48	99	0	306	-2	0
21/22	12.0	12 3.9	-9.13	13.6	5.42	6.28	13.59	11.30 to 16.27	147	36	100	0	306	-2	0
22/23	12.0	12 3.5	-9.12	13.6	5.41	6.28	13.54	11.26 to 16.23	148	25	100	0	307	-2	0
23/24	12.0	12 3.2	-9.11	13.6	5.41	6.28	13.50	11.21 to 16.19	149	14	98	0	308	-2	0
24/25	12.0	12 2.8	-9.10	13.6	5.40	6.28	13.46	11.17 to 16.14	150	9	95	0	308	-2	0
25/26	12.0	12 2.4	-9.09	13.6	5.39	6.28	13.41	11.12 to 16.10	151	15	89	0	309	-2	0
26/27	12.0	12 2.1	-9.08	13.6	5.38	6.28	13.37	11.08 to 16.06	152	27	82	0	310	-2	0
27/28	12.0	12 1.7	-9.07	13.6	5.38	6.28	13.33	11.03 to 16.02	154	39	74	0	310	-2	0
28/29	12.0	12 1.3	-9.05	13.6	5.37	6.28	13.28	10.59 to 15.58	155	51	65	0	311	-2	0

March 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	12 0.9	-9.04	13.6	5.36	6.28	13.24	10.54 to 15.54	156	64	54	0	312	-2	0
2/ 3	12.0	12 0.5	-9.03	13.6	5.36	6.28	13.20	10.50 to 15.50	157	77	44	0	313	-2	0
3/ 4	12.0	12 0.1	-9.01	13.6	5.35	6.28	13.15	10.45 to 15.46	158	91	33	0	314	-2	0
4/ 5	12.0	11 59.7	-8.60	13.6	5.34	6.28	13.11	10.41 to 15.41	159	105	22	0	316	-2	0
5/ 6	12.0	11 59.3	-8.58	13.6	5.34	6.28	13.07	10.36 to 15.37	160	119	13	0	317	-2	0
6/ 7	12.0	11 58.9	-8.56	13.6	5.33	6.28	13.02	10.31 to 15.33	161	134	6	0	318	-2	0
7/ 8	12.0	11 58.5	-8.55	13.6	5.33	6.28	12.58	10.27 to 15.29	162	149	1	0	320	-2	0
8/ 9	12.0	11 58.0	-8.53	13.6	5.32	6.28	12.54	10.22 to 15.25	163	163	0	0	322	-2	0
9/10	12.0	11 57.6	-8.51	13.6	5.32	6.28	12.49	10.17 to 15.21	164	171	1	0	324	-2	0
10/11	12.0	11 57.2	-8.49	13.6	5.32	6.28	12.45	10.13 to 15.17	165	162	5	0	326	-2	0
11/12	12.0	11 56.8	-8.47	13.6	5.31	6.28	12.40	10.08 to 15.13	165	149	12	0	328	-2	0
12/13	12.0	11 56.3	-8.46	13.6	5.31	6.28	12.36	10.03 to 15.09	166	135	20	0	331	-2	0
13/14	12.0	11 55.9	-8.44	13.6	5.30	6.28	12.32	9.59 to 15.05	167	122	30	0	334	-2	0
14/15	12.0	11 55.5	-8.42	13.6	5.30	6.28	12.27	9.54 to 15.01	168	109	40	0	338	-2	0
15/16	12.0	11 55.0	-8.39	13.6	5.30	6.28	12.23	9.49 to 14.57	169	96	50	0	342	-2	0
16/17	12.0	11 54.6	-8.37	13.6	5.30	6.28	12.19	9.45 to 14.53	169	84	60	0	346	-2	0
17/18	12.0	11 54.2	-8.35	13.6	5.30	6.28	12.14	9.40 to 14.49	170	72	69	0	351	-2	0
18/19	12.0	11 53.7	-8.33	13.6	5.29	6.28	12.10	9.35 to 14.44	171	60	78	0	357	-2	0
19/20	12.0	11 53.3	-8.31	13.6	5.29	6.28	12.05	9.30 to 14.40	171	48	85	0	4	-2	0
20/21	12.0	11 52.8	-8.29	13.6	5.29	6.28	12.01	9.26 to 14.36	171	36	91	0	10	-2	0
21/22	12.0	11 52.4	-8.26	13.6	5.29	6.28	11.57	9.21 to 14.32	171	25	96	0	18	-2	0
22/23	12.0	11 52.0	-8.24	13.6	5.29	6.28	11.52	9.16 to 14.28	171	14	99	0	25	-2	0
23/24	12.0	11 51.5	-8.22	13.6	5.29	6.28	11.48	9.12 to 14.24	171	9	100	0	33	-2	0
24/25	12.0	11 51.1	-8.19	13.6	5.29	6.28	11.44	9.07 to 14.20	171	15	100	0	40	-2	0
25/26	12.0	11 50.7	-8.17	13.6	5.29	6.28	11.39	9.02 to 14.16	171	27	97	0	46	-2	0
26/27	12.0	11 50.2	-8.15	13.6	5.29	6.28	11.35	8.57 to 14.12	170	39	93	0	52	-2	1
27/28	12.0	11 49.8	-8.12	13.6	5.29	6.28	11.30	8.53 to 14.08	170	51	87	0	58	-2	1
28/29	12.0	11 49.4	-8.10	13.6	5.29	6.28	11.26	8.48 to 14.04	169	64	79	0	63	-2	1
29/30	12.0	11 48.9	-8.07	13.6	5.30	6.28	11.22	8.43 to 14.00	168	77	70	0	67	-2	1
30/31	12.0	11 48.5	-8.05	13.6	5.30	6.28	11.17	8.38 to 13.56	168	90	59	0	71	-2	1
31/32	12.0	11 48.1	-8.02	13.6	5.30	6.28	11.13	8.34 to 13.52	167	104	48	0	74	-2	1

April 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	11 47.7	-7.60	13.6	5.30	6.28	11.09	8.29 to 13.48	166	118	37	0	77	-2	1
2/ 3	12.0	11 47.3	-7.57	13.6	5.31	6.28	11.04	8.24 to 13.44	165	132	26	0	80	-2	1
3/ 4	12.0	11 46.9	-7.55	13.6	5.31	6.28	10.60	8.19 to 13.40	164	146	16	0	82	-2	1
4/ 5	12.0	11 46.5	-7.52	13.6	5.31	6.28	10.56	8.15 to 13.36	163	160	8	0	84	-2	1
5/ 6	12.0	11 46.1	-7.50	13.6	5.32	6.28	10.51	8.10 to 13.32	162	171	3	0	86	-2	1
6/ 7	12.0	11 45.7	-7.47	13.6	5.32	6.28	10.47	8.11 to 13.28	161	165	0	0	87	-2	1
7/ 8	12.0	11 45.3	-7.45	13.6	5.33	6.28	10.43	8.14 to 13.24	160	152	0	0	89	-2	1
8/ 9	12.0	11 44.9	-7.42	13.6	5.33	6.28	10.38	8.16 to 13.21	159	138	3	0	90	-2	1
9/10	12.0	11 44.5	-7.39	13.6	5.34	6.28	10.34	8.18 to 13.17	158	124	8	0	91	-2	1
10/11	12.0	11 44.1	-7.37	13.6	5.34	6.28	10.30	8.20 to 13.13	157	111	15	0	93	-2	1
11/12	12.0	11 43.8	-7.34	13.6	5.35	6.28	10.25	8.23 to 13.09	156	98	24	0	94	-2	1
12/13	12.0	11 43.4	-7.32	13.6	5.35	6.28	10.21	8.25 to 13.05	155	85	33	0	95	-2	1
13/14	12.0	11 43.0	-7.29	13.6	5.36	6.28	10.17	8.27 to 13.01	154	72	43	0	95	-2	1
14/15	12.0	11 42.7	-7.27	13.6	5.36	6.28	10.12	8.29 to 12.57	153	60	53	0	96	-2	1

15/16	12.0	11 42.3	-7.25	13.6	5.37	6.28	10.08	8.32 to 12.53	152	49	62	0	97	-2	1
16/17	12.0	11 42.0	-7.22	13.6	5.38	6.28	10.04	8.34 to 12.49	151	37	71	0	98	-2	1
17/18	12.0	11 41.7	-7.20	13.6	5.39	6.28	9.59	8.36 to 12.45	150	25	80	0	98	-2	1
18/19	12.0	11 41.3	-7.17	13.6	5.39	6.28	9.55	8.39 to 12.41	149	15	87	0	99	-2	1
19/20	12.0	11 41.0	-7.15	13.6	5.40	6.28	9.51	8.41 to 12.37	148	8	93	0	100	-1	0
20/21	12.0	11 40.7	-7.12	13.6	5.41	6.28	9.47	8.44 to 12.33	147	15	97	0	100	-1	0
21/22	12.0	11 40.4	-7.10	13.6	5.42	6.28	9.42	8.46 to 12.29	146	26	100	0	101	-1	0
22/23	12.0	11 40.1	-7.08	13.6	5.43	6.28	9.38	8.49 to 12.26	145	38	100	0	101	-1	0
23/24	12.0	11 39.8	-7.05	13.7	5.43	6.28	9.34	8.51 to 12.22	144	50	99	0	102	-1	0
24/25	12.0	11 39.6	-7.03	13.7	5.44	6.28	9.30	8.54 to 12.18	143	63	96	0	102	-1	0
25/26	12.0	11 39.3	-7.01	13.7	5.45	6.28	9.26	8.56 to 12.14	142	76	90	0	103	-1	0
26/27	12.0	11 39.0	-6.59	13.7	5.46	6.28	9.21	8.59 to 12.10	141	90	83	0	103	-1	0
27/28	12.0	11 38.8	-6.57	13.7	5.47	6.28	9.17	9.01 to 12.06	140	103	73	0	103	-1	0
28/29	12.0	11 38.5	-6.54	13.7	5.48	6.28	9.13	9.04 to 12.02	139	117	63	0	104	-1	0
29/30	12.0	11 38.3	-6.52	13.7	5.49	6.28	9.09	9.07 to 11.58	138	131	52	0	104	-1	0
30/31	12.0	11 38.1	-6.50	13.7	5.50	6.28	9.05	9.09 to 11.54	137	144	40	0	104	-1	0

May 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	11 37.8	-6.48	13.7	5.51	6.28	9.00	9.12 to 11.51	136	158	29	0	105	-1	0
2/ 3	12.0	11 37.6	-6.46	13.7	5.52	6.28	8.56	9.14 to 11.47	135	170	19	0	105	-1	0
3/ 4	12.0	11 37.4	-6.44	13.7	5.53	6.28	8.52	9.17 to 11.43	134	168	10	0	105	-1	0
4/ 5	12.0	11 37.2	-6.42	13.7	5.55	6.28	8.48	9.20 to 11.39	133	155	4	0	106	-1	0
5/ 6	12.0	11 37.1	-6.41	13.7	5.56	6.28	8.44	9.23 to 11.35	132	142	0	0	106	-1	0
6/ 7	12.0	11 36.9	-6.39	13.7	5.57	6.28	8.40	9.25 to 11.31	131	128	0	0	106	-1	0
7/ 8	12.0	11 36.7	-6.37	13.7	5.58	6.28	8.36	9.28 to 11.27	130	114	1	0	107	-1	0
8/ 9	12.0	11 36.6	-6.35	13.7	5.59	6.28	8.32	9.31 to 11.23	129	101	5	0	107	0	0
9/10	12.0	11 36.4	-6.34	13.7	5.60	6.28	8.28	9.34 to 11.20	128	88	11	0	107	0	0
10/11	12.0	11 36.3	-6.32	13.7	5.62	6.28	8.23	9.37 to 11.16	127	75	19	0	107	0	0
11/12	12.0	11 36.2	-6.30	13.7	5.63	6.28	8.19	9.39 to 11.12	126	63	27	0	107	0	0
12/13	12.0	11 36.1	-6.29	13.7	5.64	6.28	8.15	9.42 to 11.08	125	51	36	0	108	0	0
13/14	12.0	11 36.0	-6.27	13.7	5.65	6.28	8.11	9.45 to 11.04	124	39	46	0	108	0	0
14/15	12.0	11 35.9	-6.26	13.7	5.67	6.28	8.07	9.48 to 11.00	123	27	55	0	108	0	0
15/16	12.0	11 35.8	-6.25	13.7	5.68	6.28	8.03	9.51 to 10.57	122	17	65	0	108	0	0
16/17	12.0	11 35.7	-6.23	13.8	5.69	6.28	7.59	9.54 to 10.53	121	9	74	0	109	0	0
17/18	12.0	11 35.6	-6.22	13.8	5.71	6.28	7.55	9.57 to 10.49	120	13	82	0	109	0	0
18/19	12.0	11 35.6	-6.21	13.8	5.72	6.28	7.51	9.60 to 10.45	119	23	89	0	109	0	0
19/20	12.0	11 35.5	-6.20	13.8	5.73	6.28	7.47	10.03 to 10.41	118	35	94	0	109	0	0
20/21	12.0	11 35.5	-6.18	13.8	5.75	6.28	7.43	10.06 to 10.37	117	48	98	0	109	0	0
21/22	12.0	11 35.5	-6.17	13.8	5.76	6.28	7.39	10.09 to 10.34	116	60	100	0	109	0	0
22/23	12.0	11 35.5	-6.16	13.8	5.78	6.28	7.35	10.11 to 10.30	115	74	100	0	110	0	0
23/24	12.0	11 35.4	-6.15	13.8	5.79	6.28	7.31	10.14 to 10.26	114	87	97	0	110	0	0
24/25	12.0	11 35.5	-6.15	13.8	5.80	6.28	7.27	10.17 to 10.22	113	101	92	0	110	0	0
25/26	12.0	11 35.5	-6.14	13.8	5.82	6.28	7.23	Not Observable	112	115	85	0	110	0	0
26/27	12.0	11 35.5	-6.13	13.8	5.83	6.28	7.20	Not Observable	112	128	76	0	110	0	0
27/28	12.0	11 35.5	-6.12	13.8	5.85	6.28	7.16	Not Observable	111	142	65	0	111	0	0
28/29	12.0	11 35.6	-6.12	13.8	5.86	6.28	7.12	Not Observable	110	156	54	0	111	0	0
29/30	12.0	11 35.6	-6.11	13.8	5.88	6.28	7.08	Not Observable	109	168	42	0	111	0	0
30/31	12.0	11 35.7	-6.11	13.8	5.89	6.28	7.04	Not Observable	108	170	31	0	111	0	0
31/32	12.0	11 35.7	-6.10	13.8	5.91	6.28	7.00	Not Observable	107	159	21	0	111	0	0

Ephemeris for **46P/Wirtanen**

Omega=356.2828 OMEGA= 82.2109 i= 11.7249 q= 1.064568 a= 3.101265
e=0.656731 P= 5.461 T= 1997 March 14.1665 Equinox= 2000
Magnitudes calculated from m= 9.0+5.0*Log(d)+15.0*Log(r)

January 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	22 42.9	-17.55	12.4	1.72	1.41	3.59	Not Observable	55	144	51	2	74	0	0
2/ 3	12.0	22 45.2	-17.36	12.4	1.72	1.40	3.57	Not Observable	55	133	41	2	74	13	7
3/ 4	12.0	22 47.6	-17.17	12.3	1.72	1.39	3.56	Not Observable	54	121	31	2	74	14	7
4/ 5	12.0	22 50.0	-16.58	12.3	1.71	1.38	3.54	Not Observable	54	109	22	2	74	14	8
5/ 6	12.0	22 52.4	-16.38	12.2	1.71	1.38	3.52	Not Observable	53	96	13	2	74	14	8
6/ 7	12.0	22 54.8	-16.18	12.2	1.71	1.37	3.51	Not Observable	53	83	6	2	74	14	8
7/ 8	12.0	22 57.3	-15.58	12.2	1.71	1.36	3.49	Not Observable	53	69	2	2	74	14	8
8/ 9	12.0	22 59.7	-15.38	12.1	1.71	1.35	3.48	Not Observable	52	55	0	2	74	14	8
9/10	12.0	23 2.2	-15.17	12.1	1.70	1.35	3.46	Not Observable	52	41	0	2	74	14	8
10/11	12.0	23 4.7	-14.57	12.1	1.70	1.34	3.45	Not Observable	52	28	4	2	74	15	8
11/12	12.0	23 7.2	-14.35	12.0	1.70	1.33	3.44	Not Observable	51	15	11	2	74	15	8
12/13	12.0	23 9.7	-14.14	12.0	1.70	1.32	3.42	Not Observable	51	10	20	2	73	15	8
13/14	12.0	23 12.3	-13.53	11.9	1.69	1.32	3.41	Not Observable	51	19	30	2	73	15	8
14/15	12.0	23 14.9	-13.31	11.9	1.69	1.31	3.39	Not Observable	51	31	41	2	73	15	9
15/16	12.0	23 17.5	-13.09	11.9	1.69	1.30	3.38	Not Observable	50	43	52	2	73	15	9
16/17	12.0	23 20.1	-12.46	11.8	1.69	1.30	3.37	Not Observable	50	55	63	2	73	15	9
17/18	12.0	23 22.7	-12.24	11.8	1.68	1.29	3.35	Not Observable	50	67	73	2	73	16	9
18/19	12.0	23 25.3	-12.01	11.7	1.68	1.28	3.34	Not Observable	49	79	81	2	73	16	9
19/20	12.0	23 28.0	-11.38	11.7	1.68	1.27	3.33	Not Observable	49	91	88	3	73	16	9
20/21	12.0	23 30.7	-11.15	11.7	1.67	1.27	3.32	Not Observable	49	102	94	3	73	16	9
21/22	12.0	23 33.4	-10.51	11.6	1.67	1.26	3.30	Not Observable	49	113	98	3	73	16	9
22/23	12.0	23 36.1	-10.27	11.6	1.67	1.25	3.29	Not Observable	48	125	100	3	73	16	9
23/24	12.0	23 38.8	-10.03	11.5	1.67	1.25	3.28	Not Observable	48	136	100	3	73	16	10
24/25	12.0	23 41.6	-9.39	11.5	1.66	1.24	3.27	Not Observable	48	146	99	3	73	16	10
25/26	12.0	23 44.4	-9.15	11.5	1.66	1.23	3.25	Not Observable	48	157	96	3	73	17	10
26/27	12.0	23 47.1	-8.50	11.4	1.66	1.23	3.24	Not Observable	47	167	91	3	73	17	10
27/28	12.0	23 50.0	-8.25	11.4	1.65	1.22	3.23	Not Observable	47	173	84	3	73	17	10
28/29	12.0	23 52.8	-7.60	11.4	1.65	1.22	3.22	Not Observable	47	166	77	3	73	17	10
29/30	12.0	23 55.6	-7.34	11.3	1.65	1.21	3.21	Not Observable	47	156	68	3	73	17	10
30/31	12.0	23 58.5	-7.08	11.3	1.64	1.20	3.20	6.08 to 6.10	47	145	58	3	72	17	10
31/32	12.0	0 1.4	-6.42	11.2	1.64	1.20	3.19	6.09 to 6.14	46	134	48	3	72	17	10

February 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	0 4.3	-6.16	11.2	1.64	1.19	3.18	6.11 to 6.18	46	121	38	3	72	18	10
2/ 3	12.0	0 7.2	-5.50	11.2	1.63	1.19	3.17	6.13 to 6.22	46	109	27	4	72	18	11
3/ 4	12.0	0 10.2	-5.23	11.1	1.63	1.18	3.16	6.14 to 6.26	46	96	18	4	72	18	11
4/ 5	12.0	0 13.1	-4.56	11.1	1.63	1.17	3.15	6.16 to 6.29	46	82	10	4	72	18	11
5/ 6	12.0	0 16.1	-4.29	11.1	1.62	1.17	3.14	6.18 to 6.33	46	68	4	4	72	18	11
6/ 7	12.0	0 19.2	-4.02	11.0	1.62	1.16	3.13	6.19 to 6.36	45	54	0	4	72	18	11
7/ 8	12.0	0 22.2	-3.34	11.0	1.62	1.16	3.12	6.21 to 6.40	45	40	0	4	72	18	11
8/ 9	12.0	0 25.2	-3.07	11.0	1.61	1.15	3.11	6.23 to 6.43	45	26	2	4	72	19	11
9/10	12.0	0 28.3	-2.39	10.9	1.61	1.15	3.10	6.25 to 6.47	45	12	8	4	72	19	11
10/11	12.0	0 31.4	-2.11	10.9	1.61	1.14	3.09	6.26 to 6.50	45	5	16	4	72	19	11
11/12	12.0	0 34.5	-1.42	10.9	1.60	1.14	3.09	6.28 to 6.53	45	17	25	4	72	19	11
12/13	12.0	0 37.7	-1.14	10.8	1.60	1.13	3.08	6.30 to 6.57	45	29	36	4	72	19	11
13/14	12.0	0 40.8	-0.45	10.8	1.59	1.13	3.07	6.32 to 6.60	45	42	46	4	72	19	11
14/15	12.0	0 44.0	-0.16	10.8	1.59	1.13	3.06	6.33 to 7.03	45	54	57	5	72	19	12
15/16	12.0	0 47.2	0.13	10.7	1.59	1.12	3.06	6.35 to 7.06	44	65	67	5	72	20	12
16/17	12.0	0 50.5	0.42	10.7	1.58	1.12	3.05	6.37 to 7.09	44	77	76	5	72	20	12
17/18	12.0	0 53.7	1.12	10.7	1.58	1.11	3.04	6.39 to 7.12	44	88	84	5	72	20	12
18/19	12.0	0 57.0	1.41	10.7	1.58	1.11	3.03	6.40 to 7.15	44	99	90	5	72	20	12
19/20	12.0	1 0.3	2.11	10.6	1.57	1.11	3.03	6.42 to 7.18	44	110	95	5	71	20	12
20/21	12.0	1 3.6	2.41	10.6	1.57	1.10	3.02	6.44 to 7.21	44	121	99	5	71	20	12
21/22	12.0	1 7.0	3.11	10.6	1.57	1.10	3.02	6.46 to 7.24	44	132	100	5	71	20	12
22/23	12.0	1 10.3	3.41	10.6	1.57	1.10	3.01	6.48 to 7.27	44	143	100	5	71	21	12
23/24	12.0	1 13.7	4.11	10.5	1.56	1.09	3.01	6.49 to 7.30	44	154	98	5	71	21	12
24/25	12.0	1 17.2	4.41	10.5	1.56	1.09	3.00	6.51 to 7.33	44	164	95	5	71	21	12
25/26	12.0	1 20.6	5.11	10.5	1.56	1.09	2.60	6.53 to 7.36	44	176	89	5	71	21	12
26/27	12.0	1 24.1	5.42	10.5	1.55	1.08	2.59	6.55 to 7.39	44	173	82	6	71	21	12
27/28	12.0	1 27.6	6.12	10.5	1.55	1.08	2.59	6.57 to 7.41	44	162	74	6	71	21	12
28/29	12.0	1 31.1	6.43	10.4	1.55	1.08	2.58	6.58 to 7.44	44	150	65	6	71	21	12

March 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	1 34.7	7.14	10.4	1.55	1.08	2.58	7.00 to 7.47	44	138	54	6	71	22	12
2/ 3	12.0	1 38.3	7.44	10.4	1.54	1.08	2.57	7.02 to 7.50	44	126	44	6	71	22	12
3/ 4	12.0	1 41.9	8.15	10.4	1.54	1.07	2.57	7.04 to 7.53	44	113	33	6	71	22	12
4/ 5	12.0	1 45.5	8.46	10.4	1.54	1.07	2.57	7.06 to 7.55	44	100	22	6	71	22	12
5/ 6	12.0	1 49.2	9.16	10.4	1.54	1.07	2.57	7.08 to 7.58	44	86	13	6	71	22	12
6/ 7	12.0	1 52.8	9.47	10.4	1.53	1.07	2.56	7.09 to 8.01	44	72	6	6	71	22	12
7/ 8	12.0	1 56.6	10.18	10.4	1.53	1.07	2.56	7.11 to 8.04	44	58	1	6	71	22	12
8/ 9	12.0	2 0.3	10.48	10.3	1.53	1.07	2.56	7.13 to 8.06	44	44	0	6	71	23	12
9/10	12.0	2 4.1	11.19	10.3	1.53	1.07	2.56	7.15 to 8.09	44	30	1	6	71	23	12
10/11	12.0	2 7.9	11.49	10.3	1.52	1.07	2.56	7.17 to 8.12	44	16	5	6	71	23	12
11/12	12.0	2 11.7	12.20	10.3	1.52	1.06	2.56	7.19 to 8.14	44	4	12	6	72	23	12
12/13	12.0	2 15.6	12.50	10.3	1.52	1.06	2.55	7.21 to 8.17	44	11	20	6	72	23	12
13/14	12.0	2 19.5	13.20	10.3	1.52	1.06	2.55	7.23 to 8.20	44	23	30	6	72	23	12
14/15	12.0	2 23.4	13.50	10.3	1.52	1.06	2.55	7.24 to 8.22	44	35	40	6	72	23	12
15/16	12.0	2 27.4	14.20	10.3	1.52	1.06	2.55	7.26 to 8.25	44	46	50	6	72	23	12
16/17	12.0	2 31.3	14.49	10.3	1.52	1.07	2.56	7.28 to 8.27	44	58	60	6	72	24	12
17/18	12.0	2 35.4	15.19	10.3	1.52	1.07	2.56	7.30 to 8.30	45	69	69	6	72	24	12
18/19	12.0	2 39.4	15.48	10.3	1.51	1.07	2.56	7.32 to 8.33	45	80	78	6	72	24	12
19/20	12.0	2 43.5	16.17	10.3	1.51	1.07	2.56	7.34 to 8.35	45	90	85	6	72	24	12
20/21	12.0	2 47.6	16.46	10.3	1.51	1.07	2.56	7.36 to 8.38	45	101	91	6	72	24	12
21/22	12.0	2 51.7	17.15	10.3	1.51	1.07	2.56	7.38 to 8.40	45	112	96	6	72	24	11
22/23	12.0	2 55.8	17.43	10.3	1.51	1.07	2.56	7.40 to 8.43	45	123	99	6	73	24	11
23/24	12.0	3 0.0	18.11	10.4	1.51	1.07	2.57	7.42 to 8.45	45	133	100	6	73	24	11
24/25	12.0	3 4.2	18.38	10.4	1.51	1.07	2.57	7.44 to 8.47	45	144	100	6	73	24	11
25/26	12.0	3 8.5	19.06	10.4	1.51	1.08	2.57	7.46 to 8.50	45	155	97	6	73	25	11
26/27	12.0	3 12.8	19.33	10.4	1.51	1.08	2.58	7.48 to 8.52	45	166	93	6	73	25	11
27/28	12.0	3 17.1	19.59	10.4	1.51	1.08	2.58	7.50 to 8.55	45	174	87	6	73	25	11
28/29	12.0	3 21.4	20.26	10.4	1.51	1.08	2.58	7.52 to 8.57	46	168	79	6	74	25	10
29/30	12.0	3 25.7	20.51	10.4	1.51	1.09	2.59	7.54 to 8.59	46	157	70	6	74	25	10
30/31	12.0	3 30.1	21.17	10.5	1.52	1.09	2.59	7.56 to 9.01	46	145	59	6	74	25	10
31/32	12.0	3 34.5	21.42	10.5	1.52	1.09	2.60	7.58 to 9.03	46	132	48	6	74	25	10

April 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	3 39.0	22.06	10.5	1.52	1.09	3.00	8.01 to 9.06	46	120	37	6	74	25	10
2/ 3	12.0	3 43.4	22.30	10.5	1.52	1.10	3.01	8.03 to 9.08	46	107	26	6	75	25	10
3/ 4	12.0	3 47.9	22.54	10.5	1.52	1.10	3.01	8.05 to 9.10	46	93	16	6	75	25	9
4/ 5	12.0	3 52.4	23.17	10.6	1.52	1.10	3.02	8.07 to 9.12	46	80	8	5	75	25	9
5/ 6	12.0	3 57.0	23.40	10.6	1.53	1.11	3.02	8.09 to 9.14	47	66	3	5	75	25	9
6/ 7	12.0	4 1.5	24.02	10.6	1.53	1.11	3.03	8.11 to 9.16	47	52	0	5	76	25	9
7/ 8	12.0	4 6.1	24.23	10.6	1.53	1.12	3.04	8.14 to 9.17	47	39	0	5	76	26	8
8/ 9	12.0	4 10.7	24.44	10.7	1.53	1.12	3.04	8.16 to 9.19	47	26	3	5	76	26	8
9/10	12.0	4 15.3	25.05	10.7	1.54	1.12	3.05	8.18 to 9.21	47	15	8	5	77	26	8
10/11	12.0	4 19.9	25.24	10.7	1.54	1.13	3.06	8.20 to 9.23	47	9	15	5	77	26	8
11/12	12.0	4 24.6	25.44	10.8	1.54	1.13	3.07	8.23 to 9.24	47	15	24	5	77	26	8
12/13	12.0	4 29.2	26.02	10.8	1.54	1.14	3.07	8.25 to 9.26	47	26	33	5	78	26	7
13/14	12.0	4 33.9	26.20	10.8	1.55	1.14	3.08	8.27 to 9.27	47	37	43	5	78	26	7
14/15	12.0	4 38.6	26.38	10.8	1.55	1.15	3.09	8.29 to 9.28	48	47	53	5	78	26	7
15/16	12.0	4 43.3	26.54	10.9	1.56	1.15	3.10	8.32 to 9.30	48	58	62	4	79	26	6
16/17	12.0	4 48.0	27.11	10.9	1.56	1.16	3.10	8.34 to 9.31	48	69	71	4	79	26	6
17/18	12.0	4 52.8	27.26	10.9	1.56	1.16	3.11	8.36 to 9.32	48	79	80	4	79	26	6
18/19	12.0	4 57.5	27.41	11.0	1.57	1.17	3.12	8.39 to 9.33	48	90	87	4	80	26	6
19/20	12.0	5 2.2	27.55	11.0	1.57	1.17	3.13	8.41 to 9.34	48	100	93	4	80	26	5
20/21	12.0	5 7.0	28.09	11.1	1.58	1.18	3.14	8.44 to 9.35	48	111	97	4	80	26	5
21/22	12.0	5 11.7	28.21	11.1	1.58	1.18	3.14	8.46 to 9.36	48	122	100	4	81	26	5
22/23	12.0	5 16.5	28.34	11.1	1.59	1.19	3.15	8.49 to 9.36	48	133	100	4	81	26	5
23/24	12.0	5 21.2	28.45	11.2	1.59	1.20	3.16	8.51 to 9.37	49	145	99	4	81	26	4
24/25	12.0	5 26.0	28.56	11.2	1.60	1.20	3.17	8.54 to 9.37	49	155	96	4	82	25	4
25/26	12.0	5 30.7	29.06	11.3	1.61	1.21	3.18	8.56 to 9.38	49	165	90	3	82	25	4
26/27	12.0	5 35.4	29.16	11.3	1.61	1.21	3.18	8.59 to 9.38	49	169	83	3	83	25	3
27/28	12.0	5 40.2	29.24	11.3	1.62	1.22	3.19	9.01 to 9.38	49	162	73	3	83	25	3
28/29	12.0	5 44.9	29.33	11.4	1.62	1.23	3.20	9.04 to 9.38	49	150	63	3	83	25	3

29/30	12.0	5 49.6	29.40	11.4	1.63	1.23	3.21	9.07 to 9.38	49	138	52	3	84	25	3
30/31	12.0	5 54.3	29.47	11.5	1.64	1.24	3.21	9.09 to 9.38	49	126	40	3	84	25	2

May 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	5 59.0	29.53	11.5	1.64	1.24	3.22	9.12 to 9.38	49	113	29	3	85	25	2
2/ 3	12.0	6 3.7	29.59	11.6	1.65	1.25	3.23	9.14 to 9.38	49	100	19	3	85	25	2
3/ 4	12.0	6 8.3	30.04	11.6	1.66	1.26	3.24	9.17 to 9.37	49	87	10	3	85	25	2
4/ 5	12.0	6 13.0	30.08	11.6	1.67	1.26	3.24	9.20 to 9.37	49	73	4	3	86	25	1
5/ 6	12.0	6 17.6	30.12	11.7	1.67	1.27	3.25	9.23 to 9.36	49	60	0	3	86	24	1
6/ 7	12.0	6 22.2	30.15	11.7	1.68	1.28	3.26	9.25 to 9.35	49	48	0	3	87	24	1
7/ 8	12.0	6 26.8	30.17	11.8	1.69	1.29	3.26	9.28 to 9.34	49	36	1	2	87	24	1
8/ 9	12.0	6 31.4	30.19	11.8	1.70	1.29	3.27	9.31 to 9.33	49	24	5	2	87	24	0
9/10	12.0	6 35.9	30.20	11.9	1.71	1.30	3.28	Not Observable	49	15	11	2	88	24	0
10/11	12.0	6 40.4	30.21	11.9	1.71	1.31	3.28	Not Observable	49	12	19	2	88	24	0
11/12	12.0	6 44.9	30.21	12.0	1.72	1.31	3.29	Not Observable	49	19	27	2	89	24	0
12/13	12.0	6 49.4	30.20	12.0	1.73	1.32	3.29	Not Observable	50	28	36	2	89	24	0
13/14	12.0	6 53.8	30.19	12.1	1.74	1.33	3.30	Not Observable	50	38	46	2	89	23	0
14/15	12.0	6 58.2	30.18	12.1	1.75	1.34	3.30	Not Observable	50	48	55	2	90	23	0
15/16	12.0	7 2.6	30.15	12.2	1.76	1.34	3.31	Not Observable	49	59	65	2	90	23	0
16/17	12.0	7 6.9	30.13	12.2	1.77	1.35	3.31	Not Observable	49	69	74	2	90	23	-1
17/18	12.0	7 11.2	30.10	12.2	1.78	1.36	3.31	Not Observable	49	80	82	2	91	23	-1
18/19	12.0	7 15.5	30.06	12.3	1.79	1.37	3.32	Not Observable	49	91	89	2	91	23	-1
19/20	12.0	7 19.8	30.02	12.3	1.80	1.37	3.32	Not Observable	49	103	94	2	91	22	-1
20/21	12.0	7 24.0	29.57	12.4	1.81	1.38	3.32	Not Observable	49	114	98	2	92	22	-1
21/22	12.0	7 28.1	29.52	12.4	1.82	1.39	3.32	Not Observable	49	126	100	2	92	22	-2
22/23	12.0	7 32.3	29.47	12.5	1.83	1.40	3.33	Not Observable	49	138	100	2	92	22	-2
23/24	12.0	7 36.4	29.41	12.5	1.84	1.41	3.33	Not Observable	49	149	97	1	93	22	-2
24/25	12.0	7 40.5	29.35	12.6	1.85	1.41	3.33	Not Observable	49	160	92	1	93	22	-2
25/26	12.0	7 44.5	29.28	12.6	1.86	1.42	3.33	Not Observable	49	167	85	1	93	21	-2
26/27	12.0	7 48.5	29.21	12.7	1.87	1.43	3.33	Not Observable	49	163	76	1	94	21	-2
27/28	12.0	7 52.5	29.13	12.7	1.88	1.44	3.33	Not Observable	49	153	65	1	94	21	-3
28/29	12.0	7 56.4	29.06	12.8	1.89	1.44	3.33	Not Observable	49	141	54	1	94	21	-3
29/30	12.0	8 0.3	28.57	12.8	1.90	1.45	3.33	Not Observable	49	128	42	1	95	21	-3
30/31	12.0	8 4.2	28.49	12.9	1.91	1.46	3.33	Not Observable	49	115	31	1	95	21	-3
31/32	12.0	8 8.0	28.40	12.9	1.93	1.47	3.33	Not Observable	49	103	21	1	95	20	-3

Ephemeris for **81P/Wild 2**

Omega= 41.7870 OMEGA=136.1566 i= 3.2437 q= 1.582196 a= 3.442153
e=0.540347 P= 6.386 T= 1997 May 6.6353 Equinox= 2000
Magnitudes calculated from m= 7.0+5.0*Log(d)+15.0*Log(r)

December 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	8 15.7	16.55	12.8	1.42	2.16	15.34	11.15 to 18.20	127	25	62	1	285	0	0
2/ 3	12.0	8 16.2	16.53	12.7	1.40	2.16	15.30	11.10 to 18.21	128	36	52	1	285	2	0
3/ 4	12.0	8 16.6	16.52	12.7	1.39	2.15	15.27	11.05 to 18.22	129	48	43	1	285	2	0
4/ 5	12.0	8 17.0	16.51	12.7	1.37	2.14	15.23	10.60 to 18.23	130	60	33	1	286	2	0
5/ 6	12.0	8 17.5	16.50	12.6	1.36	2.14	15.20	10.55 to 18.24	131	73	24	1	286	2	0
6/ 7	12.0	8 17.8	16.49	12.6	1.35	2.13	15.16	10.50 to 18.25	132	85	16	1	286	2	0
7/ 8	12.0	8 18.2	16.48	12.5	1.33	2.13	15.13	10.44 to 18.26	133	98	9	1	286	2	0
8/ 9	12.0	8 18.5	16.47	12.5	1.32	2.12	15.09	10.39 to 18.27	133	112	3	1	286	1	0
9/10	12.0	8 18.8	16.46	12.5	1.31	2.11	15.05	10.34 to 18.28	134	126	0	1	286	1	0
10/11	12.0	8 19.1	16.46	12.4	1.29	2.11	15.02	10.29 to 18.29	135	140	0	1	286	1	0
11/12	12.0	8 19.3	16.45	12.4	1.28	2.10	14.58	10.23 to 18.30	136	155	2	1	286	1	0
12/13	12.0	8 19.5	16.45	12.3	1.27	2.10	14.54	10.18 to 18.31	137	169	7	1	286	1	0
13/14	12.0	8 19.7	16.45	12.3	1.25	2.09	14.51	10.13 to 18.32	138	176	14	1	286	1	0
14/15	12.0	8 19.8	16.45	12.3	1.24	2.09	14.47	10.07 to 18.33	139	162	23	1	287	0	0
15/16	12.0	8 19.9	16.45	12.2	1.23	2.08	14.43	10.02 to 18.34	140	147	34	1	287	0	0
16/17	12.0	8 20.0	16.45	12.2	1.21	2.08	14.39	9.57 to 18.34	141	133	46	1	287	0	0
17/18	12.0	8 20.1	16.46	12.1	1.20	2.07	14.35	9.51 to 18.35	142	119	57	1	287	0	0
18/19	12.0	8 20.1	16.46	12.1	1.19	2.06	14.31	9.46 to 18.36	143	106	68	1	287	0	0
19/20	12.0	8 20.1	16.47	12.1	1.18	2.06	14.27	9.40 to 18.36	144	92	77	1	287	0	0
20/21	12.0	8 20.0	16.48	12.0	1.17	2.05	14.23	9.35 to 18.37	145	79	86	1	287	0	0
21/22	12.0	8 20.0	16.49	12.0	1.15	2.05	14.19	9.29 to 18.37	146	66	92	1	287	0	0
22/23	12.0	8 19.9	16.50	11.9	1.14	2.04	14.15	9.23 to 18.38	147	53	97	1	288	0	0
23/24	12.0	8 19.7	16.52	11.9	1.13	2.04	14.11	9.18 to 18.38	148	41	100	1	288	0	0
24/25	12.0	8 19.6	16.53	11.9	1.12	2.03	14.07	9.12 to 18.38	150	28	100	1	288	0	0
25/26	12.0	8 19.4	16.55	11.8	1.11	2.03	14.03	9.07 to 18.39	151	16	99	1	288	-1	0
26/27	12.0	8 19.1	16.57	11.8	1.10	2.02	13.59	9.01 to 18.39	152	4	96	1	288	-1	0
27/28	12.0	8 18.9	16.59	11.7	1.09	2.01	13.55	8.55 to 18.39	153	9	92	1	288	-1	0
28/29	12.0	8 18.6	17.01	11.7	1.08	2.01	13.50	8.49 to 18.39	154	20	85	1	288	-1	0
29/30	12.0	8 18.2	17.03	11.7	1.07	2.00	13.46	8.44 to 18.40	155	32	78	1	289	-1	0
30/31	12.0	8 17.9	17.06	11.6	1.06	2.00	13.42	8.38 to 18.40	156	44	70	1	289	-2	1
31/32	12.0	8 17.5	17.08	11.6	1.05	1.99	13.37	8.32 to 18.40	157	56	61	1	289	-2	1

January 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	8 17.1	17.11	11.6	1.04	1.99	13.33	8.26 to 18.40	158	68	51	1	289	-2	1
2/ 3	12.0	8 16.7	17.14	11.5	1.03	1.98	13.29	8.20 to 18.37	159	81	41	1	290	-2	1
3/ 4	12.0	8 16.2	17.17	11.5	1.02	1.98	13.24	8.15 to 18.34	161	94	31	1	290	-2	1
4/ 5	12.0	8 15.7	17.20	11.4	1.01	1.97	13.20	8.09 to 18.31	162	107	22	1	290	-3	1
5/ 6	12.0	8 15.1	17.24	11.4	1.00	1.97	13.15	8.03 to 18.28	163	121	13	1	291	-3	1
6/ 7	12.0	8 14.6	17.27	11.4	1.00	1.96	13.11	7.57 to 18.25	164	135	6	1	291	-3	1
7/ 8	12.0	8 14.0	17.31	11.3	0.99	1.95	13.06	7.51 to 18.22	165	149	2	1	292	-3	1
8/ 9	12.0	8 13.4	17.35	11.3	0.98	1.95	13.02	7.45 to 18.19	166	164	0	1	292	-3	1
9/10	12.0	8 12.7	17.39	11.3	0.97	1.94	12.57	7.39 to 18.16	167	178	0	1	293	-3	1
10/11	12.0	8 12.1	17.43	11.2	0.97	1.94	12.53	7.33 to 18.12	169	165	4	0	294	-3	1
11/12	12.0	8 11.4	17.47	11.2	0.96	1.93	12.48	7.27 to 18.09	170	150	11	0	295	-4	1
12/13	12.0	8 10.7	17.51	11.2	0.95	1.93	12.43	7.21 to 18.06	171	135	20	0	296	-4	1
13/14	12.0	8 10.0	17.56	11.1	0.94	1.92	12.39	7.15 to 18.03	172	120	30	0	298	-4	1
14/15	12.0	8 9.2	18.00	11.1	0.94	1.92	12.34	7.09 to 17.59	173	106	41	0	300	-4	1

15/16	12.0	8 8.5	18.05	11.1	0.93	1.91	12.29	7.03 to 17.56	174	92	52	0	304	-4	1
16/17	12.0	8 7.7	18.10	11.0	0.93	1.91	12.25	6.57 to 17.53	176	79	63	0	309	-4	1
17/18	12.0	8 6.9	18.15	11.0	0.92	1.90	12.20	6.51 to 17.49	177	66	73	0	318	-4	2
18/19	12.0	8 6.1	18.20	11.0	0.91	1.90	12.15	6.45 to 17.46	178	53	81	0	334	-4	2
19/20	12.0	8 5.3	18.25	10.9	0.91	1.89	12.10	6.38 to 17.42	178	40	88	0	4	-4	2
20/21	12.0	8 4.5	18.30	10.9	0.90	1.89	12.06	6.32 to 17.39	178	28	94	0	40	-4	2
21/22	12.0	8 3.6	18.35	10.9	0.90	1.88	12.01	6.26 to 17.35	177	16	98	0	63	-4	2
22/23	12.0	8 2.8	18.40	10.9	0.89	1.88	11.56	6.20 to 17.32	176	4	100	0	75	-4	2
23/24	12.0	8 2.0	18.46	10.8	0.89	1.87	11.51	6.14 to 17.28	175	10	100	0	82	-4	2
24/25	12.0	8 1.1	18.51	10.8	0.89	1.87	11.46	6.08 to 17.25	174	21	99	0	86	-5	2
25/26	12.0	8 0.3	18.57	10.8	0.88	1.86	11.42	6.02 to 17.21	173	33	96	0	89	-5	2
26/27	12.0	7 59.4	19.02	10.8	0.88	1.86	11.37	6.01 to 17.18	172	46	91	0	91	-4	2
27/28	12.0	7 58.6	19.07	10.7	0.87	1.85	11.32	6.03 to 17.14	170	58	84	1	93	-4	2
28/29	12.0	7 57.7	19.13	10.7	0.87	1.85	11.27	6.05 to 17.10	169	70	77	1	94	-4	2
29/30	12.0	7 56.9	19.18	10.7	0.87	1.84	11.23	6.06 to 17.07	168	82	68	1	95	-4	2
30/31	12.0	7 56.1	19.24	10.7	0.87	1.84	11.18	6.08 to 17.03	167	94	58	1	96	-4	2
31/32	12.0	7 55.3	19.30	10.6	0.86	1.83	11.13	6.09 to 16.59	165	107	48	1	96	-4	2

February 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	7 54.5	19.35	10.6	0.86	1.83	11.08	6.11 to 16.56	164	120	38	1	97	-4	2
2/ 3	12.0	7 53.7	19.41	10.6	0.86	1.82	11.04	6.13 to 16.52	163	134	27	1	97	-4	2
3/ 4	12.0	7 52.9	19.46	10.6	0.86	1.82	10.59	6.14 to 16.48	162	148	18	1	98	-4	2
4/ 5	12.0	7 52.1	19.51	10.5	0.86	1.82	10.54	6.16 to 16.45	161	163	10	1	98	-4	2
5/ 6	12.0	7 51.4	19.57	10.5	0.85	1.81	10.49	6.18 to 16.41	159	176	4	1	98	-4	2
6/ 7	12.0	7 50.7	20.02	10.5	0.85	1.81	10.45	6.19 to 16.37	158	166	0	1	99	-4	2
7/ 8	12.0	7 50.0	20.08	10.5	0.85	1.80	10.40	6.21 to 16.34	157	151	0	2	99	-4	2
8/ 9	12.0	7 49.4	20.13	10.5	0.85	1.80	10.36	6.23 to 16.30	156	136	2	2	99	-3	2
9/10	12.0	7 48.7	20.18	10.5	0.85	1.79	10.31	6.25 to 16.27	155	121	8	2	99	-3	2
10/11	12.0	7 48.1	20.23	10.4	0.85	1.79	10.26	6.26 to 16.23	154	106	16	2	99	-3	2
11/12	12.0	7 47.5	20.28	10.4	0.85	1.78	10.22	6.28 to 16.19	152	91	25	2	99	-3	2
12/13	12.0	7 47.0	20.33	10.4	0.85	1.78	10.18	6.30 to 16.16	151	77	36	2	99	-3	2
13/14	12.0	7 46.5	20.38	10.4	0.85	1.78	10.13	6.32 to 16.12	150	64	46	2	100	-2	2
14/15	12.0	7 46.0	20.43	10.4	0.85	1.77	10.09	6.33 to 16.08	149	51	57	2	100	-2	1
15/16	12.0	7 45.6	20.47	10.4	0.85	1.77	10.04	6.35 to 16.05	148	38	67	2	100	-2	1
16/17	12.0	7 45.2	20.52	10.3	0.85	1.76	9.60	6.37 to 16.01	147	26	76	2	100	-2	1
17/18	12.0	7 44.9	20.57	10.3	0.85	1.76	9.56	6.39 to 15.58	146	14	84	3	100	-2	1
18/19	12.0	7 44.5	21.01	10.3	0.85	1.75	9.51	6.40 to 15.54	145	5	90	3	100	-1	1
19/20	12.0	7 44.3	21.05	10.3	0.85	1.75	9.47	6.42 to 15.51	143	11	95	3	100	-1	1
20/21	12.0	7 44.0	21.09	10.3	0.85	1.75	9.43	6.44 to 15.47	142	23	99	3	100	-1	1
21/22	12.0	7 43.8	21.13	10.3	0.86	1.74	9.39	6.46 to 15.44	141	35	100	3	100	-1	1
22/23	12.0	7 43.7	21.17	10.3	0.86	1.74	9.35	6.48 to 15.40	140	47	100	3	100	0	1
23/24	12.0	7 43.6	21.21	10.3	0.86	1.73	9.31	6.49 to 15.37	139	58	98	3	100	0	1
24/25	12.0	7 43.5	21.25	10.2	0.86	1.73	9.27	6.51 to 15.33	138	70	95	3	100	0	1
25/26	12.0	7 43.5	21.28	10.2	0.86	1.73	9.23	6.53 to 15.30	137	82	89	3	100	0	1
26/27	12.0	7 43.6	21.32	10.2	0.87	1.72	9.19	6.55 to 15.27	136	94	82	3	100	0	1
27/28	12.0	7 43.7	21.35	10.2	0.87	1.72	9.15	6.57 to 15.23	135	107	74	3	101	0	1
28/29	12.0	7 43.8	21.38	10.2	0.87	1.71	9.11	6.58 to 15.20	134	119	65	4	101	0	1

March 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	7 44.0	21.41	10.2	0.87	1.71	9.07	7.00 to 15.17	133	132	54	4	101	1	1
2/ 3	12.0	7 44.2	21.44	10.2	0.87	1.71	9.04	7.02 to 15.13	132	145	44	4	101	1	1
3/ 4	12.0	7 44.5	21.47	10.2	0.88	1.70	9.00	7.04 to 15.10	131	159	33	4	101	1	1
4/ 5	12.0	7 44.8	21.49	10.2	0.88	1.70	8.56	7.06 to 15.07	130	172	22	4	101	1	1
5/ 6	12.0	7 45.2	21.52	10.2	0.88	1.70	8.53	7.08 to 15.04	129	170	13	4	101	2	1
6/ 7	12.0	7 45.6	21.54	10.2	0.89	1.69	8.49	7.09 to 15.01	129	157	6	4	101	2	0
7/ 8	12.0	7 46.1	21.56	10.2	0.89	1.69	8.46	7.11 to 14.57	128	142	1	4	101	2	0
8/ 9	12.0	7 46.6	21.58	10.2	0.89	1.69	8.42	7.13 to 14.54	127	127	0	4	101	3	0
9/10	12.0	7 47.1	21.60	10.2	0.90	1.68	8.39	7.15 to 14.51	126	112	1	4	101	3	0
10/11	12.0	7 47.8	22.01	10.1	0.90	1.68	8.36	7.17 to 14.48	125	97	5	4	101	3	0
11/12	12.0	7 48.4	22.03	10.1	0.90	1.68	8.32	7.19 to 14.45	124	83	12	4	101	3	0
12/13	12.0	7 49.1	22.04	10.1	0.91	1.67	8.29	7.21 to 14.42	123	69	20	5	101	4	0
13/14	12.0	7 49.9	22.05	10.1	0.91	1.67	8.26	7.23 to 14.39	123	56	30	5	101	4	0
14/15	12.0	7 50.7	22.06	10.1	0.91	1.67	8.23	7.24 to 14.36	122	43	40	5	102	4	0
15/16	12.0	7 51.6	22.07	10.1	0.92	1.66	8.20	7.26 to 14.33	121	31	50	5	102	4	0
16/17	12.0	7 52.5	22.08	10.1	0.92	1.66	8.17	7.28 to 14.30	120	19	60	5	102	5	0
17/18	12.0	7 53.4	22.08	10.1	0.93	1.66	8.14	7.30 to 14.27	119	9	69	5	102	5	0
18/19	12.0	7 54.4	22.08	10.1	0.93	1.65	8.11	7.32 to 14.24	119	8	78	5	102	5	0
19/20	12.0	7 55.4	22.08	10.1	0.93	1.65	8.08	7.34 to 14.22	118	18	85	5	102	5	0
20/21	12.0	7 56.5	22.08	10.1	0.94	1.65	8.05	7.36 to 14.19	117	29	91	5	102	6	0
21/22	12.0	7 57.6	22.08	10.1	0.94	1.65	8.02	7.38 to 14.16	116	40	96	5	102	6	0
22/23	12.0	7 58.8	22.08	10.1	0.95	1.64	7.59	7.40 to 14.13	116	52	99	5	102	6	0
23/24	12.0	8 0.0	22.07	10.1	0.95	1.64	7.57	7.42 to 14.10	115	64	100	5	102	6	0
24/25	12.0	8 1.3	22.06	10.1	0.95	1.64	7.54	7.44 to 14.08	114	75	100	5	103	7	0
25/26	12.0	8 2.5	22.05	10.1	0.96	1.64	7.51	7.46 to 14.05	113	87	97	5	103	7	0
26/27	12.0	8 3.9	22.04	10.1	0.96	1.63	7.49	7.48 to 14.02	113	99	93	5	103	7	0
27/28	12.0	8 5.2	22.02	10.1	0.97	1.63	7.46	7.50 to 13.59	112	112	87	5	103	7	0
28/29	12.0	8 6.7	22.01	10.1	0.97	1.63	7.44	7.52 to 13.57	111	124	79	5	103	8	0
29/30	12.0	8 8.1	21.59	10.1	0.98	1.63	7.41	7.54 to 13.54	111	137	70	5	103	8	0
30/31	12.0	8 9.6	21.57	10.1	0.98	1.62	7.39	7.56 to 13.51	110	149	59	5	103	8	0
31/32	12.0	8 11.1	21.55	10.1	0.99	1.62	7.36	7.58 to 13.49	110	162	48	5	103	8	0

April 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	8 12.7	21.52	10.1	0.99	1.62	7.34	8.01 to 13.46	109	173	37	6	103	9	0
2/ 3	12.0	8 14.3	21.50	10.1	1.00	1.62	7.32	8.03 to 13.43	108	168	26	6	104	9	-1
3/ 4	12.0	8 15.9	21.47	10.1	1.00	1.62	7.29	8.05 to 13.41	108	154	16	6	104	9	-1
4/ 5	12.0	8 17.6	21.44	10.1	1.01	1.61	7.27	8.07 to 13.38	107	140	8	6	104	9	-1
5/ 6	12.0	8 19.3	21.41	10.1	1.01	1.61	7.25	8.09 to 13.35	106	126	3	6	104	9	-1
6/ 7	12.0	8 21.0	21.37	10.1	1.02	1.61	7.23	8.11 to 13.33	106	112	0	6	104	10	-1
7/ 8	12.0	8 22.8	21.34	10.1	1.02	1.61	7.20	8.14 to 13.30	105	97	0	6	104	10	-1
8/ 9	12.0	8 24.6	21.30	10.1	1.03	1.61	7.18	8.16 to 13.28	105	83	3	6	104	10	-1
9/10	12.0	8 26.4	21.26	10.1	1.03	1.60	7.16	8.18 to 13.25	104	70	8	6	105	10	-1

10/11	12.0	8 28.2	21.22	10.2	1.04	1.60	7.14	8.20 to 13.22	104	57	15	6	105	10	-1
11/12	12.0	8 30.1	21.17	10.2	1.04	1.60	7.12	8.23 to 13.20	103	44	24	6	105	10	-1
12/13	12.0	8 32.0	21.12	10.2	1.05	1.60	7.10	8.25 to 13.17	103	32	33	6	105	11	-1
13/14	12.0	8 34.0	21.08	10.2	1.05	1.60	7.08	8.27 to 13.15	102	21	43	6	105	11	-2
14/15	12.0	8 35.9	21.02	10.2	1.06	1.60	7.06	8.29 to 13.12	102	10	53	6	105	11	-2
15/16	12.0	8 37.9	20.57	10.2	1.06	1.60	7.04	8.32 to 13.10	101	7	62	6	105	11	-2
16/17	12.0	8 40.0	20.52	10.2	1.07	1.59	7.02	8.34 to 13.07	101	16	71	6	105	11	-2
17/18	12.0	8 42.0	20.46	10.2	1.07	1.59	7.00	8.36 to 13.04	100	27	80	6	106	11	-2
18/19	12.0	8 44.1	20.40	10.2	1.08	1.59	6.58	8.39 to 13.02	100	38	87	6	106	12	-2
19/20	12.0	8 46.2	20.34	10.2	1.08	1.59	6.56	8.41 to 12.59	99	49	93	6	106	12	-2
20/21	12.0	8 48.3	20.27	10.2	1.09	1.59	6.55	8.44 to 12.57	99	61	97	6	106	12	-2
21/22	12.0	8 50.4	20.21	10.2	1.10	1.59	6.53	8.46 to 12.54	98	73	100	6	106	12	-2
22/23	12.0	8 52.6	20.14	10.2	1.10	1.59	6.51	8.49 to 12.52	98	84	100	6	106	12	-2
23/24	12.0	8 54.8	20.07	10.2	1.11	1.59	6.49	8.51 to 12.49	97	97	99	6	106	12	-2
24/25	12.0	8 57.0	19.59	10.2	1.11	1.59	6.47	8.54 to 12.46	97	109	96	6	107	12	-3
25/26	12.0	8 59.2	19.52	10.2	1.12	1.59	6.46	8.56 to 12.44	96	121	90	6	107	13	-3
26/27	12.0	9 1.4	19.44	10.3	1.12	1.59	6.44	8.59 to 12.41	96	134	83	6	107	13	-3
27/28	12.0	9 3.7	19.36	10.3	1.13	1.58	6.42	9.01 to 12.39	96	147	73	6	107	13	-3
28/29	12.0	9 6.0	19.28	10.3	1.14	1.58	6.41	9.04 to 12.36	95	160	63	6	107	13	-3
29/30	12.0	9 8.2	19.20	10.3	1.14	1.58	6.39	9.07 to 12.33	95	171	52	6	107	13	-3
30/31	12.0	9 10.5	19.11	10.3	1.15	1.58	6.37	9.09 to 12.31	94	170	40	6	108	13	-3

May 1997 Times in GMAT

									Elong		Moon	Comet			
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
1/ 2	12.0	9 12.9	19.02	10.3	1.15	1.58	6.36	9.12 to 12.28	94	158	29	6	108	13	-3
2/ 3	12.0	9 15.2	18.53	10.3	1.16	1.58	6.34	9.14 to 12.25	94	144	19	6	108	13	-3
3/ 4	12.0	9 17.5	18.44	10.3	1.17	1.58	6.33	9.17 to 12.23	93	131	10	6	108	13	-3
4/ 5	12.0	9 19.9	18.35	10.3	1.17	1.58	6.31	9.20 to 12.20	93	117	4	6	108	13	-3
5/ 6	12.0	9 22.3	18.25	10.3	1.18	1.58	6.29	9.23 to 12.17	92	103	0	6	108	14	-4
6/ 7	12.0	9 24.7	18.15	10.4	1.18	1.58	6.28	9.25 to 12.14	92	90	0	6	108	14	-4
7/ 8	12.0	9 27.1	18.05	10.4	1.19	1.58	6.26	9.28 to 12.12	92	77	1	6	108	14	-4
8/ 9	12.0	9 29.5	17.55	10.4	1.20	1.58	6.25	9.31 to 12.09	91	64	5	5	109	14	-4
9/10	12.0	9 31.9	17.45	10.4	1.20	1.58	6.23	9.34 to 12.06	91	51	11	5	109	14	-4
10/11	12.0	9 34.3	17.34	10.4	1.21	1.58	6.22	9.37 to 12.04	90	39	19	5	109	14	-4
11/12	12.0	9 36.8	17.23	10.4	1.22	1.58	6.20	9.39 to 12.01	90	28	27	5	109	14	-4
12/13	12.0	9 39.2	17.12	10.4	1.22	1.58	6.19	9.42 to 11.58	90	17	36	5	109	14	-4
13/14	12.0	9 41.7	17.01	10.4	1.23	1.58	6.17	9.45 to 11.55	89	7	46	5	109	14	-4
14/15	12.0	9 44.2	16.50	10.5	1.24	1.58	6.16	9.48 to 11.52	89	9	55	5	109	14	-4
15/16	12.0	9 46.6	16.38	10.5	1.24	1.58	6.14	9.51 to 11.49	89	19	65	5	110	14	-4
16/17	12.0	9 49.1	16.27	10.5	1.25	1.59	6.13	9.54 to 11.47	88	30	74	5	110	14	-4
17/18	12.0	9 51.6	16.15	10.5	1.26	1.59	6.11	9.57 to 11.44	88	41	82	5	110	14	-4
18/19	12.0	9 54.1	16.03	10.5	1.26	1.59	6.10	9.60 to 11.41	88	53	89	5	110	15	-5
19/20	12.0	9 56.6	15.50	10.5	1.27	1.59	6.08	10.03 to 11.38	87	64	94	5	110	15	-5
20/21	12.0	9 59.1	15.38	10.5	1.28	1.59	6.07	10.06 to 11.35	87	77	98	5	110	15	-5
21/22	12.0	10 1.6	15.25	10.6	1.28	1.59	6.06	10.09 to 11.32	87	89	100	5	110	15	-5
22/23	12.0	10 4.2	15.12	10.6	1.29	1.59	6.04	10.11 to 11.29	86	101	100	5	110	15	-5
23/24	12.0	10 6.7	14.60	10.6	1.30	1.59	6.03	10.14 to 11.26	86	114	97	5	110	15	-5
24/25	12.0	10 9.2	14.46	10.6	1.30	1.59	6.01	10.17 to 11.23	86	127	92	5	111	15	-5
25/26	12.0	10 11.7	14.33	10.6	1.31	1.59	5.60	10.20 to 11.20	86	141	85	5	111	15	-5
26/27	12.0	10 14.3	14.20	10.6	1.32	1.60	5.58	10.23 to 11.17	85	154	76	5	111	15	-5
27/28	12.0	10 16.8	14.06	10.7	1.33	1.60	5.57	10.26 to 11.14	85	167	65	5	111	15	-5
28/29	12.0	10 19.3	13.53	10.7	1.33	1.60	5.56	10.29 to 11.11	85	175	54	5	111	15	-5
29/30	12.0	10 21.9	13.39	10.7	1.34	1.60	5.54	10.32 to 11.08	84	164	42	5	111	15	-5
30/31	12.0	10 24.4	13.25	10.7	1.35	1.60	5.53	10.35 to 11.05	84	151	31	5	111	15	-5
31/32	12.0	10 27.0	13.11	10.7	1.36	1.60	5.51	10.38 to 11.02	84	138	21	5	111	15	-5

Ephemeris for **126P/IRAS (1996 P1)**

Omega=356.8876 OMEGA=357.7007 i= 45.9617 q= 1.702690 a= 5.611827
e=0.696589 P= 13.294 T= 1996 October 29.9968 Equinox= 2000
Magnitudes calculated from m= 8.5+5.0*Log(d)+15.0*Log(r)

November 1996 Times in GMAT

									Elong		Moon	Comet			
Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
1/ 2	12.0	21 36.7	-15.44	12.3	1.19	1.70	6.53	Not Observable	102	153	63	2	71	0	0
2/ 3	12.0	21 37.1	-15.04	12.4	1.20	1.70	6.50	Not Observable	101	165	53	1	71	2	16
3/ 4	12.0	21 37.6	-14.24	12.4	1.21	1.70	6.46	Not Observable	101	175	44	1	71	3	16
4/ 5	12.0	21 38.2	-13.44	12.4	1.22	1.70	6.43	Not Observable	100	171	34	1	71	3	16
5/ 6	12.0	21 38.7	-13.06	12.4	1.23	1.70	6.39	Not Observable	99	160	26	1	71	3	16
6/ 7	12.0	21 39.3	-12.27	12.5	1.24	1.70	6.36	Not Observable	99	148	17	1	71	3	16
7/ 8	12.0	21 39.9	-11.49	12.5	1.26	1.71	6.33	Not Observable	98	136	10	1	71	3	15
8/ 9	12.0	21 40.6	-11.11	12.5	1.27	1.71	6.29	Not Observable	97	123	5	1	71	3	15
9/10	12.0	21 41.3	-10.34	12.5	1.28	1.71	6.26	Not Observable	97	111	1	1	71	4	15
10/11	12.0	21 42.0	-9.58	12.5	1.29	1.71	6.23	5.53 to 6.52	96	98	0	1	71	4	15
11/12	12.0	21 42.7	-9.21	12.6	1.30	1.71	6.20	5.37 to 7.06	96	84	0	1	71	4	15
12/13	12.0	21 43.5	-8.45	12.6	1.31	1.71	6.16	5.36 to 7.14	95	71	4	1	71	4	14
13/14	12.0	21 44.2	-8.10	12.6	1.32	1.71	6.13	5.34 to 7.21	94	57	9	1	71	4	14
14/15	12.0	21 45.0	-7.35	12.6	1.34	1.71	6.10	5.33 to 7.26	94	43	17	1	71	4	14
15/16	12.0	21 45.9	-7.00	12.7	1.35	1.71	6.07	5.32 to 7.30	93	29	27	1	71	5	14
16/17	12.0	21 46.7	-6.26	12.7	1.36	1.71	6.04	5.31 to 7.33	92	16	38	1	71	5	14
17/18	12.0	21 47.6	-5.52	12.7	1.37	1.72	6.01	5.30 to 7.36	92	4	49	1	70	5	14
18/19	12.0	21 48.5	-5.19	12.7	1.38	1.72	5.58	5.29 to 7.38	91	13	61	1	70	5	13
19/20	12.0	21 49.4	-4.46	12.8	1.40	1.72	5.55	5.28 to 7.40	91	26	72	1	70	5	13
20/21	12.0	21 50.3	-4.13	12.8	1.41	1.72	5.52	5.27 to 7.42	90	40	81	1	70	5	13
21/22	12.0	21 51.3	-3.41	12.8	1.42	1.72	5.49	5.26 to 7.43	89	53	89	1	70	5	13
22/23	12.0	21 52.3	-3.09	12.8	1.43	1.72	5.46	5.25 to 7.44	89	66	95	1	70	6	13
23/24	12.0	21 53.2	-2.37	12.8	1.44	1.72	5.43	5.24 to 7.45	88	79	99	1	69	6	13
24/25	12.0	21 54.3	-2.06	12.9	1.46	1.73	5.40	5.23 to 7.46	88	92	100	1	69	6	13
25/26	12.0	21 55.3	-1.35	12.9	1.47	1.73	5.37	5.23 to 7.46	87	104	100	1	69	6	12
26/27	12.0	21 56.3	-1.04	12.9	1.48	1.73	5.34	5.22 to 7.47	87	116	97	1	69	6	12
27/28	12.0	21 57.4	-0.34	13.0	1.50	1.73	5.31	5.21 to 7.47	86	128	92	1	69	6	12
28/29	12.0	21 58.5	-0.04	13.0	1.51	1.73	5.28	5.21 to 7.47	85	139	86	1	68	6	12
29/30	12.0	21 59.6	0.26	13.0	1.52	1.74	5.25	5.20 to 7.47	85	151	79	1	68	6	12
30/31	12.0	22 0.7	0.56	13.0	1.53	1.74	5.23	5.19 to 7.47	84	161	71	1	68	6	12

December 1996 Times in GMAT

Day	Time	R.A. B1950		Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	22	1.8	1.25	13.1	1.55	1.74	5.20	5.19 to 7.46	84	169	62	1	68	7	12
2/ 3	12.0	22	3.0	1.54	13.1	1.56	1.74	5.17	5.19 to 7.46	83	168	52	1	67	7	12
3/ 4	12.0	22	4.1	2.22	13.1	1.57	1.75	5.14	5.18 to 7.45	83	159	43	1	67	7	11
4/ 5	12.0	22	5.3	2.51	13.1	1.58	1.75	5.11	5.18 to 7.45	82	149	33	1	67	7	11
5/ 6	12.0	22	6.5	3.19	13.2	1.60	1.75	5.09	5.18 to 7.44	82	137	24	1	67	7	11
6/ 7	12.0	22	7.7	3.47	13.2	1.61	1.75	5.06	5.17 to 7.43	81	125	16	1	66	7	11
7/ 8	12.0	22	8.9	4.14	13.2	1.62	1.76	5.03	5.17 to 7.43	81	113	9	1	66	7	11
8/ 9	12.0	22	10.1	4.42	13.2	1.64	1.76	5.00	5.17 to 7.42	80	100	3	1	66	7	11
9/10	12.0	22	11.4	5.09	13.3	1.65	1.76	4.58	5.17 to 7.41	80	87	0	1	65	7	11
10/11	12.0	22	12.6	5.36	13.3	1.66	1.76	4.55	5.17 to 7.40	79	73	0	1	65	7	11
11/12	12.0	22	13.9	6.03	13.3	1.68	1.77	4.52	5.17 to 7.39	79	60	2	1	65	7	11
12/13	12.0	22	15.2	6.29	13.4	1.69	1.77	4.50	5.17 to 7.38	78	46	7	1	65	7	11
13/14	12.0	22	16.5	6.55	13.4	1.70	1.77	4.47	5.17 to 7.37	78	33	14	1	64	8	10
14/15	12.0	22	17.8	7.21	13.4	1.71	1.78	4.44	5.17 to 7.35	77	22	23	1	64	8	10
15/16	12.0	22	19.1	7.47	13.4	1.73	1.78	4.42	5.18 to 7.34	77	15	34	1	64	8	10
16/17	12.0	22	20.5	8.13	13.5	1.74	1.78	4.39	5.18 to 7.33	76	19	46	1	63	8	10
17/18	12.0	22	21.8	8.39	13.5	1.75	1.79	4.37	5.18 to 7.31	76	29	57	1	63	8	10
18/19	12.0	22	23.2	9.04	13.5	1.77	1.79	4.34	5.19 to 7.30	75	41	68	1	63	8	10
19/20	12.0	22	24.6	9.29	13.6	1.78	1.79	4.31	5.19 to 7.29	75	53	77	1	62	8	10
20/21	12.0	22	25.9	9.54	13.6	1.79	1.80	4.29	5.19 to 7.27	74	65	86	1	62	8	10
21/22	12.0	22	27.3	10.19	13.6	1.81	1.80	4.26	5.20 to 7.26	74	77	92	1	62	8	10
22/23	12.0	22	28.7	10.44	13.6	1.82	1.80	4.24	5.20 to 7.24	73	88	97	1	61	8	10
23/24	12.0	22	30.2	11.08	13.7	1.83	1.81	4.21	5.21 to 7.23	73	100	100	1	61	8	10
24/25	12.0	22	31.6	11.33	13.7	1.85	1.81	4.19	5.22 to 7.21	72	111	100	1	61	8	10
25/26	12.0	22	33.0	11.57	13.7	1.86	1.81	4.16	5.22 to 7.19	72	122	99	1	60	8	10
26/27	12.0	22	34.5	12.21	13.7	1.87	1.82	4.14	5.23 to 7.18	71	133	96	1	60	8	10
27/28	12.0	22	35.9	12.45	13.8	1.88	1.82	4.11	5.24 to 7.16	71	143	92	1	59	8	9
28/29	12.0	22	37.4	13.09	13.8	1.90	1.82	4.09	5.25 to 7.14	71	152	85	1	59	8	9
29/30	12.0	22	38.9	13.33	13.8	1.91	1.83	4.06	5.25 to 7.13	70	159	78	1	59	8	9
30/31	12.0	22	40.4	13.56	13.9	1.92	1.83	4.04	5.26 to 7.11	70	161	70	1	58	9	9
31/32	12.0	22	41.9	14.20	13.9	1.94	1.84	4.01	5.27 to 7.09	69	157	61	1	58	9	9

Ephemeris for **Hale-Bopp 1995 O1**

Omega=130.5902 OMEGA=282.4707 i= 89.4290 q= 0.914113 a=186.667960
e=0.995103 P= 2550.379 T= 1997 April 1.1339 Equinox= 2000
Magnitudes calculated from m=-0.5+5.0*Log(d)+ 7.5*Log(r)

November 1996 Times in GMAT

Day	Time	R.A. B1950		Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	17	37.8	-3.14	4.9	3.05	2.50	2.54	5.52 to 8.05	48	146	63	82	73	0	0
2/ 3	12.0	17	38.4	-3.10	4.9	3.05	2.49	2.51	5.50 to 8.03	48	135	53	82	72	3	1
3/ 4	12.0	17	39.0	-3.05	4.9	3.05	2.48	2.47	5.49 to 7.60	47	124	44	83	72	3	1
4/ 5	12.0	17	39.7	-3.01	4.9	3.05	2.47	2.44	5.47 to 7.57	46	113	34	83	71	4	1
5/ 6	12.0	17	40.3	-2.57	4.8	3.05	2.45	2.41	5.46 to 7.54	45	102	26	83	70	4	1
6/ 7	12.0	17	41.0	-2.53	4.8	3.04	2.44	2.38	5.44 to 7.52	45	90	17	83	70	4	1
7/ 8	12.0	17	41.7	-2.48	4.8	3.04	2.43	2.34	5.43 to 7.49	44	78	10	83	69	4	1
8/ 9	12.0	17	42.4	-2.44	4.8	3.04	2.42	2.31	5.41 to 7.46	43	66	5	84	68	4	1
9/10	12.0	17	43.1	-2.39	4.8	3.04	2.41	2.28	5.40 to 7.43	43	54	1	84	67	4	1
10/11	12.0	17	43.9	-2.34	4.8	3.03	2.39	2.25	5.38 to 7.41	42	42	0	84	67	4	1
11/12	12.0	17	44.6	-2.30	4.7	3.03	2.38	2.21	5.37 to 7.38	41	30	0	84	66	4	1
12/13	12.0	17	45.4	-2.25	4.7	3.03	2.37	2.18	5.36 to 7.36	41	20	4	84	65	4	2
13/14	12.0	17	46.2	-2.20	4.7	3.02	2.36	2.15	5.34 to 7.33	40	16	9	85	64	4	2
14/15	12.0	17	47.0	-2.15	4.7	3.02	2.34	2.12	5.33 to 7.30	40	22	17	85	63	4	2
15/16	12.0	17	47.8	-2.09	4.7	3.02	2.33	2.09	5.32 to 7.28	39	34	27	85	62	5	2
16/17	12.0	17	48.6	-2.04	4.6	3.01	2.32	2.06	5.31 to 7.25	38	46	38	85	61	5	2
17/18	12.0	17	49.4	-1.59	4.6	3.01	2.31	2.03	5.30 to 7.23	38	59	49	85	60	5	2
18/19	12.0	17	50.3	-1.53	4.6	3.00	2.29	1.60	5.29 to 7.21	37	72	61	86	59	5	2
19/20	12.0	17	51.1	-1.47	4.6	3.00	2.28	1.56	5.28 to 7.18	37	86	72	86	58	5	2
20/21	12.0	17	52.0	-1.42	4.5	2.99	2.27	1.53	5.27 to 7.16	36	99	81	86	57	5	2
21/22	12.0	17	52.9	-1.36	4.5	2.99	2.26	1.50	5.26 to 7.13	36	112	89	87	56	5	2
22/23	12.0	17	53.8	-1.30	4.5	2.98	2.24	1.47	5.25 to 7.11	35	124	95	87	55	5	2
23/24	12.0	17	54.7	-1.24	4.5	2.97	2.23	1.44	5.24 to 7.09	35	136	99	87	54	5	2
24/25	12.0	17	55.7	-1.17	4.5	2.97	2.22	1.41	5.23 to 7.06	34	147	100	88	53	5	2
25/26	12.0	17	56.6	-1.11	4.4	2.96	2.21	1.38	5.23 to 7.04	34	157	100	88	52	5	2
26/27	12.0	17	57.6	-1.04	4.4	2.95	2.19	1.35	5.22 to 7.02	33	162	97	88	51	5	2
27/28	12.0	17	58.5	-0.58	4.4	2.95	2.18	1.32	5.21 to 6.60	33	160	92	89	50	6	2
28/29	12.0	17	59.5	-0.51	4.4	2.94	2.17	1.29	5.21 to 6.57	32	153	86	89	48	6	2
29/30	12.0	18	0.5	-0.44	4.3	2.93	2.16	1.26	5.20 to 6.55	32	143	79	90	47	6	2
30/31	12.0	18	1.5	-0.37	4.3	2.93	2.14	1.23	5.19 to 6.53	31	133	71	91	46	6	2

December 1996 Times in GMAT

Day	Time	R.A. B1950		Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	18	2.6	-0.29	4.3	2.92	2.13	1.21	5.19 to 6.51	31	122	62	91	44	6	3
2/ 3	12.0	18	3.6	-0.22	4.3	2.91	2.12	1.18	5.19 to 6.49	31	111	52	92	43	6	3
3/ 4	12.0	18	4.7	-0.14	4.2	2.90	2.11	1.15	5.18 to 6.47	30	100	43	93	42	6	3
4/ 5	12.0	18	5.7	-0.07	4.2	2.89	2.09	1.12	5.18 to 6.45	30	89	33	93	40	6	3
5/ 6	12.0	18	6.8	0.01	4.2	2.88	2.08	1.09	5.18 to 6.43	29	77	24	94	39	6	3
6/ 7	12.0	18	7.9	0.10	4.2	2.87	2.07	1.06	5.17 to 6.41	29	66	16	95	37	6	3
7/ 8	12.0	18	9.0	0.18	4.1	2.86	2.06	1.03	5.17 to 6.39	29	54	9	96	36	6	3
8/ 9	12.0	18	10.1	0.26	4.1	2.85	2.04	1.00	5.17 to 6.37	29	42	3	97	34	7	3
9/10	12.0	18	11.3	0.35	4.1	2.84	2.03	0.58	5.17 to 6.35	28	30	0	98	33	7	3
10/11	12.0	18	12.4	0.44	4.0	2.83	2.02	0.55	5.17 to 6.33	28	22	0	99	31	7	3
11/12	12.0	18	13.6	0.53	4.0	2.82	2.01	0.52	5.17 to 6.32	28	20	2	101	30	7	3
12/13	12.0	18	14.8	1.02	4.0	2.81	1.99	0.49	5.17 to 6.30	28	26	7	102	28	7	3
13/14	12.0	18	16.0	1.12	4.0	2.80	1.98	0.47	5.17 to 6.28	28	37	14	104	27	7	3
14/15	12.0	18	17.2	1.22	3.9	2.79	1.97	0.44	5.17 to 6.26	27	50	23	105	25	7	4
15/16	12.0	18	18.4	1.31	3.9	2.78	1.96	0.41	5.18 to 6.25	27	63	34	107	23	7	4
16/17	12.0	18	19.6	1.42	3.9	2.77	1.94	0.38	5.18 to 6.23	27	76	46	109	22	7	4
17/18	12.0	18	20.9	1.52	3.8	2.75	1.93	0.36	5.18 to 6.22	27	88	57	111	20	7	4
18/19	12.0	18	22.1	2.03	3.8	2.74	1.92	0.33	5.19 to 6.20	27	101	68	113	18	7	4
19/20	12.0	18	23.4	2.13	3.8	2.73	1.90	0.30	5.19 to 6.18	27	113	77	115	17	7	4

20/21	12.0	18 24.7	2.24	3.7	2.72	1.89	0.28	5.19 to 6.17	27	125	86	118	15	8	4
21/22	12.0	18 26.0	2.36	3.7	2.70	1.88	0.25	5.20 to 6.16 18.35 to 18.37	27	136	92	120	14	8	4
22/23	12.0	18 27.4	2.47	3.7	2.69	1.87	0.22	5.20 to 6.14 18.31 to 18.38	27	146	97	123	12	8	4
23/24	12.0	18 28.7	2.59	3.6	2.68	1.85	0.20	5.21 to 6.13 18.27 to 18.38	27	154	100	126	10	8	4
24/25	12.0	18 30.0	3.11	3.6	2.66	1.84	0.17	5.22 to 6.11 18.23 to 18.38	27	158	100	129	9	8	5
25/26	12.0	18 31.4	3.24	3.6	2.65	1.83	0.15	5.22 to 6.10 18.19 to 18.39	27	157	99	132	7	8	5
26/27	12.0	18 32.8	3.36	3.5	2.64	1.82	0.12	5.23 to 6.09 18.15 to 18.39	27	150	96	136	6	8	5
27/28	12.0	18 34.2	3.49	3.5	2.62	1.80	0.10	5.24 to 6.08 18.12 to 18.39	27	142	92	139	4	8	5
28/29	12.0	18 35.6	4.02	3.5	2.61	1.79	0.07	5.25 to 6.06 18.08 to 18.39	27	132	85	143	3	8	5
29/30	12.0	18 37.1	4.16	3.4	2.59	1.78	0.05	5.25 to 6.05 18.04 to 18.40	27	122	78	147	1	8	5
30/31	12.0	18 38.5	4.30	3.4	2.58	1.77	0.02	5.26 to 6.04 17.60 to 18.40	28	112	70	152	359	9	5
31/32	12.0	18 40.0	4.44	3.4	2.56	1.75	23.60	5.27 to 6.03 17.56 to 18.40	28	101	61	156	358	9	5

January 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	18 41.5	4.58	3.3	2.55	1.74	23.57	5.28 to 6.02 17.52 to 18.40	28	90	51	161	357	9	6
2/ 3	12.0	18 43.0	5.13	3.3	2.53	1.73	23.55	5.29 to 6.01 17.48 to 18.40	28	80	41	166	355	9	6
3/ 4	12.0	18 44.6	5.28	3.3	2.51	1.71	23.52	5.30 to 6.00 17.44 to 18.40	28	68	31	172	354	9	6
4/ 5	12.0	18 46.1	5.43	3.2	2.50	1.70	23.50	5.31 to 5.60 17.40 to 18.39	29	57	22	177	353	9	6
5/ 6	12.0	18 47.7	5.59	3.2	2.48	1.69	23.48	5.32 to 5.59 17.36 to 18.39	29	46	13	183	351	9	6
6/ 7	12.0	18 49.3	6.15	3.1	2.47	1.68	23.45	5.33 to 5.58 17.32 to 18.39	29	35	6	189	350	9	6
7/ 8	12.0	18 50.9	6.32	3.1	2.45	1.66	23.43	5.35 to 5.57 17.28 to 18.39	29	27	2	196	349	10	6
8/ 9	12.0	18 52.6	6.48	3.1	2.43	1.65	23.41	5.36 to 5.57 17.24 to 18.38	30	25	0	203	348	10	7
9/10	12.0	18 54.2	7.06	3.0	2.42	1.64	23.38	5.37 to 5.56 17.20 to 18.38	30	29	0	210	346	10	7
10/11	12.0	18 55.9	7.23	3.0	2.40	1.63	23.36	5.38 to 5.56 17.16 to 18.37	30	39	4	217	345	10	7
11/12	12.0	18 57.6	7.41	2.9	2.38	1.61	23.34	5.39 to 5.55 17.12 to 18.37	31	51	11	225	344	10	7
12/13	12.0	18 59.3	7.60	2.9	2.36	1.60	23.32	5.41 to 5.55 17.08 to 18.36	31	63	20	233	343	10	7
13/14	12.0	19 1.1	8.19	2.9	2.35	1.59	23.29	5.42 to 5.55 17.04 to 18.36	31	75	30	242	342	10	7
14/15	12.0	19 2.9	8.38	2.8	2.33	1.58	23.27	5.43 to 5.55 16.60 to 18.35	32	87	41	250	341	11	8
15/16	12.0	19 4.7	8.58	2.8	2.31	1.56	23.25	5.45 to 5.54 16.56 to 18.35	32	99	52	260	340	11	8
16/17	12.0	19 6.5	9.18	2.7	2.29	1.55	23.23	5.46 to 5.54 16.52 to 18.34	32	110	63	269	339	11	8
17/18	12.0	19 8.4	9.39	2.7	2.27	1.54	23.21	5.48 to 5.54 16.47 to 18.33	33	121	73	279	338	11	8
18/19	12.0	19 10.3	9.60	2.6	2.25	1.53	23.19	5.49 to 5.54 16.43 to 18.32	33	131	81	290	337	11	8
19/20	12.0	19 12.2	10.21	2.6	2.24	1.51	23.17	5.51 to 5.55 16.39 to 18.31	33	140	88	301	336	11	8
20/21	12.0	19 14.2	10.43	2.6	2.22	1.50	23.15	5.52 to 5.55 16.35 to 18.30	34	147	94	312	336	12	9
21/22	12.0	19 16.2	11.06	2.5	2.20	1.49	23.13	5.54 to 5.55 16.31 to 18.30	34	151	98	324	335	12	9
22/23	12.0	19 18.2	11.29	2.5	2.18	1.48	23.11	5.55 to 5.56 16.26 to 18.29	34	151	100	337	334	12	9
23/24	12.0	19 20.3	11.53	2.4	2.16	1.46	23.09	16.22 to 18.28	35	148	100	349	333	12	9
24/25	12.0	19 22.4	12.17	2.4	2.14	1.45	23.07	16.18 to 18.26	35	141	99	363	333	12	10
25/26	12.0	19 24.5	12.42	2.3	2.12	1.44	23.05	16.13 to 18.25	36	133	96	377	332	13	10
26/27	12.0	19 26.7	13.07	2.3	2.10	1.43	23.04	16.09 to 18.24	36	125	91	391	331	13	10
27/28	12.0	19 28.9	13.33	2.2	2.08	1.42	23.02	16.05 to 18.23	36	115	84	406	331	13	10
28/29	12.0	19 31.2	13.59	2.2	2.06	1.40	23.00	16.00 to 18.22	37	106	77	422	330	13	11
29/30	12.0	19 33.5	14.26	2.1	2.04	1.39	22.59	15.56 to 18.20	37	96	68	438	330	13	11
30/31	12.0	19 35.9	14.54	2.1	2.02	1.38	22.57	15.51 to 18.19	38	86	58	454	329	14	11
31/32	12.0	19 38.3	15.22	2.0	2.00	1.37	22.55	15.47 to 18.18	38	76	48	472	329	14	11

February 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	19 40.7	15.51	2.0	1.98	1.36	22.54	15.42 to 18.16	38	66	38	490	328	14	12
2/ 3	12.0	19 43.2	16.21	1.9	1.96	1.34	22.53	15.38 to 18.15	39	56	27	508	328	15	12
3/ 4	12.0	19 45.8	16.51	1.9	1.94	1.33	22.51	15.33 to 18.13	39	47	18	527	327	15	12
4/ 5	12.0	19 48.4	17.22	1.8	1.93	1.32	22.50	15.28 to 18.12	39	39	10	547	327	15	12
5/ 6	12.0	19 51.1	17.53	1.8	1.91	1.31	22.49	15.24 to 18.10	40	35	4	568	327	16	13
6/ 7	12.0	19 53.9	18.26	1.7	1.89	1.30	22.47	15.19 to 18.09	40	35	0	589	326	16	13
7/ 8	12.0	19 56.7	18.59	1.7	1.87	1.29	22.46	15.14 to 18.07	40	40	0	611	326	16	13
8/ 9	12.0	19 59.6	19.32	1.6	1.85	1.27	22.45	15.09 to 18.06	41	48	2	633	326	17	14
9/10	12.0	20 2.6	20.07	1.6	1.83	1.26	22.44	15.04 to 18.04	41	58	8	657	326	17	14
10/11	12.0	20 5.7	20.42	1.5	1.81	1.25	22.43	6.26 to 6.27 14.59 to 18.02	41	68	16	681	326	17	14
11/12	12.0	20 8.8	21.17	1.5	1.79	1.24	22.43	6.28 to 6.31 14.54 to 18.00	42	79	25	705	325	18	14
12/13	12.0	20 12.0	21.54	1.4	1.77	1.23	22.42	6.30 to 6.35 14.49 to 17.59	42	89	36	730	325	18	15

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
13/14	12.0	20 15.3	22.31	1.4	1.75	1.22	22.41	6.32 to 6.38 14.44 to 17.57	42	99	46	756	325	19	15
14/15	12.0	20 18.7	23.09	1.3	1.73	1.21	22.41	6.33 to 6.43 14.39 to 17.55	43	108	57	783	325	19	15
15/16	12.0	20 22.3	23.48	1.3	1.71	1.20	22.40	6.35 to 6.47 14.33 to 17.53	43	116	67	810	325	20	16
16/17	12.0	20 25.9	24.27	1.2	1.69	1.19	22.40	6.37 to 6.52 14.28 to 17.51	43	124	76	838	325	20	16
17/18	12.0	20 29.6	25.07	1.1	1.67	1.17	22.40	6.39 to 6.57 14.22 to 17.49	44	130	84	867	325	21	16
18/19	12.0	20 33.4	25.48	1.1	1.66	1.16	22.40	6.40 to 7.02 14.17 to 17.47	44	135	90	[illegible]	325	21	16
19/20	12.0	20 37.4	26.29	1.0	1.64	1.15	22.40	6.42 to 7.08 14.11 to 17.45	44	138	95	926	326	22	17
20/21	12.0	20 41.5	27.11	1.0	1.62	1.14	22.40	6.44 to 7.15 14.05 to 17.43	44	140	99	957	326	22	17
21/22	12.0	20 45.8	27.54	0.9	1.60	1.13	22.40	6.46 to 7.21 13.59 to 17.41	45	139	100	987	326	23	17
22/23	12.0	20 50.1	28.37	0.9	1.58	1.12	22.40	6.48 to 7.28 13.53 to 17.39	45	136	100	1019	326	24	17
23/24	12.0	20 54.7	29.21	0.8	1.57	1.11	22.41	6.49 to 7.36 13.46 to 17.37	45	131	98	1051	327	24	18
24/25	12.0	20 59.4	30.05	0.8	1.55	1.10	22.42	6.51 to 7.44 13.39 to 17.35	45	125	95	1083	327	25	18
25/26	12.0	21 4.2	30.49	0.7	1.54	1.09	22.43	6.53 to 7.53 13.33 to 17.33	45	119	89	1115	328	26	18
26/27	12.0	21 9.3	31.34	0.7	1.52	1.09	22.44	6.55 to 8.02 13.25 to 17.31	45	111	82	1148	328	26	18
27/28	12.0	21 14.5	32.19	0.6	1.50	1.08	22.45	6.57 to 8.12 13.18 to 17.29	46	104	74	1181	329	27	18
28/29	12.0	21 19.9	33.05	0.6	1.49	1.07	22.47	6.58 to 8.24 13.10 to 17.27	46	96	65	1214	330	28	18

March 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	21 25.5	33.50	0.5	1.47	1.06	22.48	7.00 to 8.36 13.01 to 17.24	46	88	54	1247	330	29	18
2/ 3	12.0	21 31.3	34.35	0.5	1.46	1.05	22.50	7.02 to 8.49 12.51 to 17.22	46	80	44	1280	331	29	18
3/ 4	12.0	21 37.4	35.21	0.4	1.45	1.04	22.52	7.04 to 9.03 12.41 to 17.20	46	72	33	1312	332	30	18
4/ 5	12.0	21 43.6	36.05	0.4	1.43	1.03	22.55	7.06 to 9.20 12.29 to 17.18	46	64	22	1345	333	31	18
5/ 6	12.0	21 50.1	36.50	0.3	1.42	1.03	22.57	7.08 to 9.39 12.15 to 17.15	46	57	13	1377	334	32	18
6/ 7	12.0	21 56.9	37.34	0.3	1.41	1.02	22.60	7.09 to 10.04 11.56 to 17.13	46	51	6	1408	335	33	18
7/ 8	12.0	22 3.9	38.17	0.3	1.40	1.01	23.03	7.11 to 10.45 11.21 to 17.11	46	47	1	1439	336	34	17
8/ 9	12.0	22 11.1	38.59	0.2	1.39	1.00	23.06	7.13 to 17.08	46	45	0	1469	337	35	17
9/10	12.0	22 18.6	39.40	0.2	1.38	1.00	23.10	7.15 to 17.06	46	47	1	1498	339	36	17
10/11	12.0	22 26.3	40.20	0.1	1.37	0.99	23.14	7.17 to 17.03	46	50	5	1526	340	36	16
11/12	12.0	22 34.3	40.59	0.1	1.36	0.98	23.18	7.19 to 17.01	46	56	12	1553	342	37	16
12/13	12.0	22 42.6	41.35	0.1	1.35	0.98	23.22	7.21 to 16.59	46	62	20	1579	343	38	15
13/14	12.0	22 51.1	42.10	0.0	1.34	0.97	23.27	7.23 to 16.56	46	69	30	1603	345	39	14
14/15	12.0	22 59.8	42.43	0.0	1.34	0.96	23.31	7.24 to 16.54	46	76	40	1626	347	40	13
15/16	12.0	23 8.8	43.13	0.0	1.33	0.96	23.36	7.26 to 16.51	46	83	50	1646	349	40	12
16/17	12.0	23 17.9	43.41	0.0	1.33	0.95	23.42	7.28 to 16.49	46	90	60	1666	351	41	11
17/18	12.0	23 27.3	44.06	-0.1	1.32	0.95	23.47	7.30 to 16.46	46	97	69	1683	353	42	10
18/19	12.0	23 36.9	44.28	-0.1	1.32	0.94	23.53	7.32 to 16.44	45	104	78	1698	355	42	9
19/20	12.0	23 46.6	44.48	-0.1	1.32	0.94	23.59	7.34 to 16.41	45	111	85	1711	357	43	7
20/21	12.0	23 56.5	45.04	-0.1	1.32	0.94	0.05	7.36 to 16.39	45	117	91	1722	359	43	6
21/22	12.0	0 6.4	45.16	-0.1	1.32	0.93	0.11	7.38 to 16.36	45	124	96	1731	1	43	5
22/23	12.0	0 16.4	45.25	-0.1	1.32	0.93	0.17	7.40 to 16.33	45	129	99	1737	4	43	3
23/24	12.0	0 26.5	45.31	-0.2	1.32	0.93	0.23	7.42 to 16.31	45	134	100	1741	6	44	2
24/25	12.0	0 36.6	45.34	-0.2	1.32	0.92	0.29	7.44 to 16.28	44	138	100	1743	8	44	0
25/26	12.0	0 46.6	45.33	-0.2	1.32	0.92	0.35	7.46 to 16.26	44	140	97	1742	11	43	0
26/27	12.0	0 56.6	45.28	-0.2	1.32	0.92	0.41	7.48 to 16.23	44	140	93	1739	13	43	-1
27/28	12.0	1 6.4	45.20	-0.2	1.33	0.92	0.47	7.50 to 16.20	44	138	87	1734	15	43	-3
28/29	12.0	1 16.2	45.09	-0.2	1.33	0.92	0.53	7.52 to 16.18	43	134	79	1726	18	43	-4
29/30	12.0	1 25.8	44.55	-0.2	1.34	0.91	0.59	7.54 to 16.15	43	127	70	1716	20	42	-5
30/31	12.0	1 35.2	44.38	-0.1	1.34	0.91	1.04	7.56 to 16.12	43	120	59	1704	22	41	-7
31/32	12.0	1 44.5	44.18	-0.1	1.35	0.91	1.10	7.58 to 16.10	43	111	48	1690	25	41	-8

April 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	1 53.5	43.55	-0.1	1.36	0.91	1.15	8.01 to 16.07	42	101	37	1673	27	40	-9
2/ 3	12.0	2 2.3	43.30	-0.1	1.37	0.91	1.20	8.03 to 16.04	42	90	26	1655	29	39	-10
3/ 4	12.0	2 10.8	43.03	-0.1	1.38	0.92	1.24	8.05 to 16.01	42	79	16	1634	31	39	-11
4/ 5	12.0	2 19.1	42.34	-0.1	1.39	0.92	1.29	8.07 to 15.59	41	68	8	1612	33	38	-12
5/ 6	12.0	2 27.2	42.02	-0.1	1.40	0.92	1.33	8.09 to 15.56	41	57	3	1589	36	37	-13
6/ 7	12.0	2 34.9	41.30	0.0	1.41	0.92	1.37	8.11 to 15.53	41	46	0	1563	38	36	-13
7/ 8	12.0	2 42.5	40.55	0.0	1.42	0.92	1.40	8.14 to 15.50	40	36	0	1537	40	35	-14
8/ 9	12.0	2 49.7	40.20	0.0	1.43	0.92	1.44	8.16 to 15.48	40	29	3	1509	42	34	-14
9/10	12.0	2 56.7	39.43	0.1	1.44	0.93	1.47	8.18 to 15.45	40	26	8	1480	43	33	-15
10/11	12.0	3 3.5	39.05	0.1	1.45	0.93	1.50	8.20 to 15.42	39	29	15	1450	45	32	-15
11/12	12.0	3 10.0	38.26	0.1	1.47	0.93	1.52	8.23 to 15.39	39	35	24	1419	47	31	-16
12/13	12.0	3 16.3	37.47	0.1	1.48	0.94	1.54	8.25 to 13.06 14.42 to 15.37	39	44	33	1388	49	30	-16
13/14	12.0	3 22.3	37.07	0.2	1.50	0.94	1.57	8.27 to 12.46 15.07 to 15.34	38	53	43	1355	51	30	-16
14/15	12.0	3 28.2	36.27	0.2	1.51	0.95	1.58	8.29 to 12.32 15.25 to 15.31	38	63	53	1323	52	29	-16
15/16	12.0	3 33.8	35.47	0.3	1.52	0.95	2.00	8.32 to 12.19	38	72	62	1290	54	28	-16
16/17	12.0	3 39.2	35.06	0.3	1.54	0.96	2.02	8.34 to 12.09	37	83	71	1256	56	27	-16
17/18	12.0	3 44.4	34.26	0.3	1.56	0.96	2.03	8.36 to 11.59	37	93	80	1223	57	26	-16
18/19	12.0	3 49.4	33.45	0.4	1.57	0.97	2.04	8.39 to 11.50	36	103	87	1189	59	26	-16

19/20	12.0	3 54.2	33.04	0.4	1.59	0.97	2.05	8.41 to 11.42	36	114	93	1155	60	25	-16
20/21	12.0	3 58.9	32.24	0.5	1.60	0.98	2.05	8.44 to 11.34	36	124	97	1122	62	24	-16
21/22	12.0	4 3.4	31.43	0.5	1.62	0.99	2.06	8.46 to 11.26	35	135	100	1089	63	23	-16
22/23	12.0	4 7.7	31.03	0.5	1.63	0.99	2.06	8.49 to 11.19	35	146	100	1056	65	23	-16
23/24	12.0	4 11.9	30.23	0.6	1.65	1.00	2.07	8.51 to 11.12	35	157	99	1023	66	22	-16
24/25	12.0	4 16.0	29.44	0.6	1.67	1.01	2.07	8.54 to 11.06	34	165	96	991	68	22	-16
25/26	12.0	4 19.9	29.04	0.7	1.69	1.02	2.07	8.56 to 10.59	34	166	90	959	69	21	-16
26/27	12.0	4 23.7	28.25	0.7	1.70	1.02	2.07	8.59 to 10.53	33	158	83	928	71	20	-16
27/28	12.0	4 27.4	27.47	0.8	1.72	1.03	2.06	9.01 to 10.47	33	147	73	897	72	20	-16
28/29	12.0	4 31.0	27.09	0.8	1.74	1.04	2.06	9.04 to 10.40	33	135	63	867	73	19	-15
29/30	12.0	4 34.5	26.31	0.9	1.75	1.05	2.05	9.07 to 10.35	32	122	52	837	75	19	-15
30/31	12.0	4 37.8	25.54	0.9	1.77	1.06	2.05	9.09 to 10.29	32	109	40	808	76	18	-15

May 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	4 41.1	25.17	1.0	1.79	1.06	2.04	9.12 to 10.23	31	95	29	780	78	18	-15
2/ 3	12.0	4 44.3	24.41	1.0	1.80	1.07	2.03	9.14 to 10.17	31	82	19	752	79	18	-15
3/ 4	12.0	4 47.4	24.05	1.1	1.82	1.08	2.03	9.17 to 10.12	31	68	10	726	80	17	-14
4/ 5	12.0	4 50.4	23.30	1.1	1.84	1.09	2.02	9.20 to 10.06	30	54	4	700	82	17	-14
5/ 6	12.0	4 53.3	22.55	1.2	1.86	1.10	2.01	9.23 to 10.01	30	41	0	674	83	16	-14
6/ 7	12.0	4 56.2	22.20	1.2	1.87	1.11	1.60	9.25 to 9.56	29	27	0	650	85	16	-14
7/ 8	12.0	4 59.0	21.46	1.3	1.89	1.12	1.58	9.28 to 9.50	29	14	1	626	86	16	-14
8/ 9	12.0	5 1.7	21.12	1.3	1.91	1.13	1.57	9.31 to 9.45	29	4	5	603	87	15	-14
9/10	12.0	5 4.3	20.39	1.4	1.92	1.14	1.56	9.34 to 9.40	28	12	11	580	89	15	-13
10/11	12.0	5 6.9	20.07	1.4	1.94	1.15	1.54	Not Observable	28	24	19	559	90	15	-13
11/12	12.0	5 9.5	19.34	1.4	1.96	1.16	1.53	Not Observable	28	36	27	538	92	14	-13
12/13	12.0	5 12.0	19.02	1.5	1.97	1.17	1.52	Not Observable	27	48	36	518	93	14	-13
13/14	12.0	5 14.4	18.31	1.5	1.99	1.18	1.50	Not Observable	27	59	46	499	95	14	-13
14/15	12.0	5 16.8	17.60	1.6	2.01	1.19	1.49	Not Observable	27	70	55	480	96	14	-12
15/16	12.0	5 19.1	17.29	1.6	2.02	1.20	1.47	Not Observable	26	82	65	462	98	13	-12
16/17	12.0	5 21.4	16.59	1.7	2.04	1.22	1.45	Not Observable	26	93	74	445	99	13	-12
17/18	12.0	5 23.7	16.29	1.7	2.06	1.23	1.44	Not Observable	26	105	82	428	101	13	-12
18/19	12.0	5 25.9	15.59	1.8	2.07	1.24	1.42	Not Observable	25	116	89	412	102	13	-12
19/20	12.0	5 28.1	15.30	1.8	2.09	1.25	1.40	Not Observable	25	128	94	397	104	13	-12
20/21	12.0	5 30.2	15.01	1.9	2.11	1.26	1.38	Not Observable	25	140	98	383	106	12	-12
21/22	12.0	5 32.3	14.33	1.9	2.12	1.27	1.36	Not Observable	24	153	100	369	107	12	-11
22/23	12.0	5 34.4	14.05	2.0	2.14	1.28	1.34	Not Observable	24	165	100	355	109	12	-11
23/24	12.0	5 36.4	13.37	2.0	2.15	1.29	1.33	Not Observable	24	175	97	343	111	12	-11
24/25	12.0	5 38.4	13.09	2.0	2.17	1.31	1.31	Not Observable	24	167	92	330	112	12	-11
25/26	12.0	5 40.4	12.42	2.1	2.18	1.32	1.29	Not Observable	23	154	85	319	114	12	-11
26/27	12.0	5 42.3	12.15	2.1	2.20	1.33	1.27	Not Observable	23	140	76	308	116	11	-11
27/28	12.0	5 44.2	11.48	2.2	2.21	1.34	1.25	Not Observable	23	127	65	297	118	11	-11
28/29	12.0	5 46.1	11.22	2.2	2.23	1.35	1.23	Not Observable	23	113	54	287	119	11	-11
29/30	12.0	5 48.0	10.55	2.3	2.24	1.36	1.20	Not Observable	23	99	42	278	121	11	-10
30/31	12.0	5 49.8	10.29	2.3	2.26	1.38	1.18	Not Observable	22	86	31	269	123	11	-10
31/32	12.0	5 51.7	10.04	2.4	2.27	1.39	1.16	Not Observable	22	72	21	260	125	11	-10

Ephemeris for comet **Tabur 1996 Q1**

Omega= 57.3749 OMEGA= 31.4123 i= 73.3617 q= 0.840015 a=**********
e=1.000000 P=********* T= 1996 November 3.5042 Equinox= 2000
Magnitudes calculated from m= 6.5+5.0*Log(d)+12.5*Log(r)

November 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	15 0.7	39.03	5.1	0.82	0.84	0.16	5.52 to 10.26 14.06 to 17.35	54	94	63	167	10	0	0
2/ 3	12.0	15 4.3	38.15	5.2	0.85	0.84	0.16	5.50 to 10.12 14.20 to 17.37	54	87	53	162	10	17	-20
3/ 4	12.0	15 7.6	37.28	5.2	0.87	0.84	0.15	5.49 to 9.59 14.32 to 17.38	53	80	44	157	10	16	-19
4/ 5	12.0	15 10.7	36.42	5.3	0.89	0.84	0.15	5.47 to 9.47 14.42 to 17.40	53	74	34	152	9	15	-19
5/ 6	12.0	15 13.6	35.58	5.4	0.91	0.84	0.13	5.46 to 9.36 14.51 to 17.42	52	67	26	146	9	14	-18
6/ 7	12.0	15 16.3	35.15	5.4	0.93	0.84	0.12	5.44 to 9.25 14.59 to 17.43	52	61	17	141	9	13	-17
7/ 8	12.0	15 18.8	34.33	5.5	0.96	0.84	0.11	5.43 to 9.16 15.06 to 17.45	51	55	10	136	8	12	-17
8/ 9	12.0	15 21.1	33.53	5.5	0.98	0.85	0.09	5.41 to 9.06 15.12 to 17.47	51	50	5	131	8	12	-16
9/10	12.0	15 23.3	33.13	5.6	1.00	0.85	0.07	5.40 to 8.57 15.18 to 17.48	51	47	1	126	7	11	-16
10/11	12.0	15 25.4	32.35	5.7	1.02	0.85	0.06	5.38 to 8.49 15.23 to 17.50	50	47	0	120	7	10	-15
11/12	12.0	15 27.4	31.57	5.7	1.04	0.85	0.04	5.37 to 8.40 15.27 to 17.51	50	49	0	115	6	10	-15
12/13	12.0	15 29.3	31.21	5.8	1.06	0.86	0.02	5.36 to 8.32 15.31 to 17.53	49	53	4	110	5	9	-15
13/14	12.0	15 31.0	30.45	5.9	1.08	0.86	23.59	5.34 to 8.24 15.35 to 17.54	49	60	9	106	5	9	-14
14/15	12.0	15 32.7	30.11	5.9	1.10	0.87	23.57	5.33 to 8.16 15.38 to 17.56	49	68	17	101	4	9	-14
15/16	12.0	15 34.3	29.37	6.0	1.12	0.87	23.55	5.32 to 8.08 15.41 to 17.58	48	77	27	96	3	8	-14
16/17	12.0	15 35.8	29.04	6.1	1.14	0.88	23.52	5.31 to 8.01 15.44 to 17.59	48	87	38	92	2	8	-13
17/18	12.0	15 37.3	28.32	6.1	1.16	0.88	23.50	5.30 to 7.54 15.46 to 18.01	48	97	49	87	2	7	-13
18/19	12.0	15 38.7	28.00	6.2	1.18	0.89	23.47	5.29 to 7.46 15.49 to 18.02	47	106	61	83	1	7	-13
19/20	12.0	15 40.0	27.29	6.3	1.20	0.89	23.45	5.28 to 7.39 15.51 to 18.04	47	116	72	79	360	7	-12
20/21	12.0	15 41.3	26.59	6.4	1.22	0.90	23.42	5.27 to 7.32							

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
								15.52 to 18.05	47	124	81	75	359	7	-12
21/22	12.0	15 42.5	26.30	6.4	1.24	0.91	23.39	5.26 to 7.25							
								15.54 to 18.06	47	132	89	71	358	6	-12
22/23	12.0	15 43.7	26.01	6.5	1.26	0.92	23.37	5.25 to 7.18							
								15.56 to 18.08	46	137	95	68	357	6	-11
23/24	12.0	15 44.8	25.33	6.6	1.27	0.92	23.34	5.24 to 7.11							
								15.57 to 18.09	46	139	99	64	356	6	-11
24/25	12.0	15 45.9	25.06	6.7	1.29	0.93	23.31	5.23 to 7.04							
								15.58 to 18.11	46	139	100	61	355	6	-11
25/26	12.0	15 47.0	24.39	6.7	1.31	0.94	23.28	5.23 to 6.57							
								15.59 to 18.12	46	135	100	58	354	6	-11
26/27	12.0	15 48.0	24.12	6.8	1.32	0.95	23.25	5.22 to 6.51							
								15.60 to 18.13	46	129	97	55	353	5	-11
27/28	12.0	15 49.0	23.46	6.9	1.34	0.96	23.22	5.21 to 6.44							
								16.01 to 18.15	45	121	92	52	352	5	-10
28/29	12.0	15 50.0	23.21	7.0	1.36	0.96	23.19	5.21 to 6.38							
								16.01 to 18.16	45	113	86	50	351	5	-10
29/30	12.0	15 51.0	22.56	7.0	1.37	0.97	23.16	5.20 to 6.31							
								16.02 to 18.17	45	104	79	47	349	5	-10
30/31	12.0	15 51.9	22.32	7.1	1.39	0.98	23.13	5.19 to 6.24							
								16.02 to 18.19	45	96	71	45	348	5	-10

December 1996 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	15 52.8	22.08	7.2	1.40	0.99	23.10	5.19 to 6.18							
								16.03 to 18.20	45	86	62	42	347	5	-9
2/ 3	12.0	15 53.6	21.45	7.3	1.42	1.00	23.07	5.19 to 6.12							
								16.03 to 18.21	45	77	52	40	346	5	-9
3/ 4	12.0	15 54.5	21.22	7.3	1.43	1.01	23.04	5.18 to 6.05							
								16.03 to 18.22	45	68	43	38	345	4	-9
4/ 5	12.0	15 55.3	20.60	7.4	1.45	1.02	23.01	5.18 to 5.59							
								16.03 to 18.23	45	59	33	36	344	4	-9
5/ 6	12.0	15 56.1	20.38	7.5	1.46	1.03	22.58	5.18 to 5.53							
								16.03 to 18.24	45	51	24	34	343	4	-9
6/ 7	12.0	15 56.9	20.16	7.6	1.47	1.04	22.55	5.17 to 5.46							
								16.03 to 18.25	45	43	16	33	341	4	-8
7/ 8	12.0	15 57.7	19.55	7.6	1.49	1.05	22.52	5.17 to 5.40							
								16.03 to 18.26	45	38	9	31	340	4	-8
8/ 9	12.0	15 58.4	19.35	7.7	1.50	1.06	22.48	5.17 to 5.34							
								16.03 to 18.27	45	35	3	30	339	4	-8
9/10	12.0	15 59.2	19.15	7.8	1.51	1.07	22.45	5.17 to 5.28							
								16.03 to 18.28	45	37	0	28	338	4	-8
10/11	12.0	15 59.9	18.55	7.9	1.52	1.08	22.42	5.17 to 5.22							
								16.02 to 18.29	45	44	0	27	337	4	-8
11/12	12.0	16 0.6	18.36	7.9	1.53	1.10	22.39	16.02 to 18.30	45	52	2	26	335	4	-8
12/13	12.0	16 1.2	18.17	8.0	1.55	1.11	22.36	16.02 to 18.31	46	63	7	24	334	4	-7
13/14	12.0	16 1.9	17.58	8.1	1.56	1.12	22.32	16.01 to 18.32	46	74	14	23	333	3	-7
14/15	12.0	16 2.6	17.40	8.1	1.57	1.13	22.29	16.01 to 18.33	46	86	23	22	332	3	-7
15/16	12.0	16 3.2	17.22	8.2	1.58	1.14	22.26	16.00 to 18.34	46	98	34	21	331	3	-7
16/17	12.0	16 3.8	17.05	8.3	1.59	1.15	22.22	15.59 to 18.34	46	110	46	20	330	3	-7
17/18	12.0	16 4.4	16.48	8.3	1.60	1.17	22.19	15.59 to 18.35	47	121	57	19	329	3	-7
18/19	12.0	16 5.0	16.31	8.4	1.61	1.18	22.16	15.58 to 18.36	47	131	68	18	327	3	-6
19/20	12.0	16 5.5	16.15	8.5	1.61	1.19	22.12	15.57 to 18.36	47	139	77	18	326	3	-6
20/21	12.0	16 6.1	15.59	8.5	1.62	1.20	22.09	15.56 to 18.37	47	146	86	17	325	3	-6
21/22	12.0	16 6.6	15.43	8.6	1.63	1.21	22.05	15.55 to 18.37	48	148	92	16	324	3	-6
22/23	12.0	16 7.2	15.28	8.7	1.64	1.23	22.02	15.55 to 18.38	48	146	97	16	323	3	-6
23/24	12.0	16 7.7	15.13	8.7	1.65	1.24	21.59	15.54 to 18.38	49	141	100	15	322	3	-6
24/25	12.0	16 8.1	14.58	8.8	1.65	1.25	21.55	15.52 to 18.38	49	133	100	14	321	2	-6
25/26	12.0	16 8.6	14.44	8.9	1.66	1.26	21.52	15.51 to 18.39	49	124	99	14	320	2	-5
26/27	12.0	16 9.1	14.30	8.9	1.67	1.28	21.48	15.50 to 18.39	50	115	96	13	319	2	-5
27/28	12.0	16 9.5	14.16	9.0	1.67	1.29	21.45	15.49 to 18.39	50	105	92	13	318	2	-5
28/29	12.0	16 9.9	14.03	9.1	1.68	1.30	21.41	15.48 to 18.39	51	95	85	12	317	2	-5
29/30	12.0	16 10.4	13.49	9.1	1.69	1.31	21.38	15.47 to 18.40	51	85	78	12	316	2	-5
30/31	12.0	16 10.7	13.37	9.2	1.69	1.33	21.34	15.45 to 18.40	52	75	70	11	315	2	-5
31/32	12.0	16 11.1	13.24	9.2	1.70	1.34	21.31	15.44 to 18.40	52	65	61	11	314	2	-5

January 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	16 11.5	13.12	9.3	1.70	1.35	21.27	15.43 to 18.40	53	55	51	11	313	2	-5
2/ 3	12.0	16 11.8	12.60	9.3	1.71	1.37	21.23	15.41 to 18.40	53	45	41	10	312	2	-5
3/ 4	12.0	16 12.1	12.48	9.4	1.71	1.38	21.20	15.40 to 18.40	54	37	31	10	311	1	-4
4/ 5	12.0	16 12.4	12.36	9.5	1.71	1.39	21.16	15.38 to 18.39	54	31	22	9	310	1	-4
5/ 6	12.0	16 12.7	12.25	9.5	1.72	1.40	21.12	15.37 to 18.39	55	29	13	9	309	1	-4
6/ 7	12.0	16 13.0	12.14	9.6	1.72	1.42	21.09	15.35 to 18.39	55	33	6	9	308	1	-4
7/ 8	12.0	16 13.2	12.03	9.6	1.72	1.43	21.05	15.34 to 18.39	56	41	2	9	307	1	-4
8/ 9	12.0	16 13.5	11.53	9.7	1.73	1.44	21.01	15.32 to 18.38	57	52	0	8	307	1	-4
9/10	12.0	16 13.7	11.42	9.7	1.73	1.46	20.58	15.30 to 18.38	57	64	0	8	306	1	-4
10/11	12.0	16 13.9	11.32	9.8	1.73	1.47	20.54	15.28 to 18.37	58	77	4	8	305	1	-4
11/12	12.0	16 14.0	11.22	9.8	1.73	1.48	20.50	15.27 to 18.37	59	91	11	8	304	1	-4
12/13	12.0	16 14.2	11.13	9.9	1.73	1.50	20.46	15.25 to 18.36	59	104	20	7	303	0	-3
13/14	12.0	16 14.3	11.04	9.9	1.74	1.51	20.43	15.23 to 18.36	60	116	30	7	303	0	-3
14/15	12.0	16 14.4	10.54	10.0	1.74	1.52	20.39	15.21 to 18.35	61	128	41	7	302	0	-3
15/16	12.0	16 14.5	10.45	10.0	1.74	1.54	20.35	15.19 to 18.35	62	139	52	7	301	0	-3
16/17	12.0	16 14.5	10.37	10.1	1.74	1.55	20.31	15.17 to 18.34	62	147	63	6	300	0	-3
17/18	12.0	16 14.6	10.28	10.1	1.74	1.56	20.27	15.15 to 18.33	63	152	73	6	300	0	-3
18/19	12.0	16 14.6	10.20	10.2	1.74	1.58	20.23	15.13 to 18.32	64	153	81	6	299	0	-3
19/20	12.0	16 14.6	10.12	10.2	1.74	1.59	20.19	15.11 to 18.31	65	148	88	6	298	0	-3
20/21	12.0	16 14.5	10.04	10.3	1.74	1.60	20.15	15.09 to 18.30	65	140	94	6	297	0	-3
21/22	12.0	16 14.5	9.56	10.3	1.74	1.62	20.11	15.06 to 18.30	66	131	98	6	297	0	-3
22/23	12.0	16 14.4	9.49	10.3	1.74	1.63	20.07	15.04 to 18.29	67	121	100	5	296	0	-3
23/24	12.0	16 14.2	9.41	10.4	1.74	1.64	20.03	15.02 to 18.28	68	110	100	5	295	0	-3
24/25	12.0	16 14.1	9.34	10.4	1.74	1.65	19.59	14.59 to 18.26	69	100	99	5	295	0	-2
25/26	12.0	16 13.9	9.27	10.5	1.74	1.67	19.55	14.57 to 18.25	69	89	96	5	294	-1	-2
26/27	12.0	16 13.7	9.20	10.5	1.74	1.68	19.51	14.54 to 18.24	70	78	91	5	294	-1	-2
27/28	12.0	16 13.5	9.14	10.6	1.73	1.69	19.47	14.52 to 18.23	71	68	84	5	293	-1	-2
28/29	12.0	16 13.3	9.07	10.6	1.73	1.71	19.42	14.49 to 18.22	72	57	77	5	292	-1	-2
29/30	12.0	16 13.0	9.01	10.6	1.73	1.72	19.38	14.47 to 18.20	73	47	68	4	292	-1	-2

30/31	12.0	16 12.7	8.55	10.7	1.73	1.73	19.34	14.44 to 18.19	74	37	58	4	291	-1	-2
31/32	12.0	16 12.3	8.49	10.7	1.73	1.75	19.30	14.41 to 18.18	75	29	48	4	291	-2	-2

February 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	16 11.9	8.43	10.8	1.72	1.76	19.25	14.39 to 18.16	76	25	38	4	290	-2	-2
2/ 3	12.0	16 11.5	8.37	10.8	1.72	1.77	19.21	14.36 to 18.15	77	27	27	4	289	-2	-2
3/ 4	12.0	16 11.1	8.32	10.8	1.72	1.79	19.17	14.33 to 18.13	78	34	18	4	289	-2	-2
4/ 5	12.0	16 10.6	8.27	10.9	1.72	1.80	19.12	14.30 to 18.12	79	45	10	4	288	-2	-2
5/ 6	12.0	16 10.1	8.21	10.9	1.71	1.81	19.08	14.27 to 18.10	79	58	4	4	288	-3	-2
6/ 7	12.0	16 9.6	8.16	10.9	1.71	1.83	19.03	14.24 to 18.09	80	71	0	4	287	-3	-2
7/ 8	12.0	16 9.0	8.11	11.0	1.71	1.84	18.59	14.21 to 18.07	81	85	0	4	287	-3	-2
8/ 9	12.0	16 8.4	8.06	11.0	1.70	1.85	18.54	14.18 to 18.06	82	99	2	3	286	-3	-2
9/10	12.0	16 7.7	8.02	11.0	1.70	1.87	18.50	14.15 to 18.04	84	113	8	3	286	-3	-1
10/11	12.0	16 7.1	7.57	11.1	1.70	1.88	18.45	14.12 to 18.02	85	126	16	3	285	-4	-1
11/12	12.0	16 6.3	7.53	11.1	1.69	1.89	18.40	14.09 to 18.00	86	138	25	3	285	-4	-1
12/13	12.0	16 5.6	7.48	11.1	1.69	1.91	18.36	14.05 to 17.59	87	149	36	3	284	-4	-1
13/14	12.0	16 4.8	7.44	11.2	1.69	1.92	18.31	14.02 to 17.57	88	155	46	3	284	-4	-1
14/15	12.0	16 4.0	7.40	11.2	1.68	1.93	18.26	13.59 to 17.55	89	156	57	3	283	-5	-1
15/16	12.0	16 3.1	7.36	11.2	1.68	1.95	18.21	13.55 to 17.53	90	151	67	3	283	-5	-1
16/17	12.0	16 2.2	7.32	11.3	1.67	1.96	18.16	13.52 to 17.51	91	142	76	3	282	-5	-1
17/18	12.0	16 1.2	7.28	11.3	1.67	1.97	18.12	13.48 to 17.49	92	132	84	3	282	-5	-1
18/19	12.0	16 0.2	7.24	11.3	1.67	1.99	18.07	13.45 to 17.47	93	121	90	3	281	-6	-1
19/20	12.0	15 59.2	7.20	11.4	1.66	2.00	18.02	13.41 to 17.45	94	110	95	3	281	-6	-1
20/21	12.0	15 58.1	7.17	11.4	1.66	2.01	17.57	13.37 to 17.43	95	99	99	3	280	-6	-1
21/22	12.0	15 57.0	7.13	11.4	1.66	2.02	17.52	13.34 to 17.41	97	88	100	2	280	-6	-1
22/23	12.0	15 55.9	7.10	11.5	1.65	2.04	17.46	13.30 to 17.39	98	77	100	2	279	-7	-1
23/24	12.0	15 54.7	7.06	11.5	1.65	2.05	17.41	13.26 to 17.37	99	66	98	2	279	-7	-1
24/25	12.0	15 53.4	7.03	11.5	1.64	2.06	17.36	13.22 to 17.35	100	55	95	2	278	-7	-1
25/26	12.0	15 52.2	6.60	11.5	1.64	2.08	17.31	13.18 to 17.33	101	44	89	2	278	-7	-1
26/27	12.0	15 50.9	6.56	11.6	1.64	2.09	17.26	13.14 to 17.31	103	34	82	2	277	-8	-1
27/28	12.0	15 49.5	6.53	11.6	1.63	2.10	17.20	13.10 to 17.29	104	26	74	2	277	-8	-1
28/29	12.0	15 48.1	6.50	11.6	1.63	2.12	17.15	13.06 to 17.27	105	22	65	2	276	-8	-1

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Please report both the comet magnitude and the coma diameter if possible. Submission via e-mail is much appreciated.

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet.

Ref Source or catalogue for comparison stars. The most common ones are AA (AAVSO atlas), VB (BAA VS chart), HS (Hubble catalogue), SC (Sky Catalogue 2000).

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

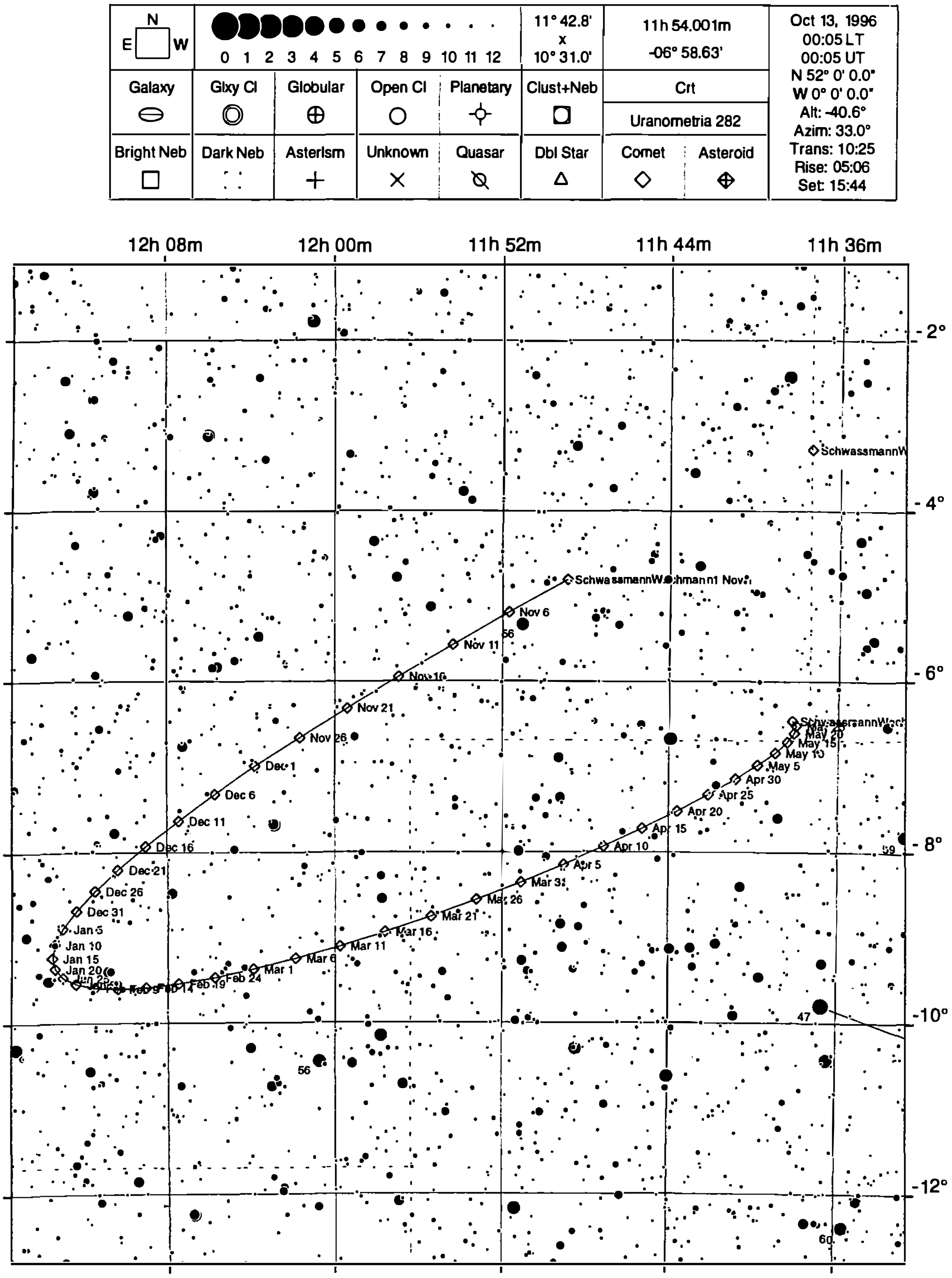
Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (2), Total Mag (6), Ref (3), Tel ap (6), Tel typ (2), f no (6), Tel mag (4), Coma Diam (5), DC (5), Tail len (7), Tail PA (4), 3 spaces, Observer Name. There is an example on the section web page.

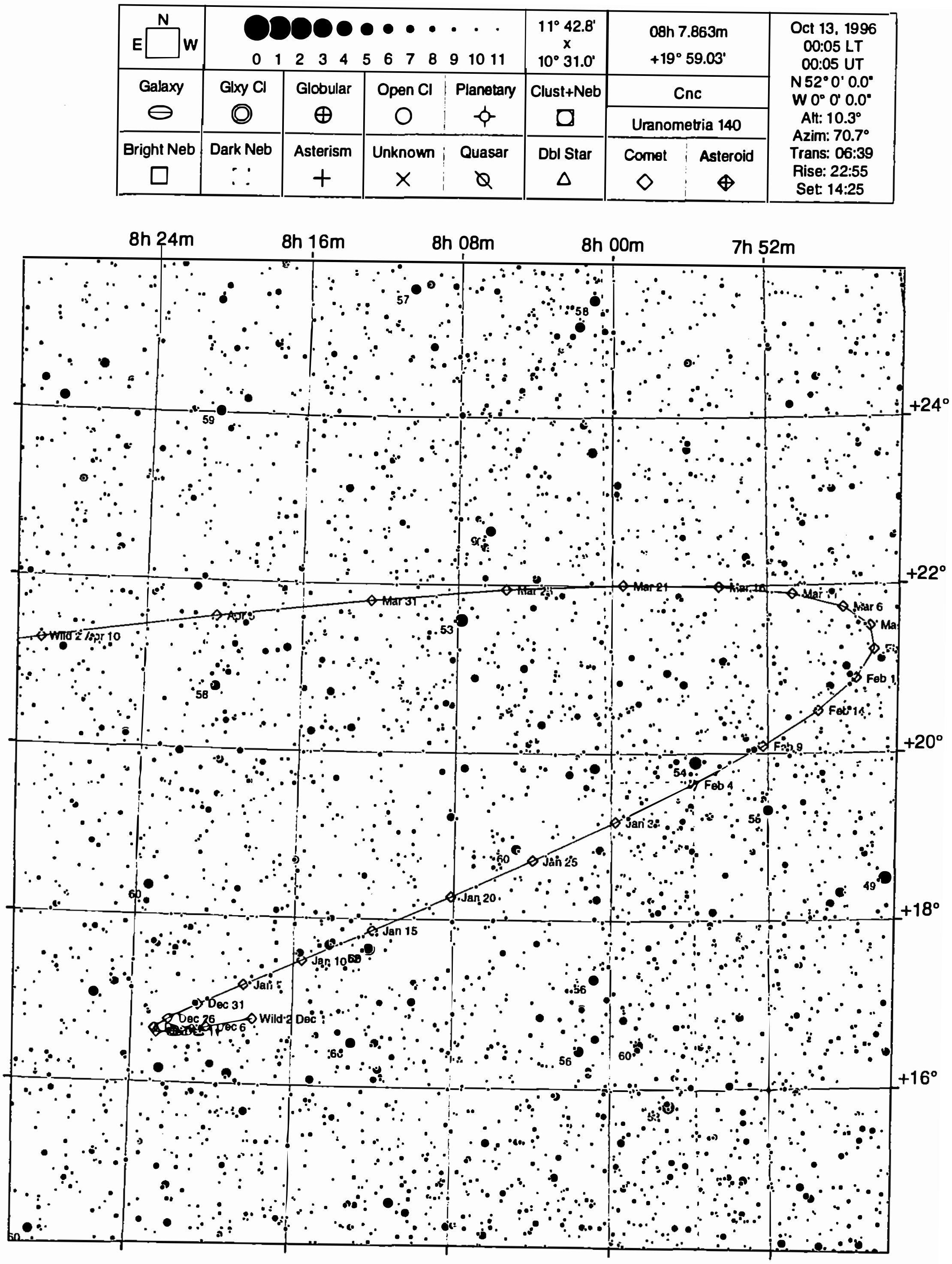
The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20.95) and your observing location (eg Cambridge) at the top of the form. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow. Space at the bottom of the form can be used for a description of the observation.

Finder Charts

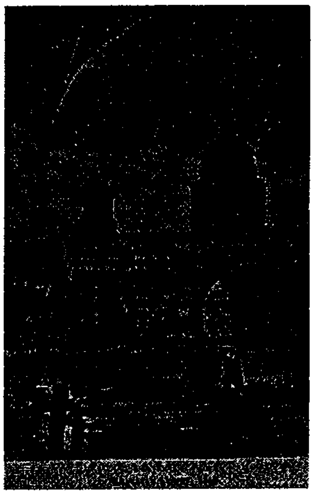
Page 15 has a chart for comet 29P/Schwassmann-Wachmann 1 and page 16 one for comet 81P/Wild 2. Bright stars are labelled with their magnitudes. When possible you should use the North Polar Sequence for comparison stars, but if necessary use field stars and derive the magnitude from the Guide Star Catalogue. The charts were produced using Megastar software.



Comet 29P/Schwassmann-Wachmann 1



Comet 81P/Wild 2

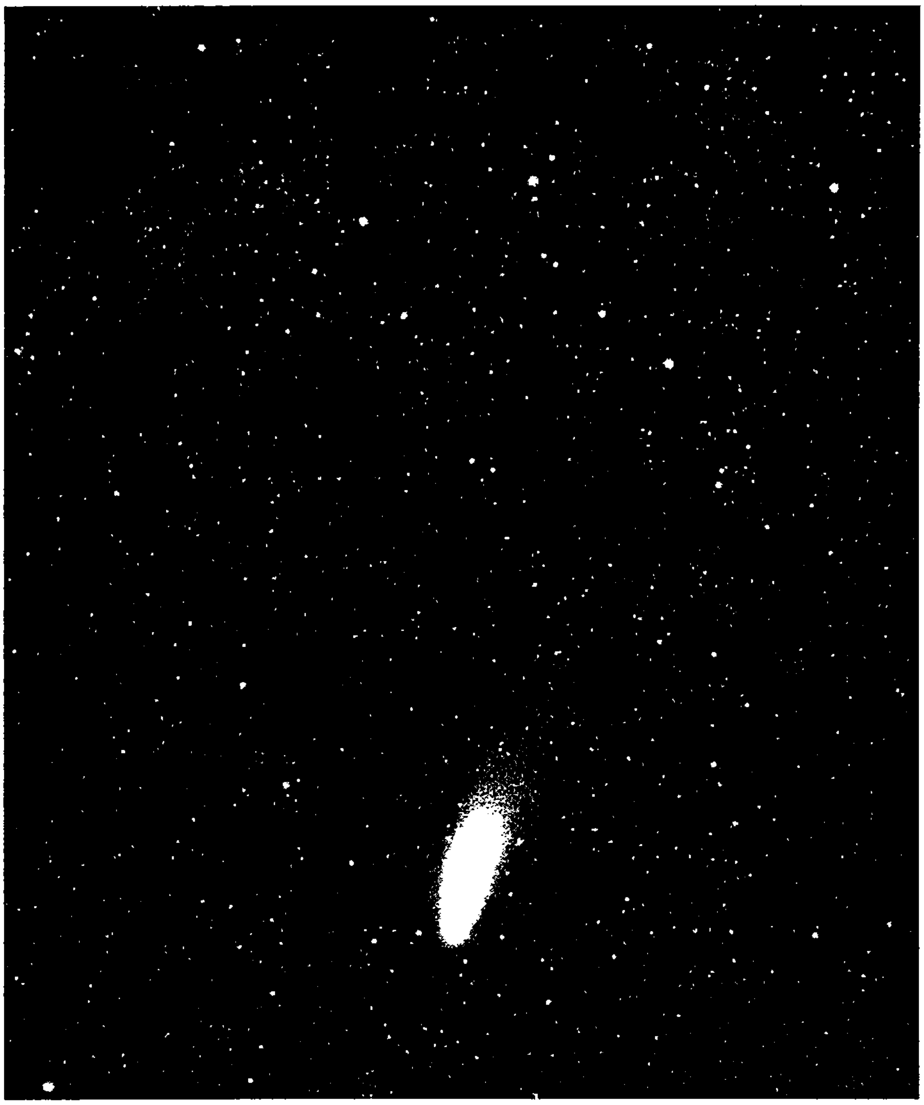


THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 4, No 1 (Issue 7), 1997 May

COMET OF THE CENTURY ?



From a colour print by Mike Cook, Romford.
1997 March 29. 50-mm lens, 10 mins, Kodak Panther 1600

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Section news from the Director

Dear Section member,

Needless to say I have been overwhelmed with observations of comet Hale-Bopp! Despite going through the details for reporting observations at the section meeting last year, observers are still making mistakes in reporting their observations. This greatly increases the workload for Guy and myself as we have to correct or replace the observations at a later date. Some of the problems are listed in the observing section.

Comet Hale-Bopp has certainly been one of the most intensively observed comets in history and section members have made the most of the opportunity. I've included a few of the many images received in the newsletter and more will be on display at the exhibition meeting. The Astronomer magazine hopes to bring out a supplement in the autumn which will document the comet's apparition and at some stage in the future a BAA Memoir will also appear. I haven't documented the results of professional observations in great detail here as they will be reported in astronomical magazines over the coming months.

The Keedy award for 1996 has been awarded to Gabriel Oksa of Starohajska, Slovakia. Gabriel has been studying at Loughborough University on a Royal Society post-doctoral fellowship, but has now returned home. He started observing comets for the Section in March 1996 with the appearance of comet Hyakutake, and has quickly developed into an experienced observer.

Since the last newsletter observations or contributions have been received from the following BAA members:

James Abott, Sally Beaumont, John Bingham, Graham Boots, Denis Buczynski, Robert Bullen, Peter Craven, Clive Curtis, Eric Dinham, Jean Dragesco, Len Entwisle, John Fletcher, James Fraser, Mike Gainsford, Steven Goldsmith, Massimo Giuntoli, David Graham, Werner Hasubick, Michael Hendrie, Colin Henshaw, Guy Hurst, Nick James, Norman Kiernan, James Lancashire, Stephen Laurie, Ron Livesey, John Mackey, Glyn Marsh, Nick Martin, John McConnel, Hazel McGee, Richard McKim, Haldun Menali, Martin Mobberley, Stewart Moore, Bob Neville, Detlev Niechoy, Brian O'Halloran, Gabriel Oksa, Roy Panther, Terry Platt, Tony Rickwood, John Rogers, Jonathan Shanklin, Don Shirreff, James Smith, John Smith, Peter Stanley, Enrico Stomeo, David Storey, David Strange, Tony Tanti, Christopher Taylor, Melvyn Taylor, Alex Vincent, Greme Waddington, Richard Walters, Peter Ward, James Weightman, Paul Yates, Joe Young and the Mid Kent AS.

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and also from: Jose Aguiar, Cornel Apetroaei, Alexandr Baransky, Sandro Baroni, John Bortle, Reinder Bouma, Mike Cook, Tim Cooper, Matyas Csukas, Alfons Diepvens, Maurizio Eltri, Stephen Getliffe, Guus Gilein, Bjoern Granslo, Roberto Haver, Lars Heen, Andreas Kammerer, Heinz Kerner, Atilla Kosa-Kiss, Martin Lehky, Dee Levers, Romualdo Lourencon, Herman Mikuz, Antonio Milani, Sue Morley, John O'Neill, Robert Oseman, Rok Palcic, Amanda Peters, Ernie Richardson, Josep Rodriguez, Virgil Scurtu, Oddleiv Skilbrei, Steinar Thorvaldsen, Alin Tolea, John Vetterlein, Seiichi Yoshida and Vittorio Zanotta (apologies for any omissions or miss-classifications). Thanks to all of you for your contributions.

Comets under observation were: 22P/Kopff, 29P/Schwassmann-Wachmann 1, 46P/Wirtanen, 81P/Wild 2, 118P/Shoemaker-Levy 4, 126P/IRAS, C/Hale-Bopp (1995 O1), C/Tabur (1996 Q1), C/Hergenrother-Spahr (1996 R1), C/Mueller (1997 D1), C/Mueller (1997 J1) and 1997 J2 (as yet unnamed).

Some of the best material showing Hale-Bopp will be on display at the Exhibition Meeting, so do come along and view it. I hope to organise a section meeting in Cambridge during the autumn, but this will depend on there being a breather from bright comets! More details in the next issue, section web page, or BAA newsletter.

Some BAA membership milestones reached over the past year include the Director (25 years), David Frydman, Mike Gainsford and Richard Miles (30 years), Philip Vince (40 years) and Roy Panther (50 years). Congratulations to all.

Finally if you do have any comments on the newsletter, or requests for topics to be covered at the Section meeting do let me know. Clear skies,

Jonathan Shanklin

RAS Discussion Meeting on "Comet-Asteroid Connections"

The media have an interest in bombardment from space at the moment, but having watched "Asteroid" on TV recently it is fairly clear that they don't have much idea about what an asteroid is, or the links between asteroids and comets. This meeting was organised by Mark Bailey of Armagh Observatory and Iwan Williams of Queen Mary College, London and was held at Burlington House on March 14. I'm not sure that the media would have been much wiser after the meeting, and although one or two new ideas were presented, most talks were repeats of presentations at the ACM meeting last summer.

David Hughes (Sheffield) kicked off proceedings with a review of the 'zoo' of small solar system bodies in a talk entitled "Distinguishing between Comets and Asteroids". When the cumulative number of bodies larger than a certain size is plotted against the size, the slope of the line is different for asteroids (~-2) and comets (~-1.67). Several asteroidal families were formed by the collisional break-up of a parent; in the case of the Eos family this would be around 300 km in diameter. Most asteroids were solid, and consisted of several types, although a few might be re-aggregates after collisions. By contrast comets were formed by accretion and were low density irregular objects. He pointed out that there seemed to be no small comets. He didn't think much of the idea of dormant comets as they would be embedded in a meteoroid stream and would soon be reactivated by collisions.

Nathan Harris (Armagh) disagreed with this in his paper on "Inactive Comets Among the Near-Earth Asteroids". Plotting the aphelion distance Q against the perihelion distance q, allows various groups of small bodies, such as main belt asteroids (MB), Trojan asteroids, Jupiter family comets (JFC) and near-earth objects (NEO) to be distinguished. NEOs have q less than 1.4 AU and most JFCs have Q greater than 4.2 AU. The NEOs can be split into class 1 with Q greater than 4.2 AU (and thus affected by Jupiter) and class 2 with Q less than 4.2 AU. Computer models suggest that it is possible to produce JFCs from both the Oort cloud (OC) and the Kuiper belt (KB), but Halley type comets (HTC) only from the OC. They also suggest it is impossible to populate the class 2 region, unless non-gravitational forces are included. Comets in this class include 2P/Encke, 111P/Helin-Roman-Crockett, 82P/Gehrels 3 and 107P/Wilson-Harrington, which are all in some sense 'strange'. The current population of JFCs can be explained with an injection rate of about one per century and a dynamical lifetime for class 1 objects of around 10,000 years and 1500 years for class 2 objects. He would expect around 100 dead JFCs to be still hanging around, but many more dead HTC (between 3000 and 12,000).

Fabio Migliorini (Armagh) presented results of his study on "Resonant Delivery of Asteroids and Meteorites from the Main Belt" which is part of a European Community funded GAPTEC project to investigate the NEO impact hazard. This project has to be multinational in order to win EC funding and will use ESO telescopes etc. He showed many viewgraphs (often in far too small print) of simulations of resonant scattering into earth crossing orbits. Most end up in the sun after a few million years. He suggested that the cosmic ray ages of meteorites didn't reflect transport time since the parent collision, but possibly the time since the 'grandfather's' collision.

Neil McBride (Kent) spoke about "Meteoroids: the Debris of Comets and Asteroids". Meteoroids can be observed from the ground as meteors and as impacts on spacecraft. We have a good idea of the mass distribution in the <u>mean isotropic</u> flux. However meteoroids also occur in streams. The flux from these can be calculated and it works out an order of magnitude less than the overall flux, which can be split into helion/anthelion. north/south toroidal and north/south apex components. The Taurids do contribute a significant amount to the anthelion flux. Meteor radars give a velocity distribution, but in the past have missed a lot of fast meteors (~60 kms^{-1}). He suggests that the apex (fast) source is cometary as is the anthelion. The toroidal component probably is (but there isn't much of it anyway). The helion source is slow and probably asteroidal in origin. Overall more than 60% of the flux could be cometary.

The final talk before lunch was by Hans Rickman (Uppsala) who spoke about "Physical and Dynamical Interrelationships and Transition Objects". He first looked at the formation region and growth mechanism of comets and asteroids. Comets formed far out in the solar system and are fragile, low density objects. The Trojan region could be a potential reservoir of objects. Icy crust formation on comets is a rapid, common process which may turn comets into apparent asteroids. Occasional collisions in the asteroid belt may temporarily turn asteroids into comets and produce dust bands. Because these events are rare there are likely to be few examples at any one time. There is a relative lack of old long period comets (LPC) with respect to new ones, implying that fading exists and a comet is mantled within about 10 revolutions. There is also a lack of old LPC with large perihelion distance implying inactivation. There are no HTC with q larger than 1.5 AU. There are a number of asteroidal objects with cometary orbits: Don Quixote (JFC), Damocles (HTC), 1996 PW (LPC, P ~5000 years, q 2.5). Its possible to decouple the JFC from Jupiter by a combination of close encounters with the Earth and Venus and secular resonances (which gives evolutionary links between MB and JFC). We don't however know what fraction of comets, dead comets and asteroids form the transition NEOs. He also drew attention to the fact that there are no comets with H_0 fainter than about 12. Fainter comets might be missed or mistaken for asteroids, alternatively small objects might erode very quickly once smaller than 1 km, especially if this is combined with fragmentation. He concluded by pointing out that comet 46P/Wirtanen is just such an object and is a target for the ESA Rosetta mission.

Simon Green (Kent) resumed after lunch, on the topic of "Centaurs". Only seven of these strange bodies are known: Chiron, Pholus and five others which orbit between Neptune and Jupiter. They might originate as Trojans, but more likely come from the KB. Their size is much larger than typical short period comets (SPC) at around 200 km. Chiron has a relatively high albedo of 14%, but the others are more typically 4%. There are probably ~5000 within detectable range with several hundred larger than 100 km. Chiron shows cometary activity and the rotational light curve shows features which point to either non sphericity or albedo variation across the surface. As the coma brightens the amplitude of the curve decreases. Only a small fraction of the surface is active. Surprisingly the absolute magnitude is brightest at aphelion. According to HST measurements still under debate the density is less than one. Pholus is very red and the reflectance spectrum (which is similar to that of KB objects) is a good match to tholins. They could be made by cosmic ray bombardment of cometary ices. The question of what makes Chiron active and Pholus inactive and if they are SPCs remains unresolved.

Iwan Williams (Queen Mary) moved a bit further out to talk on "Edgeworth-Kuiper Belt Objects". KBOs are near the limits of detection at a distance of 50 AU with a size of 100 km. There are not enough routine astrometric observations being made (because these are not exciting) and once discovered many are lost; even observations over 6 months are equivalent to only one point on the orbit. Observational selection is a problem because searches are only carried out near the ecliptic (because that is where they are expected to be seen) and away from the milky way. Unfortunately this currently excludes searches near the location of Neptune so the absence of objects here is not surprising. There may be two classes - Pluto types and the rest. Following the reported detection of many KBOs in an HST field, Anita Cochran has imaged another field with negative results.

Vacheslav Emel'yanenko (Chelyabinsk) looked at the possibility of "Asteroids from Long-Period Comets". New comets are often subject to strong fading post perihelion. Mathematical simulations suggest that there should be around 4000 HTC compared to the 20 observed if there lifetime is around 200 revolutions. Asteroid 5335 Damocles, which shows no cometary activity, has a perihelion distance of around 1 AU and has probably made around 600 revolutions. He suggested that large nuclei with radius greater than 5 km might be preferentially deactivated.

Concluding the meeting Alan Fitzsimmons (Queen's University, Belfast) summarised observations of "Comet Hale-Bopp". The apparent standstill in the light curve last autumn could be explained if the large dust output gave rise to a strong phase effect. Careful selection of the observations gave a good straight line fit over the entire apparition to date, implying no outbursts or variations in behaviour. Similar molecules to those seen in 1996 B2 had been seen and new detections included SO, HCO^+ and HCCCN. The isotope ratios of $^{12}C/^{13}C$, $^{14}N/^{15}N$ and $^{32}S/^{34}S$ are very similar to those of the Earth suggesting that it formed in the same solar nebula that we did. Measurements of the rotation period gave results ranging from 12 hours to one year. The one year period was based on the fact that there was no apparent rotation of the jets over 13 days, however these images did show shells of material being emitted one the image from one day was subtracted from an image on the previous day. In a recent INT image 6 dust shells were visible and these implied a 12 hour rotation, however the lack of rotation of the jets couldn't be explained. The latest telescope on La Palma is a 50mm camera lens attached to a cooled 2000 pixel CCD camera installed on the INT roof which had been specially made to follow the evolution of the gas and dust tails.

Jonathan Shanklin

Low-tech spectrometry: A suggestion for observations of bright near-solar comets.

Christopher Taylor

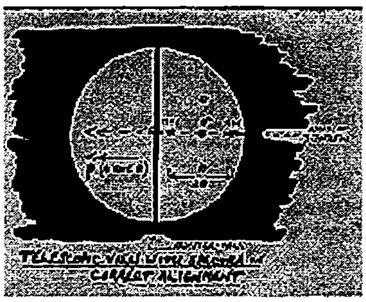
Most observers, I imagine, would welcome the chance to use their telescopes for new types of observation that reveal interesting phenomena not accessible to simple direct imaging. It is perhaps surprising then, that there is such a possibility which is very little used despite the fact that it requires only a telescope on a simple altazimuth stand, a stopclock and a few minutes preparation time. There is no need for an equatorial mount, a drive, photography, a CCD, computer or any investment in ancillary instrumentation. Pretentiously it could be called "zero-technology objective-grating spectrometer"(!).

Take a piece of plain, unpatterned nylon gauze curtain such as is to be seen in suburban front windows, preferably with a mesh as fine as 1/3 mm and stretch it flat over the main aperture of the telescope, being careful to keep the threads as straight as possible. The result, as is well known[1], is a crude and rather inefficient means of producing spectra of celestial objects. What appears to be much less well known is that such a primitive device can actually be used for quantitative spectrometry. It is possible to make absolute measurements of the wavelengths in emission line sources such as planetary nebulae and the heads of near solar comets. All that is necessary is a measurement of the diffraction angle q, an absolute count of the threads in the gauze to establish their precise mean spacing D, and a simple application of the grating formula:

$$n\lambda = D \sin (q)$$

Essentially, the theory of the method is this: the 1^{st}-order (n=1) q-value is of order 5-6 arcmin., for which the grating formula may be approximated to better than 1 in 10^6 by $\lambda = Dq$ (q in radians). D is determined from the aperture of the grating and a direct count of the threads using a strong magnifier. q is obtained as $q = 0.5\, dq.Dt$, where $dq = 7.2921 \times 10^{-5} \cos d \sec^{-1}$ is the diurnal rate at declination d and Dt is the time taken by the image, drifting at this rate, to pass over the interval between the two 1^{st}-order spectra. The latter must, therefore, be aligned fairly carefully 'fore and aft' to the preceeding-following directions in the field. One great advantage of a nylon curtain as dispersing element is that we can determine the grating constant D by actually counting the individual threads as stated above, and this determination of wavelength is therefore, an absolute one requiring no use of comparison spectra or interpolation formulae.

The nylon used should have a reasonably uniform mesh, without superimposed patterns and should be stretched flat over and fixed to a rigid diaphragm which is placed over the entrance aperture of the telescope in such a way as to be freely rotatable about the optical axis. The results below were obtained with one of 250 mm clear aperture, having 894±2 threads, hence D = 0.2880±0.0006 mm (±0.3%). The transit timings Dt were made with an electronic darkroom stopwatch by watching the two opposite 1^{st} order spectra proceed in tandem across a register mark in the centre of the field; on bringing the object into view and rotating both the grating and the register mark appropriately, one obtains an arrangement of 0^{th} order and four 1^{st} order images which should be thus:-



It follows that the true field of the eyepiece must be at least 4q, preferably rather more, but one should use the highest power that gives this - a typical comet eyepiece giving 30 - 35 arcmin. at x100 is ideal. It is obvious that another huge advantage of this method is that one looks straight into the eyepiece, at a normal telescopic view with full unrestricted field uncluttered by additional optics - there is, for instance, no awkwardness of keeping a narrow spectroscopic slit on target.

At most declinations the transit time Dt generally ranges from 50 to 80 seconds, so it only takes a few minutes to repeat the timing in order to improve accuracy by averaging: I generally take sets of four to six measures. The single most important procedural point is to ensure that the axis of dispersion (see diagram) is square to the register mark and that the latter is square to the p.-f. direction (i.e. N.-S.), both to within a tolerance of say ±3°. The second pair of 1^{st} order spectra will be found very useful in making the first of these adjustments (assuming that the 'mesh' of your nylon is truly rectangular); an offset here will cause a systematic negative bias in the results, while an offset of the p.-f. direction will have the opposite effect. Neither of these systematic errors is significant if the offsets are at the 2° level but start to become serious at about 4°. Undoubtedly a rather thick and accurately square pair of cross-wires in the focal plane would be a great advantage here but my trials of the method used nothing more than a matchstick glued across the field stop of the eyepiece! Other sources of systematic bias to watch out for, which will not be apparent in the random scatter of the Dt measures themselves, include: inaccurate clock rate, wrong D-value (error likely to be ±0.3%), systematic over estimation of Dt due to the angular diameter of the source (likely to be 0 - 1%) and finally the dq rate may need correction for the object's own proper motion in the case of a very fast moving comet.

The miracle is that such an absurdly crude 'grating' is at all capable of giving spectra of sufficient purity for any meaningful measurements. I have recently put this to the test by using some bright planetary nebulae as 'standard sources', all having visual spectra completely dominated by the [OIII] emission, which has a centre of intensity at

λ = 499.5 nm. Among the resultant sets of measures, that with the smallest scatter was also the best: NGC 7027 (visual mag +8.5) gave λ = 500.8 ±3.0 nm, allowing for both random and systematic errors, a result only 0.3% above the expected value. The miracle actually works!

Other sets of 4 - 6 measures were also taken for each of NGC 6826 (m_v = 8.8), 7009 (m_v = 8.3), 7662 (m_v = 8.3) and 3242 (m_v = 7.7) with a worst case result only 2.7% in error, this being a rather rough first attempt.... and all this with only an altazimuth telescope, a piece of old nylon curtain and a darkroom stopwatch! I have no doubt on the basis of these results that more careful use of this primitive instrumentation would be quite capable of ±1 - 2 nm accuracy. Theoretically, the resolving power in 1st order of this piece of nylon is nearly sufficient to split the sodium 'D' lines.

Planetary nebulae are rather boring objects in this sense - they always yield the same wavelength, but near solar comets are much more interesting, being essentially dynamic phenomena and displaying a rich variety of emission lines. (Novae would make another interesting field of application for the same reasons.) Comets at solar distances of 0.5 - 1.0 AU usually radiate strongly the molecular bands of C_2 at 473.7 nm, 516.5 (often the dominant visual wavelength) and 563.5 (band-head λ's) and of CN at 388 nm. Sun-grazers, by contrast, are exercises in atomic spectra rather than molecular chemistry. An earlier and much cruder attempt in this direction which I made with the same piece of nylon 20-odd years ago yielded a value of λ = 523±15 nm for comet Kobayashi-Berger-Milon on 1975 August 24. Subsequently published professional spectra showed the C_2 band-head at 516.5 nm as the brightest visual emission at that time. In addition, my further observations over the days following gave at least a strong hint of night by night changes in the spectrum.

The nylon grating method clearly has more than sufficient spectral discrimination to reveal very quickly which of the major cometary bands is the dominant emission and with a really bright comet - Hale-Bopp in April and May 1997 ? - we may reasonably expect to be able to see them all separately and so to determine their wavelengths one-by-one, and make rough visual estimates of relative intensities. This certainly has the capability of showing up nightly spectroscopic changes that would be quite beyond the reach of direct imaging with or without colour filters. I would strongly urge members of the Comet Section to add observations of this sort to the more usual direct imaging planned for Hale-Bopp this spring. Given that the comet will, when sufficiently near the sun to produce strong line emission, be at least 6 magnitudes brighter than NGC 7027, there will not be a single telescope user in our Association who will be prevented by lack of equipment from making some potentially very interesting measurements with this truly minimalist method - why not give it a try ?

Reference
1. North, G. Advanced amateur astronomy, pp284-6, 1991

CME-Fried Comets

Robert D Brown

This item was taken from the usenet and is reprinted as an example of its genre. No doubt it also explains the cometary origin of Venus! Note that the author has not provided any calculations which could attempt to justify the hypothesis, though an order of magnitude calculation is quite straightforward.

There is a potential for a parity-breaking interaction between coronal mass ejections (CME's) and comet tails that may explain the asymmetrical distribution of comets in prograde and retrograde moving orbits and explain the origin of asteroids as "CME-Fried Comets".

The long period comets are split 50-50 between prograde and retrograde moving orbits and arrive in the solar system from any direction (randomly). The intermediate period comets have an average inclination of 28 degrees to the ecliptic plane and 75% move in prograde orbits. The short period comets move within the ecliptic plane and all display prograde orbits.

CME's maintain their angular momentum as they traject away from the Sun. Comet tails, in contrast, are radially-oriented in respect to the Sun. Because the Sun's rotational rate is faster at the equator than it is toward the poles, the potential for a parity-breaking CME-comet tail interaction is greatest at the ecliptic plane.

Hypothesis: CME's tend to have head-on interactions with retrograde-moving long period comets that result in the explosive demise of the comet nucleus, while prograde moving comets tend to have tail-first interactions with CME's that result in a slow cook-off of comet volatiles. The plasma-mediated magnetic connection of CME's with comet tails converts parabolic orbits to elliptical orbits more characteristic of asteroids. An asteroid is what one gets from this process.

R. D. Brown, M.D.
Pelorus Research Laboratory

Letters

Graeme Waddington points out that the period I gave for comet Hale-Bopp in the Journal note is only true for the epoch of perihelion. He goes on to say: This is not the orbital period prior to the comet's current passage through the solar system, as it was changed as a result of the 115 million km approach to Jupiter in April 1996. The period of the previous orbit was around 4200 years - hence we should be looking for cometary apparitions around 2200BC and not 500BC as implied by your wording. As it happens, both Baldet and Hasegawa's comet lists give a candidate comet visible from Egypt in -2191 (or -2024); in both cases the comet "record" has been taken from Pingre's Cometography (1783), p 246. Pingre got his entry from Hevelius' Cometographia (1668), p 794. Hevelius, in turn, got his information from the Sequunter Exempla Cometarum of Rochenbach's De Cometis (1600; published 1619), p114 where we find the following:

Anno mundi, millesimo, nongentesimo, quadragesimo quarto. Anno post diluvia, ducentesimo, octuagesimo octavo, Cometa in Aegipto naturam Saturni referens, circa Alcairum, in dodecatemorio capricorni visus est, hicque spatio sexaginta quinque dierum, tria signa in coelo percurrit. Hunc confusiones linguarum, & dissipationes gentium in toto terrarum orbe, sunt secutae. De quibus Genes, undecimo capite, prolixus textus dicunt.

Whereas Hevelius accepts this AM 1944 (=-2191), "record", Pingre rightly regards it as a pure fiction ("imaginees sans aucun fondement"), but neither Baldet nor Hasegawa picked this up. (The alternative dating of -2024, quoted by both Baldet and Hasegawa, appears to be due to Pingre - it depends on just when you think the "flood" occurred!). Given the paucity of reliable records from 2200BC it is indeed unlikely that the previous apparition of the Hale-Bopp will be identified in the historical record.

Graeme Waddington

The cosmonauts aboard the Mir spacecraft communicate with amateur radio enthusiasts all over the world. Amongst them is BAA Member Don Shirreff (G3BGM) who asked them about observing from space. The latest Captain of Mir is Alexandr Kalery who sent this reply on 1996 October 14; reception was not good and there are some gaps in the transmission:

Dear Don,

I saw both Tabor and Hale-Bopp comet. Tabor looks like a small diffuse spot having size approx. 7-8 arcmin. I couldn't see its tale. Only the head was seen through its coma. ...... I can say nothing about this star because it is absent on my star map. I can observe this comet by binocular -20x and monocular -6x only. Hale-Bopp comet is seen also by these instruments. But in binocular I saw only its head and in monocular I saw its tale too. I can estimate its head size in 14-15 arcmin and its tale 2-3 times longer. Now it can be seen in the first 10-15 minutes of shadow in .... (Communication was lost at this point, but Don thinks he was answering the question as to how close to the sun they were able to observe the comets by going on to say that they were observing them while in shadow before sunrise or after sunset.)

Alexandr Kalery

Tales from the Past

This section gives a few excerpts from past BAA Journals, RAS Monthly Notices and Sky & Telescope.

150 Years Ago: Monthly Notices contained an anonymous review of *A Historical Survey of Comets'* by Dr Michelsen, which seems to be a forerunner of recent books by authors such as Schaaf and Yeomans. According to the review it covered great and periodic comets, including apparitions of 1P/Halley back to 426 BC [though modern research gives returns in 391 or 466 BC]. Comet Encke was one of the few other periodic comets observed at several returns at this time and its motion was thought to demonstrate the presence of a resisting medium in space. F W Bessel died in 1846 and his obituary notes his studies of 1P/Haley, and particularly refers to his observations of jets in the coma and his realization that these could create a repulsive effect and alter the comet's orbit. The review of the year notes calculations by Professor Plantamour of Geneva in AN, on the motion of Biela's comet and gives a passage from Seneca's *Naturales Quaestiones* which seems to describe a double comet. The review also records comet discoveries of the previous twelve months, including 3 by de Vico, 2 by Brorsen and two by Hind. Hind had been co-discoverer of one with de Vico and had just missed out on another, but the one that carried his name alone became visible in daylight on March 30. Hind also predicted a return of the comets 1264 N1 and 1556 D1 for February 1848, however the modern orbits bear no relation to each other.

100 Years Ago: Volume 7 of the BAA Journal reported that a new rule for telegraphing comets came into operation on November 1, when the brightness of the object was included in the cypher. A C D Crommelin published a paper in the Journal on how to compute the orbit of a comet from three observations made at intervals of a few days. Observations of the Leonids were reported and prognoses given for the forthcoming return and that of 1933. A good return of the Bielids was also expected in 1898. It was reported that Dr Riem had linked comet Tebbutt 1881 K1 to a comet seen by the Chinese in 612 BC. Mr W T Lynn suggested that comet Tewfik, seen at the solar eclipse in 1882, might be linked to 'certain appearances' seen in photographs taken at the solar eclipses of 1860 and 1893. If so the comet would have a period of 10.9 years; however he also linked sunspots to swarms of meteors! AN 3416 contained a paper by J holetschek giving notes on many ancient comets, including several apparitions of comet 1P/Halley recorded by the Chinese. Linking comet orbits was a popular pastime and another attempted linkage was between comet D/Lexell (17770 L1) and D/Swift (1895 Q1). Swift had also seen a bright object about 1 degree east of the sun on the evening of 1896 September 21; this may have been a sungrazing comet.

50 Years Ago: The Reverend Dr Martin Davidson resigned as Director of the comet Section at the AGM in October 1946 and was succeeded by Dr Gerald Merton. At the January meeting

Manning Prentice presented a paper on the Giacobinids and there was much discussion about the storm's relation to comet Giacobini-Zinner. Also in reference to the shower, known as the Draconids in the USA, Sky & Tel mentions 'No known comet can itself strike the Earth'. The March Journal (57, 3) contains a report of the comet Section for 1946 [such reports are fairly infrequent in the Journal]. Section member Albert Jones had discovered a comet (1946 P1) on August 6 the previous year whilst trying to find the variable star U Puppis, although he had carried out a comet search earlier. It moved north and was expected to be 9^m [the section archive records start the following year]. The Carter Observatory of New Zealand issued the announcement of the discovery of a comet by the Director of the RAS of New Zealand comet Section on September 2. Berry himself was doubtful and wanted to wait for confirmation. It turned out that flaws on three plates taken on separate days were coincidentally aligned.

Review of comet observations for 1996 November - 1997 April

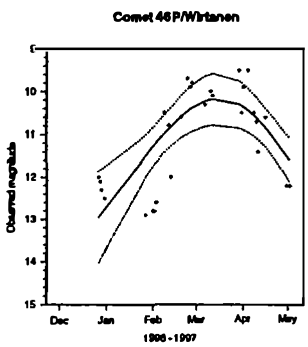
The information in this report is a synopsis of material gleaned from IAU circulars 6496 - 6654 and The Astronomer (1996 November - 1997 April). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

A final observation of 22P/Kopff was made by Werner Hasubick on 1996 November 4.7 when it was mag 13.5. A preliminary analysis of the data gives a light curve of

$6.5 + 5 \log d + 12.9 \log r$

but this is a little indeterminate.

29P/Schwassmann-Wachmann 1 was again in outburst in February and early March, peaking at around 12th mag. A further outburst commenced in early May. This comet seems to spend a lot of time in outburst and is worth monitoring with CCD cameras on a regular basis.



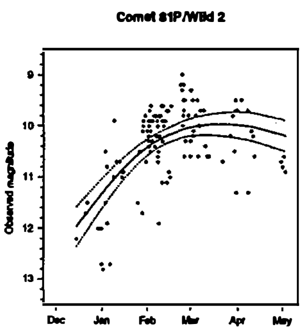
46P/Wirtanen, the target for the ESA Rosetta mission, was visible for a short while in the evening sky this spring. A diffuse object, it peaked at around 10^m in late March, but was not too difficult to see. It faded rapidly in April. Observations received so far give a preliminary light curve of

$8.2 + 5 \log d + 16.6 \log r$

81P/Wild 2, a target for the NASA Stardust mission, reached peak brightness at around 10th mag in late March and is now fading slowly. Observations received so far give a preliminary light curve of

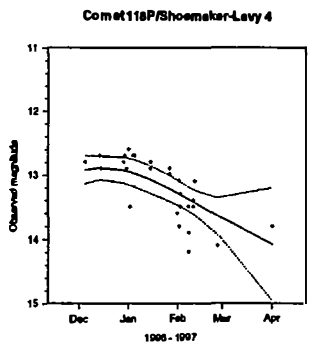
$7.2 + 5 \log d + 10.6 \log r$

not very different to the previous apparition.



118P/Shoemaker-Levy 4 never became very bright, but a number of observers recorded it fading from 13^m during the winter. Observations received so far give a preliminary light curve of

$8.9 + 5 \log d + [10] \log r$



126P/IRAS (1996 P1) was recovered at 13^m by Rob McNaught on a UK Schmidt plate taken by Q A Parker on August 8. For most of the apparition it was a southern hemisphere object, but became visible from the north late in the year as it faded from 12 to 13 mag during November and December.

C/1995 O1 (Hale-Bopp) has now disappeared from view to northern hemisphere observers. There are already over 2000 visual magnitude observations, and 400 graphic images of one sort or another in the archive, making it the most observed comet in the Section records. Although it was a 'great comet', it is presumptive to call it THE great comet of 1997 - there are 8 months of the year to go yet!

The comet faded a little in August and September last year, but during October brightened by about 1 mag and reached 4.5 to the naked eye in mid October. During the rest of the year it did not brighten much and reached 4th mag by the end of the year. The comet brightened rapidly during January and February peaking at around -0.7 in late March. It is now fading. The equation

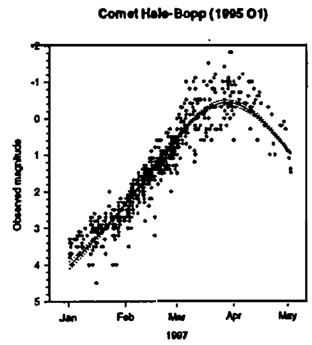
-0.5 + 5 log d + 7.2 log r

fits all the available observations (corrected for aperture), but there are long period variations about this mean curve of around a magnitude. Alan Fitzsimmons has suggested that because it is a very dusty comet the light curve is better fitted by including a phase term and the observations do bear this out, at least until February. A presentation by Alan at the RAS meeting on March 14, gave a nearly perfect straight line fit with no apparent variations.

Since the beginning of the year the comet brightened more rapidly at

-0.7 + 5 log d + 10.6 log r

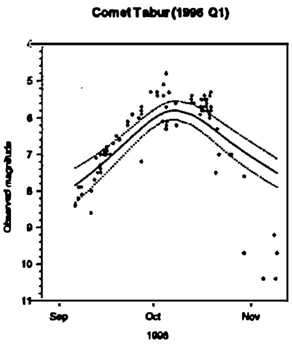
suggesting that peak brightness was around -0.5 and that observers included the tail in their magnitude estimates.



Greatest tail lengths, in excess of 20°, were seen towards the end of March. Considerable detail was visible in the inner coma, particularly a series of dust shells emitted as an active jet on the surface of the nucleus rotated into sunlight.

C/Evans-Drinkwater (1996 J1) was discovered by Robert Evans and Michael Drinkwater (a former PhD student at the Institute of Astronomy in Cambridge) on UK Schmidt plates taken on 1996 May 10. It was in conjunction with the sun following perihelion at the end of December, but was recovered in early May, much brighter than expected and with a companion. The brighter object (at mag 10) turns out to be the secondary and the fainter one (at mag 13) the primary. It is not likely to be visible from the UK. More southerly observers should be able to locate it as its elongation from the sun increases, though it will be fading.

C/Tabur (1996 Q1) was visually discovered by Vello Tabur of Wanniassa, Australian Capital Territory on August 19 at 10^{m}. It brightened rapidly and moved north, becoming an easy target for northern hemisphere observers. It broke up and faded during late October and the last observation was made in mid November. The light curve is a power law best fit over the apparition, but the observations are clearly much fainter than this in late October and November.



Details of several sungrazing comets discovered with the C2 and C3 coronographs on the SOHO spacecraft during 1996 were announced on IAUC 6653. They are all Kreutz group objects and are given the designations: comets SOHO 1996 Q2, 1996 Q3, 1996 S3 and 1996 Y1. Q2 and Y1 were discovered by Shane Stezelberger of the SOHO-LACO operations centre and Q3 and S3 by Douglas Biesecker of the University of Birmingham.

1996 R3 Details of a faint comet discovered by Claes-Ingvar Lagerkvist on an ESO Schmidt plate taken last October were given on IAUC 6564 (1997 February 21). The object was eventually confirmed on images taken by the Spacewatch and NEAT teams last September. It is an intrinsically very faint comet and may be periodic, though there are not enough observations to confirm this.

C/NEAT (1997 A1). The NEAT (Near Earth Asteroid Tracking) Team discovered a very faint comet (19th mag) with the USAF/GEODSS telescope on Hawaii. It is a distant object and unlikely to be observed visually, however at least one UK amateur has obtained CCD images.

P/Kobayashi (1997 B1) was initially reported to the IAU by S Nakano as an asteroid discovered by Takao Kobayashi, but subsequent observations showed that it was in a cometary orbit and further observations by W Offutt showed it to have a coma and tail. The nuclear magnitude of the comet is around 17, but visual observations may put it brighter. This is the first amateur CCD discovery of a comet and is also the faintest amateur discovery and shows that the field is not lost to the professional search teams.

P/Gehrels (1997 C1). Tom Gehrels discovered a comet by eye during the course of the Spacewatch survey. The comet is a periodic one, and is currently 17th mag and fading.

C/Spacewatch. Details of the orbit of an unusual asteroid, 1997 BA6 were given on MPEC C-13. The orbit is very eccentric, with a period near 4500 years and a semi-major axis of several hundred AU. This is more typical of a long period comet and subsequent observations with large telescopes showed a small faint coma. Currently it is nearly 20th mag and located at around 12 deg dec, but will be at high southern dec when near perihelion. The asteroid is currently some 8 AU from the earth and nearly 9 AU from the sun, and is heading for perihelion at 3.4 AU in 1999 December when it may be around 13th mag.

C/Mueller (1997 D1) is a new comet discovered on plates taken by Jean Mueller for the 2nd Palomar Sky Survey with the 1.2-m Oschin Schmidt Camera on Feb 17th. The object was reported as 16th mag, but appears brighter to visual observers. I observed it with the Northumberland 0.30-m refractor x170 on March 6.11, and made the comet 13.7, DC4, diameter 0.4'. Although it should remain around this brightness until conjunction in late May, few positive observations have been reported since early April. It should reappear in the autumn slightly brighter at around 12^m.

55P/Tempel-Tuttle (1997 E1) has been recovered by observers using the Keck 10-m telescope and confirmed using the ESO 3.5-m NTT at mag 22. The parent comet of the Leonids, it will not reach perihelion until 1998 Feb 28 when it may get as bright as 9^m. It will pass 0.35 AU from the earth in mid February when it gets within 8° of the pole.

The comet was originally discovered on 1865 December 19 by William Tempel in Marseilles and on 1866 January 6 by Horace Tuttle from Harvard. The comet was then around 6^m and reached perihelion on January 12 when it was 5^m. It faded and was last seen on February 9. Once the orbit was calculated it was realised that it was very similar to that of the Leonids and previous returns of the comet were found in 1366 (when it made a very close approach to earth, 0.0229 AU, and reached 3^m) and 1699. It wasn't really looked for in 1899, and couldn't be found in 1932. At the last return it was eventually recovered some three months after perihelion in 1965 June.

The Leonid rates themselves last year seem to have peaked at a ZHR of around 50-60 between 06-10 UT on November 17. Many of the meteors were bright, which is similar to what was seen prior to the big display in 1966.

C/Montani (1997 G1) was announced on IAUC 6622. It is a 19th mag object discovered by Joe Montani of the Spacewatch team. The preliminary orbit suggests that it is a distant object, with a perihelion distance of 4.3 AU and will not become any brighter. It may be a periodic comet.

C/Montani (1997 G2) quickly followed. It is another distant comet, but may just become visible to southern hemisphere observers when it reaches perihelion next Spring.

P/McNaught-Hughes (1997 H1 = 1991 S1) was recovered at its first return by Jim Scotti with the Spacewatch telescope and A Nakamura with the Kuma Kogen Astronomical Observatory 0.6-m f6 Ritchey-Chretien reflector. It is not expected to become much brighter than 18^m.

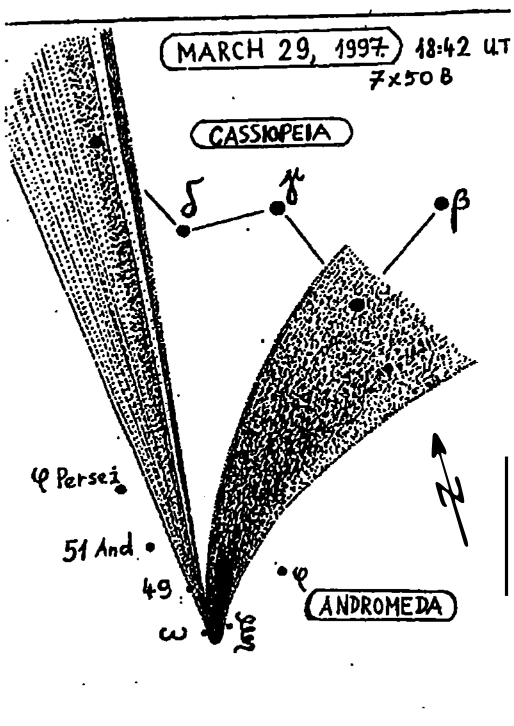
C/SOHO (1997 H2) is another sun-grazer discovered by Shane Stezelberger with the SOHO C2 and C3 coronographs. Around mag 2 – 5 on the images, with a perihelion distance of 0.14 AU it is not a Kreutz group member. It will emerge from the sun's glare at around 8^m and fade. It will not be visible from the UK, but may be picked up from more southerly locations. See the section web page for an ephemeris.

C/Mueller (1997 J1) is another new comet discovered on plates taken by Jean Mueller for the 2nd Palomar Sky Survey. The object was reported as 14th mag, but appeared a little brighter to visual observers. Just past perihelion and at high northern declination when discovered, it will fade. The comet will pass close to M81 and M82 on May 18.

1997 J2 was discovered only 6' SW of 1997 J1 by French amateurs using CCD detectors on 0.20-m reflectors. It may be in outburst as it should have been brighter than 12^m for over a year prior to discovery, but is now fading. I observed it on May 10.9 when it was mag 13.5, but more condensed and easier to see than 1997 J1.

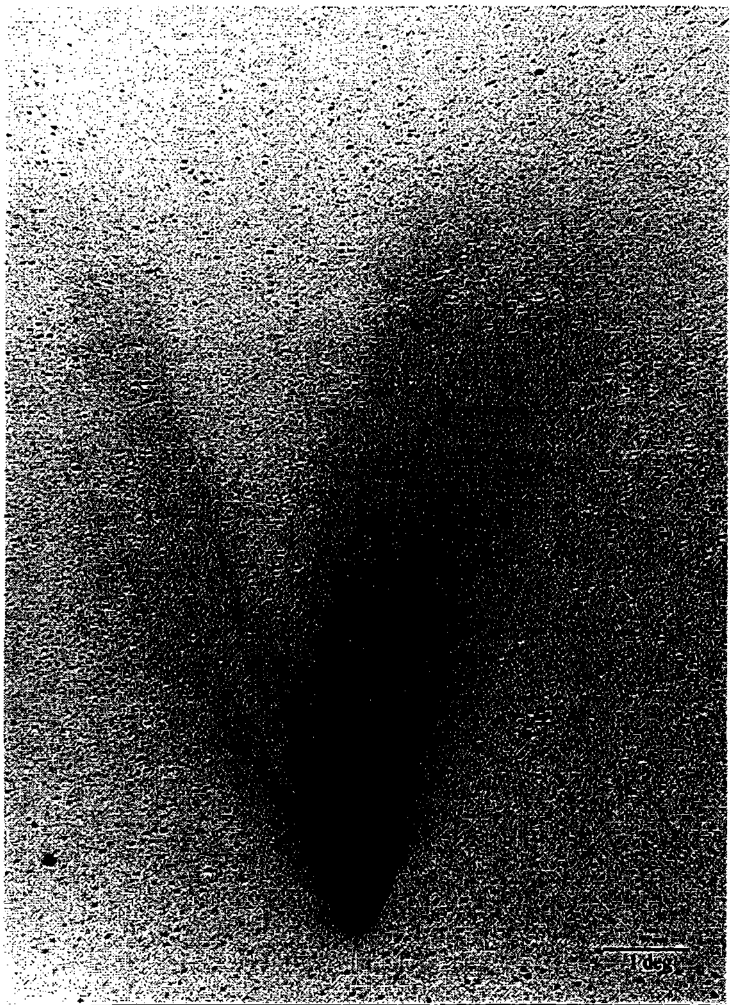
For the latest information on all discoveries, the current brightness of comets and up to date ephemerides, see the section www page:
http://www.ast.cam.ac.uk/~jds

A selection of drawings and images of C/Hale-Bopp follow:

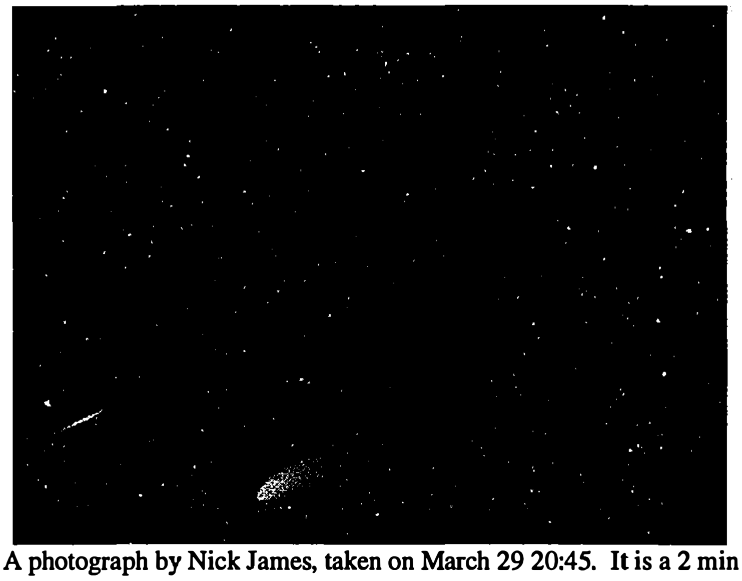


Drawing by Atilla Kosa-Kiss

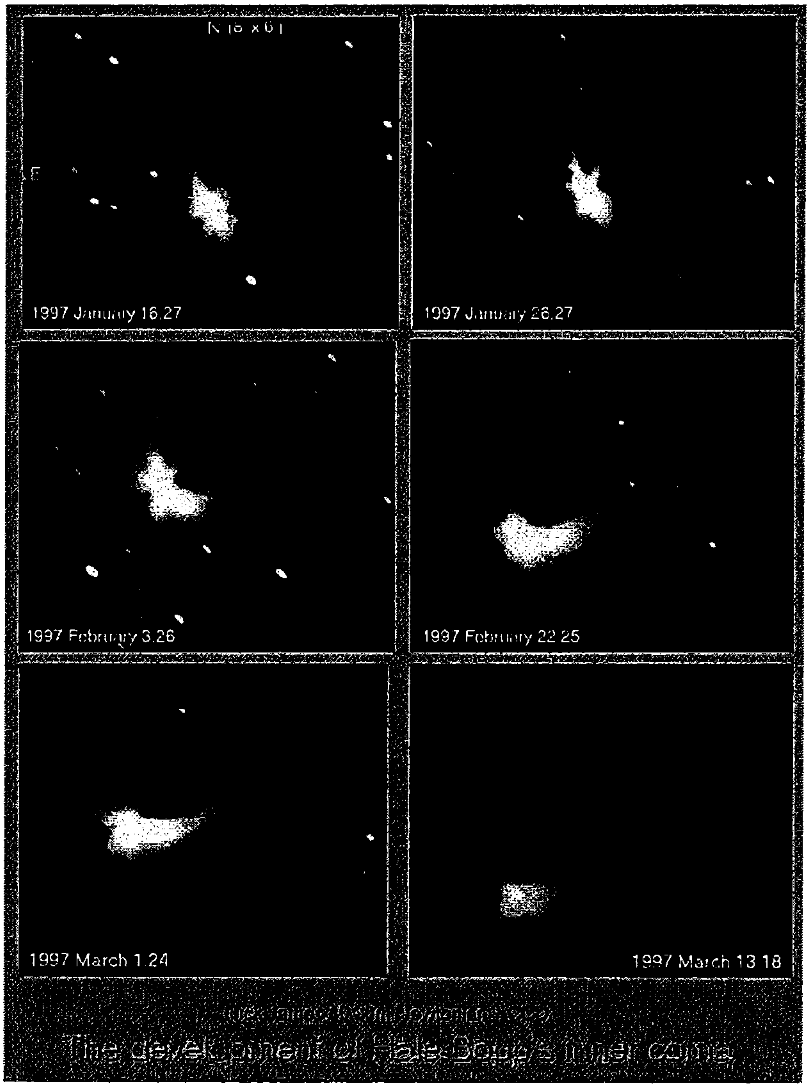
Drawing by Sally Beaumont



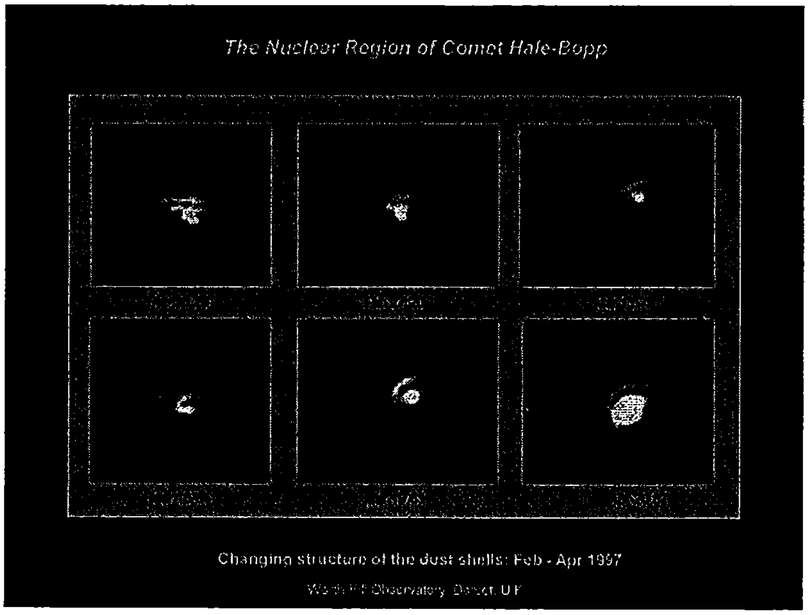
C/1995 O1 (Hale-Bopp), 8.4.1997, 19:05-19:35 UT 12 x 9 deg
Telephoto lens Sonnar fl=30 cm, f/4. Ilford HP5+, ISO 400, 6x6 cm. N
(C) Gabriel Okša, Trnava, Slovakia W



A photograph by Nick James, taken on March 29 20:45. It is a 2 min exposure on Fuji SG800 film with a 55mm f2 lens. Also visible are the double cluster and a meteor



Images by Nick James



Images by David Strange

Introduction

Ephemerides are given for comets:

- 43P/Wolf-Harrington
- 78P/Gehrels 2
- 103P/Hartley 2
- C/Mueller (1997 D1)
- 2P/Encke (Southern hemisphere)
- 81P/Wild 2 (Southern hemisphere)

Current ephemerides are also available on the section web page.

A finder chart and visibility diagram for comet Hale-Bopp is given for a latitude of 40° South. The comet should be naked eye brightness until the next newsletter is due out.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU circulars, Minor Planet Circulars, IAU comet catalogue or from Don Yeomans of JPL.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. All times are in Greenwich Mean Astronomical Time (GMAT), i.e. the day is the day on which the night starts. To convert to UT (GMT) add 12 hours. If the value is greater than 24, add 1 to the day and subtract 24 from the hour. If necessary, convert to local time. Strictly ephemeris time is used which is currently some 60 seconds ahead of UT.
- Column headings:

a) Double-date format. Time in GMAT. 12.0 is midnight UT.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are for epoch 1950).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for 43P/Wolf-Harrington

```
Omega=186.9536 OMEGA=254.8053 i= 18.5175 q= 1.585042 a=  3.472763
e=0.543579  P=    6.472  T= 1997 September 29.2547    Equinox= 2000
Magnitudes calculated from m= 6.5+5.0*Log(d)+15.0*Log(r)
```

August 1997 — Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	4 59.5	29.28	11.5	2.10	1.69	20.20	14.07 to 14.26	53	39	1	2	269	17	0
2/ 3	12.0	5 2.6	29.26	11.5	2.09	1.68	20.19	14.05 to 14.29	53	50	0	2	270	17	0
3/ 4	12.0	5 5.8	29.23	11.5	2.08	1.68	20.18	14.04 to 14.32	53	61	0	3	270	17	-1
4/ 5	12.0	5 9.0	29.20	11.5	2.07	1.68	20.18	14.03 to 14.35	53	72	2	3	270	17	-1
5/ 6	12.0	5 12.1	29.17	11.4	2.06	1.68	20.17	14.02 to 14.37	54	83	6	3	270	17	-1
6/ 7	12.0	5 15.3	29.14	11.4	2.05	1.67	20.16	14.01 to 14.40	54	94	11	3	270	17	-1
7/ 8	12.0	5 18.5	29.10	11.4	2.05	1.67	20.15	13.59 to 14.43	54	105	18	3	271	17	-1
8/ 9	12.0	5 21.6	29.05	11.4	2.04	1.67	20.15	13.58 to 14.45	54	116	26	3	271	17	-1
9/10	12.0	5 24.8	29.01	11.3	2.03	1.66	20.14	13.57 to 14.48	55	127	35	3	271	17	-1
10/11	12.0	5 28.0	28.56	11.3	2.02	1.66	20.13	13.56 to 14.51	55	138	45	3	271	17	-2
11/12	12.0	5 31.1	28.51	11.3	2.01	1.66	20.12	13.55 to 14.53	55	149	55	3	271	17	-2
12/13	12.0	5 34.3	28.46	11.3	2.00	1.65	20.11	13.54 to 14.56	55	160	65	3	272	17	-2
13/14	12.0	5 37.5	28.40	11.3	1.99	1.65	20.11	13.53 to 14.58	56	169	75	3	272	17	-2
14/15	12.0	5 40.6	28.34	11.2	1.99	1.65	20.10	13.53 to 15.01	56	166	84	3	272	17	-2
15/16	12.0	5 43.8	28.27	11.2	1.98	1.65	20.09	13.52 to 15.03	56	155	92	3	272	17	-2
16/17	12.0	5 46.9	28.21	11.2	1.97	1.64	20.08	13.51 to 15.06	57	142	97	3	272	17	-2
17/18	12.0	5 50.1	28.14	11.2	1.96	1.64	20.07	13.50 to 15.08	57	129	100	3	272	17	-2
18/19	12.0	5 53.2	28.06	11.2	1.95	1.64	20.07	13.49 to 15.11	57	115	100	3	273	17	-3
19/20	12.0	5 56.4	27.58	11.1	1.94	1.64	20.06	13.49 to 15.13	57	100	97	3	273	17	-3

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
20/21	12.0	5 59.5	27.50	11.1	1.94	1.63	20.05	13.48 to 15.15	58	86	91	3	273	17	-3
21/22	12.0	6 2.6	27.42	11.1	1.93	1.63	20.04	13.47 to 15.18	58	72	83	3	273	17	-3
22/23	12.0	6 5.7	27.34	11.1	1.92	1.63	20.03	13.47 to 15.20	58	59	73	3	273	17	-3
23/24	12.0	6 8.8	27.25	11.1	1.91	1.63	20.03	13.46 to 15.22	58	46	62	3	274	17	-3
24/25	12.0	6 11.9	27.15	11.1	1.90	1.62	20.02	13.46 to 15.25	59	33	51	3	274	17	-3
25/26	12.0	6 15.0	27.06	11.0	1.89	1.62	20.01	13.45 to 15.27	59	21	40	4	274	17	-3
26/27	12.0	6 18.1	26.56	11.0	1.89	1.62	20.00	13.45 to 15.29	59	11	30	4	274	17	-4
27/28	12.0	6 21.2	26.46	11.0	1.88	1.62	19.59	13.44 to 15.32	59	10	21	4	274	17	-4
28/29	12.0	6 24.3	26.35	11.0	1.87	1.62	19.58	13.44 to 15.34	60	18	14	4	275	17	-4
29/30	12.0	6 27.3	26.24	11.0	1.86	1.61	19.57	13.43 to 15.36	60	29	8	4	275	17	-4
30/31	12.0	6 30.4	26.13	11.0	1.86	1.61	19.57	13.43 to 15.38	60	39	3	4	275	17	-4
31/32	12.0	6 33.4	26.02	10.9	1.85	1.61	19.56	13.43 to 15.40	60	50	0	4	275	17	-4

September 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	6 36.5	25.50	10.9	1.84	1.61	19.55	13.42 to 15.43	61	62	0	4	275	17	-4
2/ 3	12.0	6 39.5	25.38	10.9	1.83	1.61	19.54	13.42 to 15.45	61	73	0	4	276	17	-5
3/ 4	12.0	6 42.5	25.26	10.9	1.82	1.61	19.53	13.42 to 15.47	61	84	3	4	276	16	-5
4/ 5	12.0	6 45.5	25.13	10.9	1.82	1.60	19.52	13.42 to 15.49	62	95	8	4	276	16	-5
5/ 6	12.0	6 48.5	25.00	10.9	1.81	1.60	19.51	13.41 to 15.51	62	106	14	4	276	16	-5
6/ 7	12.0	6 51.4	24.47	10.8	1.80	1.60	19.50	13.41 to 15.53	62	117	21	4	276	16	-5
7/ 8	12.0	6 54.4	24.33	10.8	1.79	1.60	19.49	13.41 to 15.55	62	128	30	4	277	16	-5
8/ 9	12.0	6 57.3	24.19	10.8	1.79	1.60	19.48	13.41 to 15.57	63	140	39	4	277	16	-5
9/10	12.0	7 0.3	24.05	10.8	1.78	1.60	19.47	13.41 to 15.59	63	152	49	4	277	16	-5
10/11	12.0	7 3.2	23.51	10.8	1.77	1.60	19.46	13.40 to 16.01	63	164	60	4	277	16	-5
11/12	12.0	7 6.1	23.36	10.8	1.76	1.59	19.45	13.40 to 16.03	64	174	71	4	277	16	-6
12/13	12.0	7 9.0	23.21	10.8	1.76	1.59	19.44	13.40 to 16.05	64	167	81	4	277	16	-6
13/14	12.0	7 11.8	23.06	10.7	1.75	1.59	19.43	13.40 to 16.07	64	154	89	4	278	16	-6
14/15	12.0	7 14.7	22.51	10.7	1.74	1.59	19.42	13.40 to 16.09	64	140	96	4	278	16	-6
15/16	12.0	7 17.5	22.35	10.7	1.74	1.59	19.40	13.40 to 16.11	65	126	100	4	278	16	-6
16/17	12.0	7 20.4	22.19	10.7	1.73	1.59	19.39	13.40 to 16.13	65	111	100	5	278	16	-6
17/18	12.0	7 23.2	22.03	10.7	1.72	1.59	19.38	13.40 to 16.15	65	97	98	5	278	16	-6
18/19	12.0	7 26.0	21.46	10.7	1.71	1.59	19.37	13.40 to 16.17	66	83	93	5	279	16	-6
19/20	12.0	7 28.7	21.29	10.7	1.71	1.59	19.36	13.40 to 16.19	66	69	86	5	279	16	-6
20/21	12.0	7 31.5	21.12	10.7	1.70	1.59	19.35	13.40 to 16.21	66	55	77	5	279	16	-7
21/22	12.0	7 34.2	20.55	10.7	1.69	1.59	19.33	13.40 to 16.23	66	42	67	5	279	16	-7
22/23	12.0	7 37.0	20.37	10.6	1.69	1.59	19.32	13.40 to 16.25	67	30	56	5	279	15	-7
23/24	12.0	7 39.7	20.20	10.6	1.68	1.59	19.31	13.40 to 16.27	67	18	46	5	279	15	-7
24/25	12.0	7 42.4	20.02	10.6	1.67	1.59	19.30	13.40 to 16.28	67	6	36	5	280	15	-7
25/26	12.0	7 45.1	19.43	10.6	1.67	1.59	19.28	13.40 to 16.30	68	7	26	5	280	15	-7
26/27	12.0	7 47.7	19.25	10.6	1.66	1.59	19.27	13.40 to 16.32	68	18	18	5	280	15	-7
27/28	12.0	7 50.3	19.06	10.6	1.65	1.59	19.26	13.40 to 16.34	68	29	11	5	280	15	-7
28/29	12.0	7 53.0	18.47	10.6	1.65	1.59	19.25	13.41 to 16.36	69	40	6	5	280	15	-7
29/30	12.0	7 55.6	18.28	10.6	1.64	1.59	19.23	13.41 to 16.38	69	51	2	5	280	15	-7
30/31	12.0	7 58.1	18.09	10.6	1.63	1.59	19.22	13.41 to 16.39	69	62	0	5	281	15	-8

October 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	8 0.7	17.50	10.6	1.63	1.59	19.20	13.41 to 16.41	70	74	0	5	281	15	-8
2/ 3	12.0	8 3.3	17.30	10.6	1.62	1.59	19.19	13.41 to 16.43	70	85	1	5	281	15	-8
3/ 4	12.0	8 5.8	17.10	10.5	1.61	1.59	19.18	13.41 to 16.45	70	96	4	5	281	15	-8
4/ 5	12.0	8 8.3	16.50	10.5	1.61	1.59	19.16	13.41 to 16.47	71	108	10	5	281	14	-8
5/ 6	12.0	8 10.8	16.29	10.5	1.60	1.59	19.15	13.41 to 16.48	71	120	16	5	281	14	-8
6/ 7	12.0	8 13.2	16.09	10.5	1.60	1.59	19.13	13.41 to 16.50	71	132	25	5	282	14	-8
7/ 8	12.0	8 15.7	15.48	10.5	1.59	1.59	19.12	13.42 to 16.52	72	144	34	5	282	14	-8
8/ 9	12.0	8 18.1	15.28	10.5	1.58	1.59	19.10	13.42 to 16.54	72	156	44	5	282	14	-8
9/10	12.0	8 20.5	15.07	10.5	1.58	1.59	19.09	13.42 to 16.56	72	169	55	5	282	14	-8
10/11	12.0	8 22.9	14.45	10.5	1.57	1.59	19.07	13.42 to 16.57	73	178	67	5	282	14	-8
11/12	12.0	8 25.2	14.24	10.5	1.56	1.59	19.05	13.42 to 16.59	73	164	77	5	282	14	-8
12/13	12.0	8 27.6	14.03	10.5	1.56	1.59	19.04	13.42 to 17.01	73	150	86	5	283	14	-8
13/14	12.0	8 29.9	13.41	10.5	1.55	1.59	19.02	13.42 to 17.02	74	136	94	5	283	14	-9
14/15	12.0	8 32.2	13.19	10.5	1.55	1.59	19.01	13.43 to 17.04	74	121	98	5	283	13	-9
15/16	12.0	8 34.5	12.57	10.5	1.54	1.59	18.59	13.43 to 17.06	74	107	100	5	283	13	-9
16/17	12.0	8 36.7	12.35	10.5	1.53	1.60	18.57	13.43 to 17.08	75	93	99	5	283	13	-9
17/18	12.0	8 39.0	12.13	10.5	1.53	1.60	18.56	13.43 to 17.09	75	78	96	5	283	13	-9
18/19	12.0	8 41.2	11.51	10.5	1.52	1.60	18.54	13.43 to 17.11	76	65	89	5	284	13	-9
19/20	12.0	8 43.4	11.28	10.5	1.52	1.60	18.52	13.43 to 17.13	76	52	81	5	284	13	-9
20/21	12.0	8 45.6	11.06	10.5	1.51	1.60	18.50	13.43 to 17.15	76	39	72	5	284	13	-9
21/22	12.0	8 47.7	10.43	10.5	1.51	1.60	18.48	13.44 to 17.16	77	27	62	5	284	13	-9
22/23	12.0	8 49.8	10.20	10.5	1.50	1.60	18.47	13.44 to 17.18	77	15	52	5	284	13	-9
23/24	12.0	8 51.9	9.58	10.5	1.49	1.60	18.45	13.44 to 17.20	77	5	42	5	284	12	-9
24/25	12.0	8 54.0	9.35	10.4	1.49	1.61	18.43	13.44 to 17.21	78	10	33	5	285	12	-9
25/26	12.0	8 56.1	9.12	10.4	1.48	1.61	18.41	13.44 to 17.23	78	21	24	5	285	12	-9
26/27	12.0	8 58.1	8.48	10.4	1.48	1.61	18.39	13.44 to 17.25	79	32	17	5	285	12	-9
27/28	12.0	9 0.1	8.25	10.4	1.47	1.61	18.37	13.44 to 17.26	79	43	10	5	285	12	-9
28/29	12.0	9 2.1	8.02	10.4	1.47	1.61	18.35	13.44 to 17.28	79	54	5	5	285	12	-9
29/30	12.0	9 4.1	7.39	10.4	1.46	1.61	18.33	13.45 to 17.30	80	65	1	5	285	12	-9
30/31	12.0	9 6.0	7.15	10.4	1.45	1.62	18.31	13.45 to 17.31	80	77	0	5	286	12	-9
31/32	12.0	9 8.0	6.52	10.4	1.45	1.62	18.29	13.45 to 17.33	81	89	0	5	286	11	-9

November 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	9 9.9	6.28	10.4	1.44	1.62	18.27	13.45 to 17.35	81	100	2	5	286	11	-9
2/ 3	12.0	9 11.7	6.04	10.4	1.44	1.62	18.25	13.45 to 17.36	82	112	6	5	286	11	-9
3/ 4	12.0	9 13.6	5.41	10.4	1.43	1.63	18.23	13.45 to 17.38	82	125	12	5	286	11	-9
4/ 5	12.0	9 15.4	5.17	10.4	1.43	1.63	18.21	13.45 to 17.40	82	137	20	5	287	11	-9
5/ 6	12.0	9 17.2	4.53	10.4	1.42	1.63	18.19	13.45 to 17.41	83	149	30	5	287	11	-9
6/ 7	12.0	9 19.0	4.29	10.4	1.42	1.63	18.17	13.45 to 17.43	83	161	40	5	287	11	-9
7/ 8	12.0	9 20.7	4.06	10.4	1.41	1.63	18.14	13.45 to 17.45	84	171	51	5	287	10	-9
8/ 9	12.0	9 22.4	3.42	10.4	1.41	1.64	18.12	13.45 to 17.46	84	167	63	5	287	10	-9
9/10	12.0	9 24.1	3.18	10.5	1.40	1.64	18.10	13.46 to 17.48	85	155	74	5	287	10	-9
10/11	12.0	9 25.8	2.54	10.5	1.40	1.64	18.08	13.46 to 17.49	85	141	83	5	288	10	-9
11/12	12.0	9 27.5	2.30	10.5	1.39	1.64	18.05	13.46 to 17.51	86	128	91	5	288	10	-9
12/13	12.0	9 29.1	2.06	10.5	1.39	1.65	18.03	13.46 to 17.53	86	114	97	5	288	10	-9
13/14	12.0	9 30.7	1.42	10.5	1.38	1.65	18.01	13.46 to 17.54	87	100	100	5	288	9	-9
14/15	12.0	9 32.3	1.18	10.5	1.37	1.65	17.58	13.46 to 17.56	87	86	100	5	289	9	-9
15/16	12.0	9 33.8	0.54	10.5	1.37	1.66	17.56	13.46 to 17.57	88	72	98	5	289	9	-9

16/17	12.0	9 35.3	0.30	10.5	1.36	1.66	17.53	13.46 to 17.59	88	59	93	5	289	9	-9
17/18	12.0	9 36.8	0.06	10.5	1.36	1.66	17.51	13.46 to 18.00	89	47	86	5	289	9	-9
18/19	12.0	9 38.3	-0.17	10.5	1.35	1.66	17.48	13.46 to 18.02	89	35	78	5	289	9	-9
19/20	12.0	9 39.7	-0.41	10.5	1.35	1.67	17.46	13.46 to 18.03	90	24	69	5	290	8	-9
20/21	12.0	9 41.1	-1.05	10.5	1.34	1.67	17.43	13.46 to 18.05	90	15	60	5	290	8	-9
21/22	12.0	9 42.5	-1.29	10.5	1.34	1.67	17.41	13.46 to 18.06	91	13	50	5	290	8	-9
22/23	12.0	9 43.9	-1.53	10.5	1.34	1.68	17.38	13.46 to 18.08	91	19	41	5	290	8	-9
23/24	12.0	9 45.2	-2.16	10.5	1.33	1.68	17.36	13.46 to 18.09	92	28	31	5	291	8	-9
24/25	12.0	9 46.5	-2.40	10.5	1.33	1.68	17.33	13.46 to 18.10	92	39	23	5	291	8	-9
25/26	12.0	9 47.7	-3.04	10.5	1.32	1.69	17.30	13.46 to 18.12	93	50	15	5	291	7	-9
26/27	12.0	9 49.0	-3.27	10.5	1.32	1.69	17.28	13.46 to 18.13	93	61	9	5	291	7	-9
27/28	12.0	9 50.2	-3.51	10.5	1.31	1.69	17.25	13.46 to 18.14	94	72	4	5	292	7	-9
28/29	12.0	9 51.4	-4.14	10.5	1.31	1.70	17.22	13.47 to 18.16	94	84	1	5	292	7	-9
29/30	12.0	9 52.5	-4.37	10.5	1.30	1.70	17.19	13.47 to 18.17	95	96	0	5	292	7	-9
30/31	12.0	9 53.6	-5.01	10.5	1.30	1.70	17.16	13.47 to 18.18	96	108	0	5	293	6	-9

Ephemeris for 78P/Gehrels 2

Omega=192.3187 OMEGA=210.8395 i= 6.2584 q= 2.002708 a= 3.740492
e=0.464587 P= 7.234 T= 1997 August 6.3455 Equinox= 2000
Magnitudes calculated from m= 5.5+5.0*Log(d)+20.0*Log(r)

September 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	5 28.6	20.44	13.1	2.00	2.01	18.47	14.21 to 15.43	76	77	0	1	267	11	0
2/ 3	12.0	5 30.5	20.42	13.1	1.99	2.02	18.45	14.19 to 15.45	77	88	0	1	267	11	0
3/ 4	12.0	5 32.5	20.40	13.1	1.98	2.02	18.43	14.17 to 15.47	77	100	3	1	267	11	0
4/ 5	12.0	5 34.5	20.38	13.1	1.97	2.02	18.41	14.15 to 15.49	78	111	8	1	267	11	0
5/ 6	12.0	5 36.4	20.36	13.1	1.96	2.02	18.39	14.13 to 15.51	78	123	14	1	267	11	0
6/ 7	12.0	5 38.3	20.33	13.1	1.96	2.02	18.37	14.11 to 15.53	79	134	21	1	268	11	0
7/ 8	12.0	5 40.2	20.31	13.1	1.95	2.02	18.35	14.09 to 15.55	79	146	30	1	268	11	-1
8/ 9	12.0	5 42.1	20.28	13.1	1.94	2.02	18.33	14.07 to 15.57	80	158	39	1	268	11	-1
9/10	12.0	5 44.0	20.26	13.0	1.93	2.02	18.31	14.05 to 15.59	80	170	49	1	268	10	-1
10/11	12.0	5 45.8	20.23	13.0	1.92	2.02	18.28	14.03 to 16.01	81	176	60	1	268	10	-1
11/12	12.0	5 47.7	20.20	13.0	1.91	2.03	18.26	14.01 to 16.03	82	164	71	1	269	10	-1
12/13	12.0	5 49.5	20.17	13.0	1.90	2.03	18.24	13.59 to 16.05	82	150	81	1	269	10	-1
13/14	12.0	5 51.3	20.14	13.0	1.90	2.03	18.22	13.57 to 16.07	83	136	89	1	269	10	-1
14/15	12.0	5 53.1	20.11	13.0	1.89	2.03	18.20	13.55 to 16.09	83	122	96	1	269	10	-1
15/16	12.0	5 54.9	20.08	13.0	1.88	2.03	18.18	13.52 to 16.11	84	107	100	1	269	10	-1
16/17	12.0	5 56.6	20.04	13.0	1.87	2.03	18.16	13.50 to 16.13	84	92	100	1	270	10	-1
17/18	12.0	5 58.3	20.01	13.0	1.86	2.03	18.13	13.48 to 16.15	85	77	98	1	270	10	-1
18/19	12.0	6 0.1	19.57	13.0	1.85	2.03	18.11	13.46 to 16.17	85	63	93	1	270	10	-1
19/20	12.0	6 1.8	19.53	13.0	1.84	2.04	18.09	13.44 to 16.19	86	48	86	1	270	9	-1
20/21	12.0	6 3.4	19.49	13.0	1.83	2.04	18.07	13.42 to 16.21	87	35	77	1	270	9	-1
21/22	12.0	6 5.1	19.46	13.0	1.83	2.04	18.04	13.40 to 16.23	87	21	67	1	271	9	-1
22/23	12.0	6 6.7	19.42	13.0	1.82	2.04	18.02	13.38 to 16.25	88	8	56	1	271	9	-1
23/24	12.0	6 8.3	19.38	13.0	1.81	2.04	17.60	13.36 to 16.27	88	4	46	1	271	9	-1
24/25	12.0	6 9.9	19.33	13.0	1.80	2.04	17.57	13.33 to 16.28	89	16	36	1	271	9	-1
25/26	12.0	6 11.5	19.29	13.0	1.79	2.05	17.55	13.31 to 16.30	90	28	26	1	271	9	-1
26/27	12.0	6 13.1	19.25	13.0	1.78	2.05	17.53	13.29 to 16.32	90	40	18	1	272	9	-1
27/28	12.0	6 14.6	19.20	13.0	1.77	2.05	17.50	13.27 to 16.34	91	51	11	1	272	9	-1
28/29	12.0	6 16.1	19.16	13.0	1.77	2.05	17.48	13.25 to 16.36	91	63	6	1	272	8	-1
29/30	12.0	6 17.6	19.11	13.0	1.76	2.05	17.45	13.23 to 16.38	92	74	2	1	272	8	-1
30/31	12.0	6 19.1	19.07	13.0	1.75	2.05	17.43	13.20 to 16.39	93	86	0	1	272	8	-1

October 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	6 20.5	19.02	13.0	1.74	2.06	17.40	13.18 to 16.41	93	97	0	1	273	8	-1
2/ 3	12.0	6 21.9	18.57	13.0	1.73	2.06	17.38	13.16 to 16.43	94	109	1	1	273	8	-1
3/ 4	12.0	6 23.3	18.52	13.0	1.72	2.06	17.35	13.14 to 16.45	95	121	4	1	273	8	-2
4/ 5	12.0	6 24.7	18.47	13.0	1.71	2.06	17.33	13.11 to 16.47	95	133	10	1	273	8	-2
5/ 6	12.0	6 26.0	18.42	13.0	1.71	2.06	17.30	13.09 to 16.48	96	145	16	1	273	7	-2
6/ 7	12.0	6 27.3	18.37	13.0	1.70	2.07	17.27	13.07 to 16.50	97	157	25	1	274	7	-2
7/ 8	12.0	6 28.6	18.32	12.9	1.69	2.07	17.25	13.05 to 16.52	97	169	34	1	274	7	-2
8/ 9	12.0	6 29.9	18.27	12.9	1.68	2.07	17.22	13.02 to 16.54	98	178	44	1	274	7	-2
9/10	12.0	6 31.1	18.22	12.9	1.67	2.07	17.19	12.60 to 16.56	99	165	55	1	274	7	-2
10/11	12.0	6 32.3	18.17	12.9	1.66	2.07	17.17	12.58 to 16.57	99	151	67	1	274	7	-2
11/12	12.0	6 33.5	18.12	12.9	1.66	2.08	17.14	12.55 to 16.59	100	137	77	1	274	7	-2
12/13	12.0	6 34.7	18.06	12.9	1.65	2.08	17.11	12.53 to 17.01	101	123	86	1	275	6	-2
13/14	12.0	6 35.8	18.01	12.9	1.64	2.08	17.08	12.50 to 17.02	101	108	94	1	275	6	-2
14/15	12.0	6 36.9	17.56	12.9	1.63	2.08	17.05	12.48 to 17.04	102	93	98	1	275	6	-2
15/16	12.0	6 38.0	17.50	12.9	1.62	2.09	17.03	12.45 to 17.06	103	78	100	1	275	6	-2
16/17	12.0	6 39.0	17.45	12.9	1.61	2.09	16.60	12.43 to 17.08	104	64	99	1	275	6	-2
17/18	12.0	6 40.1	17.39	12.9	1.61	2.09	16.57	12.40 to 17.09	104	49	96	1	276	6	-2
18/19	12.0	6 41.0	17.34	12.9	1.60	2.09	16.54	12.38 to 17.11	105	35	89	1	276	5	-2
19/20	12.0	6 42.0	17.28	12.9	1.59	2.09	16.51	12.35 to 17.13	106	22	81	1	276	5	-2
20/21	12.0	6 42.9	17.23	12.9	1.58	2.10	16.48	12.33 to 17.15	107	8	72	1	276	5	-2
21/22	12.0	6 43.8	17.17	12.9	1.58	2.10	16.45	12.30 to 17.16	107	4	62	1	276	5	-2
22/23	12.0	6 44.7	17.12	12.9	1.57	2.10	16.42	12.28 to 17.18	108	17	52	1	277	5	-2
23/24	12.0	6 45.5	17.06	12.9	1.56	2.10	16.39	12.25 to 17.20	109	29	42	1	277	4	-2
24/25	12.0	6 46.3	17.01	12.9	1.55	2.11	16.35	12.22 to 17.21	110	40	33	1	277	4	-2
25/26	12.0	6 47.1	16.55	12.9	1.54	2.11	16.32	12.20 to 17.23	110	52	24	1	277	4	-2
26/27	12.0	6 47.9	16.50	12.9	1.54	2.11	16.29	12.17 to 17.25	111	64	17	1	277	4	-2
27/28	12.0	6 48.6	16.44	12.9	1.53	2.11	16.26	12.14 to 17.26	112	75	10	1	278	4	-2
28/29	12.0	6 49.2	16.39	12.9	1.52	2.12	16.23	12.11 to 17.28	113	87	5	1	278	4	-2
29/30	12.0	6 49.9	16.33	12.9	1.51	2.12	16.19	12.09 to 17.30	114	99	1	1	278	3	-2
30/31	12.0	6 50.5	16.28	12.9	1.51	2.12	16.16	12.06 to 17.31	115	111	0	1	278	3	-2
31/32	12.0	6 51.1	16.22	12.9	1.50	2.12	16.13	12.03 to 17.33	115	123	0	1	278	3	-2

November 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	6 51.6	16.17	12.9	1.49	2.13	16.09	12.00 to 17.35	116	135	2	1	279	3	-2
2/ 3	12.0	6 52.1	16.11	12.9	1.49	2.13	16.06	11.57 to 17.36	117	148	6	1	279	3	-2
3/ 4	12.0	6 52.6	16.06	12.9	1.48	2.13	16.02	11.54 to 17.38	118	161	12	1	279	2	-2
4/ 5	12.0	6 53.0	16.01	12.9	1.47	2.14	15.59	11.51 to 17.40	119	173	20	1	279	2	-2
5/ 6	12.0	6 53.4	15.55	12.9	1.47	2.14	15.55	11.48 to 17.41	120	173	30	1	280	2	-2

6/ 7	12.0	6 53.8	15.50	12.9	1.46	2.14	15.52	11.45 to 17.43	121	160	40	1	280	2	-2
7/ 8	12.0	6 54.1	15.45	12.9	1.45	2.14	15.48	11.42 to 17.45	122	146	51	1	280	2	-2
8/ 9	12.0	6 54.4	15.40	12.9	1.45	2.15	15.44	11.39 to 17.46	122	132	63	1	280	1	-2
9/10	12.0	6 54.7	15.34	12.9	1.44	2.15	15.41	11.36 to 17.48	123	118	74	1	281	1	-2
10/11	12.0	6 54.9	15.29	12.9	1.43	2.15	15.37	11.33 to 17.49	124	104	83	1	281	1	-2
11/12	12.0	6 55.1	15.24	12.9	1.43	2.16	15.33	11.30 to 17.51	125	89	91	1	281	1	-2
12/13	12.0	6 55.3	15.19	12.9	1.42	2.16	15.29	11.27 to 17.53	126	74	97	1	281	0	-2
13/14	12.0	6 55.4	15.14	13.0	1.42	2.16	15.26	11.23 to 17.54	127	60	100	1	282	0	-2
14/15	12.0	6 55.5	15.09	13.0	1.41	2.16	15.22	11.20 to 17.56	128	45	100	1	282	0	-2
15/16	12.0	6 55.6	15.05	13.0	1.40	2.17	15.18	11.17 to 17.57	129	31	98	1	282	0	-2
16/17	12.0	6 55.6	14.60	13.0	1.40	2.17	15.14	11.13 to 17.59	130	17	93	1	282	0	-1
17/18	12.0	6 55.6	14.55	13.0	1.39	2.17	15.10	11.10 to 18.00	131	5	86	1	283	0	-1
18/19	12.0	6 55.5	14.51	13.0	1.39	2.18	15.06	11.07 to 18.02	132	10	78	1	283	0	-1
19/20	12.0	6 55.5	14.46	13.0	1.38	2.18	15.02	11.03 to 18.03	133	22	69	1	283	0	-1
20/21	12.0	6 55.4	14.42	13.0	1.38	2.18	14.58	10.60 to 18.05	134	34	60	1	284	0	-1
21/22	12.0	6 55.2	14.37	13.0	1.37	2.19	14.54	10.56 to 18.06	135	47	50	1	284	0	-1
22/23	12.0	6 55.0	14.33	13.0	1.37	2.19	14.50	10.53 to 18.08	136	58	41	1	284	-1	-1
23/24	12.0	6 54.8	14.29	13.0	1.36	2.19	14.46	10.50 to 18.09	137	70	31	1	285	-1	-1
24/25	12.0	6 54.6	14.25	13.0	1.36	2.20	14.41	10.46 to 18.10	138	82	23	1	285	-1	-1
25/26	12.0	6 54.3	14.21	13.0	1.36	2.20	14.37	10.42 to 18.12	139	94	15	1	286	-1	-1
26/27	12.0	6 54.0	14.17	13.0	1.35	2.20	14.33	10.39 to 18.13	140	106	9	1	286	-1	-1
27/28	12.0	6 53.6	14.13	13.0	1.35	2.21	14.29	10.35 to 18.14	141	119	4	1	286	-2	-1
28/29	12.0	6 53.2	14.09	13.0	1.35	2.21	14.24	10.32 to 18.16	142	131	1	0	287	-2	-1
29/30	12.0	6 52.8	14.06	13.0	1.34	2.21	14.20	10.28 to 18.12	143	144	0	0	287	-2	-1
30/31	12.0	6 52.4	14.02	13.0	1.34	2.22	14.16	10.24 to 18.07	144	157	0	0	288	-2	-1

Ephemeris for 103P/Hartley 2

Omega=180.7410 OMEGA=220.0645 i= 13.6470 q= 1.028277 a= 3.438674
e=0.700967 P= 6.377 T= 1997 December 21.8389 Equinox= 2000
Magnitudes calculated from m= 8.4+5.0*Log(d)+ 9.6*Log(r)

June 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Moon	Moon Phase	Comet Tail	pA	d RA	dDec
10/11	12.0	19 53.1	-1.44	13.3	1.66	2.49	14.38	Not Observable	136	150	30	0	238	-2	3
11/12	12.0	19 52.7	-1.36	13.3	1.65	2.48	14.34	Not Observable	137	139	39	0	237	-2	3
12/13	12.0	19 52.3	-1.27	13.2	1.63	2.48	14.29	12.48 to 12.51	138	128	48	0	236	-2	3
13/14	12.0	19 51.9	-1.19	13.2	1.61	2.47	14.25	12.39 to 12.49	139	116	58	0	235	-2	3
14/15	12.0	19 51.4	-1.11	13.2	1.60	2.46	14.21	12.29 to 12.48	139	104	67	0	234	-2	3
15/16	12.0	19 50.9	-1.03	13.1	1.58	2.45	14.16	12.21 to 12.47	140	93	76	0	233	-3	3
16/17	12.0	19 50.3	-0.55	13.1	1.57	2.44	14.12	12.12 to 12.46	141	80	84	0	232	-3	3
17/18	12.0	19 49.8	-0.46	13.1	1.55	2.44	14.07	12.03 to 12.45	142	68	91	0	231	-3	3
18/19	12.0	19 49.2	-0.39	13.0	1.54	2.43	14.03	11.54 to 12.45	143	55	96	0	230	-3	3
19/20	12.0	19 48.6	-0.31	13.0	1.52	2.42	13.58	11.46 to 12.44	144	42	100	0	229	-3	3
20/21	12.0	19 47.9	-0.23	13.0	1.51	2.41	13.53	11.38 to 12.44	144	30	100	0	227	-4	3
21/22	12.0	19 47.3	-0.15	12.9	1.50	2.40	13.49	11.29 to 12.45	145	20	99	0	226	-4	3
22/23	12.0	19 46.5	-0.08	12.9	1.48	2.39	13.44	11.21 to 12.45	146	17	94	0	225	-4	3
23/24	12.0	19 45.8	0.00	12.9	1.47	2.38	13.39	11.19 to 12.46	147	24	87	0	223	-4	3
24/25	12.0	19 45.0	0.07	12.8	1.46	2.38	13.35	11.18 to 12.47	147	36	78	0	222	-4	3
25/26	12.0	19 44.2	0.15	12.8	1.44	2.37	13.30	11.17 to 12.48	148	49	68	0	220	-4	3
26/27	12.0	19 43.4	0.22	12.8	1.43	2.36	13.25	11.16 to 12.50	149	63	56	0	219	-5	2
27/28	12.0	19 42.6	0.29	12.7	1.42	2.35	13.20	11.15 to 12.51	150	76	45	0	217	-5	2
28/29	12.0	19 41.7	0.36	12.7	1.40	2.34	13.16	11.14 to 12.53	150	90	34	0	215	-5	2
29/30	12.0	19 40.8	0.42	12.7	1.39	2.33	13.11	11.12 to 12.55	151	103	23	0	213	-5	2
30/31	12.0	19 39.8	0.49	12.6	1.38	2.33	13.06	11.10 to 12.57	152	116	15	0	211	-5	2

July 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	19 38.9	0.55	12.6	1.37	2.32	13.01	11.08 to 12.59	152	129	8	0	209	-6	2
2/ 3	12.0	19 37.9	1.02	12.6	1.36	2.31	12.56	11.06 to 13.02	153	141	3	0	207	-6	2
3/ 4	12.0	19 36.8	1.08	12.5	1.35	2.30	12.51	11.04 to 13.04	153	151	0	0	205	-6	2
4/ 5	12.0	19 35.8	1.14	12.5	1.33	2.29	12.46	11.02 to 13.07	154	159	0	0	202	-6	2
5/ 6	12.0	19 34.7	1.19	12.4	1.32	2.28	12.41	10.60 to 13.09	154	161	1	0	200	-6	2
6/ 7	12.0	19 33.6	1.25	12.4	1.31	2.27	12.36	10.58 to 13.12	155	156	4	0	197	-6	2
7/ 8	12.0	19 32.5	1.30	12.4	1.30	2.27	12.31	10.55 to 13.15	155	147	9	1	194	-7	2
8/ 9	12.0	19 31.3	1.36	12.4	1.29	2.26	12.26	10.53 to 13.18	155	136	16	1	192	-7	2
9/10	12.0	19 30.2	1.41	12.3	1.28	2.25	12.21	10.50 to 13.20	156	125	24	1	189	-7	2
10/11	12.0	19 29.0	1.45	12.3	1.27	2.24	12.16	10.48 to 13.23	156	114	32	1	186	-7	1
11/12	12.0	19 27.8	1.50	12.3	1.26	2.23	12.10	10.45 to 13.26	156	102	41	1	183	-7	1
12/13	12.0	19 26.6	1.54	12.2	1.25	2.22	12.05	10.43 to 13.29	156	91	51	1	180	-7	1
13/14	12.0	19 25.3	1.58	12.2	1.25	2.21	12.00	10.40 to 13.32	156	79	61	1	177	-7	1
14/15	12.0	19 24.1	2.02	12.2	1.24	2.20	11.55	10.37 to 13.35	156	67	71	1	174	-7	1
15/16	12.0	19 22.8	2.06	12.1	1.23	2.20	11.50	10.34 to 13.38	156	55	80	1	171	-7	1
16/17	12.0	19 21.5	2.09	12.1	1.22	2.19	11.44	10.32 to 13.40	156	43	88	1	168	-8	1
17/18	12.0	19 20.2	2.12	12.1	1.21	2.18	11.39	10.29 to 13.43	156	31	94	1	165	-8	1
18/19	12.0	19 18.9	2.15	12.0	1.20	2.17	11.34	10.26 to 13.46	155	22	99	1	162	-8	1
19/20	12.0	19 17.6	2.18	12.0	1.20	2.16	11.29	10.23 to 13.49	155	20	100	1	159	-8	1
20/21	12.0	19 16.2	2.20	12.0	1.19	2.15	11.23	10.21 to 13.52	155	28	99	1	156	-8	0
21/22	12.0	19 14.9	2.22	11.9	1.18	2.14	11.18	10.18 to 13.55	154	40	96	1	153	-8	0
22/23	12.0	19 13.5	2.24	11.9	1.18	2.13	11.13	10.15 to 13.58	154	53	89	1	150	-8	0
23/24	12.0	19 12.2	2.25	11.9	1.17	2.13	11.08	10.12 to 14.01	153	67	80	1	148	-8	0
24/25	12.0	19 10.8	2.27	11.9	1.16	2.12	11.02	10.09 to 14.04	153	81	70	1	145	-8	0
25/26	12.0	19 9.5	2.28	11.8	1.16	2.11	10.57	10.06 to 14.07	152	95	59	1	143	-8	0
26/27	12.0	19 8.1	2.28	11.8	1.15	2.10	10.52	10.03 to 14.10	151	108	47	1	141	-8	0
27/28	12.0	19 6.8	2.29	11.8	1.14	2.09	10.46	10.01 to 14.12	151	121	37	1	138	-8	0
28/29	12.0	19 5.4	2.29	11.7	1.14	2.08	10.41	9.58 to 14.15	150	133	26	1	136	-8	0
29/30	12.0	19 4.1	2.29	11.7	1.13	2.07	10.36	9.55 to 14.16	149	144	18	1	134	-8	0
30/31	12.0	19 2.7	2.28	11.7	1.13	2.06	10.30	9.52 to 14.12	149	154	10	1	132	-8	0
31/32	12.0	19 1.4	2.28	11.7	1.12	2.05	10.25	9.49 to 14.08	148	159	5	1	131	-8	0

August 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	19 0.1	2.27	11.6	1.12	2.05	10.20	9.46 to 14.03	147	158	1	1	129	-8	0
2/ 3	12.0	18 58.7	2.25	11.6	1.12	2.04	10.15	9.43 to 13.59	146	151	0	1	127	-8	0
3/ 4	12.0	18 57.4	2.24	11.6	1.11	2.03	10.09	9.40 to 13.55	145	141	0	1	126	-8	0
4/ 5	12.0	18 56.2	2.22	11.6	1.11	2.02	10.04	9.37 to 13.50	144	130	2	1	124	-8	0

5/ 6	12.0	18 54.9	2.20	11.5	1.10	2.01	9.59	9.35 to 13.46	143	119	6	1	123	-7	0
6/ 7	12.0	18 53.6	2.18	11.5	1.10	2.00	9.54	9.32 to 13.41	142	108	11	1	121	-7	0
7/ 8	12.0	18 52.4	2.15	11.5	1.10	1.99	9.49	9.29 to 13.37	141	97	18	1	120	-7	-1
8/ 9	12.0	18 51.2	2.12	11.4	1.09	1.98	9.43	9.26 to 13.32	140	85	26	1	119	-7	-1
9/10	12.0	18 50.0	2.09	11.4	1.09	1.97	9.38	9.23 to 13.27	140	74	35	1	117	-7	-1
10/11	12.0	18 48.9	2.05	11.4	1.09	1.97	9.33	9.20 to 13.23	139	62	45	2	116	-7	-1
11/12	12.0	18 47.7	2.02	11.4	1.08	1.96	9.28	9.17 to 13.18	138	51	55	2	115	-7	-1
12/13	12.0	18 46.6	1.58	11.4	1.08	1.95	9.23	9.14 to 13.14	137	39	65	2	114	-6	-1
13/14	12.0	18 45.5	1.54	11.3	1.08	1.94	9.18	9.11 to 13.09	136	28	75	2	113	-6	-1
14/15	12.0	18 44.5	1.49	11.3	1.08	1.93	9.13	9.08 to 13.04	135	21	84	2	112	-6	-1
15/16	12.0	18 43.5	1.45	11.3	1.08	1.92	9.08	9.06 to 12.60	134	21	92	2	111	-6	-1
16/17	12.0	18 42.5	1.40	11.3	1.07	1.91	9.03	9.03 to 12.55	133	30	97	2	110	-6	-2
17/18	12.0	18 41.5	1.35	11.2	1.07	1.90	8.58	8.60 to 12.50	132	42	100	2	109	-5	-2
18/19	12.0	18 40.6	1.29	11.2	1.07	1.89	8.53	8.57 to 12.46	131	56	100	2	108	-5	-2
19/20	12.0	18 39.7	1.24	11.2	1.07	1.88	8.49	8.54 to 12.41	130	70	97	2	108	-5	-2
20/21	12.0	18 38.8	1.18	11.2	1.07	1.87	8.44	8.51 to 12.37	129	84	91	2	107	-5	-2
21/22	12.0	18 38.0	1.12	11.1	1.07	1.87	8.39	8.48 to 12.32	128	98	83	2	106	-5	-2
22/23	12.0	18 37.3	1.06	11.1	1.07	1.86	8.34	8.45 to 12.27	127	112	73	2	105	-4	-2
23/24	12.0	18 36.5	0.60	11.1	1.06	1.85	8.30	8.42 to 12.23	126	125	62	2	105	-4	-2
24/25	12.0	18 35.8	0.53	11.1	1.06	1.84	8.25	8.40 to 12.18	125	138	51	2	104	-4	-2
25/26	12.0	18 35.2	0.47	11.1	1.06	1.83	8.20	8.37 to 12.14	124	149	40	3	103	-4	-2
26/27	12.0	18 34.5	0.40	11.0	1.06	1.82	8.16	8.34 to 12.09	123	158	30	3	103	-3	-2
27/28	12.0	18 34.0	0.33	11.0	1.06	1.81	8.11	8.31 to 12.05	122	161	21	3	102	-3	-2
28/29	12.0	18 33.4	0.26	11.0	1.06	1.80	8.07	8.28 to 12.00	121	157	14	3	101	-3	-2
29/30	12.0	18 32.9	0.19	11.0	1.06	1.79	8.02	8.25 to 11.56	120	149	8	3	101	-3	-3
30/31	12.0	18 32.5	0.11	10.9	1.06	1.78	7.58	8.23 to 11.51	119	139	3	3	100	-2	-3
31/32	12.0	18 32.1	0.04	10.9	1.06	1.77	7.54	8.20 to 11.47	118	128	0	3	100	-2	-3

September 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	18 31.7	-0.04	10.9	1.06	1.77	7.49	8.17 to 11.42	117	117	0	3	99	-2	-3
2/ 3	12.0	18 31.4	-0.11	10.9	1.06	1.76	7.45	8.14 to 11.38	116	106	0	3	98	-1	-3
3/ 4	12.0	18 31.1	-0.19	10.9	1.06	1.75	7.41	8.11 to 11.34	115	94	3	3	98	-1	-3
4/ 5	12.0	18 30.9	-0.27	10.8	1.06	1.74	7.37	8.09 to 11.29	114	83	8	3	97	-1	-3
5/ 6	12.0	18 30.7	-0.35	10.8	1.06	1.73	7.33	8.06 to 11.25	113	72	14	3	97	-1	-3
6/ 7	12.0	18 30.6	-0.43	10.8	1.06	1.72	7.29	8.03 to 11.21	113	60	21	4	96	0	-3
7/ 8	12.0	18 30.5	-0.51	10.8	1.06	1.71	7.25	8.00 to 11.17	112	49	30	4	96	0	-3
8/ 9	12.0	18 30.5	-0.60	10.7	1.06	1.70	7.21	7.58 to 11.12	111	38	39	4	95	0	-3
9/10	12.0	18 30.5	-1.08	10.7	1.06	1.69	7.17	7.55 to 11.08	110	27	49	4	95	0	-3
10/11	12.0	18 30.6	-1.16	10.7	1.06	1.68	7.13	7.52 to 11.04	109	19	60	4	94	0	-3
11/12	12.0	18 30.7	-1.25	10.7	1.06	1.67	7.09	7.49 to 11.00	108	18	71	4	94	0	-3
12/13	12.0	18 30.8	-1.33	10.7	1.06	1.67	7.05	7.47 to 10.56	107	26	81	4	94	0	-3
13/14	12.0	18 31.0	-1.42	10.6	1.06	1.66	7.01	7.44 to 10.52	106	37	89	4	93	1	-3
14/15	12.0	18 31.3	-1.50	10.6	1.06	1.65	6.58	7.41 to 10.48	106	51	96	4	93	1	-3
15/16	12.0	18 31.5	-1.59	10.6	1.06	1.64	6.54	7.39 to 10.44	105	65	100	4	92	1	-3
16/17	12.0	18 31.9	-2.07	10.6	1.06	1.63	6.50	7.36 to 10.41	104	80	100	4	92	2	-3
17/18	12.0	18 32.3	-2.16	10.5	1.06	1.62	6.47	7.33 to 10.37	103	94	98	5	91	2	-3
18/19	12.0	18 32.7	-2.25	10.5	1.06	1.61	6.43	7.31 to 10.33	102	108	93	5	91	2	-3
19/20	12.0	18 33.2	-2.33	10.5	1.06	1.60	6.40	7.28 to 10.29	102	122	86	5	91	2	-3
20/21	12.0	18 33.7	-2.42	10.5	1.06	1.59	6.37	7.25 to 10.26	101	136	77	5	90	3	-3
21/22	12.0	18 34.3	-2.51	10.4	1.06	1.58	6.33	7.23 to 10.22	100	148	67	5	90	3	-3
22/23	12.0	18 34.9	-2.59	10.4	1.06	1.57	6.30	7.20 to 10.18	99	158	56	5	90	3	-3
23/24	12.0	18 35.5	-3.08	10.4	1.06	1.57	6.27	7.18 to 10.15	99	165	46	5	89	4	-3
24/25	12.0	18 36.2	-3.17	10.4	1.06	1.56	6.23	7.15 to 10.11	98	162	36	5	89	4	-3
25/26	12.0	18 37.0	-3.25	10.4	1.06	1.55	6.20	7.13 to 10.08	97	154	26	5	88	4	-3
26/27	12.0	18 37.8	-3.34	10.3	1.06	1.54	6.17	7.10 to 10.05	96	144	18	6	88	4	-3
27/28	12.0	18 38.6	-3.43	10.3	1.06	1.53	6.14	7.08 to 10.01	96	133	11	6	88	5	-3
28/29	12.0	18 39.5	-3.51	10.3	1.06	1.52	6.11	7.05 to 9.58	95	122	6	6	87	5	-3
29/30	12.0	18 40.5	-3.60	10.3	1.06	1.51	6.08	7.03 to 9.55	94	111	2	6	87	5	-3
30/31	12.0	18 41.5	-4.08	10.2	1.06	1.50	6.05	7.00 to 9.52	94	100	0	6	87	6	-3

October 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	18 42.5	-4.17	10.2	1.06	1.49	6.02	6.58 to 9.49	93	89	0	6	86	6	-3
2/ 3	12.0	18 43.6	-4.25	10.2	1.06	1.49	5.59	6.55 to 9.45	92	77	1	6	86	6	-3
3/ 4	12.0	18 44.7	-4.34	10.2	1.06	1.48	5.56	6.53 to 9.42	92	66	4	6	86	7	-3
4/ 5	12.0	18 45.9	-4.42	10.1	1.06	1.47	5.54	6.50 to 9.39	91	54	10	7	85	7	-3
5/ 6	12.0	18 47.1	-4.50	10.1	1.06	1.46	5.51	6.48 to 9.37	90	43	16	7	85	7	-3
6/ 7	12.0	18 48.4	-4.59	10.1	1.06	1.45	5.48	6.46 to 9.34	90	31	25	7	85	7	-3
7/ 8	12.0	18 49.7	-5.07	10.0	1.06	1.44	5.46	6.43 to 9.31	89	21	34	7	84	8	-3
8/ 9	12.0	18 51.0	-5.15	10.0	1.06	1.43	5.43	6.41 to 9.28	88	13	44	7	84	8	-3
9/10	12.0	18 52.4	-5.23	10.0	1.06	1.42	5.40	6.39 to 9.25	88	16	55	7	84	8	-3
10/11	12.0	18 53.8	-5.31	10.0	1.06	1.42	5.38	6.36 to 9.23	87	26	67	7	83	8	-3
11/12	12.0	18 55.3	-5.39	9.9	1.05	1.41	5.35	6.34 to 9.20	87	39	77	8	83	9	-3
12/13	12.0	18 56.9	-5.47	9.9	1.05	1.40	5.33	6.32 to 9.18	86	52	86	8	83	9	-3
13/14	12.0	18 58.4	-5.55	9.9	1.05	1.39	5.31	6.30 to 9.15	85	66	94	8	82	9	-3
14/15	12.0	19 0.1	-6.02	9.9	1.05	1.38	5.28	6.28 to 9.13	85	81	98	8	82	10	-3
15/16	12.0	19 1.7	-6.10	9.8	1.05	1.37	5.26	6.25 to 9.10	84	95	100	8	82	10	-3
16/17	12.0	19 3.4	-6.18	9.8	1.05	1.37	5.24	6.23 to 9.08	84	109	99	8	81	10	-3
17/18	12.0	19 5.2	-6.25	9.8	1.05	1.36	5.22	6.21 to 9.06	83	123	96	9	81	10	-3
18/19	12.0	19 7.0	-6.32	9.7	1.05	1.35	5.20	6.19 to 9.03	83	137	89	9	81	11	-3
19/20	12.0	19 8.8	-6.40	9.7	1.04	1.34	5.17	6.17 to 9.01	82	149	81	9	80	11	-3
20/21	12.0	19 10.7	-6.47	9.7	1.04	1.33	5.15	6.15 to 8.59	82	161	72	9	80	11	-2
21/22	12.0	19 12.6	-6.54	9.7	1.04	1.32	5.13	6.13 to 8.57	81	169	62	9	80	11	-2
22/23	12.0	19 14.6	-7.01	9.6	1.04	1.32	5.11	6.11 to 8.55	81	166	52	10	80	12	-2
23/24	12.0	19 16.6	-7.08	9.6	1.04	1.31	5.09	6.09 to 8.53	80	157	42	10	79	12	-2
24/25	12.0	19 18.7	-7.14	9.6	1.04	1.30	5.08	6.07 to 8.51	80	147	33	10	79	12	-2
25/26	12.0	19 20.8	-7.21	9.5	1.03	1.29	5.06	6.05 to 8.49	79	136	24	10	79	13	-2
26/27	12.0	19 23.0	-7.28	9.5	1.03	1.28	5.04	6.03 to 8.48	79	125	17	10	78	13	-2
27/28	12.0	19 25.2	-7.34	9.5	1.03	1.28	5.02	6.01 to 8.46	78	114	10	11	78	13	-2
28/29	12.0	19 27.4	-7.40	9.4	1.03	1.27	5.01	5.59 to 8.44	78	103	5	11	78	13	-2
29/30	12.0	19 29.7	-7.47	9.4	1.02	1.26	4.59	5.58 to 8.43	77	91	1	11	78	14	-2
30/31	12.0	19 32.1	-7.53	9.4	1.02	1.25	4.57	5.56 to 8.41	77	80	0	11	77	14	-2
31/32	12.0	19 34.4	-7.59	9.4	1.02	1.25	4.56	5.54 to 8.40	77	68	0	12	77	14	-2

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Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	19 36.9	-8.04	9.3	1.02	1.24	4.54	5.52 to 8.38	76	57	2	12	77	15	-2
2/ 3	12.0	19 39.3	-8.10	9.3	1.01	1.23	4.53	5.51 to 8.37	76	45	6	12	76	15	-2
3/ 4	12.0	19 41.9	-8.16	9.3	1.01	1.22	4.51	5.49 to 8.36	75	33	12	12	76	15	-2
4/ 5	12.0	19 44.4	-8.21	9.2	1.01	1.22	4.50	5.48 to 8.34	75	21	20	13	76	15	-2
5/ 6	12.0	19 47.0	-8.26	9.2	1.01	1.21	4.49	5.46 to 8.33	75	11	30	13	76	16	-2
6/ 7	12.0	19 49.7	-8.31	9.2	1.00	1.20	4.47	5.44 to 8.32	74	10	40	13	75	16	-2
7/ 8	12.0	19 52.4	-8.36	9.1	1.00	1.20	4.46	5.43 to 8.31	74	21	51	14	75	16	-2
8/ 9	12.0	19 55.1	-8.41	9.1	1.00	1.19	4.45	5.41 to 8.30	74	33	63	14	75	16	-2
9/10	12.0	19 57.9	-8.46	9.1	0.99	1.18	4.44	5.40 to 8.29	73	46	74	14	75	17	-1
10/11	12.0	20 0.8	-8.50	9.1	0.99	1.18	4.43	5.39 to 8.28	73	60	83	14	74	17	-1
11/12	12.0	20 3.7	-8.55	9.0	0.99	1.17	4.42	5.37 to 8.27	73	74	91	15	74	17	-1
12/13	12.0	20 6.6	-8.59	9.0	0.98	1.16	4.41	5.36 to 8.26	72	88	97	15	74	18	-1
13/14	12.0	20 9.6	-9.03	9.0	0.98	1.16	4.40	5.35 to 8.25	72	102	100	15	74	18	-1
14/15	12.0	20 12.6	-9.07	8.9	0.98	1.15	4.39	5.33 to 8.25	72	115	100	16	73	18	-1
15/16	12.0	20 15.7	-9.10	8.9	0.97	1.14	4.38	5.32 to 8.24	71	129	98	16	73	18	-1
16/17	12.0	20 18.8	-9.14	8.9	0.97	1.14	4.37	5.31 to 8.24	71	141	93	16	73	19	-1
17/18	12.0	20 21.9	-9.17	8.8	0.97	1.13	4.36	5.30 to 8.23	71	154	86	17	73	19	-1
18/19	12.0	20 25.1	-9.20	8.8	0.96	1.13	4.35	5.29 to 8.23	71	165	78	17	73	19	-1
19/20	12.0	20 28.4	-9.23	8.8	0.96	1.12	4.35	5.28 to 8.22	70	174	69	17	72	20	-1
20/21	12.0	20 31.7	-9.26	8.8	0.95	1.12	4.34	5.27 to 8.22	70	168	60	18	72	20	-1
21/22	12.0	20 35.1	-9.29	8.7	0.95	1.11	4.34	5.26 to 8.22	70	158	50	18	72	20	-1
22/23	12.0	20 38.5	-9.31	8.7	0.95	1.11	4.33	5.25 to 8.21	70	147	41	18	72	20	0
23/24	12.0	20 41.9	-9.33	8.7	0.94	1.10	4.33	5.24 to 8.21	69	136	31	19	71	21	0
24/25	12.0	20 45.4	-9.35	8.6	0.94	1.10	4.32	5.23 to 8.21	69	125	23	19	71	21	0
25/26	12.0	20 49.0	-9.37	8.6	0.93	1.09	4.32	5.23 to 8.21	69	114	15	19	71	21	0
26/27	12.0	20 52.6	-9.38	8.6	0.93	1.09	4.31	5.22 to 8.21	69	103	9	20	71	22	0
27/28	12.0	20 56.2	-9.40	8.6	0.93	1.08	4.31	5.21 to 8.21	69	92	4	20	71	22	0
28/29	12.0	20 59.9	-9.41	8.5	0.92	1.08	4.31	5.21 to 8.21	69	80	1	20	71	22	0
29/30	12.0	21 3.6	-9.42	8.5	0.92	1.07	4.31	5.20 to 8.22	68	68	0	21	70	23	0
30/31	12.0	21 7.4	-9.42	8.5	0.92	1.07	4.30	5.20 to 8.22	68	56	0	21	70	23	0

Ephemeris for Mueller 1997 D1

Omega=184.9783 OMEGA=279.1664 i=141.8922 q= 2.247616 a=**********
e=1.000000 P=********* T= 1997 October 11.7338 Equinox= 2000
Magnitudes calculated from m= 6.5+5.0*Log(d)+10.0*Log(r)

September 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	8 24.6	24.40	12.5	3.02	2.29	21.43	Not Observable	37	38	0	1	291	0	-4
2/ 3	12.0	8 24.6	24.30	12.5	3.01	2.29	21.39	Not Observable	38	49	0	1	290	0	-4
3/ 4	12.0	8 24.5	24.20	12.5	2.99	2.29	21.35	Not Observable	38	61	3	1	290	0	-4
4/ 5	12.0	8 24.5	24.10	12.5	2.97	2.29	21.31	Not Observable	39	72	8	1	290	0	-4
5/ 6	12.0	8 24.4	23.60	12.4	2.96	2.28	21.27	Not Observable	40	84	14	1	289	0	-4
6/ 7	12.0	8 24.3	23.50	12.4	2.94	2.28	21.23	Not Observable	41	96	21	1	289	0	-4
7/ 8	12.0	8 24.2	23.40	12.4	2.92	2.28	21.19	Not Observable	42	108	30	1	288	0	-4
8/ 9	12.0	8 24.1	23.30	12.4	2.91	2.28	21.15	Not Observable	43	120	39	1	288	0	-4
9/10	12.0	8 24.0	23.19	12.4	2.89	2.28	21.10	Not Observable	44	133	49	1	288	0	-4
10/11	12.0	8 23.8	23.09	12.4	2.87	2.27	21.06	15.58 to 16.01	45	146	60	1	287	0	-4
11/12	12.0	8 23.6	22.59	12.3	2.85	2.27	21.02	15.54 to 16.03	46	159	71	1	287	0	-4
12/13	12.0	8 23.4	22.48	12.3	2.83	2.27	20.58	15.50 to 16.05	47	171	81	1	287	-1	-4
13/14	12.0	8 23.2	22.38	12.3	2.82	2.27	20.54	15.46 to 16.07	48	169	89	1	287	-1	-4
14/15	12.0	8 23.0	22.27	12.3	2.80	2.27	20.50	15.42 to 16.09	49	155	96	1	286	-1	-4
15/16	12.0	8 22.8	22.16	12.3	2.78	2.27	20.46	15.38 to 16.11	50	141	100	1	286	-1	-4
16/17	12.0	8 22.5	22.06	12.3	2.76	2.26	20.41	15.34 to 16.13	51	126	100	1	286	-1	-4
17/18	12.0	8 22.2	21.55	12.2	2.74	2.26	20.37	15.30 to 16.15	52	110	98	1	286	-1	-4
18/19	12.0	8 21.9	21.44	12.2	2.72	2.26	20.33	15.26 to 16.17	53	96	93	1	285	-1	-4
19/20	12.0	8 21.6	21.33	12.2	2.70	2.26	20.29	15.22 to 16.19	54	81	86	1	285	-1	-4
20/21	12.0	8 21.2	21.22	12.2	2.68	2.26	20.24	15.18 to 16.21	55	67	77	1	285	-2	-4
21/22	12.0	8 20.8	21.11	12.2	2.66	2.26	20.20	15.14 to 16.23	56	53	67	1	285	-2	-4
22/23	12.0	8 20.4	20.60	12.1	2.64	2.26	20.16	15.10 to 16.25	57	40	56	1	284	-2	-4
23/24	12.0	8 20.0	20.48	12.1	2.62	2.26	20.11	15.06 to 16.27	58	27	46	1	284	-2	-4
24/25	12.0	8 19.5	20.37	12.1	2.60	2.25	20.07	15.02 to 16.28	59	15	36	1	284	-2	-4
25/26	12.0	8 19.1	20.25	12.1	2.58	2.25	20.02	14.58 to 16.30	60	5	26	2	284	-2	-4
26/27	12.0	8 18.6	20.13	12.1	2.56	2.25	19.58	14.53 to 16.32	61	11	18	2	284	-2	-4
27/28	12.0	8 18.0	20.02	12.0	2.54	2.25	19.54	14.49 to 16.34	62	23	11	2	283	-3	-4
28/29	12.0	8 17.4	19.50	12.0	2.52	2.25	19.49	14.45 to 16.36	63	35	6	2	283	-3	-4
29/30	12.0	8 16.8	19.38	12.0	2.50	2.25	19.44	14.41 to 16.38	64	46	2	2	283	-3	-5
30/31	12.0	8 16.2	19.25	12.0	2.48	2.25	19.40	14.37 to 16.39	65	58	0	2	283	-3	-5

October 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	8 15.5	19.13	12.0	2.45	2.25	19.35	14.32 to 16.41	66	70	0	2	283	-3	-5
2/ 3	12.0	8 14.8	19.00	11.9	2.43	2.25	19.31	14.28 to 16.43	68	82	1	2	283	-4	-5
3/ 4	12.0	8 14.1	18.48	11.9	2.41	2.25	19.26	14.24 to 16.45	69	95	4	2	283	-4	-5
4/ 5	12.0	8 13.3	18.35	11.9	2.39	2.25	19.21	14.19 to 16.47	70	107	10	2	282	-4	-5
5/ 6	12.0	8 12.5	18.22	11.9	2.37	2.25	19.16	14.15 to 16.48	71	119	16	2	282	-4	-5
6/ 7	12.0	8 11.7	18.08	11.9	2.34	2.25	19.12	14.11 to 16.50	72	132	25	2	282	-5	-5
7/ 8	12.0	8 10.8	17.55	11.8	2.32	2.25	19.07	14.06 to 16.52	73	145	34	2	282	-5	-5
8/ 9	12.0	8 9.9	17.41	11.8	2.30	2.25	19.02	14.02 to 16.54	74	158	44	2	282	-5	-5
9/10	12.0	8 8.9	17.28	11.8	2.28	2.25	18.57	13.57 to 16.56	75	172	55	2	282	-5	-5
10/11	12.0	8 7.9	17.14	11.8	2.26	2.25	18.52	13.53 to 16.57	77	174	67	2	282	-6	-5
11/12	12.0	8 6.8	16.59	11.8	2.23	2.25	18.47	13.48 to 16.59	78	159	77	2	282	-6	-5
12/13	12.0	8 5.7	16.45	11.7	2.21	2.25	18.42	13.44 to 17.01	79	144	86	2	282	-6	-6
13/14	12.0	8 4.6	16.30	11.7	2.19	2.25	18.37	13.39 to 17.02	80	129	94	2	281	-6	-6
14/15	12.0	8 3.3	16.15	11.7	2.17	2.25	18.32	13.34 to 17.04	81	114	98	2	281	-7	-6
15/16	12.0	8 2.1	15.60	11.7	2.14	2.25	18.27	13.30 to 17.06	83	99	100	2	281	-7	-6
16/17	12.0	8 0.8	15.44	11.6	2.12	2.25	18.21	13.25 to 17.08	84	83	99	2	281	-7	-6
17/18	12.0	7 59.4	15.29	11.6	2.10	2.25	18.16	13.20 to 17.09	85	68	96	2	281	-8	-6
18/19	12.0	7 58.0	15.13	11.6	2.08	2.25	18.11	13.16 to 17.11	86	54	89	2	281	-8	-6
19/20	12.0	7 56.5	14.56	11.6	2.05	2.25	18.05	13.11 to 17.13	88	40	81	2	281	-8	-6
20/21	12.0	7 55.0	14.40	11.6	2.03	2.25	17.60	13.06 to 17.15	89	26	72	2	281	-9	-6
21/22	12.0	7 53.4	14.23	11.5	2.01	2.25	17.54	13.01 to 17.16	90	13	62	2	281	-9	-7
22/23	12.0	7 51.7	14.05	11.5	1.99	2.25	17.49	12.56 to 17.18	92	3	52	2	281	-10	-7

23/24	12.0	7 50.0	13.48	11.5	1.97	2.25	17.43	12.51 to 17.20	93	13	42	2	281	-10	-7
24/25	12.0	7 48.2	13.30	11.5	1.94	2.25	17.37	12.47 to 17.21	94	26	33	2	281	-10	-7
25/26	12.0	7 46.3	13.11	11.4	1.92	2.25	17.31	12.42 to 17.23	96	38	24	2	281	-11	-7
26/27	12.0	7 44.4	12.53	11.4	1.90	2.25	17.25	12.37 to 17.25	97	50	17	2	281	-11	-7
27/28	12.0	7 42.4	12.34	11.4	1.88	2.25	17.20	12.32 to 17.26	99	62	10	2	282	-12	-7
28/29	12.0	7 40.3	12.14	11.4	1.86	2.25	17.14	12.27 to 17.28	100	75	5	2	282	-12	-8
29/30	12.0	7 38.2	11.54	11.4	1.84	2.26	17.07	12.22 to 17.30	101	87	1	2	282	-13	-8
30/31	12.0	7 35.9	11.34	11.3	1.82	2.26	17.01	12.16 to 17.31	103	100	0	2	282	-13	-8
31/32	12.0	7 33.6	11.13	11.3	1.80	2.26	16.55	12.11 to 17.33	104	112	0	2	282	-14	-8

November 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	7 31.2	10.52	11.3	1.78	2.26	16.49	12.06 to 17.35	106	125	2	2	282	-14	-8
2/ 3	12.0	7 28.7	10.30	11.3	1.76	2.26	16.42	12.01 to 17.36	107	138	6	2	283	-15	-9
3/ 4	12.0	7 26.2	10.08	11.2	1.74	2.26	16.36	11.56 to 17.38	109	151	12	2	283	-15	-9
4/ 5	12.0	7 23.5	9.46	11.2	1.72	2.26	16.29	11.50 to 17.40	110	164	20	2	283	-16	-9
5/ 6	12.0	7 20.8	9.23	11.2	1.70	2.26	16.22	11.45 to 17.41	112	172	30	2	284	-16	-9
6/ 7	12.0	7 17.9	8.59	11.2	1.68	2.27	16.16	11.40 to 17.43	114	164	40	2	284	-17	-9
7/ 8	12.0	7 15.0	8.35	11.2	1.66	2.27	16.09	11.35 to 17.45	115	150	51	2	284	-18	-9
8/ 9	12.0	7 12.0	8.11	11.1	1.64	2.27	16.02	11.29 to 17.46	117	136	63	2	285	-18	-10
9/10	12.0	7 8.9	7.46	11.1	1.63	2.27	15.55	11.24 to 17.48	118	121	74	2	285	-19	-10
10/11	12.0	7 5.7	7.20	11.1	1.61	2.27	15.48	11.18 to 17.49	120	106	83	2	286	-19	-10
11/12	12.0	7 2.4	6.54	11.1	1.59	2.27	15.40	11.13 to 17.51	122	91	91	2	287	-20	-10
12/13	12.0	6 59.1	6.28	11.1	1.58	2.28	15.33	11.08 to 17.53	123	76	97	2	287	-20	-10
13/14	12.0	6 55.6	6.01	11.0	1.56	2.28	15.26	11.02 to 17.54	125	61	100	2	288	-21	-11
14/15	12.0	6 52.0	5.34	11.0	1.55	2.28	15.18	10.57 to 17.56	126	46	100	2	289	-22	-11
15/16	12.0	6 48.4	5.06	11.0	1.54	2.28	15.10	10.51 to 17.57	128	32	98	2	290	-22	-11
16/17	12.0	6 44.6	4.38	11.0	1.52	2.28	15.03	10.46 to 17.59	130	20	93	2	291	-23	-11
17/18	12.0	6 40.8	4.10	11.0	1.51	2.29	14.55	10.40 to 18.00	131	14	86	2	292	-23	-11
18/19	12.0	6 36.9	3.41	11.0	1.50	2.29	14.47	10.35 to 18.02	133	20	78	2	293	-24	-12
19/20	12.0	6 32.9	3.12	11.0	1.49	2.29	14.39	10.29 to 18.03	135	31	69	2	295	-25	-12
20/21	12.0	6 28.8	2.42	10.9	1.48	2.29	14.31	10.24 to 18.05	136	43	60	2	296	-25	-12
21/22	12.0	6 24.6	2.12	10.9	1.47	2.30	14.23	10.18 to 18.06	138	55	50	2	298	-26	-12
22/23	12.0	6 20.3	1.42	10.9	1.46	2.30	14.15	10.13 to 18.08	139	68	41	2	300	-26	-12
23/24	12.0	6 16.0	1.12	10.9	1.45	2.30	14.07	10.07 to 18.06	141	80	31	2	302	-27	-12
24/25	12.0	6 11.6	0.42	10.9	1.44	2.30	13.58	10.02 to 17.55	142	92	23	2	304	-27	-12
25/26	12.0	6 7.1	0.12	10.9	1.43	2.31	13.50	9.56 to 17.43	144	105	15	2	307	-27	-12
26/27	12.0	6 2.6	-0.19	10.9	1.43	2.31	13.41	9.51 to 17.32	145	117	9	2	309	-28	-12
27/28	12.0	5 58.1	-0.49	10.9	1.42	2.31	13.33	9.45 to 17.20	146	130	4	2	312	-28	-12
28/29	12.0	5 53.4	-1.19	10.9	1.42	2.31	13.24	9.40 to 17.09	147	141	1	2	315	-28	-12
29/30	12.0	5 48.8	-1.50	10.9	1.42	2.32	13.16	9.34 to 16.57	148	152	0	1	319	-29	-12
30/31	12.0	5 44.1	-2.19	10.9	1.42	2.32	13.07	9.29 to 16.45	149	159	0	1	323	-29	-12

Ephemeris for 2P/Encke (Southern hemisphere)

Omega=186.2689 OMEGA=334.7284 i= 11.9310 q= 0.331387 a= 2.209188
e=0.849996 P= 3.284 T= 1997 May 23.6206 Equinox= 2000
Magnitudes calculated from m= 9.8+5.0*Log(d)+ 6.9*Log(r)

June 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	5 59.5	17.22	6.5	0.72	0.42	1.20	Not Observable	20	60	12	65	107	17	17
2/ 3	12.0	6 2.3	16.39	6.5	0.69	0.43	1.19	Not Observable	20	47	6	61	110	17	-18
3/ 4	12.0	6 5.0	15.53	6.5	0.67	0.45	1.18	Not Observable	20	34	2	57	112	16	-18
4/ 5	12.0	6 7.5	15.06	6.5	0.64	0.47	1.16	Not Observable	20	21	0	53	115	15	-19
5/ 6	12.0	6 9.9	14.17	6.6	0.62	0.48	1.15	Not Observable	20	9	0	50	118	14	-20
6/ 7	12.0	6 12.2	13.27	6.6	0.59	0.50	1.13	Not Observable	20	6	3	47	120	13	-21
7/ 8	12.0	6 14.3	12.33	6.6	0.57	0.52	1.11	Not Observable	20	17	7	45	123	13	-22
8/ 9	12.0	6 16.5	11.38	6.6	0.55	0.54	1.10	5.51 to 5.52	20	29	14	43	126	13	-23
9/10	12.0	6 18.6	10.40	6.6	0.52	0.56	1.08	5.51 to 5.54	20	40	21	41	129	12	-24
10/11	12.0	6 20.7	9.39	6.6	0.50	0.57	1.06	5.51 to 5.55	21	52	30	40	132	12	-25
11/12	12.0	6 22.7	8.34	6.6	0.48	0.59	1.04	5.51 to 5.58	21	63	39	38	135	12	-26
12/13	12.0	6 24.8	7.27	6.6	0.46	0.61	1.02	5.51 to 5.60	22	74	48	38	138	13	-28
13/14	12.0	6 27.0	6.15	6.6	0.44	0.63	1.00	5.51 to 6.02	22	85	58	37	141	13	-29
14/15	12.0	6 29.2	4.58	6.6	0.42	0.65	0.58	5.51 to 6.05	23	96	67	37	144	13	-31
15/16	12.0	6 31.5	3.37	6.6	0.40	0.67	0.57	5.51 to 6.08	24	107	76	37	147	14	-33
16/17	12.0	6 34.0	2.10	6.6	0.39	0.69	0.55	5.51 to 6.12	25	119	84	37	149	15	-36
17/18	12.0	6 36.5	0.37	6.6	0.37	0.71	0.54	5.51 to 6.16	26	130	91	38	152	16	-38
18/19	12.0	6 39.3	-1.03	6.6	0.35	0.72	0.53	5.51 to 6.21	28	140	96	39	154	17	-41
19/20	12.0	6 42.2	-2.51	6.5	0.33	0.74	0.52	5.51 to 6.26	29	149	100	40	156	18	-44
20/21	12.0	6 45.4	-4.47	6.5	0.32	0.76	0.51	5.52 to 6.32	31	155	100	41	158	19	-48
21/22	12.0	6 48.8	-6.53	6.5	0.30	0.78	0.50	5.52 to 6.39	33	155	99	43	159	21	-52
22/23	12.0	6 52.6	-9.10	6.4	0.29	0.80	0.50	5.52 to 6.47	35	148	94	44	160	23	-57
23/24	12.0	6 56.8	-11.39	6.4	0.27	0.81	0.50	5.52 to 6.56	37	139	87	46	162	25	-62
24/25	12.0	7 1.5	-14.22	6.3	0.26	0.83	0.51	5.53 to 7.06	40	129	78	48	162	28	-67
25/26	12.0	7 6.8	-17.18	6.3	0.25	0.85	0.52	5.53 to 7.18	42	118	68	51	163	31	-73
26/27	12.0	7 12.7	-20.30	6.3	0.24	0.87	0.54	5.53 to 7.31	46	108	56	53	163	34	-79
27/28	12.0	7 19.5	-23.57	6.2	0.23	0.88	0.57	5.54 to 7.47 18.07 to 18.13	49	98	45	55	164	38	-86
28/29	12.0	7 27.3	-27.41	6.2	0.22	0.90	1.01	5.54 to 8.06 17.55 to 18.13	53	90	34	58	163	43	-93
29/30	12.0	7 36.3	-31.39	6.2	0.21	0.92	1.06	5.54 to 8.29 17.43 to 18.13	57	84	23	60	163	47	-99
30/31	12.0	7 46.8	-35.52	6.1	0.20	0.94	1.12	5.55 to 8.56 17.29 to 18.13	61	79	15	61	162	53	-105

July 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	7 59.3	-40.15	6.1	0.20	0.95	1.21	5.55 to 9.29 17.13 to 18.13	66	76	8	62	161	59	-109
2/ 3	12.0	8 14.3	-44.44	6.1	0.19	0.97	1.32	5.56 to 10.10 16.53 to 18.13	71	74	3	63	159	66	-112
3/ 4	12.0	8 32.2	-49.12	6.2	0.19	0.99	1.46	5.56 to 11.04 16.27 to 18.12	76	74	0	62	156	73	-111
4/ 5	12.0	8 54.0	-53.31	6.2	0.19	1.00	2.03	5.57 to 12.21 15.46 to 18.12	81	75	0	60	152	81	-107

5/ 6	12.0	9 .20.5	-57.31	6.3	0.19	1.02	2.26	5.57 to 18.12	86	76	1	58	148	88	-100
6/ 7	12.0	9 52.4	-61.02	6.3	0.19	1.04	2.54	5.58 to 18.12	90	77	4	54	142	96	-87
7/ 8	12.0	10 30.0	-63.52	6.4	0.20	1.05	3.28	5.58 to 18.12	95	76	9	51	134	103	-71
8/ 9	12.0	11 12.4	-65.54	6.6	0.20	1.07	4.06	5.59 to 18.12	99	75	16	47	125	108	-50
9/10	12.0	11 57.5	-67.02	6.7	0.21	1.09	4.48	5.59 to 18.11	103	73	24	43	116	109	-28
10/11	12.0	12 42.0	-67.20	6.8	0.22	1.10	5.29	5.60 to 18.11	107	69	32	39	107	107	-7
11/12	12.0	13 22.9	-66.56	6.9	0.23	1.12	6.07	6.00 to 18.11	110	65	41	35	99	100	10
12/13	12.0	13 58.5	-66.01	7.1	0.24	1.13	6.39	6.01 to 18.10	113	60	51	31	92	90	23
13/14	12.0	14 28.5	-64.45	7.2	0.25	1.15	7.05	6.02 to 18.10	116	55	61	28	86	79	31
14/15	12.0	14 53.3	-63.19	7.4	0.26	1.16	7.26	6.02 to 18.10	118	51	71	25	82	69	36
15/16	12.0	15 13.8	-61.47	7.5	0.28	1.18	7.42	6.03 to 18.09	120	47	80	23	79	60	38
16/17	12.0	15 30.8	-60.15	7.6	0.29	1.19	7.55	6.04 to 18.09	122	45	88	21	77	52	38
17/18	12.0	15 45.0	-58.44	7.8	0.30	1.21	8.06	6.04 to 18.08	123	46	94	19	75	46	37
18/19	12.0	15 56.9	-57.16	7.9	0.32	1.23	8.14	6.05 to 18.08	124	50	99	17	74	40	36
19/20	12.0	16 7.2	-55.53	8.1	0.33	1.24	8.20	6.06 to 18.07	125	57	100	16	74	35	34
20/21	12.0	16 16.0	-54.34	8.2	0.35	1.26	8.25	6.06 to 17.55	126	65	99	14	73	31	32
21/22	12.0	16 23.6	-53.19	8.3	0.37	1.27	8.28	6.07 to 17.40	127	76	96	13	73	28	31
22/23	12.0	16 30.4	-52.09	8.5	0.38	1.29	8.31	6.08 to 17.27	128	87	89	12	73	25	29
23/24	12.0	16 36.4	-51.03	8.6	0.40	1.30	8.33	6.08 to 17.15	128	98	80	11	74	23	27
24/25	12.0	16 41.7	-50.01	8.7	0.41	1.31	8.34	6.09 to 17.05	128	109	70	10	74	21	25
25/26	12.0	16 46.6	-49.02	8.8	0.43	1.33	8.35	6.10 to 16.55	129	121	59	10	74	19	24
26/27	12.0	16 50.9	-48.08	8.9	0.45	1.34	8.36	6.11 to 16.46	129	131	47	9	75	18	22
27/28	12.0	16 54.9	-47.16	9.1	0.47	1.36	8.36	6.11 to 16.38	129	141	37	8	75	17	21
28/29	12.0	16 58.6	-46.28	9.2	0.48	1.37	8.35	6.12 to 16.30	129	148	26	8	76	15	20
29/30	12.0	17 2.1	-45.42	9.3	0.50	1.39	8.35	6.13 to 16.22	129	152	18	7	76	14	19
30/31	12.0	17 5.2	-44.59	9.4	0.52	1.40	8.34	6.14 to 16.14	129	151	10	7	77	14	17
31/32	12.0	17 8.2	-44.18	9.5	0.54	1.41	8.33	6.14 to 16.07	129	146	5	6	77	13	16

August 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	17 11.0	-43.40	9.6	0.56	1.43	8.32	6.15 to 16.00	128	138	1	6	78	12	16
2/ 3	12.0	17 13.7	-43.03	9.7	0.57	1.44	8.31	6.16 to 15.53	128	129	0	6	78	12	15
3/ 4	12.0	17 16.2	-42.29	9.8	0.59	1.46	8.29	6.17 to 15.47	128	119	0	5	78	11	14
4/ 5	12.0	17 18.6	-41.56	9.9	0.61	1.47	8.28	6.18 to 15.40	127	109	2	5	79	11	13
5/ 6	12.0	17 20.8	-41.25	10.0	0.63	1.48	8.26	6.18 to 15.34	127	99	6	5	79	10	12
6/ 7	12.0	17 23.0	-40.55	10.1	0.65	1.50	8.24	6.19 to 15.28	127	88	11	5	80	10	12
7/ 8	12.0	17 25.1	-40.27	10.2	0.67	1.51	8.22	6.20 to 15.21	126	78	18	4	80	9	11
8/ 9	12.0	17 27.1	-39.60	10.2	0.69	1.52	8.20	6.21 to 15.15	126	67	26	4	81	9	11
9/10	12.0	17 29.1	-39.34	10.3	0.71	1.54	8.18	6.22 to 15.09	125	57	35	4	81	9	10
10/11	12.0	17 31.0	-39.10	10.4	0.73	1.55	8.16	6.22 to 15.04	125	46	45	4	81	9	10
11/12	12.0	17 32.8	-38.46	10.5	0.75	1.56	8.14	6.23 to 14.58	124	36	55	4	82	8	9
12/13	12.0	17 34.6	-38.24	10.6	0.77	1.58	8.12	6.24 to 14.52	124	26	65	4	82	8	9
13/14	12.0	17 36.4	-38.02	10.7	0.79	1.59	8.10	6.25 to 14.46	123	20	75	3	82	8	8
14/15	12.0	17 38.1	-37.42	10.7	0.81	1.60	8.08	6.26 to 14.41	123	21	84	3	82	8	8
15/16	12.0	17 39.8	-37.22	10.8	0.83	1.61	8.05	6.26 to 14.35	122	30	92	3	83	8	8
16/17	12.0	17 41.4	-37.03	10.9	0.85	1.63	8.03	6.27 to 14.30	122	41	97	3	83	8	7
17/18	12.0	17 43.1	-36.44	11.0	0.87	1.64	8.01	6.28 to 14.24	121	54	100	3	83	8	7
18/19	12.0	17 44.6	-36.27	11.0	0.89	1.65	7.58	6.29 to 14.19	121	68	100	3	83	7	7
19/20	12.0	17 46.2	-36.10	11.1	0.91	1.66	7.56	6.30 to 14.13	120	82	97	3	84	7	7
20/21	12.0	17 47.8	-35.53	11.2	0.93	1.68	7.54	6.31 to 14.08	119	96	91	3	84	7	6
21/22	12.0	17 49.3	-35.38	11.3	0.95	1.69	7.51	6.32 to 14.03	119	110	83	2	84	7	6
22/23	12.0	17 50.8	-35.22	11.3	0.97	1.70	7.49	6.32 to 13.57	118	123	73	2	84	7	6
23/24	12.0	17 52.3	-35.08	11.4	0.99	1.71	7.46	6.33 to 13.52	118	136	62	2	84	7	6
24/25	12.0	17 53.7	-34.53	11.5	1.01	1.73	7.44	6.34 to 13.47	117	148	51	2	84	7	5
25/26	12.0	17 55.2	-34.39	11.5	1.04	1.74	7.41	6.35 to 13.42	116	158	40	2	85	7	5
26/27	12.0	17 56.7	-34.26	11.6	1.06	1.75	7.39	6.36 to 13.37	116	164	30	2	85	7	5
27/28	12.0	17 58.1	-34.13	11.7	1.08	1.76	7.36	6.37 to 13.31	115	161	21	2	85	7	5
28/29	12.0	17 59.5	-34.01	11.7	1.10	1.77	7.34	6.38 to 13.26	114	154	14	2	85	7	5
29/30	12.0	18 0.9	-33.48	11.8	1.12	1.79	7.31	6.38 to 13.21	114	144	8	2	85	7	5
30/31	12.0	18 2.3	-33.36	11.8	1.14	1.80	7.29	6.39 to 13.16	113	133	3	2	85	7	4
31/32	12.0	18 3.8	-33.25	11.9	1.16	1.81	7.26	6.40 to 13.11	112	122	0	2	85	7	4

Ephemeris for 81P/Wild 2 (Southern hemisphere)

Omega= 41.7870 OMEGA=136.1566 i= 3.2437 q= 1.582196 a= 3.442153
e=0.540347 P= 6.386 T= 1997 May 6.6353 Equinox= 2000
Magnitudes calculated from m= 7.4+5.0*Log(d)+11.3*Log(r)

June 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	10 29.5	12.56	10.4	1.36	1.60	5.50	5.52 to 9.32	83	125	12	6	111	15	5
2/ 3	12.0	10 32.1	12.42	10.4	1.37	1.61	5.49	5.52 to 9.31	83	112	6	6	111	15	-5
3/ 4	12.0	10 34.6	12.28	10.4	1.38	1.61	5.47	5.52 to 9.30	83	99	2	5	111	15	-6
4/ 5	12.0	10 37.2	12.13	10.4	1.39	1.61	5.46	5.52 to 9.30	83	86	0	5	112	15	-6
5/ 6	12.0	10 39.7	11.58	10.5	1.39	1.61	5.44	5.51 to 9.29	82	73	0	5	112	15	-6
6/ 7	12.0	10 42.2	11.43	10.5	1.40	1.61	5.43	5.51 to 9.28	82	61	3	5	112	15	-6
7/ 8	12.0	10 44.8	11.28	10.5	1.41	1.62	5.42	5.51 to 9.28	82	49	7	5	112	15	-6
8/ 9	12.0	10 47.3	11.13	10.5	1.42	1.62	5.40	5.51 to 9.27	81	38	14	5	112	15	-6
9/10	12.0	10 49.9	10.58	10.5	1.43	1.62	5.39	5.51 to 9.26	81	26	21	5	112	15	-6
10/11	12.0	10 52.4	10.43	10.6	1.43	1.62	5.37	5.51 to 9.25	81	15	30	5	112	15	-6
11/12	12.0	10 55.0	10.28	10.6	1.44	1.62	5.36	5.51 to 9.25	81	6	39	5	112	15	-6
12/13	12.0	10 57.5	10.12	10.6	1.45	1.63	5.35	5.51 to 9.24	80	9	48	5	112	15	-6
13/14	12.0	11 0.1	9.57	10.6	1.46	1.63	5.33	5.51 to 9.23	80	19	58	5	112	15	-6
14/15	12.0	11 2.6	9.41	10.6	1.47	1.63	5.32	5.51 to 9.23	80	31	67	5	112	15	-6
15/16	12.0	11 5.1	9.25	10.7	1.48	1.63	5.30	5.51 to 9.22	80	42	76	5	112	15	-6
16/17	12.0	11 7.7	9.10	10.7	1.49	1.64	5.29	5.51 to 9.21	79	54	84	5	112	15	-6
17/18	12.0	11 10.2	8.54	10.7	1.49	1.64	5.28	5.51 to 9.20	79	66	91	5	112	15	-6
18/19	12.0	11 12.7	8.38	10.7	1.50	1.64	5.26	5.51 to 9.20	79	79	96	5	112	15	-6
19/20	12.0	11 15.3	8.22	10.7	1.51	1.64	5.25	5.51 to 9.19	78	92	100	5	112	15	-6
20/21	12.0	11 17.8	8.06	10.8	1.52	1.65	5.23	5.52 to 9.18	78	105	100	4	112	15	-6
21/22	12.0	11 20.3	7.50	10.8	1.53	1.65	5.22	5.52 to 9.17	78	118	99	4	112	15	-6
22/23	12.0	11 22.9	7.34	10.8	1.54	1.65	5.21	5.52 to 9.16	78	132	94	4	112	15	-6
23/24	12.0	11 25.4	7.18	10.8	1.55	1.65	5.19	5.52 to 9.16	77	146	87	4	112	15	-6
24/25	12.0	11 27.9	7.01	10.8	1.56	1.66	5.18	5.53 to 9.15	77	159	78	4	113	15	-6
25/26	12.0	11 30.4	6.45	10.9	1.57	1.66	5.16	5.53 to 9.14	77	172	68	4	113	15	-6
26/27	12.0	11 32.9	6.29	10.9	1.57	1.66	5.15	5.53 to 9.13	77	172	56	4	113	15	-6
27/28	12.0	11 35.4	6.13	10.9	1.58	1.67	5.13	5.54 to 9.12	76	159	45	4	113	15	-6
28/29	12.0	11 37.9	5.56	10.9	1.59	1.67	5.12	5.54 to 9.11	76	146	34	4	113	15	-6

29/30	12.0	11 40.4	5.40	10.9	1.60	1.67	5.10	5.54 to 9.11	76	133	23	4	113	15	-6
30/31	12.0	11 42.9	5.23	11.0	1.61	1.68	5.09	5.55 to 9.10	75	121	15	4	113	15	-6

July 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	11 45.4	5.07	11.0	1.62	1.68	5.08	5.55 to 9.09	75	108	8	4	113	15	-6
2/ 3	12.0	11 47.9	4.51	11.0	1.63	1.68	5.06	5.56 to 9.08	75	96	3	4	113	15	-6
3/ 4	12.0	11 50.4	4.34	11.0	1.64	1.69	5.05	5.56 to 9.07	75	83	0	4	113	15	-6
4/ 5	12.0	11 52.9	4.18	11.1	1.65	1.69	5.03	5.57 to 9.06	74	71	0	4	113	15	-6
5/ 6	12.0	11 55.3	4.01	11.1	1.66	1.69	5.02	5.57 to 9.05	74	60	1	4	113	15	-6
6/ 7	12.0	11 57.8	3.45	11.1	1.67	1.70	5.00	5.58 to 9.04	74	48	4	4	113	15	-6
7/ 8	12.0	12 0.3	3.28	11.1	1.68	1.70	4.59	5.58 to 9.03	73	37	9	3	113	15	-6
8/ 9	12.0	12 2.8	3.12	11.2	1.69	1.70	4.57	5.59 to 9.02	73	26	16	3	113	15	-6
9/10	12.0	12 5.2	2.55	11.2	1.70	1.71	4.56	5.59 to 9.01	73	14	24	3	112	15	-6
10/11	12.0	12 7.7	2.39	11.2	1.71	1.71	4.54	5.60 to 9.00	73	4	32	3	112	15	-6
11/12	12.0	12 10.1	2.22	11.2	1.72	1.71	4.53	6.00 to 8.59	72	8	41	3	112	15	-6
12/13	12.0	12 12.6	2.06	11.2	1.73	1.72	4.51	6.01 to 8.58	72	20	51	3	112	15	-6
13/14	12.0	12 15.0	1.50	11.3	1.74	1.72	4.50	6.02 to 8.57	72	31	61	3	112	15	-6
14/15	12.0	12 17.5	1.33	11.3	1.75	1.73	4.48	6.02 to 8.56	72	43	71	3	112	15	-6
15/16	12.0	12 19.9	1.17	11.3	1.76	1.73	4.47	6.03 to 8.55	71	55	80	3	112	15	-6
16/17	12.0	12 22.4	1.00	11.3	1.77	1.73	4.45	6.04 to 8.54	71	68	88	3	112	15	-6
17/18	12.0	12 24.8	0.44	11.4	1.78	1.74	4.44	6.04 to 8.53	71	81	94	3	112	15	-6
18/19	12.0	12 27.2	0.28	11.4	1.80	1.74	4.42	6.05 to 8.52	70	94	99	3	112	15	-6
19/20	12.0	12 29.7	0.12	11.4	1.81	1.74	4.41	6.06 to 8.51	70	108	100	3	112	15	-6
20/21	12.0	12 32.1	-0.05	11.4	1.82	1.75	4.39	6.06 to 8.49	70	122	99	3	112	15	-6
21/22	12.0	12 34.5	-0.21	11.5	1.83	1.75	4.38	6.07 to 8.48	70	137	96	3	112	15	-6
22/23	12.0	12 36.9	-0.37	11.5	1.84	1.76	4.36	6.08 to 8.47	69	151	89	3	112	15	-6
23/24	12.0	12 39.3	-0.53	11.5	1.85	1.76	4.35	6.08 to 8.46	69	165	80	3	112	15	-6
24/25	12.0	12 41.7	-1.09	11.5	1.86	1.77	4.33	6.09 to 8.45	69	178	70	3	112	15	-6
25/26	12.0	12 44.1	-1.25	11.6	1.87	1.77	4.32	6.10 to 8.44	68	168	59	3	112	15	-6
26/27	12.0	12 46.5	-1.41	11.6	1.88	1.77	4.30	6.11 to 8.42	68	154	47	3	112	14	-6
27/28	12.0	12 48.9	-1.57	11.6	1.89	1.78	4.29	6.11 to 8.41	68	142	37	2	112	14	-6
28/29	12.0	12 51.3	-2.12	11.6	1.91	1.78	4.27	6.12 to 8.40	67	129	26	2	112	14	-6
29/30	12.0	12 53.7	-2.28	11.7	1.92	1.79	4.25	6.13 to 8.38	67	117	18	2	111	14	-6
30/31	12.0	12 56.1	-2.44	11.7	1.93	1.79	4.24	6.14 to 8.37	67	105	10	2	111	14	-6
31/32	12.0	12 58.5	-2.59	11.7	1.94	1.80	4.22	6.14 to 8.36	67	93	5	2	111	14	-6

August 1997 Times in GMAT

Day	Time	R.A. B1950	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12.0	13 0.9	-3.15	11.7	1.95	1.80	4.21	6.15 to 8.35	66	81	1	2	111	14	-6
2/ 3	12.0	13 3.2	-3.31	11.8	1.96	1.80	4.19	6.16 to 8.33	66	69	0	2	111	14	-6
3/ 4	12.0	13 5.6	-3.46	11.8	1.98	1.81	4.18	6.17 to 8.32	66	58	0	2	111	14	-6
4/ 5	12.0	13 8.0	-4.01	11.8	1.99	1.81	4.16	6.18 to 8.31	65	47	2	2	111	14	-6
5/ 6	12.0	13 10.4	-4.17	11.8	2.00	1.82	4.15	6.18 to 8.29	65	35	6	2	111	14	-6
6/ 7	12.0	13 12.7	-4.32	11.9	2.01	1.82	4.13	6.19 to 8.28	65	24	11	2	111	14	-6
7/ 8	12.0	13 15.1	-4.47	11.9	2.02	1.83	4.11	6.20 to 8.26	64	13	18	2	111	14	-6
8/ 9	12.0	13 17.4	-5.02	11.9	2.03	1.83	4.10	6.21 to 8.25	64	2	26	2	111	14	-6
9/10	12.0	13 19.8	-5.17	11.9	2.05	1.84	4.08	6.22 to 8.23	64	10	35	2	110	14	-6
10/11	12.0	13 22.1	-5.32	12.0	2.06	1.84	4.07	6.22 to 8.22	63	21	45	2	110	14	-6
11/12	12.0	13 24.5	-5.47	12.0	2.07	1.85	4.05	6.23 to 8.21	63	33	55	2	110	14	-6
12/13	12.0	13 26.8	-6.01	12.0	2.08	1.85	4.03	6.24 to 8.19	63	45	65	2	110	14	-6
13/14	12.0	13 29.2	-6.16	12.0	2.09	1.86	4.02	6.25 to 8.18	62	58	75	2	110	14	-6
14/15	12.0	13 31.5	-6.31	12.1	2.11	1.86	4.00	6.26 to 8.16	62	71	84	2	110	14	-6
15/16	12.0	13 33.9	-6.45	12.1	2.12	1.87	3.59	6.26 to 8.15	62	85	92	2	110	14	-6
16/17	12.0	13 36.2	-6.59	12.1	2.13	1.87	3.57	6.27 to 8.13	61	99	97	2	110	14	-5
17/18	12.0	13 38.5	-7.14	12.1	2.14	1.88	3.55	6.28 to 8.11	61	113	100	2	110	14	-5
18/19	12.0	13 40.8	-7.28	12.2	2.16	1.88	3.54	6.29 to 8.10	61	127	100	2	109	14	-5
19/20	12.0	13 43.2	-7.42	12.2	2.17	1.89	3.52	6.30 to 8.08	60	142	97	2	109	14	-5
20/21	12.0	13 45.5	-7.56	12.2	2.18	1.89	3.51	6.31 to 8.07	60	156	91	2	109	14	-5
21/22	12.0	13 47.8	-8.10	12.2	2.19	1.90	3.49	6.32 to 8.05	60	171	83	2	109	14	-5
22/23	12.0	13 50.1	-8.24	12.3	2.21	1.90	3.47	6.32 to 8.03	59	176	73	2	109	14	-5
23/24	12.0	13 52.4	-8.37	12.3	2.22	1.91	3.46	6.33 to 8.02	59	162	62	1	109	14	-5
24/25	12.0	13 54.8	-8.51	12.3	2.23	1.91	3.44	6.34 to 8.00	59	149	51	1	109	14	-5
25/26	12.0	13 57.1	-9.04	12.3	2.24	1.92	3.42	6.35 to 7.59	58	137	40	1	109	14	-5
26/27	12.0	13 59.4	-9.18	12.4	2.26	1.92	3.41	6.36 to 7.57	58	124	30	1	108	14	-5
27/28	12.0	14 1.7	-9.31	12.4	2.27	1.93	3.39	6.37 to 7.55	58	112	21	1	108	14	-5
28/29	12.0	14 4.0	-9.44	12.4	2.28	1.93	3.38	6.38 to 7.53	57	101	14	1	108	14	-5
29/30	12.0	14 6.3	-9.57	12.4	2.29	1.94	3.36	6.38 to 7.52	57	89	8	1	108	14	-5
30/31	12.0	14 8.6	-10.10	12.5	2.31	1.94	3.34	6.39 to 7.50	57	78	3	1	108	14	-5
31/32	12.0	14 10.9	-10.23	12.5	2.32	1.95	3.33	6.40 to 7.48	56	66	0	1	108	14	-5

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Until Hale-Bopp is out of the way sending observations once a week would be helpful, though normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

A few observers claim to be making magnitude estimates of the zero magnitude comet with 20 cm reflectors. I hope they are not! Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The most common ones are AA (AAVSO atlas), VB (BAA VS chart), HS (Hubble catalogue), SC (Sky Catalogue 2000).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

TA format (example)

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T     fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R     18 290                        Shanklin
970328.89 S   9.5  NP  20   T     10  75  2.5   2               Shanklin
961214.70 S   3.8  AA   8   B         20  6     7/  0.50   40   Baroni
```

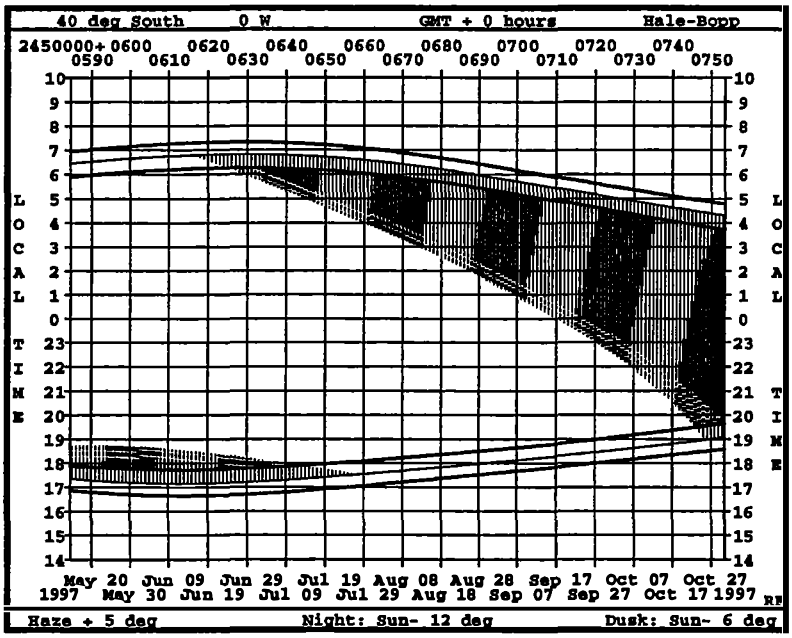
ICQ format (example)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
 991992     1992  5 18.94  S   9.3 AA   7.5R     50    6    4         135 ICQ XX BEA
  P1955A1   1955  6 18.08      5.0 BD  5  R       6    5    s5   0.75 335 ICQ XX STO01
```

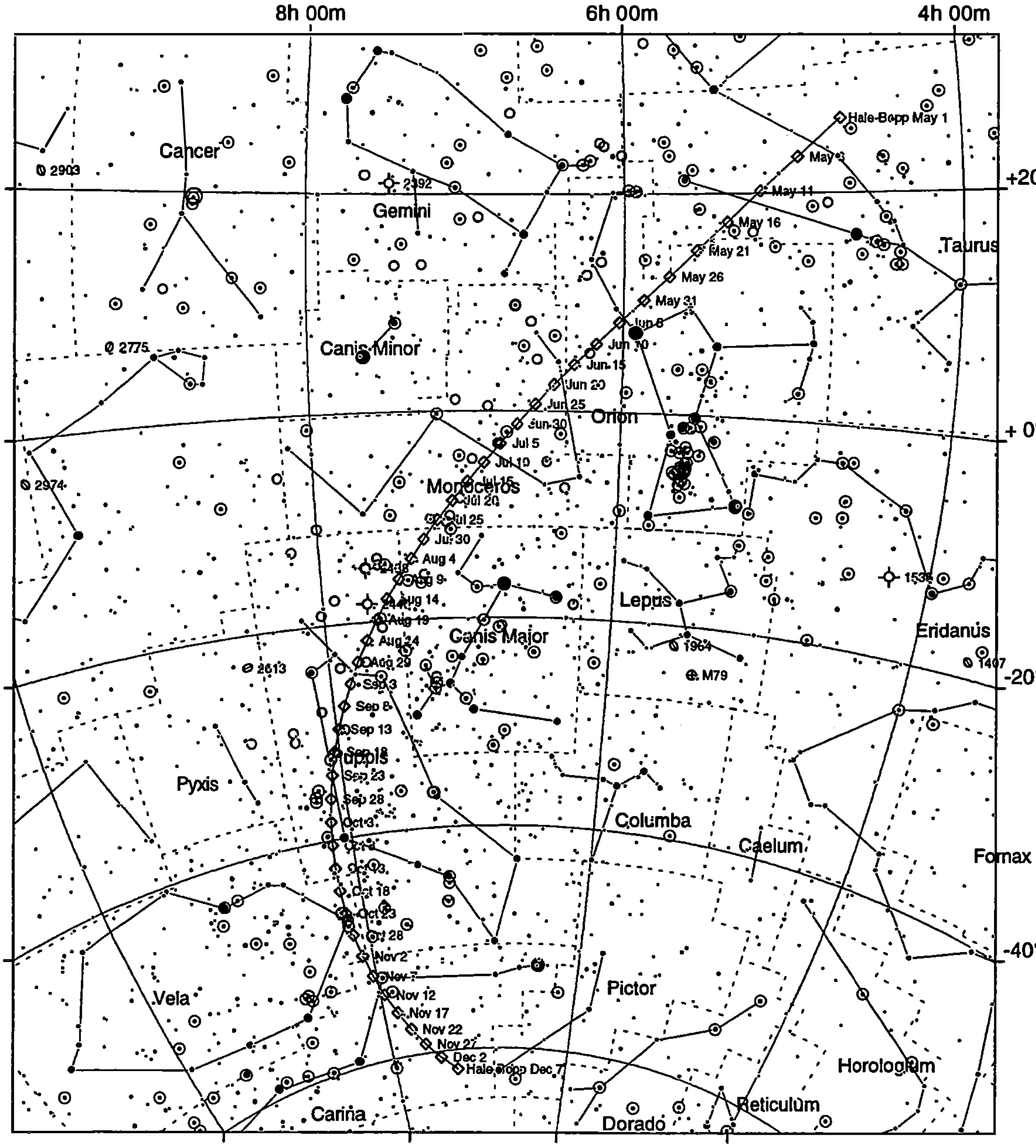
Finder Charts

There are two finder charts for southern hemisphere observers. This page has a visibility diagram for the comet, produced using software written by Richard Fleet. After the end of October the come is visible all night from 40°S. Page 12 has a chart for comet Hale-Bopp (1995 O1). This shows stars down to the naked eye limit, but where possible stars from the AAVSO atlas (or other approved source) should be used as comparisons. The chart was produced using Megastar software. Variable stars are shown with circles round them.

The other comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet.



N E W	● ● ● ● • • · 0 1 2 3 4 5 6	100° 23.5' x 90° 9.1'	06h 44.560m -16° 45.95'		May 4, 1997 21:18 LT 21:18 UT N 52° 0' 0.0" W 0° 0' 0.0" Alt: -7.8° Azim: 252.8° Trans: 15:59 Rise: 11:35 Set: 20:24
Galaxy	Glxy Cl	Globular	Open Cl	Planetary	Clust+Neb	CMa	
						Uranometria 273	
Bright Neb	Dark Neb	Asterism	Unknown	Quasar	Dbl Star	Comet	Asteroid



Hale-Bopp

THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 4, No 2 (Issue 8), 1997 November

The Search for Comet P/Pons-Gambart

Andreas Kammerer, Ettlingen, Germany

It was an article by Alex Vincent in the newsletter of BAA's Comet Section which drew my attention to the then "lost" comets de Vico and Pons-Gambart. The author predicted the return of these comets for 1997-1999 and 1999-2000, respectively. As is known, comet de Vico was rediscovered in September, 1995, reaching 5 mag and displaying a very dynamic ion tail. Three years before another "lost" periodical comet, Swift-Tuttle, was rediscovered as it approached the sun, again observed by thousands of people, although the circumstances were as bad as they could be, with the comet at perihelion nearly on the opposite side of the sun. Most astronomers had anticipated this mother comet of the Perseids 12 years in advance. However, the orbit was not well determined and an investigation by Brian Marsden even showed a possible identity with comet Kegler in 1737, leading to his prediction of a probable perihelion date at the end of 1992. Several weeks before this date the comet was rediscovered heading towards the sun.

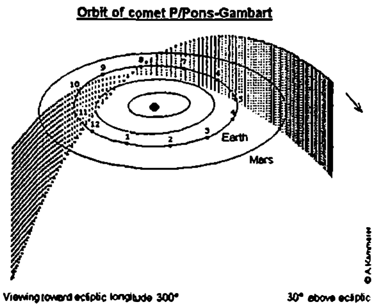
Now there is the possibility of rediscovering just another "lost" comet within the next few years. Because comet Pons-Gambart was observed for only one month its period too can only be determined with an uncertainty of several years.

Details about the apparition are poor: On June 21, 1827 Jean Louis Pons in Florence, Italy and Adolphe Gambart in Marseille, France independently discovered a comet in the constellation Cassiopeia. They did not make any remarks concerning the brightness, but it seems that the comet was of magnitude 5 to 6. The comet steadily grew fainter and the last observation already came on July 21 with an assumed brightness of about 8 mag.

First calculations assumed a parabolic orbit with perihelion date on June 8. But in 1917 Ogura showed that the comet really was of short period. He calculated two different periods of either 46 or 64 years. In 1978 S. Nakano reinvestigated the apparition of this comet and found a period of 57.5 +/- 10 years. All these calculations confirmed however, that the comet was hopelessly lost. Since 1827 it should have reached perihelion twice, but was not observed.

Then in 1979 I. Hasegawa found an interesting link. While investigating Chinese records of ancient comets he noted that a comet in 1110 had a very similar orbit to that of comet Pons-Gambart. More recently Kenji Muraoka determined a current orbital period of 56.15 years and proposed the likely return to perihelion for December 5, 1997. However, it has to be pointed out that his investigation still has an uncertainty of several years.

As a result, the circumstances for rediscovering comet Pons-Gambart are not any better than they were for comet Swift-Tuttle - with the latter having a higher intrinsic magnitude. However, with the help of a search ephemeris it should be possible to find this comet too, even in the case of the worst perihelion circumstances. These occur in the case the comet reaches perihelion in winter, with the comet never getting brighter than 8-9 mag and being situated uncomfortably for Northerners. In contrast, a perihelion date in mid-August will bring it close to the earth (minimum distance: 0.16 A.U.), with the comet perhaps as bright as 3-4 mag (Fig. 1).



Continued on page 4

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Section news from the Director

Dear Section member,

Thankfully no new bright comets have been discovered, so I have been able to catch up a little on Section work, though pressure on my time has meant that this newsletter is a little later than intended. A paper on the comets of 1993 has been accepted for the Journal and I've made good progress on the comets of 1994. Despite requesting an improvement in reporting standards in the last newsletter, the majority of observers are still making mistakes in reporting their observations to Guy. This greatly increases the workload for Guy, so please try and submit observations exactly in TA or ICQ format if you are submitting by e-mail, or use the Section report forms if submitting by post. We will give a further briefing on submitting observations at the Section meeting in February. This meeting will concentrate on observational techniques and how to report observations, though there will be time for a few general talks as well. See the details on page ?.

Several deaths have occurred in the last six months. Stan Milbourn, a former Section Director died in August. A full obituary will appear in the Journal in due course. I have also just learnt of the death of Paul Doherty who was a long standing cometary observer. You will all have heard of the death of Gene Shoemaker; he will be sadly missed. Dr Jurgen Rahe, a leading NASA astronomer, was killed when a tree fell on his car during a severe storm near his home of Potomac, MD. He had been a co-leader of the International Halley Watch and was also involved with the Giotto, Clementine, Rosetta and NEAR missions.

Since the last newsletter observations or contributions have been received from the following BAA members:

James Abott, Mark Armstrong, Sally Beaumont, Denis Buczynski, Emilio Colombo, Eric Dinham, Mike Gainsford, Massimo Giuntoli, Werner Hasubick, Mike Hendrie, Colin Henshaw, Guy Hurst, Nick James, Albert Jones, Norman Kiernan, John Mackey, Glyn Marsh, Richard McKim, Haldun Menali, Martin Mobberley, Stewart Moore, Bob Neville, Detlev Niechoy, Brian O'Halloran, Gabriel Oksa, John Rogers, Jonathan Shanklin, Tony Tanti, Melvyn Taylor and Alex Vincent.

and also from: Jose Aguiar, Cornel Apetroaei, Alexandr Baransky, Sandro Baroni, John Bortle, Reinder Bouma, Haakon Dahle, Alfons Diepvens, Stephen Getliffe, Guus Gilein, Bjoern Granslo, Roberto Haver, Andreas Kammerer, Graham Keitch, Heinz Kerner, Mark Kidger, Atilla Kosa-Kiss, Martin Lehky, Romualdo Lourencon, Herman Mikuz, John O'Neil, Andrew Pearce, Oddleiv Skilbrei, Josep Trigo, Vince Tuboly, Graham Wolf, Seiichi Yoshida and Vittorio Zanotta (apologies for any omissions or miss-classifications).

Comets under observation were: 2P/Encke, 29P/Schwassmann-Wachmann 1, 43P/Wolf-Harrington, 46P/Wirtanen, 48P/Johnson, 78P/Gehrels 2, 81P/Wild 2, 103P/Hartley 2, C/Hale-Bopp (1995 O1), C/Evans-Drinkwater (1996 J1), C/Mueller (1997 D1), C/Mueller (1997 J1), C/Meunier-Dupouy (1997 J2), C/Tabur (1997 N1), C/Tilbrook (1997 O1) and C//Utsunomiya (1997 T1).

You will see a few changes to the format of the ephemerides in the observing supplement. I now give positions for both B1950 and J2000 epochs, and the times are in UT. I've increased the interval between positions to 5 days for the fainter comets and those not visible from the UK. Let me know if you like these changes and if there is anything else you'd like to see in the Newsletter. I look forward to seeing as many of you as possible at the Section meeting.

Jonathan Shanklin

Provisional Meeting Programme

Observing Techniques

Saturday, February 14

Institute of Astronomy, Cambridge

10:30	Doors open, refreshments available	
11:15	Tour of RGO and Observatories	
12:15	Lunch	
13:30	Jon Shanklin	Introduction
13:35	Jon Shanklin	Visual Observing
14:05	Guy Hurst	Reporting Observations
14:30	Mike Irwin	Discovering Kuiper Belt Objects
15:00	Members slot	
15:15	Tea	
15:45	Nick James	Comet image processing
16:15	Bob Neville	Determining CCD comet magnitudes
16:45	TBA	CCD astrometry
17:30	Observing if clear	

There is an entry charge of £1.00 to cover administration costs, tea, coffee and biscuits. A buffet lunch is available for £4.00 if you book in advance – please send bookings to me. The Churchill is just down the road and there are a couple of good pubs in Coton, about a mile away.

If you would like to speak please let me know. Some exhibition space is available and recent observations will be on display. If you would like to exhibit material, please let me know in advance. There will be stands by the BAA, CAA, CUAS and TA. The TA special supplement on Hale-Bopp and the CD ROM will be available for purchase.

The meeting will take place in the Hoyle building of the Institute of Astronomy. Cambridge rail and coach stations are a lengthy walk from the Observatories. The Birmingham train arrives at 10:29, London trains at 10:04 and 10:34 (fast from Kings Cross) and 10:06 and 10:57 (Liverpool Street). The Madingley Road park & ride bus is reasonably convenient for the Observatories. Car parking is available on site.

Comet Pons-Gambart

Continued from page 1

The accompanying search ephemeris (Table 1 and 2) give right ascension (in hours), declination (in degrees) and magnitude for various observing dates along the most promising orbital arc. Because of the orbital uncertainties the search should be extended to about +/- 5 degrees on either side of the arc (at times of small earth distances even more). Every column lists for a specific observation date the position and magnitude of the comet for distinct intervals to the perihelion. In this way, one can define the most promising arc for the search.

The listed magnitudes were derived by using the brightness parameters H10 = 7.5 mag, n = 4. It has to be stressed, however, that on average periodical comets show n>4. If this would be the case for comet Pons-Gambart, the actual magnitude could be much fainter than the listed value, especially with the comet far from the sun. Therefore, the listed magnitudes should be regarded as maximum values.

References:
Gary W. Kronk: Comets. A descriptive catalog. Hillside, 1984.
Gary W. Kronk: Comet Homepage, 1997.
Alex Vincent: Lost Periodical Comets. Newsletter of the Comet Section of the British Astronomical Association, 1994.
S.K. Vsekhsvyatskii: Physical Characteristics of Comets. Jerusalem 1964.

(andreas.kammerer@x400.lfuka.um.bwl.de)

Table 1: Search ephemeris for comet P/Pons-Gambart (Jan.-June) (Equinox 2000.0)

	Jan 1	Jan 11	Jan 21	Jan 31	Feb 10	Feb 20	Mar 2	Mar 12	Mar 22	Apr 1	Apr 11	Apr 21	May 1	May 11	May 21	May 31	Jun 10	Jun 20	Jun 30
-160	3.0/-38 13 mag	2.8/-35 13 mag	2.7/-33 14 mag	2.7/-30 14 mag	2.7/-27 14 mag	2.8/-25 14 mag	2.9/-22 14 mag	3.0/-20 14 mag	3.1/-18 14 mag	3.3/-16 14 mag	3.4/-15 14 mag	3.6/-13 14 mag	3.8/-12 14 mag	4.0/-11 14 mag	4.1/-11 14 mag	4.3/-10 14 mag	4.5/-10 14 mag	4.7/-10 14 mag	4.9/-10 14 mag
-150	2.8/-39 13 mag	2.6/-36 13 mag	2.5/-33 13 mag	2.5/-30 13 mag	2.5/-27 14 mag	2.6/-25 14 mag	2.7/-22 14 mag	2.8/-20 14 mag	3.0/-18 14 mag	3.1/-16 14 mag	3.3/-15 14 mag	3.5/-13 14 mag	3.7/-12 14 mag	3.8/-11 14 mag	4.0/-11 14 mag	4.2/-10 14 mag	4.4/-10 14 mag	4.6/-10 14 mag	4.8/-10 14 mag
-140	2.5/-40 13 mag	2.3/-37 13 mag	2.3/-34 13 mag	2.3/-31 13 mag	2.3/-28 13 mag	2.4/-25 13 mag	2.5/-23 13 mag	2.6/-20 13 mag	2.8/-18 14 mag	3.0/-16 14 mag	3.1/-15 14 mag	3.3/-13 14 mag	3.5/-12 14 mag	3.7/-11 14 mag	3.9/-11 14 mag	4.1/-10 14 mag	4.3/-10 14 mag	4.6/-10 14 mag	4.8/-10 14 mag
-130	2.1/-41 12 mag	2.0/-37 13 mag	2.0/-34 13 mag	2.0/-31 13 mag	2.1/-28 13 mag	2.2/-25 13 mag	2.3/-23 13 mag	2.5/-20 13 mag	2.6/-18 13 mag	2.8/-16 13 mag	3.0/-15 13 mag	3.2/-13 13 mag	3.4/-12 13 mag	3.6/-11 13 mag	3.8/-11 13 mag	4.0/-10 13 mag	4.2/-10 13 mag	4.5/-10 13 mag	4.7/-10 13 mag
-120	1.8/-41 12 mag	1.7/-38 12 mag	1.7/-34 12 mag	1.7/-31 13 mag	1.8/-28 13 mag	1.9/-25 13 mag	2.1/-23 13 mag	2.3/-20 13 mag	2.4/-18 13 mag	2.6/-16 13 mag	2.8/-15 13 mag	3.0/-13 13 mag	3.3/-12 13 mag	3.5/-11 13 mag	3.7/-11 13 mag	3.9/-10 13 mag	4.1/-10 13 mag	4.4/-10 13 mag	4.6/-10 13 mag
-110	1.4/-42 12 mag	1.3/-38 12 mag	1.3/-34 12 mag	1.4/-31 12 mag	1.5/-28 12 mag	1.7/-25 12 mag	1.9/-23 12 mag	2.0/-20 13 mag	2.2/-18 13 mag	2.4/-16 13 mag	2.6/-15 13 mag	2.9/-13 13 mag	3.1/-12 13 mag	3.3/-11 13 mag	3.6/-10 13 mag	3.8/-10 13 mag	4.0/-10 13 mag	4.2/-10 13 mag	4.5/-10 12 mag
-100	0.9/-42 11 mag	0.9/-38 12 mag	1.0/-34 12 mag	1.1/-31 12 mag	1.2/-28 12 mag	1.4/-25 12 mag	1.6/-23 12 mag	1.8/-20 12 mag	2.0/-18 12 mag	2.2/-16 12 mag	2.5/-15 12 mag	2.7/-13 12 mag	2.9/-12 12 mag	3.2/-11 12 mag	3.4/-10 12 mag	3.6/-10 12 mag	3.9/- 9 12 mag	4.1/-10 12 mag	4.4/-10 12 mag
-90	0.4/-42 11 mag	0.5/-38 11 mag	0.6/-34 11 mag	0.7/-31 11 mag	0.9/-28 12 mag	1.1/-25 12 mag	1.3/-22 12 mag	1.5/-20 12 mag	1.8/-18 12 mag	2.0/-16 12 mag	2.2/-14 12 mag	2.5/-13 12 mag	2.7/-12 12 mag	3.0/-11 12 mag	3.2/-10 12 mag	3.5/- 9 12 mag	3.7/- 9 12 mag	4.0/- 9 12 mag	4.2/-10 12 mag
-80	23.9/-41 11 mag	0.0/-37 11 mag	0.2/-33 11 mag	0.4/-30 11 mag	0.6/-27 11 mag	0.8/-24 11 mag	1.0/-22 11 mag	1.3/-20 11 mag	1.5/-17 11 mag	1.8/-16 11 mag	2.0/-14 11 mag	2.3/-12 11 mag	2.5/-11 11 mag	2.8/-10 11 mag	3.1/- 9 11 mag	3.3/- 9 11 mag	3.6/- 9 11 mag	3.8/- 9 11 mag	4.1/- 9 11 mag
-70	23.4/-39 10 mag	23.5/-36 10 mag	23.7/-32 11 mag	24.0/-29 11 mag	0.2/-26 11 mag	0.5/-24 11 mag	0.7/-21 11 mag	1.0/-19 11 mag	1.2/-17 11 mag	1.5/-15 11 mag	1.8/-13 11 mag	2.0/-12 11 mag	2.3/-10 11 mag	2.6/- 9 11 mag	2.8/- 9 11 mag	3.1/- 8 11 mag	3.4/- 8 11 mag	3.7/- 8 11 mag	4.0/- 9 10 mag
-60	22.8/-37 10 mag	23.0/-34 10 mag	23.3/-31 10 mag	23.5/-28 10 mag	23.8/-25 10 mag	0.1/-23 10 mag	0.4/-20 10 mag	0.6/-18 10 mag	0.9/-16 10 mag	1.2/-14 10 mag	1.5/-12 10 mag	1.8/-11 10 mag	2.0/-10 10 mag	2.3/- 9 10 mag	2.6/- 8 10 mag	2.9/- 7 10 mag	3.2/- 7 10 mag	3.5/- 7 10 mag	3.8/- 8 10 mag
-50	22.2/-35 9 mag	22.5/-32 10 mag	22.8/-29 10 mag	23.1/-26 10 mag	23.4/-24 10 mag	23.7/-21 10 mag	24.0/-19 10 mag	0.3/-17 10 mag	0.6/-15 10 mag	0.9/-13 10 mag	1.2/-11 10 mag	1.5/-10 10 mag	1.8/- 8 10 mag	2.1/- 7 10 mag	2.4/- 6 10 mag	2.7/- 6 10 mag	3.0/- 5 9 mag	3.3/- 6 9 mag	3.6/- 6 9 mag
-40	21.7/-32 9 mag	22.0/-29 9 mag	22.3/-27 9 mag	22.6/-24 9 mag	23.0/-22 9 mag	23.3/-20 9 mag	23.6/-18 9 mag	23.9/-15 9 mag	0.2/-13 9 mag	0.5/-12 9 mag	0.8/-10 9 mag	1.1/- 8 9 mag	1.4/- 7 9 mag	1.7/- 6 9 mag	2.1/- 5 9 mag	2.4/- 4 9 mag	2.7/- 3 9 mag	3.0/- 3 9 mag	3.4/- 4 8 mag
-30	21.1/-28 9 mag	21.5/-26 9 mag	21.8/-24 9 mag	22.2/-22 9 mag	22.5/-20 9 mag	22.8/-18 9 mag	23.1/-16 9 mag	23.5/-14 9 mag	23.8/-12 9 mag	0.1/-10 9 mag	0.4/- 8 9 mag	0.8/- 6 9 mag	1.1/- 5 9 mag	1.4/- 3 9 mag	1.7/- 2 8 mag	2.1/- 1 8 mag	2.4/- 0 8 mag	2.8/- 0 8 mag	3.1/- 0 8 mag
-20	20.6/-24 8 mag	20.9/-22 8 mag	21.3/-21 8 mag	21.7/-19 8 mag	22.0/-17 8 mag	22.4/-15 8 mag	22.7/-13 8 mag	23.0/-11 8 mag	23.4/- 9 8 mag	23.7/- 7 8 mag	0.0/- 5 8 mag	0.4/- 3 8 mag	0.7/- 1 8 mag	1.0/- 0 8 mag	1.4/+ 1 8 mag	1.7/+ 2 8 mag	2.1/+ 4 7 mag	2.5/+ 5 7 mag	2.9/+ 5 7 mag
-10	20.0/-19 8 mag	20.4/-18 8 mag	20.8/-17 8 mag	21.2/-15 8 mag	21.5/-14 8 mag	21.9/-12 8 mag	22.2/-10 8 mag	22.6/- 8 8 mag	22.9/- 6 8 mag	23.2/- 4 8 mag	23.6/- 2 8 mag	23.9/+ 0 8 mag	0.3/+ 2 7 mag	0.6/+ 4 7 mag	1.0/+ 7 7 mag	1.3/+ 9 7 mag	1.7/+11 7 mag	2.2/+14 6 mag	2.7/+17 6 mag
0	19.5/-15 8 mag	19.9/-14 8 mag	20.3/-13 8 mag	20.6/-12 8 mag	21.0/-10 8 mag	21.4/- 8 8 mag	21.7/- 6 8 mag	22.1/- 4 8 mag	22.4/- 2 8 mag	22.8/- 0 8 mag	23.1/+ 2 7 mag	23.4/+ 5 7 mag	23.8/+ 8 7 mag	0.2/+11 7 mag	0.5/+15 7 mag	0.9/+19 6 mag	1.4/+24 6 mag	1.9/+30 6 mag	2.6/+37 5 mag
10	19.0/-11 8 mag	19.4/-10 8 mag	19.8/- 9 8 mag	20.1/- 8 8 mag	20.5/- 6 8 mag	20.9/- 4 8 mag	21.2/- 2 8 mag	21.6/- 0 8 mag	21.9/+ 2 8 mag	22.3/+ 5 7 mag	22.6/+ 8 7 mag	23.0/+11 7 mag	23.3/+16 7 mag	23.7/+21 7 mag	0.1/+26 6 mag	0.5/+33 6 mag	1.0/+42 6 mag	1.7/+53 5 mag	3.0/+67 5 mag
20	18.5/- 6 8 mag	18.9/- 6 8 mag	19.3/- 5 8 mag	19.6/- 4 8 mag	20.0/- 2 8 mag	20.4/- 0 8 mag	20.7/+ 1 8 mag	21.1/+ 4 8 mag	21.4/+ 7 8 mag	21.7/+11 8 mag	22.1/+15 7 mag	22.4/+20 7 mag	22.8/+26 7 mag	23.1/+33 7 mag	23.5/+41 6 mag	23.9/+52 6 mag	0.5/+65 6 mag	2.0/+79 6 mag	10.2/+80 6 mag
30	18.1/- 3 9 mag	18.4/- 2 9 mag	18.8/- 1 9 mag	19.2/- 0 9 mag	19.5/+ 1 8 mag	19.9/+ 3 8 mag	20.2/+ 6 8 mag	20.5/+ 9 8 mag	20.9/+13 8 mag	21.2/+17 8 mag	21.5/+23 8 mag	21.8/+30 7 mag	22.1/+38 7 mag	22.4/+47 7 mag	22.7/+58 7 mag	22.9/+72 7 mag	22.7/+86 7 mag	12.0/+79 7 mag	12.1/+66 7 mag
40	17.6/+ 0 9 mag	18.0/+ 0 9 mag	18.3/+ 1 9 mag	18.7/+ 3 9 mag	19.0/+ 5 9 mag	19.4/+ 7 9 mag	19.7/+11 9 mag	20.0/+14 8 mag	20.3/+19 8 mag	20.6/+25 8 mag	20.9/+32 8 mag	21.1/+40 8 mag	21.3/+50 8 mag	21.4/+61 7 mag	21.1/+74 7 mag	18.0/+84 7 mag	12.9/+78 7 mag	12.2/+67 8 mag	12.2/+57 8 mag
50	17.2/+ 3 10 mag	17.6/+ 4 10 mag	17.9/+ 5 10 mag	18.2/+ 6 9 mag	18.5/+ 9 9 mag	18.9/+12 9 mag	19.2/+15 9 mag	19.4/+20 9 mag	19.7/+26 9 mag	19.9/+32 8 mag	20.1/+41 8 mag	20.2/+50 8 mag	20.1/+61 8 mag	19.4/+72 8 mag	16.8/+79 8 mag	13.5/+76 8 mag	12.4/+67 8 mag	12.1/+59 8 mag	12.2/+51 9 mag
60	16.9/+ 5 10 mag	17.2/+ 6 10 mag	17.5/+ 8 10 mag	17.8/+10 10 mag	18.1/+12 10 mag	18.4/+16 10 mag	18.6/+20 9 mag	18.8/+25 9 mag	19.0/+32 9 mag	19.2/+39 9 mag	19.2/+48 9 mag	19.0/+58 9 mag	18.2/+68 9 mag	16.4/+74 9 mag	13.9/+73 9 mag	12.6/+67 9 mag	12.1/+60 9 mag	12.0/+53 9 mag	12.1/+47 9 mag
70	16.5/+ 8 11 mag	16.8/+ 9 10 mag	17.1/+10 10 mag	17.3/+13 10 mag	17.6/+15 10 mag	17.8/+19 10 mag	18.1/+24 10 mag	18.2/+30 10 mag	18.3/+37 9 mag	18.3/+45 9 mag	18.1/+54 9 mag	17.5/+63 9 mag	16.2/+69 9 mag	14.3/+70 9 mag	12.9/+67 9 mag	12.2/+61 10 mag	12.0/+55 10 mag	11.9/+49 10 mag	11.9/+44 10 mag
80	16.2/+10 11 mag	16.4/+11 11 mag	16.7/+13 11 mag	16.9/+15 11 mag	17.2/+18 10 mag	17.3/+22 10 mag	17.5/+27 10 mag	17.6/+34 10 mag	17.6/+41 10 mag	17.4/+49 10 mag	16.9/+57 10 mag	16.0/+64 10 mag	14.6/+67 10 mag	13.3/+65 10 mag	12.4/+61 10 mag	12.0/+56 10 mag	11.8/+51 10 mag	11.8/+46 10 mag	11.8/+42 11 mag
90	15.9/+12 11 mag	16.1/+13 11 mag	16.3/+15 11 mag	16.5/+17 11 mag	16.7/+21 11 mag	16.9/+25 11 mag	16.9/+30 10 mag	16.9/+37 10 mag	16.8/+44 10 mag	16.4/+51 10 mag	15.8/+58 10 mag	14.8/+62 10 mag	13.6/+63 10 mag	12.7/+60 10 mag	12.1/+57 11 mag	11.8/+52 11 mag	11.7/+48 11 mag	11.7/+44 11 mag	11.7/+40 11 mag
100	15.6/+13 12 mag	15.8/+14 12 mag	16.0/+16 12 mag	16.2/+19 11 mag	16.3/+23 11 mag	16.4/+27 11 mag	16.4/+32 11 mag	16.3/+39 11 mag	16.1/+45 11 mag	15.6/+52 11 mag	14.9/+57 11 mag	13.9/+59 11 mag	13.0/+59 11 mag	12.3/+57 11 mag	11.9/+53 11 mag	11.7/+49 11 mag	11.6/+46 11 mag	11.6/+42 12 mag	11.6/+39 12 mag

Table 2: Search ephemeris for comet P/Pons-Gambart (July-Dec.) (Equinox 2000.0)

	Jul 10	Jul 20	Jul 30	Aug 9	Aug 19	Aug 29	Sep 8	Sep 18	Sep 28	Oct 8	Oct 18	Oct 28	Nov 7	Nov 17	Nov 27	Dec 7	Dec 17	Dec 27
-160	5.1/-11 14 mag	5.3/-12 14 mag	5.4/-13 14 mag	5.6/-14 14 mag	5.7/-16 14 mag	5.8/-18 14 mag	5.9/-20 14 mag	5.9/-23 14 mag	5.9/-26 13 mag	5.8/-30 13 mag	5.7/-33 13 mag	5.5/-37 13 mag	5.1/-40 13 mag	4.7/-42 13 mag	4.3/-43 13 mag	3.9/-43 13 mag	3.5/-41 13 mag	3.2/-39 13 mag
-150	5.0/-11 14 mag	5.2/-12 14 mag	5.4/-13 14 mag	5.5/-14 14 mag	5.7/-16 14 mag	5.8/-19 13 mag	5.8/-21 13 mag	5.9/-24 13 mag	5.9/-28 13 mag	5.8/-31 13 mag	5.6/-35 13 mag	5.4/-39 13 mag	5.0/-42 13 mag	4.6/-44 13 mag	4.1/-45 13 mag	3.6/-44 13 mag	3.2/-43 13 mag	2.9/-40 13 mag
-140	4.9/-11 13 mag	5.1/-12 13 mag	5.3/-13 13 mag	5.5/-15 13 mag	5.6/-17 13 mag	5.7/-19 13 mag	5.8/-22 13 mag	5.8/-25 13 mag	5.8/-29 13 mag	5.7/-33 13 mag	5.5/-37 13 mag	5.2/-41 12 mag	4.8/-44 12 mag	4.3/-46 12 mag	3.8/-47 12 mag	3.3/-46 13 mag	2.9/-44 13 mag	2.6/-41 13 mag
-130	4.9/-11 13 mag	5.1/-12 13 mag	5.2/-13 13 mag	5.4/-15 13 mag	5.6/-17 13 mag	5.7/-20 13 mag	5.8/-23 13 mag	5.8/-26 12 mag	5.8/-30 12 mag	5.7/-35 12 mag	5.4/-39 12 mag	5.1/-43 12 mag	4.6/-47 12 mag	4.1/-49 12 mag	3.5/-49 12 mag	2.9/-48 12 mag	2.5/-45 12 mag	2.2/-42 12 mag
-120	4.8/-11 13 mag	5.0/-12 13 mag	5.2/-13 13 mag	5.4/-15 13 mag	5.5/-18 12 mag	5.6/-20 12 mag	5.7/-24 12 mag	5.7/-28 12 mag	5.7/-32 12 mag	5.6/-37 12 mag	5.3/-42 12 mag	4.9/-46 12 mag	4.4/-50 12 mag	3.7/-52 12 mag	3.1/-51 12 mag	2.5/-49 12 mag	2.1/-47 12 mag	1.9/-43 12 mag
-110	4.7/-11 12 mag	4.9/-12 12 mag	5.1/-14 12 mag	5.3/-16 12 mag	5.4/-18 12 mag	5.6/-21 12 mag	5.7/-25 12 mag	5.7/-29 12 mag	5.7/-34 11 mag	5.5/-40 11 mag	5.2/-45 11 mag	4.7/-50 11 mag	4.0/-53 11 mag	3.3/-55 11 mag	2.6/-54 11 mag	2.0/-51 11 mag	1.6/-48 12 mag	1.4/-44 12 mag
-100	4.6/-11 12 mag	4.8/-12 12 mag	5.0/-14 12 mag	5.2/-16 12 mag	5.4/-19 11 mag	5.5/-22 11 mag	5.6/-26 11 mag	5.7/-31 11 mag	5.6/-37 11 mag	5.4/-43 11 mag	5.0/-49 11 mag	4.4/-54 11 mag	3.6/-57 11 mag	2.7/-58 11 mag	1.9/-56 11 mag	1.4/-52 11 mag	1.1/-48 11 mag	0.9/-44 11 mag
-90	4.5/-11 11 mag	4.7/-12 11 mag	4.9/-14 11 mag	5.1/-16 11 mag	5.3/-19 11 mag	5.5/-23 11 mag	5.6/-28 11 mag	5.6/-34 10 mag	5.5/-40 10 mag	5.3/-47 10 mag	4.8/-54 10 mag	4.0/-59 10 mag	2.9/-62 10 mag	1.9/-60 10 mag	1.1/-57 11 mag	0.7/-53 11 mag	0.5/-48 11 mag	0.4/-44 11 mag
-80	4.4/-10 11 mag	4.6/-12 11 mag	4.8/-14 11 mag	5.1/-16 11 mag	5.3/-20 10 mag	5.4/-25 10 mag	5.5/-30 10 mag	5.6/-37 10 mag	5.5/-45 10 mag	5.1/-53 10 mag	4.4/-60 10 mag	3.3/-65 10 mag	1.9/-65 10 mag	0.8/-62 10 mag	0.2/-58 10 mag	23.9/-52 10 mag	23.8/-47 10 mag	23.9/-43 11 mag
-70	4.2/-10 10 mag	4.5/-11 10 mag	4.7/-14 10 mag	5.0/-17 10 mag	5.2/-21 10 mag	5.4/-26 10 mag	5.5/-33 9 mag	5.5/-41 9 mag	5.4/-50 9 mag	4.9/-60 9 mag	3.8/-68 9 mag	1.9/-71 9 mag	0.3/-68 9 mag	23.5/-62 9 mag	23.2/-56 10 mag	23.1/-51 10 mag	23.1/-46 10 mag	23.3/-42 10 mag
-60	4.1/- 9 10 mag	4.4/-11 10 mag	4.6/-13 9 mag	4.9/-17 9 mag	5.2/-22 9 mag	5.4/-28 9 mag	5.5/-36 8 mag	5.6/-47 8 mag	5.4/-59 8 mag	4.5/-70 8 mag	2.1/-77 8 mag	23.4/-73 9 mag	22.4/-66 9 mag	22.1/-59 9 mag	22.1/-53 9 mag	22.3/-48 9 mag	22.4/-43 10 mag	22.7/-39 10 mag
-50	3.9/- 7 9 mag	4.2/- 9 9 mag	4.5/-12 9 mag	4.8/-17 8 mag	5.1/-23 8 mag	5.4/-31 8 mag	5.6/-42 8 mag	5.8/-56 7 mag	5.5/-71 7 mag	2.6/-83 7 mag	21.3/-78 8 mag	20.7/-68 8 mag	20.8/-60 8 mag	21.0/-54 9 mag	21.2/-48 9 mag	21.5/-44 9 mag	21.8/-40 9 mag	22.1/-37 9 mag
-40	3.7/- 5 8 mag	4.1/- 7 8 mag	4.4/-11 8 mag	4.8/-16 7 mag	5.2/-24 7 mag	5.6/-35 7 mag	6.1/-51 6 mag	6.9/-70 6 mag	12.0/-86 7 mag	18.0/-75 7 mag	18.7/-65 7 mag	19.2/-57 8 mag	19.7/-51 8 mag	20.1/-46 8 mag	20.4/-42 8 mag	20.8/-39 9 mag	21.1/-36 9 mag	21.5/-33 9 mag
-30	3.5/- 1 7 mag	4.0/- 3 7 mag	4.4/- 7 7 mag	4.9/-14 6 mag	5.6/-25 6 mag	6.5/-43 5 mag	8.6/-65 5 mag	13.4/-71 5 mag	16.1/-62 6 mag	17.2/-54 6 mag	17.8/-48 7 mag	18.4/-44 7 mag	18.9/-41 8 mag	19.3/-38 8 mag	19.7/-36 8 mag	20.2/-33 8 mag	20.5/-31 8 mag	20.9/-29 8 mag
-20	3.4/+ 5 6 mag	3.9/+ 4 6 mag	4.6/+ 1 5 mag	5.5/- 6 5 mag	7.2/-23 4 mag	10.5/-44 4 mag	13.6/-44 4 mag	15.2/-40 5 mag	16.1/-37 6 mag	16.8/-35 6 mag	17.3/-33 7 mag	17.8/-32 7 mag	18.3/-31 7 mag	18.7/-30 8 mag	19.2/-29 8 mag	19.6/-27 8 mag	20.0/-26 8 mag	20.4/-25 8 mag
-10	3.3/+20 5 mag	4.1/+23 5 mag	5.5/+26 4 mag	8.4/+24 3 mag	11.8/+ 6 3 mag	13.6/- 6 4 mag	14.6/-13 5 mag	15.3/-16 6 mag	15.9/-18 6 mag	16.4/-20 6 mag	16.9/-21 7 mag	17.3/-22 7 mag	17.8/-22 7 mag	18.2/-22 7 mag	18.6/-22 8 mag	19.0/-22 8 mag	19.4/-21 8 mag	19.8/-20 8 mag
0	3.6/+48 5 mag	6.0/+60 4 mag	10.1/+56 4 mag	12.4/+36 4 mag	13.5/+19 5 mag	14.2/+ 8 5 mag	14.7/+ 1 6 mag	15.2/- 3 6 mag	15.6/- 7 6 mag	16.1/-10 7 mag	16.5/-12 7 mag	16.9/-13 7 mag	17.3/-15 7 mag	17.7/-15 7 mag	18.1/-16 8 mag	18.5/-16 8 mag	18.9/-16 8 mag	19.3/-15 8 mag
10	7.5/+76 5 mag	11.3/+64 5 mag	12.6/+47 5 mag	13.2/+33 6 mag	13.7/+23 6 mag	14.2/+15 6 mag	14.6/+ 9 7 mag	15.0/+ 4 7 mag	15.4/+ 0 7 mag	15.7/- 2 7 mag	16.1/- 5 8 mag	16.5/- 7 8 mag	16.9/- 8 8 mag	17.3/-10 8 mag	17.7/-10 8 mag	18.0/-11 8 mag	18.4/-11 8 mag	18.8/-11 8 mag
20	11.9/+66 6 mag	12.5/+52 6 mag	12.9/+41 6 mag	13.3/+32 7 mag	13.7/+24 7 mag	14.0/+18 7 mag	14.4/+13 7 mag	14.7/+ 9 8 mag	15.1/+ 5 8 mag	15.4/+ 2 8 mag	15.8/+ 0 8 mag	16.1/- 2 8 mag	16.5/- 3 8 mag	16.8/- 5 8 mag	17.2/- 6 8 mag	17.6/- 6 8 mag	18.0/- 7 8 mag	18.3/- 7 8 mag
30	12.4/+55 7 mag	12.6/+46 7 mag	12.9/+37 7 mag	13.2/+31 8 mag	13.5/+25 8 mag	13.8/+20 8 mag	14.1/+16 8 mag	14.4/+12 8 mag	14.8/+ 9 8 mag	15.1/+ 6 8 mag	15.4/+ 4 9 mag	15.8/+ 1 9 mag	16.1/+ 0 9 mag	16.5/- 1 9 mag	16.8/- 2 9 mag	17.2/- 2 9 mag	17.5/- 3 9 mag	17.9/- 3 9 mag
40	12.4/+49 8 mag	12.6/+42 8 mag	12.8/+36 8 mag	13.1/+30 8 mag	13.3/+25 9 mag	13.6/+21 9 mag	13.9/+18 9 mag	14.2/+14 9 mag	14.5/+11 9 mag	14.8/+ 9 9 mag	15.1/+ 7 9 mag	15.4/+ 5 9 mag	15.8/+ 3 9 mag	16.1/+ 2 9 mag	16.4/+ 1 9 mag	16.8/+ 0 9 mag	17.1/+ 0 9 mag	17.5/+ 0 9 mag
50	12.3/+45 9 mag	12.5/+39 9 mag	12.7/+34 9 mag	12.9/+30 9 mag	13.2/+26 9 mag	13.4/+22 9 mag	13.7/+19 10 mag	14.0/+16 10 mag	14.2/+13 10 mag	14.5/+11 10 mag	14.8/+ 9 10 mag	15.1/+ 7 10 mag	15.4/+ 6 10 mag	15.8/+ 4 10 mag	16.1/+ 3 10 mag	16.4/+ 3 10 mag	16.7/+ 3 10 mag	17.1/+ 3 10 mag
60	12.2/+42 10 mag	12.3/+37 10 mag	12.5/+33 10 mag	12.8/+29 10 mag	13.0/+26 10 mag	13.2/+23 10 mag	13.5/+20 10 mag	13.7/+17 10 mag	14.0/+15 10 mag	14.3/+13 10 mag	14.6/+11 10 mag	14.9/+ 9 10 mag	15.2/+ 8 10 mag	15.5/+ 7 10 mag	15.8/+ 6 10 mag	16.1/+ 5 10 mag	16.4/+ 5 10 mag	16.7/+ 5 10 mag
70	12.1/+40 10 mag	12.2/+36 10 mag	12.4/+32 10 mag	12.6/+29 11 mag	12.8/+26 11 mag	13.1/+23 11 mag	13.3/+20 11 mag	13.6/+18 11 mag	13.8/+16 11 mag	14.1/+14 11 mag	14.3/+12 11 mag	14.6/+11 11 mag	14.9/+ 9 11 mag	15.2/+ 8 11 mag	15.5/+ 8 11 mag	15.8/+ 7 11 mag	16.1/+ 7 11 mag	16.4/+ 7 11 mag
80	12.0/+38 11 mag	12.1/+35 11 mag	12.3/+31 11 mag	12.5/+28 11 mag	12.7/+26 11 mag	12.9/+23 11 mag	13.1/+21 11 mag	13.4/+19 11 mag	13.6/+17 11 mag	13.9/+15 11 mag	14.1/+13 11 mag	14.4/+12 11 mag	14.7/+11 11 mag	14.9/+10 11 mag	15.2/+ 9 11 mag	15.5/+ 9 11 mag	15.8/+ 9 11 mag	16.0/+ 9 11 mag
90	11.9/+37 11 mag	12.0/+34 11 mag	12.2/+31 12 mag	12.4/+28 12 mag	12.6/+26 12 mag	12.8/+23 12 mag	13.0/+21 12 mag	13.2/+19 12 mag	13.5/+17 12 mag	13.7/+16 12 mag	13.9/+14 12 mag	14.2/+13 12 mag	14.5/+12 12 mag	14.7/+11 12 mag	15.0/+11 12 mag	15.2/+10 12 mag	15.5/+11 12 mag	15.7/+11 11 mag
100	11.8/+36 12 mag	11.9/+33 12 mag	12.1/+30 12 mag	12.2/+28 12 mag	12.4/+26 12 mag	12.6/+23 12 mag	12.9/+21 12 mag	13.1/+20 12 mag	13.3/+18 12 mag	13.5/+16 12 mag	13.8/+15 12 mag	14.0/+14 12 mag	14.3/+13 12 mag	14.5/+12 12 mag	14.7/+12 12 mag	15.0/+12 12 mag	15.2/+12 12 mag	15.4/+13 12 mag

Natural Catastrophes during Bronze Age Civilisations: Archaeological, Geological and Astronomical Perspectives.

A Conference organised by the Society for Interdisciplinary Studies

The Society organised a meeting at Fitzwilliam College, Cambridge over the weekend of July 12/13 to discuss the possibility that Bronze Age civilisations had been molded by the impact of celestial bodies on the surface of the Earth. Many of the lecturers seemed to be the converted, though the archaeologists seemed to be more worried by the dating of events than by what caused them. I attended the Saturday lectures, which were mostly connected with presenting the astronomical ideas behind catastrophism. I've added a few comments of my own in square brackets [].

The first speaker was Mark Bailey (Armagh) who gave a resume of current cometary theories. He identified six groups: long period comets, short period comets (comprising Jupiter family and Halley type), Centaurs, Kuiper-belt objects and Near-Earth objects (NEOs, including 2P/Encke). The first three and last are mostly small objects, but the Centaurs and KBOs are large, up to 800 km in diameter. The other group of small solar system bodies are the asteroids, with the main belt being the remains of an unformed planet. There is an ongoing process of collisional fragmentation and resonant scattering which can take 0.5 - 2.5 My to put objects on earth crossing orbits. This creation of asteroid families can therefore lead to surges in NEOs. The number of fragments is proportional to d^{-3} which is a much steeper distribution than the background, implying that there are many more small objects than might be predicted by extrapolating the curve of large objects; this is to some extent confirmed by Spacewatch observations. The time scale of the surges is long in terms of our civilisation, but kilometre sized objects can be expected to hit the Earth once every 10^5 years.

He then gave some recent results of theoretical studies. Centaurs can evolve onto short period orbits, of which about 5% can evolve into earth crossing objects on a time scale of 15,000 years; non gravitational forces increase the chance of this happening. They can remain Earth crossing for 5000 years, which gives the chance of dense meteor streams of 1500 times the mass of the Halley streams and could increase the mass of the zodiacal cloud by 15 times. There could also be stratospheric dust loading which implies climatic cooling. Sungrazing is a common end state, not only for NEAs but also HT comets. 2P/Encke will become one in the near future, 98P/Machholz 1(an ex HT) in about 12,000 years and 1P/Halley in perhaps 10^5 years. [The recent discovery of a second group of sungrazing comets by SOHO lends support to this theory.] He predicts that there should be a large number (~3000) extinct long period comets on Halley type orbits. [The recent discovery of 1997 MD10 is perhaps one of these objects.] One giant comet moves into the inner solar system every 10^5 years.

Concluding his talk he emphasised that giant comets do exist and comprise around 0.1% of the comet population. They can evolve into earth crossing or sungrazing orbits and create massive meteor streams. Finally he speculated that perhaps ring markings on some prehistoric stones represent comets. During the discussion a questioner commented that there was much mythology of objects falling into the sun such as Phaeton and Icarus [though they actually fell to Earth]. There are also passages in the bible suggesting that stones fell from the heavens.

Bill Napier (Armagh) started his talk by saying that Brandt & Chapman in their book noted that one Tunguska event occurred every 2000 years and there was nothing to worry about. Clube & Napier however suggested that much bigger events occur every 500 years and there is everything to worry about as there will also be a few dozen in the 10 MT range (the equivalent of Tunguska). Such airbursts leave little trace after as little as 50 years. Spacewatch shows an excess of sub kilometre bodies, in agreement with fireball surveys. A 1000 MT event would create a 5 metre ocean wave, which would build to 50 - 200 metres near shore and travel 20 km inland; the pressure wave would be 4 psi overpressure up to 250 km from the epicenter. 20% of the Earth's land surface has experienced Tunguska like events in the last 5000 years.

Most of the mass flux comes in the largest 2 or 3 objects, there is evidence for a giant comet in the inner solar system within the last 10 - 20,000 years. Fortunately the Kreutz progenitor was inclined at 144 degrees to the ecliptic or there would be lots of debris hitting us. The zodiacal cloud has a lifetime of only 20,000 years as observations show only 2 tonnes/second coming in to it and 40 tonnes/second leaving it. The Stohl streams comprising of Taurids, 2P/Encke and other comets and asteroids have a short dynamical lifetime so the night sky must have looked very different 5000 years ago. There is evidence for fireball swarms: the Lunar seismometer events of 1975 June 26 - 30, 12 fireball storms are recorded in Chinese annals (of which 5 were seen in daylight), radar observations of comet nuclei showing boulder sized objects (IAA, Wilson) and historical peaks in the 11th Century.

All this would give rise to stratospheric dustings: 10^{14}g would lead to a 2° C cooling and this might explain some of the flickering in the Vostok ice core [though glaciologists think it more likely to be natural climatic variability]. He showed a picture of the Newgrange stones which shows a feature very similar to the haloes in Hale-Bopp and pondered that maybe megalithic roofed structures (such as seen in the UK, Turkey and North America) were shelters ?

Duncan Steel (Spaceguard Australia), the next speaker, came up with some original ideas on the origin of Stonehenge. He suggested that the axis of Stonehenge originally pointed further to the north and therefore couldn't be a luni-solar observatory. He thought it might be connected with cosmic events from the break-up of the precursor of comet 2P/Encke. The earliest stage of Stonehenge consisted of a circular bank, Aubrey holes and the two heel stones and he thought that the bank was a shield for meteor observers against light pollution from camp fires. [This was partly based on a photograph of Canadian observers with a shield around them; in this case the time of year was winter and the shield was actually against the wind.]. The Cursus next to Stonehenge is actually a much bigger construction than Stonehenge I and required ten times as much effort to build (around 10% of the GDP). The Cursus was built between 3500 and 3300 BC and has an inclination of 55°, whilst Stonehenge I was built between 3200 and 2800 BC and has an inclination of 55°. The period of the comet might have been such that major storms occurred at intervals of 19 years. Stonehenge II, built between 2200 and 1100 BC was just a ritual temple and the 19 year period might have been interpreted as of lunar origin.

[I actually visited the site the next day and viewed it from the standpoint of a meteor observer. One might expect a meteor observatory to be at the highest point in the area, but the Cursus is on a sloping hillside and Stonehenge is in a low valley. The Cursus is rather a wide feature and I couldn't see any obvious way that it could be used to observe meteors or comets. I didn't visit the Stonehenge site itself as there are far too many tourists there, but virtually none of them made it the few hundred metres to the Cursus. What did strike me was an alternative possibility to explain the origin and location of megalithic circles - they could mark the sites of observed meteor falls. In this case one might expect to find the remains of impact pits at the centre of each feature.]

He pointed out that one of the original sources of a print showing a Leonid storm came from Daniel and the Revelation by Uriah Smith. He went on to suggest that when corrected for observing geometry and Faraday rotation of daytime echoes, 90 - 95% of radar meteors come from helion/antehelion sources which are associated with comet 2P/Encke. IRAS showed that many comets have trails associated with them. [Ref Icarus 95, 180, 1992 - comet trails]. It would take between 6 and 24 hours for the Earth to transit a trail. If comet Encke had a semi-major axis of 2.15 - 2.20 AU (P ~3.16 years) this would give rise to trail crossing every 19 years. It is possible to integrate the orbit of comet Encke back in time and find out when its associated trail intersected the Earth. This might have happened in 200 AD and 0 AD, however the orbit is not known well enough to go back more than a few hundred years so its not really possible to tell what might have happened around 3000 BC. In 3500 BC the intersection of the ascending node of the orbit would occur in daylight and by 3200 BC the intersection of the descending node would occur at night. The core of the trail would contain Tunguska sized objects and such meteor storms would be truly terrifying experiences.

He concluded by suggesting that long barrows were air-raid shelters and the Aubrey holes were for the meteor observers to stand in!

Following a question in another talk he commented that the US Space Command planned a launch in 1999 to visit two NEAs. The US search programs were currently only covering <1% of the northern sky and there was no southern program.

Gerrit Verschuur (Memphis) concluded the morning session with an 'eminent persons' talk on some implications of impact catastrophes. He started by outlining the solar system formation - how impacts gave Venus its slow rotation and created the Earth-Moon system with Earth's inclination of 23.5 degrees. Interstellar comets gave rise to our oceans - he had a 'gut feeling' that comets must form in regions around giant stars and that the solar system might have included largish objects from the beginning, rather than the usual idea of aggregation of small fluffy particles. A planet formed between Mars and Jupiter which subsequently broke up. Mars without a moon had a larger range of orbital inclinations that the Earth. He couldn't accept the Oort cloud.

Bronze age civilisations were destroyed by abrupt climate change caused by impacts, which would also cause tsunamis round the coast. He gave a list of 'hits' which included the 1176 AD event, the wiping out of South Island, New Zealand and the 1879? Chicago fires. [It seemed a very uncritical list, which included many entries gleaned from the internet, though he did qualify it by saying that the degree of authenticity ranged from Tunguska downwards]. The sky is filled with cosmic debris, but mankind has an illusion of invulnerability and is always hopeful so won't act to do anything about the risk. As an example he had counted only 3 deaths in the sequence of the destruction of Dallas in the film 'Asteroid'. What we needed was a small event that would kill a million people.

The afternoon session moved on to cover archaeology, geology and climatology. Marie-Agnes Courty (Paris-Grignon) described work she had carried out in the middle east on sites from the 3rd millennium BC. A layer of tephra was originally dated at 2250 BC, coincident with the fall of the Akad empire, but was now dated at 2350 BC. It was associated with increased aridity and the decline of empire. The tephra could have come from Turkey, a few hundred kilometres away, but the deposit was well sorted and yet the grains were inhomogeneous and there was a sequence of a few cm of yellow dust overlying a fired layer, which was found over several thousand km^2. She had also found calcite spherules, which she suggested had similarities to the Orguiel carbonaceous chondrite and the KT boundary event. Possibly crystallisation from a vapour could explain some of the tailed spherules, inclusion of soil fragments and nickel-iron whiskers. There was a peak of carbon black, perhaps implying a wildfire, but no conclusively extra-terrestrial material. A volcanic event was improbable, anthropogenic possible, but didn't explain the spherule layer and a cosmic event not that convincing; misinterpretation was a possibility. It might be worth looking for links with ice core events to explain the feature.

Mike Baillie (Queen's, Belfast) described his analysis of Irish tree rings, in particular looking at extremes of climate. Some of these coincided with volcanoes such as 1882 Krakatoa, 1912 Katmai and 1628 BC Santorini. There was poor growth for several years following 1628 BC and this can be linked to the decline of civilisation in the Aegean. Many of the narrow ring events link with acid layers in the Greenland Camp Century core. A tree ring event in 2354 to 2345 BC has no equivalent in the Greenland core. The wood of the rings takes on a diffuse appearance and the rings become unclear; the trees could have been standing in a bog. Tephra in the peat was dated to around 2320 which is not close enough. The Lisbon earthquake of 1755 AD gave rise to raised water levels across Europe and maybe volcanic events could do the same. Coincidentally Archbishop Usher had dated the flood to 2349, Irish annals gave the flood as 2341 and Chinese to 2349.

Tree rings showed a narrow event in 540 AD, which was general throughout the northern hemisphere. The dust veil index gave an event in 536 AD (dim sun etc) as well as famines and plagues, and possibly there were multiple events. The Dye core is missing around 540, but there is no good evidence for a volcano in 540 AD, so perhaps there was a cosmic event. This would tie in with Bailey, Napier & Clube's suggestion of events between 400 and 600 AD.

Temperature sensitive chronologies suggest that both the 1628 BC and 1159 BC events occurred during the middle of a cold period. Did volcanoes just happen in the middle of the cold period ? Perhaps Gaia causes volcanoes to go off to counteract the cold? [However volcanoes actually lead to additional cooling]. Ice core workers have a naive faith in using their own dating techniques when tree ring data does better. The dates may link to the collapse of Egyptian and Chinese dynasties.

The next speaker was the organiser of the conference, Benny Peiser (Liverpool). There are 4 or 5 impact craters dated to 4000 BP; these include the Argentinean Rio Quarto craters where the main crater is 4.5 x 1 km and there are several smaller elongate craters. Only this one would be big enough to have global effects. Most cultures have flood legends and fireball reports. There is a Chinese legend of 10 suns that would destroy the world. There are only two well investigated events - Tunguska and the KT event. Scientists need to define what features are associated with impact events so that researchers know what to look for. Features include: blast, fires, earthquakes, tsunamis, dust veils, acid rain and ozone depletion. Tunguska had twice the energy yield of the Barringer crater. The age of the Chad craters is proven at either 12,000 BC or 36 My. Tektite strewn fields are linked to impacts. In Mesopotamia, events of general destruction occurred in 2300, 1600 and 1200 BC. The event in 2300 was global, though there are dating problems, so linking it with the end of the first urban phase may be wrong. There are lake level changes throughout Africa ~5000 BP. He carried out an abstract search of archaeological events dated between 2500 and 2000 BC and found a common event at 2350 +/- which included destruction layers, site abandonment, tephra layers, seismic events etc.

The final speaker that I heard was Bruce Masse (Hawaii), who spoke about various myths and legends and their possible relation to impacts. He made a list of 1400 tales recorded over the past 4000 years. The AD 1301 return of 1P/Halley coincided with a major eruption of Heliakala and in Hawaiian legend, Ku is the comet god, which bears a passing resemblance to comet Donati. The explanation of the flood could be a) local, b) psychological, c) a single global event. Several myths have horned serpents, dragons or fishes with glowing eyes appearing before the flood, sometimes appearing twice with a delay of a few months. These could refer to comets. Flood myths suggest that the flood began at or near full moon, in late April or early May. Possible dates between -2810 and -2900 are found in Chinese, Egyptian and middle eastern calendars. Other celestial events, which included conjunctions and a move of a Pleiad star to the Plough, presaged the flood. There are links to a partial solar eclipse (one occurred on -2807 May 10) and to Aquarius, Pisces and the Pleiades (there was a quadruple conjunction on the Aquarius/Pisces border in -2807). Other events include a dark sun, hurricane winds for a week or two, strong earthquakes, torrential rain for 5 - 7 days, with such large drops that it was difficult to breath (maybe 50 mm/hr) and was hot or warm; tsunami such that people had to flee to hilly locations (suggesting a wave 200 m high penetrating 50 - 100 km from the coast); it was light at midnight (cf Tunguska). Taken together such tales imply an impact in the southern ocean, near the Greenwich meridian. 75 - 95% of the population died, but numbers would recover within about 100 years, perhaps leading to migrations. The Pleiades are linked to the origin of fire, therefore it was a north Taurid object that caused the event! He concluded by mentioning an earlier event at 3800 to 3900 BC, coincident with the date for the Argentinean Rio Quarto impact, which is described in Indian legends.

Talks continued on Sunday, though I was not able to attend for these. Mostly they concentrated on the philosophical implications of a potentially catastrophic environment. One or two, including some of the poster papers had an astronomical content. One paper suggested that glacial features known as eskers and drumlins are actually cometary debris, created when the rotating jets from a comet's nucleus hit the earth!

Letters

Spectroscopy

As a postscript to my piece in the May '97 newsletter, it is worth pointing out that in the event Hale-Bopp did not oblige with a spectacular display of spectroscopic fireworks; despite its brightness, it has actually not been a suitable target for 'nylon curtain spectrometry'. The comet was out of range of my permanently-mounted 0.32-m Newtonian due to a line of trees immediately to the north, so I was unable to try the method on this occasion. However, using a handheld 10x80 with a 15° flint glass objective prism sellotaped over the top of the dew-cap, I recorded the following on 11th April: "Spectrum exactly as before, a pure continuum extremely bright & intense with no hint whatever of dark gaps or of bright emission bands, the colours vivid all the way from dark red to deep violet-blue", with identical results on 8 other dates from 30th March to 30th April (all referring to the head, of course). A very similar result was suggested by a quite different method of observation on 23rd March, when the comet displayed a surprisingly small difference in brightness when viewed through narrow-band filters centred, respectively, on 515 nm which transmits the brightest C_2 band, and 500 nm which falls entirely in a dark gap between the main emission bands.

The conclusion seems clear that, for all the spectacle Hale-Bopp undeniably provided in other respects, it was an extra-ordinarily dull & inactive specimen in these terms. Whatever the professionals may have been seeing with their large apertures & powerful spectrographs, in small instruments the comet's spectrum was visually indistinguishable from a pure solar continuum. This, of course, is entirely in keeping with the huge visual brightness of the dust-tail compared with that of the plasma-tail, in such marked contrast with Hyakutake last year. However, most comets brighter than about 6th mag should provide something worth measuring by the 'nylon curtain' method when within 1 AU of the sun, so we shouldn't have too long to wait for other suitable candidates. Meanwhile, if anyway wants further details or explanation of the method, please send an A4 sae to Christopher Taylor at: Mathematics Dept., Harris Manchester College, Oxford. OX1 3TD.

Christopher Taylor

Tales from the Past

This section gives a few excerpts from past BAA Journals, RAS Monthly Notices and Sky & Telescope

100 Years Ago: The comet Section report for the 1896/97 session comments "The comets which have been visible during the year have not been of the class which arouses enthusiasm, but have required very considerable optical power for their adequate observation." At the 1897 October 27 meeting an ephemeris for the new comet [Perrine 1897 U1] was written on the blackboard for Members to copy.

50 Years Ago: The annual report of the Section noted that six comets had been observed by five observers and that Section membership was a nominal 20. Sky & Tel noted that several comets were visible over the year. Eight had been discovered up to July, but none were visible to the naked eye. The previous record had been 13 in 1932. [Provisional letters up to 'n' were assigned in 1932, 1939 and 1947, but not all of these were confirmed.]

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

Science, 1997 May 9. Robert Brown *et al* look at the surface composition of Kuiper Belt Object 1993 SC using the Keck I telescope in the near infra-red. The strongly red continuum has several prominent absorption features. By analogy with Pluto and Triton they suggest that these may be due to CH_4, C_2H_6, C_2H_4 or C_2H_2 and that the red continuum may indicate more complex hydrocarbons. Another paper in the same issue, by Roman M HJberli *et al*, comes up with an explanation for the X-ray emission from comets, first seen in comet Hyakutake (1996 B2). They suggest that it is caused by highly charged solar-wind ions capturing electrons from molecules or atoms in the comet's coma. Modeling the process gives a good fit to observations and they suggest that detailed X-ray observations of comets could give another way of monitoring the solar wind.

Old text books often give another perspective on present day theories. I recently obtained a copy of R A Lyttleton's book on comets, published in 1952. In it I discovered that P/Shoemaker-Levy 9 was not the first 'string-of-pearls' comet. This title was given to comet 1882 R1 which broke up near the time of perihelion into at least six star-like knots or condensations. I also read that Professor Challis (who had used the observation of comets as an excuse for not discovering Neptune) had observed the splitting of Biela's comet with the Northumberland refractor in 1846. At first he thought he was seeing things, two days later he still thought his eyes were deceiving him and not until 10 days had elapsed did he feel sufficiently convinced to publish his findings; but by then it had been established elsewhere and Challis lost the chance to be first in the field. He apparently attributed this slowness to confirm his suspicions to the pressing claims on his attention of the search for the theoretical planet Neptune! Ideas about comets have changed substantially since the book was written. Lyttleton didn't think that the coma and tail are produced by sublimation : 'Another class of hypothesis simply accepts, without explanation, the existence of comets in the solar system and is concerned solely with their structure and development. The coma and the tail are considered to be produced by the warming effect of the sun's radiation as the comet approaches perihelion. Theories of this kind amount to little more than descriptive accounts of a purely *ad hoc* character without providing any real explanation.' He didn't think much of what is now known as the Oort cloud either: 'Yet another obscurant idea dating back indefinitely is that a vast assembly of comets associated with the sun subsists in the form of a nebulous shell at 10^4 or 10^5 astronomical units distance (where it would be quite beyond the possibility of observational detection), and that the few comets seen are rare members of this cloud that happen to be deflected inwards to a sufficient extent through chance perturbations by passing stars. The question as to how the alleged comets got there, lately estimated to be 10^{11} in number - recalling Kepler's view that 'there are as many comets in the sky as fishes in the sea' - and all the additional unnatural requirements that have to be introduced to explain away the abundant difficulties and contradictions that appear as soon as the idea is subjected to test, are dealt with simply by confident assertion that there is evidence tending to support the necessary saving clauses but always without the smallest attempt to say what the evidence is.' I wonder what the future will say about the Big Bang theory. Perhaps gamma ray bursters are Hoyle's sites of continuous creation of matter!

Several spacecraft are being targeted to visit comets. NASA plans to send Stardust to 81P/Wild 2 (and you can send your name to it as well by writing to the Planetary Society). Deep Space 4 will visit 9P/Tempel 1 in December 2004 and return samples. Contour will fly past 2P/Encke, 73P/Schwassmann-Wachmann 3 and 6P/d'Arrest between 2003 and 2008. ESA is sending Rosetta to 46P/Wirtanen in 2012 and Japan also has plans for a cometary mission.

Jonathan Shanklin

Review of comet observations for 1997 May - 1997 October

The information in this report is a synopsis of material gleaned from IAU circulars 6655 - 6771 and The Astronomer (1997 May - 1997 October). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

2P/Encke put on a brief show for southern hemisphere observers during June and July as it made its closest approach to the earth since discovery. A bit fainter than expected it faded from 7th to 10th magnitude, becoming very diffuse. The observations give a preliminary light curve of 11.8 + 5 log d + 18.6 log r.

29P/Schwassmann-Wachmann 1 outburst to around 11th mag in late May, just as it was becoming lost in the twilight. This comet seems to spend a lot of time in outburst and is worth monitoring with CCD cameras on a regular basis. Observers are encouraged to check the comet at every opportunity over the coming apparition. It is in Virgo and a finding chart is included in the Observing Supplement.

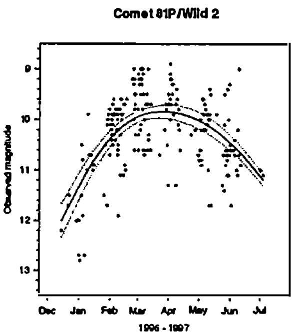
43P/Wolf-Harrington has been visible in the early morning since August. A small faint object, it peaked at around 13^m and is now slowly fading. Observations received so far give a preliminary light curve of 8.9 + 5 log d + [15] log r

48P/Johnson was observed twice in August at mag 14.

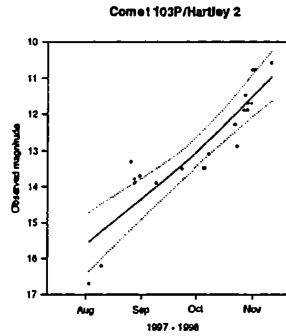
65P/Gunn was brighter than expected in September, but at around 13th mag few observations were made.

78P/Gehrels 2 peaked at around 12th mag in October; but again few observers were following it. The observations give a preliminary light curve of 6.9 + 5 log d + [15] log r.

81P/Wild 2 continued its slow fading reported in the last issue and was lost to southern hemisphere observers in early July when it was 11th mag. The observations give a preliminary light curve of 6.2 + 5 log d + 14.2 log r.



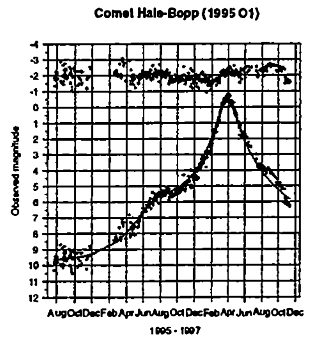
103P/Hartley seemed rather slow to start brightening, but eventually began to follow more or less the same light curve as at the last return. It should now be around 9th mag and will remain this bright for several months. Observations received so far give a preliminary light curve of 9.7 + 5 log d + 18.1 log r and combining them with those from the previous apparition gives 8.9 + 5 log d + 18.8 log r.



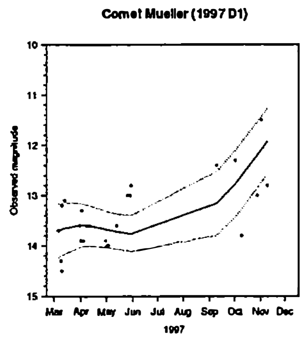
104P/Kowal 2 is a little brighter than expected at 14th mag and may become visible at around 13th mag later in the year.

C/1995 O1 (Hale-Bopp) has now disappeared from view to northern hemisphere observers and will not be seen again from the UK for another 2380 years. Although it was a 'great comet', it is not yet THE great comet of 1997 - there is still a month to go! In total I've now received 3100 visual magnitude observations of the comet and some 600 drawings, images and photographs. Nick James is preparing a paper on the comet for the Journal.

The comet continued to fade slowly after perihelion, but in the second half of October it suddenly faded by about 1 mag dropping below naked visibility after 16 months. The equation -0.7 + 5 log d + 7.5 log r fits the available observations, but there are long period variations about this mean curve of around a magnitude.



Comet Evans-Drinkwater (1996 J1) was observed to have fragmented into two after conjunction and was brighter than expected in the summer, although it was only 13th magnitude at best.

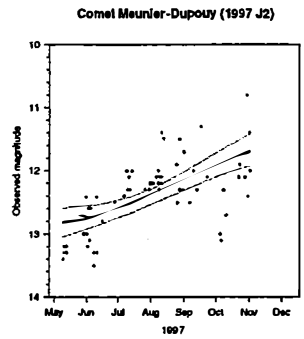


Asteroidal images of 1996 N2 133P/Elst-Pizarro from previous apparitions have been found (1979 OW7, and also in 1985) and the comet has been given permanent cometary (133) and asteroid numbers (7968) and also named as asteroid Elst-Pizarro

Comet Mueller (1997 D1) was very difficult to see when it reappeared from conjunction and the early light curve clearly overestimated its rate of brightening. It should peak at around 11th mag if the preliminary light curve of 9.0 + 5 log d + 5.1 log r holds, however 13th magnitude seems more likely at the moment.

55P/Tempel-Tuttle (1997 E1) has not yet been recovered after solar conjunction. The parent comet of the Leonids, it will not reach perihelion until 1998 Feb 28 when it may get as bright as 9^m. It will pass 0.35 AU from the earth in mid February when it gets within 8° of the pole.

C/Mueller (1997 J1) was visible at around 13th mag in the early summer.



1997 J2 Meunier-Dupouy was an accidental discovery by two independent French amateurs who were imaging 1997 J1 with CCD cameras. First reported by Michel Meunier on May 7.9 it was also found by P Dupouy and J F Lahitte the next day. It is a slow moving, distant comet and will remain on view for another year, reaching 11th mag at best during December. The observations received so far give a preliminary light curve of 5.7 + 5 log d + 6.3 log r

1997 L1 Xinglong was a faint, distant comet, discovered with the Beijing Astronomical Observatory 0.6-m Schmidt during the course of an asteroid survey, and originally thought to be an asteroid. Observations with the 1.8-m reflector of the Dominion Astrophysical Observatory showed its cometary nature.

1997 L2 SOHO was one of only two non sungrazing comets discovered by the satellite so far. It was not observed by other means.

1997 M2 131P/Mueller 2 was independently recovered by Japanese observers A Sugie and A Nakamura, both using 0.60-m reflectors and CCDs. The comet was 0.26 days behind the prediction by K Muraoka in the ICQ Handbook.

Asteroid 1997 MD10 is on an eccentric cometary orbit with a period of 124 years and perihelion distance of 1.5 AU, though no sign of a coma has been seen so far. It may be one of the many extinct Halley type comets that are expected on dynamical grounds.

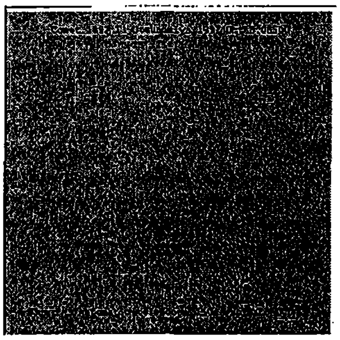
1997 N1 Tabur was discovered by Vello Tabur of Wanniassa, ACT, Australia. At discovery the comet was around 10th mag, with a diffuse coma, however it didn't brighten much as it approached perihelion and became more diffuse, suggesting that it was becoming extinct. I made some tentative observations of it after perihelion as it emerged into the northern twilight, but no confirming observations have been made. Combining the pre-perihelion observations with my own post-perihelion ones gives a light curve of 9.4 + 5 log d + 7.3 log r.

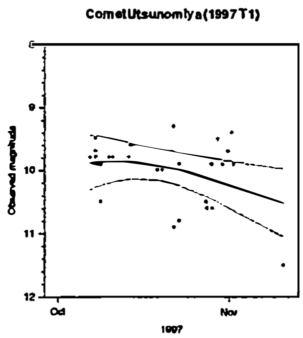
1997 N2 132P/Helin-Roman-Alu 2 was recovered by Carl Hergenrother using a CCD camera on the SAO 1.2-m reflector on Mt Hopkins.

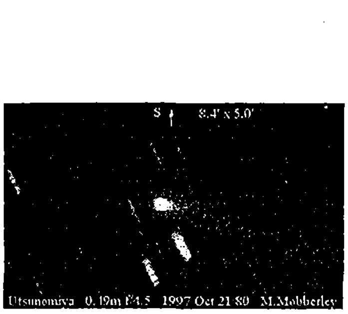
1997 O1 Tilbrook was discovered by Jason Tilbrook, Clare, S Australia whilst observing TV Crv. 10th mag at discovery, it was only a southern hemisphere object and faded as it approached conjunction.

1997 P2 Spacewatch was another comet discovered by the automated search program on the Spacewatch telescope on Kitt Peak. It is a distant comet with a strongly hyperbolic orbit following an approach to Jupiter at the beginning of February. The only comet with a greater eccentricity was comet Bowell 1980 E1 which was well observed by the Section.

1997 T1 Utsunomiya was discovered by Syogo Utsunomiya of Azamihara, Minami-Oguni cho, Aso-gun, Kumamoto-ken, Japan. Unusually it was relatively bright when it was found at high northern declination with 25x150B. Early observations showed a strongly condensed coma, with a short tail (image by Denis Buczynski). Now at its brightest (image by Martin Mobberley), it will fade, though may become visible after conjunction next year.







1997 T3 was discovered by a team of observers from the DLR Institute of Planetary Exploration, Berlin during the course of the Uppsala-DLR Trojan Survey. It is in a distant elliptical orbit with a period of 19.7 years.

1997 V1 P/Larsen is a 17th mag comet discovered by Jeff Larsen on images taken with the Spacewatch telescope. Another distant periodic comet it has a period of 10.8 years.

Thirty two sungrazing comets have now been discovered by the LASCO coronographs on the SOHO spacecraft and it will soon eclipse the Shoemaker-Levy team as the leading cometary discoverer. The comets are: 1996 B3, 1996 D1, 1996 F2, 1996 H1, 1996 M1, 1996 M2, 1996 O1, 1996 O2, 1996 O3, 1996 O4, 1996 Q2, 1996 Q3, 1996 S3, 1996 X1, 1996 X2, 1996 Y1, 1997 B2, 1997 K1, 1997 L3, 1997 L4, 1997 M1, 1997 P1, 1997 Q1, 1997 Q2, 1997 R1, 1997 R2, 1997 R3, 1997 S1, 1997 T2, 1997 T4, 1997 T5 and 1997 V2. These are among the intrinsically faintest comets ever seen, with an absolute magnitude of around 20. They mostly represent minor fragments from the Kreutz group of sungrazing comets whose orbital evolution has been described by Brian Marsden (AJ 1967, 72:1170, 1989 98:2306). These comets have perihelion distance, q < 0.02 AU, longitude of perihelion, L (L = longitude of ascending node + arctan(tan(argument of perihelion) * cos(inclination)) around 282 degrees and latitude of perihelion, B (B = arcsin(sin(argument of perihelion) * sin(inclination)) around 35 degrees. Only the larger objects survive perihelion, and then only if q > 0.005 AU.

The comets probably originated from the breakup of a comet seen in -371, which was reported to have fragmented into two parts by the Greek historian Ephorus. This breakup seems to have given rise to two main comets, one of which had a period of around 350 years and the other a period of around twice this. The shorter period object returned in the 1st, 4th, 8th and 11th centuries and may be identical with the comet of 1487. The 11th century return seems to have caused further breakup which gave rise to sub-group I of the Kreutz sungrazers. This group includes 1843 D1 (Great March Comet), comet Pereyra (1963 R1) and more recently the Solwind and SMM objects, plus 1997 L4 discovered by SOHO (and probably 1996 H1, 1996 M1, 1996 M2, 1996 X2, 1996 Y1, 1997 K1, 1997 M1, 1997 R1, 1997 R2, 1997 R3, 1997 S1, 1997 T4 and 1997 T5). The longer period object returned in the 4th century and in 1106 when it also broke up, to give rise to sub-group II comets including 1882 R1 (Great September Comet) and Ikeya-Seki (1965 S1), plus 1997 L3 (and probably 1997 Q1and 1997 Q2) discovered by SOHO. Comet White-Ortiz-Bolelli (1970 K1) appears to be belong to a slightly different sub-group of this grouping and may represent an earlier breakup. Some new groupings appear to be possible from the SOHO objects: 1996 O1, 1996 O3, 1996 O4, 1996 Q2, 1996 Q3, 1996 X1 and 1997 P1 appear to form a group with B around 28°, 1996 O2 and 1996 S3 have L around 272 and 1996 F2, 1997 T2 and 1997 V2 have L > 285 and q > 0.008.

Three of the SOHO comets (1996 B3, 1996 D1 and 1997 B2) appear to belong to a slightly different group of sungrazers as they have L around 270 and B around 50, rather than the 282 and 35 expected for the Kreutz group.

The exact orbit of the comets on their return depends very much on what the solar system barycentre is doing at the time and this is largely controlled by the position of Jupiter and Saturn. The breakup velocities were probably very small and objects may have remained gravitationally bound in orbit round each other or even in contact.

SOHO has discovered two comets that are not sungrazers. These are 1997 H2 and 1997 L2, though neither has been observed by other means. It observed comet 96P/Machholz 1 at perihelion, and found it a little brighter than expected and has also observed comets 45P/Honda-Mrkos-Pajdusakova and Hyakutake (1996 B2).

For the latest information on discoveries and the brightness of comets see the section www page: http://www.ast.cam.ac.uk/~jds

Comet Prospects for 1998

Although now long gone from the northern hemisphere, comet Hale-Bopp is still predicted to be the brightest comet of 1998, though there is always the chance of something better coming along. A couple of long period comets discovered in 1997 are still visible and there are several reasonable returns of short period comets. Recent theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. Ephemerides for new and currently observable comets are published in the *Circulars*, in this Newsletter and on the Section and CBAT web pages, with predictions for returns in the Handbook[1] and on Seiichi Yoshida's web pages[2]. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook[3]; details of subscription to the ICQ are available from me.

Comet Hale-Bopp (1995 O1), the great comet of 1997, is fading very slowly and could still be 7^m at the beginning of the year, fading to 11^m by the year's end. The catch is that it is only easily observable from southern hemisphere locations. Thanks to its high southern declination of more than 50 degrees, UK observers will need to arrange a foreign holiday if they want to see it again.

Comet Mueller (1997 D1) is a new comet discovered on plates taken by Jean Mueller for the 2nd Palomar Sky Survey with the 1.2m Oschin Schmidt Camera on 1997 Feb 17th. The object was initially reported as 16th mag, but appeared brighter to visual observers, though when recovered after solar conjunction it was fainter than expected. At perihelion on 1997 October 12, it should fade from around 11^m at the beginning of the year to 15^m at the end of April whilst completing a loop in Eridanus and Cetus. UK observers may be able to follow it until mid February and southern hemisphere observers until March, after which the solar elongation becomes too small. Recent observations suggest it is fading away and may be difficult to observe.

Comet Meunier-Dupouy (1997 J2) was accidentally discovered by French amateur astronomers who were imaging comet Mueller 1997 J1. Michel Meunier reported a comet 6' SW of 1997 J1 on May 7.9, moving more slowly and perhaps 0.5 mag brighter. Independently another pair of French amateurs P Dupouy and J F Lahitte reported it the next day. It should remain visible for the entire year, starting at around 11^m and then fading from a peak of 10^m in July to 13^m. Initially heading south-eastward through Cygnus into Pegasus it changes direction and heads more rapidly south and a little west through Equuleus and Capricornus. It is at opposition in August, but its southern declination means that UK observers will loose it after early November.

21P/Giacobini-Zinner, the parent comet of the October Draconid meteors, should be visible from August until the end of the year, brightening from 14^m to 9^m. It is an evening object and at its best at the end of November. Starting off in Hercules and accelerating into Aquila, it then moves through the zodiacal constellations of Capricornus and Aquarius. An increasingly southern declination means that UK observers will loose it towards the end of the year. The comet was first discovered by Giacobini at Nice observatory in December 1900 and was thought to have a period of 6.8 years. The next two returns were expected to be difficult to observe, but in October 1913, Zinner, of Bamberg, Germany, discovered a comet whilst observing variable stars in Scutum. This turned out to be the same comet, but the period had been incorrectly determined. The comet was missed at three unfavourable returns, so this will be the thirteenth apparition of the comet.

29P/Schwassmann-Wachmann 1 is an annual comet which has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. In the first half of 1997 it was in outburst for several months. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet. This year it is at opposition in April in Virgo and should be observable until June. It is then in conjunction until September and will be observable in Libra for the rest of the year. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. Unfortunately opportunities for UK observers may be limited as its altitude does not exceed 20° during its period of visibility from this country.

43P/Wolf-Harrington was at perihelion at the end of September 1997, and will be observable in Hydra as it fades from 13^m to 15^m. UK observers will loose it in mid January, but southern hemisphere observers may be able to follow it till March.

55P/Tempel-Tuttle (1997 E1), the parent comet of the Leonids, was recovered by observers using the Keck 10m telescope on March 4.6 and confirmed using the ESO 3.5m NTT at mag 22 on March 7.3. At the start of the year it is in Canes Venatici, heading swiftly north towards the pole. Initially a morning object it brightens rapidly as heads towards a relatively close approach to the earth in mid January, when it may reach 8^m. It then heads rapidly south again, passing through Andromeda in late January and into Pisces. Intrinsically it is quite a faint comet and by the time it reaches perihelion at the end of February will be over 1 AU from the earth, so it will not put on as good a show as is expected from the meteors it has produced. The solar elongation becomes too small for observation past early March.

The comet was originally discovered on 1865 December 19 by William Tempel in Marseilles and on 1866 January 6 by Horace Tuttle from Harvard. The comet was then around 6^m and reached perihelion on January 12 when it was 5^m. It faded and was last seen on February 9. Once the orbit was calculated it was realised that it was very similar to that of the Leonids and previous returns of the comet were found in 1366 (when it made a very close approach to earth, 0.0229 AU, and reached 3^m) and 1699. It wasn't really looked for in 1899, and couldn't be found in 1932. At its last return, it was eventually recovered some three months after perihelion in 1965 June.

88P/Howell might be observable from April, when it is at opposition in Virgo, but it is usually brighter after perihelion, which occurs at the end of September. It is unlikely to be brighter than 11^m and could be fainter as it fades to the year's end. With a low inclination orbit, the comet sticks to the zodiacal constellations and can be found in Scorpius at perihelion, moving onwards to Capricornus at the end of the year. UK observers will loose it after early June, after which it belongs to more southerly located observers. The comet was discovered in 1981 by Ellen Howell with the 0.46-m Palomar Schmidt. It passed 0.6 AU from Jupiter in 1978, which reduced the perihelion distance, but the biggest change to its orbit occurred in 1585 when an encounter reduced q from 4.7 to 2.4 AU.

103P/Hartley 2 is another comet left over from 1997. It is an evening object and will slowly fade from 7^m - 8^m in late December when it was at perihelion to 14^m by the end of April. Beginning the year in Aquarius it moves rapidly eastwards, reaching Monoceros in April, remaining an evening object.

104P/Kowal 2 may be visible for a short while at the beginning of the year (see observing supplement).

A number of fainter comets may be of interest to CCD observers. These include: 78P/Gehrels 2 (a left over from 1997) and 62P/Tsuchinshan 1 (13^m, April), 68P/Klemola (14^m, September), 80P/Peters-Hartley (14^m, July), 93P/Lovas (13^m, October) and 95P/Chiron (opposition early May in Libra, 15^m). Ephemerides for these can be found on the Comet Section or CBAT WWW pages. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically.

Several other comets return to perihelion during 1997, however they are unlikely to become bright enough to observe or are poorly placed. These include: 49P/Arend-Rigaux, 98P/Takamizawa and D/Harrington-Wilson which have unfavorable returns and 83P/Russell 1, 129P/Shoemaker-Levy 3 (1996 U1), 130P/McNaught-Hughes (1997 H1), P/Shoemaker-Levy 7 (1991 V2), P/Kowal-Vavrova (1983 J3) and Montani (1997 G2) which are intrinsically faint or distant comets. D/Harrington-Wilson (1952 B1) was only observed at its discovery apparition and is probably lost as it came within 0.6 AU of Jupiter in 1961 which would have changed an already uncertain orbit.

Looking ahead, 1999 sees favorable returns of comets 10P/Tempel 2, 37P/Forbes and P/Machholz 2 (1994 P1). Of these the best are Tempel 2, which should reach 9^m in the summer and Machholz 2 which should reach 8^m late in the year.

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Comets reaching perihelion in 1998

Comet	T	q	P	N	H1	K1
130P/McNaught-Hughes	Feb 23.8	2.12	6.69	1	10.0	15
55P/Tempel-Tuttle	Feb 28.1	0.98	33.2	4	10.0	25
104P/Kowal 2	Mar 02.2	1.40	6.18	2	10.0	15
129P/Shoemaker-Levy 3	Mar 04.8	2.82	7.25	1	11.0	10
C/Meunier-Dupouy (1997 J2)	Mar 10.3	3.05			1.8	12
D/Harrington-Wilson	Apr 11.0	1.89	6.71	1	12.0	10
C/Montani (1997 G2)	Apr 16.3	3.08			8.0	10
62P/Tsuchinshan 1	Apr 19.1	1.50	6.64	5	8.0	25
68P/Klemola	May 01.7	1.75	10.8	3	10.0	10
49P/Arend-Rigaux	Jul 12.6	1.37	6.61	7	11.3	11
80P/Peters-Hartley	Aug 11.7	1.62	8.12	3	8.5	15
P/Shoemaker-Levy 7	Aug 25.3	1.70	6.89	1	14.0	15
83P/Russell 1	Aug 26.1	2.18	7.64	2	14.0	15
88P/Howell	Sep 27.2	1.41	5.57	4	8.0	15
93P/Lovas 1	Oct 14.2	1.69	9.14	2	9.5	15
98P/Takamizawa	Nov 08.0	1.59	7.21	2	9.0	20
P/Kowal-Vavrova	Nov 15.2	2.58	15.6	1	10.5	10
21P/Giacobini-Zinner	Nov 21.3	1.03	6.61	12	9.0	15

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 are given for each comet.

Note: $m_1 = H1 + 5.0 * \log(\Delta) + K1 * \log(r)$

Introduction

This issue has ephemerides for comets:

- 29P/Schwassmann-Wachmann 1 (Equator)
- 43P/Wolf-Harrington (Southern Hemisphere)
- 55P/Tempel-Tuttle
- 78P/Gehrels 2
- 88P/Howell
- 103P/Hartley 2
- 104P/Kowal 2
- C/Hale-Bopp (1995 O1) (Southern Hemisphere)
- C/Mueller (1997 D1)
- C/Meunier-Dupouy (1997 J2)
- C/Utsunomiya (1997 T1) (UK & Equator)

Current ephemerides are also available on the Section web page.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU Circulars, Minor Planet Circulars, Minor Planet Electronic Circulars, IAU web pages, IAU comet catalogue, Kenji Muraoka or from Don Yeomans of JPL.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.

- Column headings:

a) Double-date format. Time in GMAT. 12. is midnight UT.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for 29P/Schwassmann-Wachmann 1 (Equator)

Note: when in outburst the comet may be visible from the UK, although it is low in the southern sky.

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Omega= 46.7016 OMEGA=312.8257 i=  9.3854 q= 5.732961 a=  6.005490
e=0.045380  P=   14.717  T= 2004 June      10.9673    Equinox= 2000
Magnitudes calculated from m= 1.0+5.0*Log(d)+10.0*Log(r)
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December 1997 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	13 16.6	-16.27	13 19.3	-16.43	13.2	6.90	6.26	8.32	4.42 to 4.53	47	83	9	0	285	3	1
7/ 8	13 19.4	-16.49	13 22.1	-17.05	13.1	6.83	6.26	8.15	4.25 to 4.55	51	150	59	0	286	3	-1
12/13	13 22.0	-17.11	13 24.7	-17.26	13.1	6.77	6.26	7.58	4.08 to 4.57	55	137	99	0	286	3	-1
17/18	13 24.5	-17.32	13 27.2	-17.47	13.1	6.70	6.26	7.41	3.50 to 4.60	60	73	85	0	287	2	-1
22/23	13 26.9	-17.52	13 29.6	-18.08	13.1	6.63	6.26	7.23	3.32 to 5.02	64	17	40	0	288	2	-1
27/28	13 29.0	-18.12	13 31.7	-18.27	13.0	6.55	6.26	7.06	3.14 to 5.05	69	49	3	0	288	2	-1

January 1998 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	13 31.0	-18.31	13 33.7	-18.46	13.0	6.48	6.26	6.48	2.56 to 5.07	73	116	13	0	289	2	-1
6/ 7	13 32.7	-18.48	13 35.5	-19.04	13.0	6.40	6.26	6.30	2.37 to 5.10	78	166	66	0	290	2	-1
11/12	13 34.3	-19.05	13 37.0	-19.20	13.0	6.32	6.26	6.12	2.19 to 5.12	82	105	100	0	290	1	-1
16/17	13 35.6	-19.21	13 38.3	-19.36	12.9	6.23	6.26	5.53	1.60 to 5.14	87	45	83	0	291	1	-1
21/22	13 36.7	-19.36	13 39.4	-19.51	12.9	6.15	6.26	5.35	1.40 to 5.16	92	20	39	0	292	1	-1
26/27	13 37.5	-19.49	13 40.2	-20.04	12.9	6.07	6.26	5.16	1.21 to 5.18	96	81	2	0	292	0	-1
31/32	13 38.0	-20.01	13 40.8	-20.16	12.9	5.99	6.26	4.57	1.01 to 5.19	101	151	18	0	293	0	-1

Ephemeris for 29P/Schwassmann-Wachmann 1 (Equator)

February 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
5/ 6	13 38.3	-20.12	13 41.1	-20.27	12.8	5.91	6.25	4.37	0.41 to 5.20	106	135	72	0	294	0	0
10/11	13 38.3	-20.21	13 41.1	-20.37	12.8	5.83	6.25	4.18	0.20 to 5.21	111	73	100	0	295	0	0
15/16	13 38.1	-20.29	13 40.8	-20.44	12.8	5.76	6.25	3.58	23.60 to 5.21	116	18	83	0	296	0	0
20/21	13 37.6	-20.35	13 40.3	-20.50	12.7	5.69	6.25	3.37	23.39 to 5.21	121	50	37	0	297	0	0
25/26	13 36.8	-20.40	13 39.5	-20.55	12.7	5.62	6.25	3.17	23.18 to 5.20	126	117	0	0	299	0	0

March 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	13 35.7	-20.42	13 38.5	-20.58	12.7	5.56	6.25	2.56	22.56 to 5.20	131	161	24	0	300	-1	0
7/ 8	13 34.5	-20.43	13 37.2	-20.59	12.7	5.50	6.25	2.35	22.35 to 5.19	136	99	77	0	302	-1	0
12/13	13 33.0	-20.43	13 35.7	-20.58	12.6	5.44	6.25	2.14	22.13 to 5.18	141	40	100	0	305	-1	0
17/18	13 31.3	-20.40	13 34.0	-20.55	12.6	5.40	6.25	1.52	21.51 to 5.16	146	26	81	0	308	-1	0
22/23	13 29.4	-20.36	13 32.1	-20.51	12.6	5.36	6.25	1.31	21.29 to 5.15	151	85	33	0	312	-2	0
27/28	13 27.4	-20.30	13 30.1	-20.45	12.6	5.32	6.25	1.09	21.06 to 5.12	156	154	0	0	317	-2	0

April 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	13 25.2	-20.22	13 27.9	-20.38	12.6	5.29	6.25	0.47	20.44 to 4.50	161	126	30	0	325	-2	0
6/ 7	13 23.0	-20.13	13 25.7	-20.29	12.6	5.27	6.25	0.25	20.22 to 4.29	165	64	80	0	337	-2	0
11/12	13 20.7	-20.03	13 23.4	-20.18	12.6	5.26	6.25	0.03	19.60 to 4.07	168	15	100	0	357	-2	0
16/17	13 18.5	-19.51	13 21.2	-20.07	12.6	5.26	6.25	23.41	19.37 to 3.45	169	59	78	0	25	-2	0
21/22	13 16.2	-19.39	13 18.9	-19.55	12.6	5.26	6.24	23.19	19.15 to 3.24	168	124	27	0	52	-2	1
26/27	13 14.1	-19.26	13 16.7	-19.42	12.6	5.27	6.24	22.58	18.53 to 3.02	164	155	0	0	70	-2	1

May 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	13 12.0	-19.12	13 14.7	-19.28	12.6	5.29	6.24	22.36	18.51 to 2.40	160	89	36	0	81	-2	1
6/ 7	13 10.0	-18.59	13 12.7	-19.15	12.6	5.31	6.24	22.14	18.51 to 2.18	156	30	82	0	88	-2	1
11/12	13 8.3	-18.45	13 10.9	-19.01	12.6	5.34	6.24	21.53	18.51 to 1.57	151	36	100	0	93	-2	1
16/17	13 6.7	-18.31	13 9.4	-18.47	12.6	5.38	6.24	21.31	18.52 to 1.35	146	97	73	0	97	-1	1
21/22	13 5.3	-18.18	13 8.0	-18.34	12.6	5.42	6.24	21.10	18.52 to 1.14	141	161	20	0	100	-1	1
26/27	13 4.1	-18.06	13 6.8	-18.22	12.6	5.47	6.24	20.49	18.53 to 0.52	136	118	2	0	102	-1	1
31/32	13 3.2	-17.55	13 5.9	-18.11	12.7	5.53	6.24	20.29	18.54 to 0.31	131	54	40	0	104	-1	0

Ephemeris for 43P/Wolf-Harrington (Southern hemisphere)

Note: the comet may be visible from the UK in the early morning during December

Omega=187.1337 OMEGA=254.7560 i= 18.5103 q= 1.581811 a= 3.468770
e=0.543985 P= 6.460 T= 1997 September 29.2169 Equinox= 2000
Magnitudes calculated from m= 8.9+5.0*Log(d)+15.0*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	9 57.0	-5.56	9 59.5	-6.10	12.9	1.29	1.71	5.12	1.28 to 3.05	96	132	9	1	293	6	-9
7/ 8	10 1.9	-7.50	10 4.3	-8.04	13.0	1.27	1.73	4.57	1.07 to 3.04	99	152	59	1	295	5	-9
12/13	10 5.9	-9.40	10 8.4	-9.55	13.0	1.25	1.75	4.41	0.46 to 3.03	102	89	99	1	297	4	-9
17/18	10 9.0	-11.26	10 11.5	-11.41	13.1	1.23	1.77	4.25	0.25 to 3.04	106	31	85	1	299	3	-8
22/23	10 11.3	-13.08	10 13.8	-13.23	13.1	1.21	1.79	4.07	0.04 to 3.06	109	41	40	1	301	2	-8
27/28	10 12.6	-14.43	10 15.1	-14.58	13.2	1.19	1.81	3.49	23.42 to 3.10	112	96	3	1	304	1	-7

January 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	10 13.0	-16.12	10 15.4	-16.27	13.2	1.18	1.84	3.30	23.20 to 3.14	116	151	13	1	307	0	-7
6/ 7	10 12.4	-17.32	10 14.9	-17.47	13.3	1.16	1.86	3.09	22.58 to 3.20	120	121	66	1	310	0	-6
11/12	10 11.0	-18.43	10 13.3	-18.58	13.3	1.15	1.88	2.48	22.35 to 3.26	124	61	100	1	314	-1	-5
16/17	10 8.6	-19.44	10 11.0	-19.59	13.4	1.15	1.91	2.26	22.13 to 3.33	127	30	83	1	319	-2	-5
21/22	10 5.4	-20.33	10 7.8	-20.48	13.5	1.14	1.94	2.03	21.51 to 3.40	131	70	39	1	324	-3	-4
26/27	10 1.6	-21.11	10 3.9	-21.25	13.6	1.14	1.96	1.40	21.29 to 3.48	135	125	2	0	330	-4	-3
31/32	9 57.2	-21.35	9 59.6	-21.49	13.7	1.14	1.99	1.15	21.08 to 3.55	138	140	18	0	338	-5	-2

Ephemeris for 55P/Tempel-Tuttle (UK)

Omega=172.4971 OMEGA=235.2580 i=162.4858 q= 0.976608 a= 10.336226
e=0.905516 P= 33.231 T= 1998 February 28.1019 Equinox= 2000
Magnitudes calculated from m= 9.0+5.0*Log(d)+20.0*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
15/16	12 34.0	19.19	12 36.5	19.03	13.1	1.26	1.52	6.58	2.44 to 6.33	84	75	96	1	297	1	10
16/17	12 34.3	19.46	12 36.8	19.29	13.0	1.23	1.51	6.54	2.32 to 6.34	85	63	91	1	297	1	10
17/18	12 34.6	20.14	12 37.1	19.57	12.9	1.20	1.50	6.50	2.20 to 6.35	86	51	85	1	297	1	11
18/19	12 34.8	20.44	12 37.3	20.27	12.8	1.16	1.49	6.47	2.08 to 6.35	87	41	77	1	296	1	12
19/20	12 35.0	21.16	12 37.5	20.59	12.6	1.13	1.48	6.43	1.56 to 6.36	88	31	68	1	296	1	13
20/21	12 35.2	21.50	12 37.7	21.34	12.5	1.09	1.46	6.39	1.44 to 6.37	90	25	59	2	295	1	14
21/22	12 35.4	22.27	12 37.9	22.11	12.4	1.06	1.45	6.35	1.32 to 6.37	91	23	49	2	295	0	15
22/23	12 35.5	23.07	12 38.0	22.51	12.2	1.02	1.44	6.32	1.19 to 6.38	92	26	40	2	295	0	16
23/24	12 35.6	23.50	12 38.1	23.34	12.1	0.99	1.43	6.28	1.06 to 6.38	93	34	31	2	294	0	17
24/25	12 35.6	24.36	12 38.1	24.20	12.0	0.95	1.42	6.24	0.53 to 6.38	94	44	22	2	294	0	19
25/26	12 35.6	25.27	12 38.1	25.10	11.8	0.92	1.41	6.20	0.40 to 6.39	96	54	14	2	293	0	20
26/27	12 35.5	26.21	12 38.0	26.04	11.7	0.89	1.40	6.16	0.26 to 6.39	97	66	8	3	293	0	22

Ephemeris for 55P/Tempel-Tuttle (UK)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
27/28	12 35.4	27.20	12 37.9	27.03	11.5	0.85	1.39	6.12	0.11 to 6.39	98	78	3	3	292	0	24
28/29	12 35.2	28.24	12 37.7	28.08	11.4	0.82	1.38	6.08	23.56 to 6.39	100	90	0	3	291	-1	26
29/30	12 34.9	29.34	12 37.4	29.18	11.2	0.78	1.37	6.03	23.40 to 6.40	101	102	0	3	291	-1	29
30/31	12 34.6	30.51	12 37.0	30.34	11.0	0.75	1.36	5.59	23.24 to 6.40	102	114	2	4	290	-1	31
31/32	12 34.1	32.15	12 36.6	31.58	10.9	0.72	1.35	5.55	23.06 to 6.40	104	126	6	4	289	-2	34

January 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12 33.5	33.47	12 35.9	33.30	10.7	0.69	1.34	5.50	22.46 to 6.40	105	136	13	4	288	-3	38
2/ 3	12 32.7	35.28	12 35.1	35.12	10.5	0.65	1.33	5.45	22.25 to 6.40	107	142	22	5	287	-3	42
3/ 4	12 31.7	37.21	12 34.2	37.04	10.4	0.62	1.32	5.40	22.02 to 6.40	108	144	32	5	285	-4	46
4/ 5	12 30.5	39.25	12 32.9	39.08	10.2	0.59	1.31	5.35	21.35 to 6.39	110	140	43	6	284	-5	51
5/ 6	12 29.0	41.42	12 31.4	41.26	10.0	0.56	1.30	5.30	21.03 to 6.39	111	132	55	6	282	-7	57
6/ 7	12 27.1	44.15	12 29.5	43.59	9.8	0.53	1.29	5.24	20.24 to 6.39	113	121	66	7	280	-8	63
7/ 8	12 24.6	47.05	12 27.1	46.49	9.6	0.51	1.28	5.18	19.31 to 6.39	114	110	76	7	277	-10	70
8/ 9	12 21.5	50.14	12 23.9	49.58	9.5	0.48	1.27	5.10	17.46 to 6.38	116	98	85	8	274	-12	78
9/10	12 17.3	53.44	12 19.8	53.27	9.3	0.45	1.26	5.02	17.37 to 6.38	117	86	92	9	271	-15	87
10/11	12 11.7	57.36	12 14.2	57.19	9.1	0.43	1.25	4.53	17.38 to 6.38	118	76	97	9	267	-18	96
11/12	12 3.7	61.50	12 6.3	61.34	8.9	0.41	1.24	4.41	17.39 to 6.37	119	68	100	10	262	-23	106
12/13	11 51.8	66.27	11 54.5	66.10	8.8	0.39	1.23	4.25	17.40 to 6.37	120	63	100	11	255	-29	115
13/14	11 32.6	71.21	11 35.5	71.04	8.6	0.38	1.22	4.02	17.42 to 6.36	120	61	99	12	247	-38	122
14/15	10 57.2	76.21	11 1.0	76.04	8.5	0.37	1.21	3.24	17.43 to 6.35	120	65	95	13	234	-52	125
15/16	9 40.7	80.53	9 47.2	80.39	8.4	0.36	1.20	2.06	17.44 to 6.35	119	71	90	14	211	-75	113
16/17	6 54.5	83.03	7 5.9	82.58	8.3	0.36	1.19	23.20	17.46 to 6.34	118	81	83	15	167	-125	54
17/18	4 10.2	80.41	4 18.7	80.48	8.2	0.36	1.18	20.30	17.47 to 6.33	116	92	76	16	122	-165	-59
18/19	2 55.2	75.57	3 0.9	76.09	8.2	0.36	1.17	19.08	17.49 to 6.32	113	103	67	17	99	-113	-118
19/20	2 20.5	70.42	2 24.9	70.56	8.2	0.37	1.17	18.28	17.50 to 6.32	110	114	58	18	87	-71	-131
20/21	2 1.4	65.31	2 5.2	65.45	8.2	0.38	1.16	18.04	17.52 to 6.31	107	123	48	19	80	-49	-129
21/22	1 49.6	60.34	1 53.1	60.49	8.2	0.40	1.15	17.48	17.53 to 6.30	104	130	39	19	75	-36	-123
22/23	1 41.6	55.59	1 44.9	56.14	8.2	0.41	1.14	17.36	17.55 to 6.29	101	132	29	19	72	-27	-114
23/24	1 35.9	51.47	1 39.1	52.03	8.3	0.43	1.13	17.27	17.56 to 6.28	98	130	20	19	69	-21	-104
24/25	1 31.7	47.59	1 34.8	48.14	8.3	0.46	1.12	17.18	17.58 to 6.27	96	124	13	19	67	-17	-95
25/26	1 28.5	44.32	1 31.4	44.47	8.4	0.48	1.12	17.11	17.59 to 3.27	93	114	6	19	66	-14	-86
26/27	1 25.9	41.25	1 28.8	41.41	8.4	0.51	1.11	17.04	18.01 to 2.29	90	102	2	19	65	-12	-77
27/28	1 23.8	38.37	1 26.7	38.53	8.5	0.53	1.10	16.58	18.02 to 1.49	88	89	0	19	64	-10	-69
28/29	1 22.1	36.06	1 25.0	36.22	8.5	0.56	1.09	16.53	18.04 to 1.18	85	75	0	19	64	-8	-63
29/30	1 20.8	33.49	1 23.6	34.05	8.6	0.59	1.09	16.47	18.06 to 0.53	83	61	4	18	63	-7	-56
30/31	1 19.6	31.46	1 22.4	32.02	8.6	0.62	1.08	16.42	18.07 to 0.31	81	47	10	18	63	-6	-51
31/32	1 18.6	29.54	1 21.4	30.09	8.7	0.65	1.07	16.37	18.09 to 0.12	79	34	18	18	63	-5	-46

February 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	1 17.7	28.12	1 20.5	28.28	8.7	0.68	1.07	16.32	18.11 to 23.55	77	24	28	18	62	-4	-42
2/ 3	1 17.0	26.39	1 19.7	26.55	8.8	0.71	1.06	16.28	18.12 to 23.40	75	21	39	17	62	-4	-38
3/ 4	1 16.4	25.14	1 19.1	25.30	8.8	0.74	1.05	16.23	18.14 to 23.25	74	27	51	17	62	-3	-35
4/ 5	1 15.8	23.56	1 18.5	24.12	8.8	0.77	1.05	16.19	18.16 to 23.12	72	38	62	17	62	-3	-32
5/ 6	1 15.3	22.44	1 18.0	22.60	8.9	0.81	1.04	16.14	18.17 to 23.00	70	50	72	17	62	-2	-29
6/ 7	1 14.9	21.38	1 17.6	21.54	8.9	0.84	1.04	16.10	18.19 to 22.49	69	63	81	16	62	-2	-27
7/ 8	1 14.5	20.36	1 17.2	20.52	9.0	0.87	1.03	16.05	18.21 to 22.38	67	76	89	16	62	-2	-25
8/ 9	1 14.1	19.39	1 16.8	19.55	9.0	0.90	1.03	16.01	18.22 to 22.28	66	88	95	16	63	-2	-23
9/10	1 13.8	18.46	1 16.5	19.02	9.0	0.93	1.02	15.57	18.24 to 22.18	64	101	98	16	63	-1	-22
10/11	1 13.5	17.57	1 16.2	18.13	9.1	0.96	1.02	15.53	18.26 to 22.09	63	113	100	15	63	-1	-20
11/12	1 13.3	17.10	1 16.0	17.26	9.1	1.00	1.01	15.48	18.28 to 21.60	61	126	100	15	63	-1	-19
12/13	1 13.0	16.27	1 15.7	16.43	9.1	1.03	1.01	15.44	18.29 to 21.51	60	138	98	15	63	-1	-18
13/14	1 12.8	15.46	1 15.5	16.02	9.2	1.06	1.00	15.40	18.31 to 21.43	59	149	94	14	63	-1	-17
14/15	1 12.6	15.07	1 15.3	15.23	9.2	1.09	1.00	15.36	18.33 to 21.34	57	161	89	14	63	-1	-16
15/16	1 12.4	14.31	1 15.1	14.47	9.2	1.12	1.00	15.32	18.35 to 21.27	56	169	83	14	63	-1	-15
16/17	1 12.3	13.57	1 14.9	14.13	9.3	1.15	0.99	15.28	18.36 to 21.19	55	168	75	14	64	-1	-14
17/18	1 12.1	13.24	1 14.7	13.40	9.3	1.18	0.99	15.24	18.38 to 21.11	53	158	66	13	64	-1	-13
18/19	1 11.9	12.53	1 14.6	13.09	9.3	1.21	0.99	15.20	18.40 to 21.04	52	147	57	13	64	0	-12
19/20	1 11.8	12.24	1 14.4	12.39	9.3	1.24	0.99	15.15	18.42 to 20.56	51	135	47	13	64	0	-12
20/21	1 11.7	11.55	1 14.3	12.11	9.4	1.27	0.98	15.11	18.43 to 20.49	50	123	37	12	64	0	-11
21/22	1 11.5	11.29	1 14.1	11.44	9.4	1.30	0.98	15.07	18.45 to 20.42	48	110	27	12	65	0	-11
22/23	1 11.4	11.03	1 14.0	11.19	9.4	1.33	0.98	15.03	18.47 to 20.35	47	96	18	11	65	0	-10
23/24	1 11.3	10.38	1 13.9	10.54	9.5	1.36	0.98	14.59	18.49 to 20.28	46	82	10	11	65	0	-10
24/25	1 11.1	10.15	1 13.8	10.31	9.5	1.39	0.98	14.55	18.51 to 20.21	45	68	4	11	65	0	-9
25/26	1 11.0	9.52	1 13.7	10.08	9.6	1.41	0.98	14.51	18.52 to 20.15	44	53	0	10	66	0	-9
26/27	1 10.9	9.30	1 13.5	9.46	9.6	1.44	0.98	14.47	18.54 to 20.08	42	38	0	10	66	0	-9
27/28	1 10.8	9.09	1 13.4	9.25	9.6	1.47	0.98	14.43	18.56 to 20.01	41	23	2	10	66	0	-8
28/29	1 10.7	8.49	1 13.3	9.05	9.7	1.50	0.98	14.39	18.58 to 19.54	40	9	7	9	66	0	-8

March 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	1 10.6	8.30	1 13.2	8.46	9.7	1.52	0.98	14.35	18.60 to 19.48	39	9	15	9	67	0	-8
2/ 3	1 10.5	8.11	1 13.1	8.27	9.8	1.55	0.98	14.31	19.02 to 19.41	38	23	24	8	67	0	-7
3/ 4	1 10.4	7.53	1 13.0	8.08	9.8	1.57	0.98	14.27	19.03 to 19.34	37	37	35	8	67	0	-7
4/ 5	1 10.3	7.35	1 12.9	7.51	9.8	1.60	0.98	14.23	19.05 to 19.28	36	51	46	8	68	0	-7
5/ 6	1 10.2	7.18	1 12.8	7.34	9.9	1.62	0.98	14.19	19.07 to 19.21	34	64	57	7	68	0	-7
6/ 7	1 10.1	7.01	1 12.7	7.17	9.9	1.65	0.98	14.15	19.09 to 19.15	33	77	67	7	68	0	-6
7/ 8	1 10.0	6.45	1 12.6	7.01	10.0	1.67	0.99	14.11	Not Observable	32	90	77	6	69	0	-6
8/ 9	1 10.0	6.29	1 12.6	6.45	10.0	1.69	0.99	14.07	Not Observable	31	103	85	6	69	0	-6
9/10	1 9.9	6.14	1 12.5	6.30	10.1	1.72	0.99	14.02	Not Observable	30	115	91	6	70	0	-6
10/11	1 9.8	5.59	1 12.4	6.15	10.1	1.74	0.99	13.58	Not Observable	29	128	96	5	70	0	-6
11/12	1 9.7	5.44	1 12.3	6.00	10.2	1.76	1.00	13.54	Not Observable	28	140	99	5	71	0	-6
12/13	1 9.6	5.30	1 12.2	5.46	10.3	1.78	1.00	13.50	Not Observable	27	152	100	5	71	0	-5
13/14	1 9.5	5.16	1 12.1	5.32	10.3	1.80	1.00	13.46	Not Observable	26	164	100	4	72	0	-5
14/15	1 9.5	5.03	1 12.1	5.19	10.4	1.82	1.01	13.42	Not Observable	24	176	98	4	72	0	-5

Ephemeris for 78P/Gehrels 2 (UK)

Omega=192.7703 OMEGA=210.6270 i= 6.2578 q= 2.000252 a= 3.728954
e=0.463589 P= 7.201 T= 1997 August 7.0463 Equinox= 2000
Magnitudes calculated from m= 6.9+5.0*Log(d)+15.0*Log(r)

December 1997 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	6 52.0	13.53	6 54.9	13.49	12.7	1.33	2.22	2.07	22.01 to 6.13	146	174	9	1	289	-2	1
7/ 8	6 49.2	13.38	6 52.0	13.34	12.7	1.32	2.23	1.45	21.41 to 5.48	152	106	59	0	293	-3	-1
12/13	6 45.8	13.27	6 48.6	13.23	12.8	1.31	2.25	1.22	21.21 to 5.22	157	35	99	0	298	-4	0
17/18	6 41.9	13.18	6 44.7	13.15	12.8	1.31	2.27	0.58	21.01 to 4.55	162	33	85	0	307	-4	0
22/23	6 37.8	13.13	6 40.6	13.10	12.9	1.32	2.29	0.34	20.41 to 4.28	167	94	40	0	322	-5	0
27/28	6 33.5	13.10	6 36.3	13.08	13.0	1.33	2.31	0.10	20.20 to 4.00	170	156	3	0	349	-5	0

January 1998 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 29.3	13.11	6 32.1	13.09	13.1	1.35	2.33	23.46	20.01 to 3.32	169	133	13	0	22	-5	0
6/ 7	6 25.4	13.14	6 28.2	13.12	13.2	1.38	2.35	23.23	19.41 to 3.04	166	61	66	0	47	-4	0
11/12	6 21.8	13.20	6 24.6	13.18	13.3	1.41	2.37	22.59	19.23 to 2.36	162	9	100	0	60	-4	0
16/17	6 18.6	13.28	6 21.5	13.27	13.4	1.45	2.39	22.37	19.05 to 2.08	157	71	83	0	68	-3	0
21/22	6 16.1	13.38	6 19.0	13.37	13.5	1.50	2.41	22.14	18.49 to 1.40	151	131	39	0	74	-3	0
26/27	6 14.2	13.49	6 17.1	13.48	13.6	1.55	2.43	21.53	18.33 to 1.12	146	162	2	0	77	-2	0
31/32	6 13.1	14.02	6 15.9	14.01	13.8	1.60	2.45	21.32	18.19 to 0.44	141	90	18	0	80	-1	1

Ephemeris for 88P/Howell (UK)

Omega=234.9119 OMEGA= 57.6688 i= 4.3983 q= 1.406136 a= 3.143524
e=0.552688 P= 5.573 T= 1998 September 27.2533 Equinox= 2000
Magnitudes calculated from m= 7.7+5.0*Log(d)+15.0*Log(r)

April 1998 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	13 43.2	-5.35	13 45.8	-5.49	13.4	1.26	2.24	1.05	Not Observable	165	127	30	0	273	-4	1
6/ 7	13 38.9	-5.13	13 41.5	-5.28	13.3	1.21	2.20	0.41	Not Observable	170	62	80	0	262	-5	1
11/12	13 34.1	-4.51	13 36.7	-5.06	13.1	1.17	2.17	0.17	23.19 to 1.14	175	1	100	0	228	-5	1
16/17	13 28.9	-4.28	13 31.5	-4.44	12.9	1.14	2.14	23.52	22.27 to 1.17	174	61	78	0	161	-6	1
21/22	13 23.5	-4.06	13 26.1	-4.22	12.8	1.11	2.11	23.27	21.42 to 1.11	169	128	27	0	135	-6	1
26/27	13 18.0	-3.46	13 20.6	-4.02	12.6	1.09	2.08	23.01	21.01 to 1.01	163	156	0	0	126	-6	1

May 1998 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	13 12.7	-3.28	13 15.3	-3.44	12.5	1.08	2.04	22.36	21.11 to 0.49	157	84	36	0	121	-6	1
6/ 7	13 7.7	-3.14	13 10.3	-3.30	12.4	1.07	2.01	22.12	21.25 to 0.34	151	21	82	1	119	-6	1
11/12	13 3.3	-3.05	13 5.9	-3.21	12.3	1.07	1.98	21.48	21.39 to 0.18	145	40	100	1	117	-5	0
16/17	12 59.5	-3.01	13 2.1	-3.17	12.2	1.07	1.95	21.24	21.53 to 0.01	140	103	73	1	116	-4	0
21/22	12 56.5	-3.03	12 59.1	-3.19	12.1	1.07	1.92	21.01	22.08 to 23.43	134	174	20	1	115	-3	0
26/27	12 54.4	-3.10	12 57.0	-3.26	12.0	1.08	1.89	20.40	22.23 to 23.25	129	112	2	1	115	-2	0
31/32	12 53.3	-3.24	12 55.9	-3.40	11.9	1.09	1.86	20.19	22.37 to 23.06	124	45	40	2	114	-1	-1

Ephemeris for 103P/Hartley 2 (UK)

Omega=180.7240 OMEGA=219.9547 i= 13.6191 q= 1.031725 a= 3.443571
e=0.700391 P= 6.390 T= 1997 December 22.0242 Equinox= 2000
Magnitudes calculated from m= 8.9+5.0*Log(d)+18.8*Log(r)

December 1997 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	21 11.5	-9.42	21 14.2	-9.29	9.3	0.92	1.07	16.31	17.19 to 20.06	68	44	4	13	70	23	0
2/ 3	21 15.4	-9.42	21 18.1	-9.29	9.2	0.91	1.07	16.31	17.19 to 20.06	68	32	9	14	70	23	0
3/ 4	21 19.3	-9.41	21 22.0	-9.29	9.2	0.91	1.06	16.31	17.18 to 20.07	68	19	16	14	70	24	0
4/ 5	21 23.3	-9.41	21 26.0	-9.28	9.2	0.90	1.06	16.31	17.18 to 20.08	68	7	25	14	70	24	0
5/ 6	21 27.3	-9.40	21 30.0	-9.27	9.1	0.90	1.06	16.31	17.18 to 20.09	68	7	36	14	69	24	0
6/ 7	21 31.4	-9.40	21 34.1	-9.26	9.1	0.90	1.05	16.31	17.17 to 20.10	68	20	47	15	69	25	0
7/ 8	21 35.5	-9.38	21 38.2	-9.25	9.1	0.89	1.05	16.31	17.17 to 20.11	68	33	59	15	69	25	0
8/ 9	21 39.7	-9.37	21 42.3	-9.23	9.0	0.89	1.05	16.31	17.17 to 20.12	68	46	70	15	69	25	0
9/10	21 43.9	-9.35	21 46.5	-9.21	9.0	0.89	1.05	16.31	17.17 to 20.13	68	59	80	16	69	25	0
10/11	21 48.1	-9.33	21 50.8	-9.19	9.0	0.88	1.04	16.32	17.17 to 20.14	68	73	89	16	69	26	0
11/12	21 52.4	-9.31	21 55.1	-9.17	9.0	0.88	1.04	16.32	17.17 to 20.15	68	86	95	16	69	26	0
12/13	21 56.7	-9.29	21 59.4	-9.14	8.9	0.87	1.04	16.32	17.17 to 20.17	68	99	99	16	69	26	1
13/14	22 1.1	-9.26	22 3.8	-9.11	8.9	0.87	1.04	16.33	17.17 to 20.18	68	112	100	17	69	27	1
14/15	22 5.5	-9.23	22 8.2	-9.08	8.9	0.87	1.04	16.33	17.17 to 20.19	68	124	100	17	69	27	1
15/16	22 10.0	-9.19	22 12.7	-9.04	8.9	0.86	1.04	16.34	17.18 to 20.20	68	136	96	17	68	27	1
16/17	22 14.5	-9.16	22 17.2	-9.01	8.8	0.86	1.03	16.34	17.18 to 20.22	68	148	91	17	68	27	1
17/18	22 19.1	-9.12	22 21.7	-8.56	8.8	0.86	1.03	16.35	17.18 to 20.23	68	160	85	17	68	28	1
18/19	22 23.7	-9.07	22 26.3	-8.52	8.8	0.85	1.03	16.36	17.18 to 20.25	68	171	77	17	68	28	1
19/20	22 28.3	-9.03	22 30.9	-8.47	8.8	0.85	1.03	16.36	17.19 to 20.26	68	178	68	18	68	28	1
20/21	22 33.0	-8.58	22 35.6	-8.42	8.8	0.85	1.03	16.37	17.19 to 20.28	68	167	59	18	68	28	2
21/22	22 37.7	-8.53	22 40.3	-8.37	8.8	0.85	1.03	16.38	17.20 to 20.29	68	156	49	18	68	29	2
22/23	22 42.5	-8.47	22 45.1	-8.31	8.8	0.84	1.03	16.39	17.20 to 20.31	68	146	40	18	68	29	2
23/24	22 47.3	-8.41	22 49.9	-8.25	8.8	0.84	1.03	16.40	17.21 to 20.32	68	135	31	18	68	29	2
24/25	22 52.1	-8.35	22 54.7	-8.19	8.8	0.84	1.03	16.40	17.21 to 20.34	69	124	22	18	68	29	2
25/26	22 57.0	-8.29	22 59.6	-8.12	8.8	0.84	1.03	16.41	17.22 to 20.36	69	113	14	18	68	30	2
26/27	23 1.9	-8.22	23 4.5	-8.06	8.8	0.83	1.03	16.42	17.23 to 20.37	69	101	8	18	68	30	2
27/28	23 6.8	-8.15	23 9.4	-7.58	8.8	0.83	1.04	16.43	17.24 to 20.39	69	90	3	18	68	30	2
28/29	23 11.8	-8.07	23 14.4	-7.51	8.8	0.83	1.04	16.44	17.24 to 20.41	69	78	0	18	68	30	3
29/30	23 16.8	-7.59	23 19.3	-7.43	8.8	0.83	1.04	16.45	17.25 to 20.42	69	65	0	18	68	30	3
30/31	23 21.8	-7.51	23 24.4	-7.35	8.8	0.83	1.04	16.46	17.26 to 20.44	69	53	2	18	68	31	3
31/32	23 26.8	-7.43	23 29.4	-7.26	8.8	0.82	1.04	16.48	17.27 to 20.46	70	40	6	17	68	31	3

Ephemeris for 103P/Hartley 2 (UK)

January 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	23 31.9	-7.34	23 34.5	-7.17	8.8	0.82	1.04	16.49	17.28 to 20.48	70	27	13	17	68	31	3
2/ 3	23 37.0	-7.25	23 39.6	-7.08	8.8	0.82	1.05	16.50	17.29 to 20.50	70	14	22	17	68	31	3
3/ 4	23 42.1	-7.16	23 44.7	-6.59	8.9	0.82	1.05	16.51	17.30 to 20.52	70	4	32	17	68	31	3
4/ 5	23 47.3	-7.06	23 49.8	-6.49	8.9	0.82	1.05	16.52	17.31 to 20.54	71	13	43	17	68	31	4
5/ 6	23 52.4	-6.56	23 55.0	-6.39	8.9	0.82	1.05	16.53	17.32 to 20.55	71	25	55	16	68	32	4
6/ 7	23 57.6	-6.45	24 0.2	-6.29	8.9	0.82	1.06	16.55	17.33 to 20.57	71	38	66	16	68	32	4
7/ 8	0 2.8	-6.35	0 5.4	-6.18	8.9	0.82	1.06	16.56	17.34 to 20.59	71	50	76	16	69	32	4
8/ 9	0 8.0	-6.24	0 10.6	-6.07	9.0	0.82	1.06	16.57	17.35 to 21.01	72	63	85	16	69	32	4
9/10	0 13.2	-6.13	0 15.8	-5.56	9.0	0.82	1.07	16.58	17.37 to 21.03	72	75	92	15	69	32	4
10/11	0 18.4	-6.01	0 21.0	-5.45	9.0	0.82	1.07	16.60	17.38 to 21.05	72	87	97	15	69	32	4
11/12	0 23.7	-5.49	0 26.2	-5.33	9.0	0.82	1.07	17.01	17.39 to 21.07	72	99	100	15	69	32	4
12/13	0 28.9	-5.37	0 31.5	-5.21	9.1	0.82	1.08	17.02	17.40 to 21.09	73	111	100	15	69	32	5
13/14	0 34.1	-5.25	0 36.7	-5.09	9.1	0.82	1.08	17.04	17.42 to 21.10	73	122	99	14	69	32	5
14/15	0 39.4	-5.13	0 41.9	-4.56	9.2	0.82	1.09	17.05	17.43 to 21.12	73	133	95	14	69	32	5
15/16	0 44.6	-4.60	0 47.1	-4.44	9.2	0.83	1.09	17.06	17.44 to 21.14	74	144	90	14	69	32	5
16/17	0 49.8	-4.47	0 52.4	-4.31	9.2	0.83	1.09	17.07	17.46 to 21.16	74	154	83	13	70	32	5
17/18	0 55.1	-4.34	0 57.6	-4.18	9.3	0.83	1.10	17.09	17.47 to 21.18	74	164	76	13	70	32	5
18/19	1 0.3	-4.21	1 2.8	-4.04	9.3	0.83	1.10	17.10	17.49 to 21.19	74	172	67	13	70	32	5
19/20	1 5.5	-4.07	1 8.0	-3.51	9.4	0.83	1.11	17.11	17.50 to 21.21	75	170	58	12	70	32	5
20/21	1 10.7	-3.53	1 13.2	-3.37	9.4	0.84	1.11	17.12	17.52 to 21.23	75	161	48	12	70	32	5
21/22	1 15.8	-3.39	1 18.4	-3.24	9.4	0.84	1.12	17.14	17.53 to 21.24	75	151	39	12	70	32	5
22/23	1 21.0	-3.25	1 23.5	-3.10	9.5	0.84	1.12	17.15	17.55 to 21.26	76	140	29	11	71	32	5
23/24	1 26.2	-3.11	1 28.7	-2.56	9.5	0.85	1.13	17.16	17.56 to 21.27	76	129	20	11	71	32	5
24/25	1 31.3	-2.57	1 33.8	-2.42	9.6	0.85	1.14	17.17	17.58 to 21.29	76	118	13	10	71	32	5
25/26	1 36.4	-2.43	1 38.9	-2.28	9.6	0.85	1.14	17.18	17.59 to 21.30	76	106	6	10	71	31	5
26/27	1 41.5	-2.28	1 44.0	-2.13	9.7	0.86	1.15	17.20	18.01 to 21.32	77	93	2	10	71	31	6
27/28	1 46.5	-2.14	1 49.1	-1.59	9.7	0.86	1.15	17.21	18.02 to 21.33	77	80	0	9	72	31	6
28/29	1 51.6	-1.59	1 54.1	-1.45	9.8	0.87	1.16	17.22	18.04 to 21.34	77	67	0	9	72	31	6
29/30	1 56.6	-1.45	1 59.1	-1.30	9.9	0.87	1.17	17.23	18.06 to 21.35	78	54	4	9	72	31	6
30/31	2 1.6	-1.30	2 4.1	-1.16	9.9	0.88	1.17	17.24	18.07 to 21.37	78	41	10	8	72	31	6
31/32	2 6.5	-1.15	2 9.1	-1.01	10.0	0.88	1.18	17.25	18.09 to 21.38	78	28	18	8	73	30	6

February 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	2 11.4	-1.01	2 14.0	-0.47	10.0	0.89	1.19	17.26	18.11 to 21.38	78	16	28	8	73	30	6
2/ 3	2 16.3	-0.46	2 18.9	-0.32	10.1	0.89	1.19	17.27	18.12 to 21.39	79	10	39	8	73	30	6
3/ 4	2 21.2	-0.32	2 23.7	-0.18	10.2	0.90	1.20	17.28	18.14 to 21.40	79	15	51	7	73	30	6
4/ 5	2 26.0	-0.17	2 28.6	-0.04	10.2	0.91	1.21	17.29	18.16 to 21.41	79	26	62	7	74	30	6
5/ 6	2 30.8	-0.02	2 33.3	0.11	10.3	0.91	1.21	17.30	18.17 to 21.41	79	38	72	7	74	29	6
6/ 7	2 35.5	0.12	2 38.1	0.25	10.3	0.92	1.22	17.30	18.19 to 21.42	80	50	81	6	74	29	6
7/ 8	2 40.2	0.26	2 42.8	0.39	10.4	0.93	1.23	17.31	18.21 to 21.42	80	61	89	6	75	29	5
8/ 9	2 44.9	0.41	2 47.5	0.53	10.5	0.93	1.23	17.32	18.22 to 21.43	80	73	95	6	75	29	5
9/10	2 49.6	0.55	2 52.1	1.07	10.5	0.94	1.24	17.33	18.24 to 21.43	80	84	98	6	75	28	5
10/11	2 54.2	1.09	2 56.7	1.21	10.6	0.95	1.25	17.33	18.26 to 21.43	80	95	100	5	75	28	5
11/12	2 58.7	1.23	3 1.3	1.35	10.7	0.96	1.26	17.34	18.28 to 21.43	81	106	100	5	76	28	5
12/13	3 3.2	1.37	3 5.8	1.48	10.7	0.96	1.26	17.34	18.29 to 21.43	81	117	98	5	76	28	5
13/14	3 7.7	1.50	3 10.3	2.02	10.8	0.97	1.27	17.35	18.31 to 21.43	81	127	94	5	76	27	5
14/15	3 12.2	2.04	3 14.8	2.15	10.9	0.98	1.28	17.35	18.33 to 21.43	81	138	89	5	77	27	5
15/16	3 16.6	2.17	3 19.2	2.28	10.9	0.99	1.29	17.36	18.35 to 21.43	81	148	83	4	77	27	5
16/17	3 20.9	2.31	3 23.5	2.41	11.0	1.00	1.29	17.36	18.36 to 21.42	81	158	75	4	77	27	5
17/18	3 25.2	2.44	3 27.8	2.54	11.1	1.01	1.30	17.37	18.38 to 21.42	81	166	66	4	78	26	5
18/19	3 29.5	2.57	3 32.1	3.07	11.1	1.02	1.31	17.37	18.40 to 21.41	82	169	57	4	78	26	5
19/20	3 33.8	3.09	3 36.4	3.19	11.2	1.03	1.32	17.37	18.42 to 21.40	82	163	47	4	78	26	5
20/21	3 38.0	3.22	3 40.6	3.31	11.3	1.04	1.33	17.38	18.43 to 21.39	82	154	37	4	79	26	5
21/22	3 42.1	3.34	3 44.7	3.43	11.4	1.05	1.33	17.38	18.45 to 21.39	82	142	27	3	79	25	5
22/23	3 46.2	3.46	3 48.9	3.55	11.4	1.06	1.34	17.38	18.47 to 21.37	82	130	18	3	79	25	5
23/24	3 50.3	3.58	3 53.0	4.07	11.5	1.07	1.35	17.38	18.49 to 21.36	82	118	10	3	80	25	4
24/25	3 54.4	4.10	3 57.0	4.19	11.6	1.08	1.36	17.38	18.51 to 21.35	82	105	4	3	80	25	4
25/26	3 58.4	4.22	4 1.0	4.30	11.6	1.09	1.37	17.38	18.52 to 21.34	82	92	0	3	80	24	4
26/27	4 2.3	4.33	4 5.0	4.41	11.7	1.10	1.38	17.38	18.54 to 21.32	82	78	0	3	81	24	4
27/28	4 6.3	4.44	4 8.9	4.52	11.8	1.11	1.38	17.38	18.56 to 21.31	82	64	2	3	81	24	4
28/29	4 10.2	4.55	4 12.8	5.03	11.9	1.12	1.39	17.38	18.58 to 21.29	82	50	7	2	81	24	4

March 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	4 14.0	5.06	4 16.7	5.13	11.9	1.13	1.40	17.38	18.60 to 21.27	82	37	15	2	82	23	4
2/ 3	4 17.8	5.16	4 20.5	5.23	12.0	1.14	1.41	17.38	19.02 to 21.25	82	24	24	2	82	23	4
3/ 4	4 21.6	5.27	4 24.3	5.33	12.1	1.16	1.42	17.38	19.03 to 21.23	82	14	35	2	83	23	4
4/ 5	4 25.3	5.37	4 28.0	5.43	12.1	1.17	1.43	17.38	19.05 to 21.21	82	11	46	2	83	23	4
5/ 6	4 29.0	5.47	4 31.7	5.53	12.2	1.18	1.44	17.38	19.07 to 21.19	82	20	57	2	83	23	4
6/ 7	4 32.7	5.56	4 35.4	6.02	12.3	1.19	1.44	17.37	19.09 to 21.16	82	30	67	2	84	22	4
7/ 8	4 36.3	6.06	4 39.0	6.11	12.4	1.21	1.45	17.37	19.11 to 21.14	82	42	77	2	84	22	3
8/ 9	4 39.9	6.15	4 42.6	6.20	12.4	1.22	1.46	17.37	19.13 to 21.11	82	53	85	2	84	22	3
9/10	4 43.5	6.24	4 46.2	6.29	12.5	1.23	1.47	17.36	19.15 to 21.09	82	64	91	2	85	22	3
10/11	4 47.0	6.33	4 49.7	6.38	12.6	1.24	1.48	17.36	19.16 to 21.06	82	75	96	2	85	21	3
11/12	4 50.5	6.41	4 53.2	6.46	12.6	1.26	1.49	17.35	19.18 to 21.03	82	86	99	1	85	21	3
12/13	4 54.0	6.49	4 56.7	6.54	12.7	1.27	1.50	17.35	19.20 to 20.60	82	97	100	1	86	21	3
13/14	4 57.4	6.57	5 0.1	7.02	12.8	1.28	1.51	17.34	19.22 to 20.56	82	108	100	1	86	21	3
14/15	5 0.8	7.05	5 3.5	7.09	12.9	1.30	1.51	17.34	19.24 to 20.53	82	119	98	1	87	21	3
15/16	5 4.2	7.13	5 6.9	7.17	12.9	1.31	1.52	17.33	19.26 to 20.50	81	129	94	1	87	20	3
16/17	5 7.5	7.20	5 10.2	7.24	13.0	1.33	1.53	17.33	19.28 to 20.46	81	140	88	1	87	20	3
17/18	5 10.8	7.28	5 13.5	7.31	13.1	1.34	1.54	17.32	19.30 to 20.43	81	151	81	1	88	20	3
18/19	5 14.1	7.35	5 16.8	7.38	13.1	1.35	1.55	17.31	19.32 to 20.39	81	161	73	1	88	20	2
19/20	5 17.3	7.41	5 20.0	7.44	13.2	1.37	1.56	17.31	19.34 to 20.35	81	169	64	1	88	20	2
20/21	5 20.5	7.48	5 23.2	7.51	13.3	1.38	1.57	17.30	19.36 to 20.31	81	168	54	1	89	19	2
21/22	5 23.7	7.54	5 26.4	7.57	13.3	1.40	1.58	17.29	19.38 to 20.27	81	159	43	1	89	19	2
22/23	5 26.9	8.00	5 29.6	8.03	13.4	1.41	1.59	17.28	19.40 to 20.22	80	147	33	1	90	19	2
23/24	5 30.0	8.06	5 32.7	8.08	13.5	1.43	1.59	17.28	19.42 to 20.18	80	135	22	1	90	19	2
24/25	5 33.1	8.12	5 35.8	8.14	13.6	1.44	1.60	17.27	19.44 to 20.13	80	122	13	1	90	19	2
25/26	5 36.2	8.18	5 38.9	8.19	13.6	1.46	1.61	17.26	19.46 to 20.08	80	108	6	1	91	19	2
26/27	5 39.2	8.23	5 42.0	8.24	13.7	1.47	1.62	17.25	19.48 to 20.04	80	94	1	1	91	18	2
27/28	5 42.3	8.28	5 45.0	8.29	13.8	1.49	1.63	17.24	19.50 to 19.58	79	80	0	1	91	18	2
28/29	5 45.2	8.33	5 48.0	8.34	13.8	1.50	1.64	17.23	19.52 to 19.53	79	66	1	1	92	18	2

Ephemeris for 104P/Kowal 2 (UK)

Omega=191.9109 OMEGA=246.1492 i= 15.4892 q= 1.396513 a= 3.368289
e=0.585394 P= 6.182 T= 1998 March 2.1804 Equinox= 2000
Magnitudes calculated from m=10.1+5.0*Log(d)+15.0*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	22 37.6	6.52	22 40.1	7.07	13.7	1.32	1.70	17.53	17.19 to 20.24	93	57	9	1	68	10	1
7/ 8	22 46.0	6.36	22 48.6	6.52	13.6	1.34	1.67	17.41	17.17 to 20.16	90	17	59	1	67	10	-1
12/13	22 55.3	6.26	22 57.8	6.42	13.5	1.36	1.64	17.31	17.17 to 20.10	87	80	99	1	66	11	0
17/18	23 5.2	6.22	23 7.7	6.38	13.4	1.37	1.61	17.21	17.18 to 20.05	85	143	85	1	66	12	0
22/23	23 15.7	6.23	23 18.2	6.39	13.3	1.39	1.59	17.12	17.20 to 20.01	82	156	40	1	65	13	0
27/28	23 26.9	6.29	23 29.4	6.45	13.3	1.41	1.56	17.03	17.24 to 19.58	80	99	3	1	65	13	0

January 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	23 38.6	6.40	23 41.2	6.56	13.2	1.42	1.54	16.55	17.28 to 19.55	77	34	13	1	65	14	0
6/ 7	23 50.9	6.55	23 53.5	7.11	13.1	1.44	1.52	16.48	17.33 to 19.54	75	36	66	1	64	15	1
11/12	0 3.8	7.14	0 6.3	7.31	13.0	1.45	1.50	16.41	17.39 to 19.53	73	99	100	1	64	15	1
16/17	0 17.1	7.36	0 19.6	7.53	13.0	1.47	1.48	16.35	17.46 to 19.52	71	158	83	1	65	16	1
21/22	0 30.8	8.02	0 33.4	8.18	12.9	1.49	1.46	16.29	17.53 to 19.51	69	144	39	1	65	17	2
26/27	0 45.1	8.30	0 47.7	8.46	12.9	1.50	1.45	16.23	18.01 to 19.51	68	83	2	1	66	17	2
31/32	0 59.7	8.60	1 2.3	9.16	12.9	1.52	1.43	16.18	18.09 to 19.51	66	15	18	1	66	18	2

February 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
5/ 6	1 14.7	9.31	1 17.4	9.47	12.8	1.53	1.42	16.14	18.17 to 19.51	65	52	72	1	67	18	2
10/11	1 30.1	10.04	1 32.8	10.19	12.8	1.55	1.41	16.09	18.26 to 19.51	63	113	100	1	68	18	2
15/16	1 45.9	10.36	1 48.5	10.51	12.8	1.57	1.41	16.05	18.35 to 19.50	62	168	83	1	69	19	2
20/21	2 1.9	11.08	2 4.5	11.23	12.8	1.59	1.40	16.02	18.43 to 19.50	61	134	37	1	71	19	2
25/26	2 18.1	11.39	2 20.8	11.53	12.8	1.61	1.40	15.58	18.52 to 19.49	60	69	0	1	72	19	2

March 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	2 34.7	12.09	2 37.4	12.22	12.8	1.63	1.40	15.55	19.02 to 19.47	59	2	24	1	74	20	2
7/ 8	2 51.4	12.37	2 54.1	12.49	12.9	1.65	1.40	15.52	19.11 to 19.45	58	65	77	1	76	20	2
12/13	3 8.2	13.02	3 11.0	13.13	12.9	1.67	1.40	15.49	19.20 to 19.42	57	122	100	1	77	20	2
17/18	3 25.2	13.24	3 28.0	13.35	13.0	1.70	1.41	15.46	19.30 to 19.39	56	177	81	1	79	20	1
22/23	3 42.3	13.43	3 45.1	13.53	13.0	1.72	1.42	15.44	Not Observable	55	124	33	1	81	20	1
27/28	3 59.4	13.59	4 2.2	14.07	13.1	1.75	1.43	15.41	Not Observable	54	55	0	1	83	20	1

April 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	4 16.4	14.10	4 19.2	14.17	13.2	1.78	1.44	15.39	Not Observable	54	14	30	1	85	20	0
6/ 7	4 33.4	14.17	4 36.3	14.23	13.3	1.82	1.45	15.36	Not Observable	53	74	80	1	88	20	0
11/12	4 50.4	14.20	4 53.2	14.24	13.4	1.85	1.47	15.33	Not Observable	52	130	100	1	90	20	0
16/17	5 7.1	14.18	5 10.0	14.22	13.6	1.89	1.49	15.30	Not Observable	51	173	78	1	92	20	0
21/22	5 23.7	14.12	5 26.6	14.14	13.7	1.92	1.50	15.27	Not Observable	51	112	27	1	94	20	0
26/27	5 40.1	14.01	5 43.0	14.03	13.8	1.97	1.53	15.24	Not Observable	50	41	0	1	96	19	0

Ephemeris for Hale-Bopp 1995 O1 (Southern hemisphere)

Omega=130.5910 OMEGA=282.4708 i= 89.4293 q= 0.914104 a=186.856909

e=0.995108 P= 2554.252 T= 1997 April 1.1354 Equinox= 2000
Magnitudes calculated from m=-0.7+5.0*Log(d)+ 7.5*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	7 24.8	-60.40	7 25.5	-60.46	6.2	3.47	3.61	2.38	20.34 to 3.05	90	101	9	38	322	0	0
7/ 8	7 14.3	-61.47	7 14.9	-61.52	6.3	3.51	3.67	2.08	20.40 to 3.04	91	98	59	36	329	-6	-5
12/13	7 2.8	-62.42	7 3.3	-62.47	6.3	3.56	3.72	1.36	20.45 to 3.03	92	85	99	34	337	-6	-4
17/18	6 50.5	-63.26	6 50.9	-63.30	6.4	3.61	3.78	1.04	20.49 to 3.04	92	82	85	32	344	-6	-3
22/23	6 37.8	-63.58	6 38.1	-64.01	6.5	3.66	3.83	0.32	20.51 to 3.06	92	89	40	31	352	-6	-2
27/28	6 24.8	-64.18	6 25.1	-64.20	6.6	3.72	3.88	23.59	20.53 to 3.10	92	96	3	29	1	-7	-1

January 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 12.1	-64.26	6 12.3	-64.27	6.6	3.77	3.94	23.27	20.53 to 3.14	92	94	13	27	9	-6	0
6/ 7	5 59.8	-64.23	6 0.0	-64.23	6.7	3.83	3.99	22.55	20.52 to 3.20	92	85	66	26	16	-6	0
11/12	5 48.3	-64.11	5 48.6	-64.10	6.8	3.89	4.04	22.23	20.50 to 3.26	92	84	100	25	24	-6	1
16/17	5 37.8	-63.49	5 38.1	-63.48	6.9	3.95	4.10	21.53	20.47 to 3.33	91	92	83	23	32	-5	1
21/22	5 28.4	-63.21	5 28.7	-63.19	7.0	4.02	4.15	21.24	20.43 to 3.40	91	99	39	22	39	-5	2
26/27	5 20.1	-62.46	5 20.6	-62.43	7.0	4.08	4.20	20.56	20.38 to 3.48	90	96	2	21	46	-4	2
31/32	5 13.1	-62.06	5 13.6	-62.03	7.1	4.15	4.25	20.30	20.32 to 3.55	89	82	18	20	52	-4	3

February 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
5/ 6	5 7.3	-61.23	5 7.9	-61.19	7.2	4.21	4.30	20.04	20.25 to 4.03	89	79	72	19	59	-3	3
10/11	5 2.7	-60.37	5 3.3	-60.33	7.3	4.28	4.36	19.40	20.18 to 4.10	88	90	100	18	65	-2	3
15/16	4 59.1	-59.50	4 59.8	-59.46	7.3	4.35	4.41	19.17	20.11 to 4.18	87	102	83	17	70	-2	3
20/21	4 56.4	-59.02	4 57.2	-58.57	7.4	4.42	4.46	18.54	20.03 to 4.25	86	103	37	16	76	-1	4
25/26	4 54.7	-58.13	4 55.6	-58.09	7.5	4.48	4.51	18.33	19.54 to 4.32	85	88	0	16	81	-1	4

Ephemeris for Hale-Bopp 1995 O1 (Southern hemisphere)

March 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	4 53.8	-57.25	4 54.7	-57.21	7.5	4.55	4.56	18.12	19.46 to 4.38	84	73	24	15	86	0	3
7/ 8	4 53.6	-56.38	4 54.6	-56.34	7.6	4.62	4.61	17.53	19.38 to 4.17	83	81	77	14	91	0	3
12/13	4 54.1	-55.53	4 55.1	-55.48	7.7	4.69	4.66	17.33	19.29 to 3.40	82	98	100	14	96	0	3
17/18	4 55.2	-55.09	4 56.2	-55.05	7.7	4.75	4.71	17.15	19.21 to 3.07	81	109	81	13	100	0	3
22/23	4 56.7	-54.27	4 57.8	-54.23	7.8	4.82	4.76	16.57	19.12 to 2.37	81	100	33	12	105	1	3
27/28	4 58.8	-53.48	4 59.9	-53.44	7.9	4.89	4.81	16.39	19.04 to 2.08	80	78	0	12	109	1	3

April 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	5 1.3	-53.11	5 2.4	-53.07	7.9	4.95	4.86	16.22	18.56 to 1.42	79	71	30	11	114	1	3
6/ 7	5 4.1	-52.37	5 5.2	-52.33	8.0	5.01	4.91	16.05	18.48 to 1.17	78	88	80	11	118	2	2
11/12	5 7.3	-52.05	5 8.4	-52.02	8.0	5.08	4.96	15.48	18.40 to 0.53	78	106	100	10	122	2	2
16/17	5 10.7	-51.37	5 11.9	-51.33	8.1	5.14	5.01	15.32	18.33 to 0.31	77	110	78	10	126	2	2
21/22	5 14.4	-51.11	5 15.6	-51.08	8.2	5.20	5.06	15.16	18.26 to 0.10	76	92	27	10	130	2	2
26/27	5 18.4	-50.49	5 19.6	-50.46	8.2	5.26	5.10	15.00	18.20 to 23.49	76	70	0	9	134	3	1

May 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	5 22.5	-50.29	5 23.7	-50.27	8.3	5.31	5.15	14.45	18.14 to 23.29	75	75	36	9	138	3	1
6/ 7	5 26.8	-50.13	5 28.1	-50.11	8.3	5.37	5.20	14.29	18.09 to 23.10	75	96	82	9	142	3	1
11/12	5 31.3	-50.00	5 32.5	-49.58	8.4	5.43	5.25	14.14	18.05 to 22.52							
									5.36 to 5.48	74	111	100	8	146	3	1
16/17	5 35.9	-49.50	5 37.1	-49.49	8.4	5.48	5.30	13.59	18.01 to 22.34							
									5.24 to 5.52	74	106	73	8	150	3	0
21/22	5 40.6	-49.44	5 41.8	-49.42	8.5	5.53	5.34	13.44	17.57 to 22.17							
									5.11 to 5.56	74	82	20	8	154	3	0
26/27	5 45.4	-49.40	5 46.6	-49.39	8.5	5.59	5.39	13.29	17.55 to 22.01							
									4.58 to 5.60	74	68	2	7	158	3	0
31/32	5 50.3	-49.40	5 51.5	-49.39	8.6	5.64	5.44	13.14	17.53 to 21.45							
									4.44 to 6.03	74	82	40	7	162	3	0

Ephemeris for Mueller 1997 D1 (UK)

Note: the comet may be fainter than predicted here.

Omega=184.9589 OMEGA=279.1719 i=141.8886 q= 2.247691 a=**********
e=1.001120 P=********* T= 1997 October 11.6088 Equinox= 2000
Magnitudes calculated from m= 9.0+5.0*Log(d)+ 5.1*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	5 34.7	-3.16	5 37.2	-3.14	11.6	1.42	2.33	0.50	21.45 to 3.54	151	148	9	1	331	-29	12
7/ 8	5 10.9	-5.35	5 13.4	-5.32	11.7	1.43	2.34	0.06	21.22 to 2.50	152	81	59	1	353	-29	-11
12/13	4 47.6	-7.39	4 50.1	-7.34	11.7	1.46	2.36	23.23	21.01 to 1.45	148	25	99	1	14	-28	-10
17/18	4 25.7	-9.23	4 28.1	-9.16	11.8	1.52	2.38	22.41	20.44 to 0.39	143	72	85	1	29	-27	-8
22/23	4 5.7	-10.46	4 8.1	-10.38	11.9	1.59	2.39	22.02	20.31 to 23.32	135	130	40	1	40	-24	-6
27/28	3 47.9	-11.49	3 50.3	-11.40	12.1	1.68	2.41	21.24	20.29 to 22.20	128	146	3	1	48	-21	-5

Ephemeris for 1997 J2 Meunier-Dupouy (UK)

Omega=122.6796 OMEGA=148.8428 i= 91.2731 q= 3.050994 a=**********
e=1.000840 P=********* T= 1998 March 10.4514 Equinox= 2000
Magnitudes calculated from m= 5.7+5.0*Log(d)+ 6.3*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	18 8.1	47.21	18 9.4	47.22	11.5	3.35	3.20	13.22	17.19 to 21.36							
									5.08 to 6.21	72	67	9	2	22	11	-6
7/ 8	18 21.5	46.09	18 22.9	46.11	11.5	3.36	3.18	13.16	17.17 to 21.20							
									5.12 to 6.26	71	86	59	2	20	11	-6
12/13	18 34.5	44.58	18 35.9	45.01	11.5	3.36	3.17	13.09	17.17 to 21.03							
									5.15 to 6.31	70	112	99	2	18	11	-5
17/18	18 47.1	43.49	18 48.6	43.53	11.5	3.37	3.16	13.02	17.18 to 20.48							
									5.16 to 6.35	69	114	85	2	16	11	-5
22/23	18 59.4	42.42	19 0.9	42.47	11.5	3.39	3.14	12.55	17.20 to 20.32							
									5.17 to 6.38	67	93	40	2	14	11	-5
27/28	19 11.3	41.38	19 12.9	41.43	11.5	3.40	3.13	12.47	17.24 to 20.16							
									5.17 to 6.39	66	67	3	2	11	11	-5

January 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	19 22.8	40.36	19 24.4	40.42	11.5	3.42	3.12	12.39	17.28 to 20.01							
									5.17 to 6.40	64	62	13	2	9	10	-5
6/ 7	19 33.9	39.38	19 35.6	39.45	11.5	3.44	3.11	12.30	17.33 to 19.45							
									5.15 to 6.39	62	92	66	2	6	10	-4
11/12	19 44.7	38.43	19 46.4	38.51	11.5	3.46	3.10	12.21	17.39 to 19.30							
									5.12 to 6.37	61	122	100	2	4	10	-4
16/17	19 55.1	37.52	19 56.9	37.60	11.5	3.49	3.09	12.12	17.46 to 19.15							
									5.09 to 6.34	59	117	83	2	1	10	-4
21/22	20 5.1	37.04	20 7.0	37.12	11.5	3.51	3.09	12.02	17.53 to 19.00							
									5.04 to 6.30	57	87	39	2	357	10	-3

Ephemeris for 1997 J2 Meunier-Dupouy (UK)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
26/27	20 14.8	36.19	20 16.7	36.29	11.5	3.53	3.08	11.52	18.01 to 18.46 4.59 to 6.24	55	56	2	2	354	9	-3
31/32	20 24.2	35.38	20 26.1	35.48	11.5	3.55	3.07	11.42	18.09 to 18.31 4.53 to 6.18	54	64	18	2	351	9	-3

February 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
5/ 6	20 33.2	35.01	20 35.1	35.12	11.5	3.58	3.07	11.31	4.46 to 6.11	52	105	72	2	347	9	-3
10/11	20 41.9	34.27	20 43.9	34.38	11.5	3.60	3.06	11.20	4.39 to 6.03	50	131	100	1	343	8	-2
15/16	20 50.2	33.57	20 52.3	34.08	11.5	3.61	3.06	11.09	4.31 to 5.54	49	113	83	1	339	8	-2
20/21	20 58.3	33.29	21 0.3	33.41	11.6	3.63	3.06	10.57	4.22 to 5.44	48	75	37	1	334	8	-2
25/26	21 6.0	33.05	21 8.1	33.17	11.6	3.64	3.05	10.45	4.13 to 5.34	47	46	0	1	330	8	-2

March 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	21 13.4	32.43	21 15.5	32.56	11.6	3.65	3.05	10.33	4.03 to 5.23	46	78	24	1	325	7	-1
7/ 8	21 20.5	32.24	21 22.7	32.37	11.6	3.66	3.05	10.21	3.52 to 5.11	46	122	77	1	320	7	-1
12/13	21 27.3	32.08	21 29.5	32.21	11.6	3.66	3.05	10.08	3.41 to 4.59	46	134	100	1	315	7	-1
17/18	21 33.8	31.53	21 36.0	32.07	11.6	3.66	3.05	9.54	3.29 to 4.47	46	101	81	1	310	6	-1
22/23	21 40.0	31.40	21 42.1	31.54	11.6	3.66	3.05	9.41	3.16 to 4.34	46	58	33	1	305	6	-1
27/28	21 45.8	31.30	21 48.0	31.44	11.6	3.65	3.06	9.27	3.03 to 4.21	47	49	0	1	300	6	0

April 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	21 51.4	31.20	21 53.6	31.34	11.6	3.63	3.06	9.13	2.50 to 4.08	48	97	30	1	295	5	0
6/ 7	21 56.6	31.12	21 58.8	31.26	11.6	3.62	3.06	8.58	2.36 to 3.54	49	136	80	1	290	5	0
11/12	22 1.4	31.05	22 3.6	31.19	11.5	3.60	3.07	8.44	2.21 to 3.40	51	125	100	2	286	5	0
16/17	22 5.9	30.58	22 8.2	31.13	11.5	3.57	3.07	8.28	2.07 to 3.26	53	82	78	2	281	4	0
21/22	22 10.1	30.52	22 12.3	31.07	11.5	3.54	3.08	8.13	1.51 to 3.12	55	42	27	2	277	4	0
26/27	22 13.9	30.46	22 16.1	31.01	11.5	3.51	3.09	7.57	1.35 to 2.57	58	66	0	2	273	4	0

May 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	22 17.3	30.40	22 19.5	30.55	11.5	3.47	3.09	7.41	1.19 to 2.43	60	119	36	2	269	3	0
6/ 7	22 20.3	30.33	22 22.5	30.49	11.5	3.43	3.10	7.24	1.02 to 2.28	63	140	82	2	266	3	0
11/12	22 22.8	30.26	22 25.1	30.41	11.5	3.38	3.11	7.07	0.45 to 2.14	66	107	100	2	262	2	0
16/17	22 25.0	30.17	22 27.3	30.32	11.4	3.33	3.12	6.49	0.27 to 1.60	69	59	73	2	259	2	0
21/22	22 26.6	30.07	22 28.9	30.22	11.4	3.28	3.13	6.31	0.09 to 1.45	73	42	20	2	256	1	0
26/27	22 27.8	29.54	22 30.1	30.10	11.4	3.23	3.14	6.13	23.51 to 1.31	76	93	2	2	253	1	-1
31/32	22 28.5	29.39	22 30.8	29.55	11.4	3.17	3.16	5.54	23.33 to 1.18	80	138	40	2	250	0	-1

Ephemeris for 1997 T1 Utsunomiya (UK)

Omega= 95.9210 OMEGA= 53.7126 i=127.9944 q= 1.359625 a=**********
e=1.000000 P=********* T= 1997 December 10.0770 Equinox= 2000
Magnitudes calculated from m= 7.9+5.0*Log(d)+10.0*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
3/ 4	18 44.3	12.52	18 46.6	12.56	10.6	1.84	1.36	13.55	17.18 to 19.10	47	36	16	5	41	0	-10
4/ 5	18 44.3	12.27	18 46.6	12.30	10.6	1.85	1.36	13.51	17.18 to 19.03	46	43	25	4	41	0	-10
5/ 6	18 44.3	12.02	18 46.6	12.06	10.6	1.87	1.36	13.47	17.18 to 18.57	45	53	36	4	40	0	-10
6/ 7	18 44.3	11.38	18 46.6	11.42	10.6	1.89	1.36	13.43	17.17 to 18.50	44	64	47	4	39	0	-9
7/ 8	18 44.2	11.15	18 46.6	11.18	10.6	1.90	1.36	13.39	17.17 to 18.44	43	76	59	4	38	0	-9
8/ 9	18 44.3	10.52	18 46.6	10.56	10.6	1.92	1.36	13.35	17.17 to 18.37	42	88	70	4	37	0	-9
9/10	18 44.3	10.30	18 46.6	10.33	10.7	1.93	1.36	13.31	17.17 to 18.31	41	101	80	4	36	0	-9
10/11	18 44.3	10.08	18 46.7	10.12	10.7	1.95	1.36	13.28	17.17 to 18.25	40	113	89	4	35	0	-9
11/12	18 44.3	9.47	18 46.7	9.51	10.7	1.96	1.36	13.24	17.17 to 18.18	40	125	95	4	34	0	-8
12/13	18 44.4	9.27	18 46.7	9.30	10.7	1.98	1.36	13.20	17.17 to 18.12	39	136	99	4	32	0	-8
13/14	18 44.4	9.06	18 46.8	9.10	10.7	1.99	1.36	13.16	17.17 to 18.06	38	146	100	4	31	0	-8
14/15	18 44.5	8.47	18 46.8	8.50	10.8	2.01	1.36	13.12	17.17 to 17.60	37	152	100	4	30	0	-8
15/16	18 44.5	8.27	18 46.9	8.31	10.8	2.02	1.36	13.08	17.18 to 17.54	36	152	96	3	29	0	-8
16/17	18 44.6	8.08	18 47.0	8.12	10.8	2.04	1.36	13.04	17.18 to 17.48	36	148	91	3	28	0	-7
17/18	18 44.6	7.50	18 47.0	7.53	10.8	2.05	1.36	13.00	17.18 to 17.42	35	140	85	3	26	0	-7
18/19	18 44.7	7.32	18 47.1	7.35	10.8	2.06	1.37	12.56	17.18 to 17.36	34	130	77	3	25	0	-7
19/20	18 44.8	7.14	18 47.2	7.18	10.8	2.07	1.37	12.53	17.19 to 17.30	34	120	68	3	23	0	-7
20/21	18 44.9	6.57	18 47.3	7.00	10.9	2.09	1.37	12.49	17.19 to 17.24	33	110	59	3	22	0	-7
21/22	18 44.9	6.40	18 47.4	6.43	10.9	2.10	1.37	12.45	Not Observable	32	99	49	3	20	0	-7
22/23	18 45.0	6.23	18 47.5	6.27	10.9	2.11	1.37	12.41	Not Observable	32	89	40	3	19	0	-6
23/24	18 45.1	6.07	18 47.6	6.10	10.9	2.12	1.38	12.37	Not Observable	31	78	31	3	17	0	-6
24/25	18 45.2	5.51	18 47.7	5.54	10.9	2.13	1.38	12.33	Not Observable	30	67	22	3	15	0	-6
25/26	18 45.3	5.35	18 47.8	5.39	11.0	2.14	1.38	12.30	Not Observable	30	56	14	3	14	0	-6

Ephemeris for 1997 T1 Utsunomiya (Equator)

Note: the comet may be visible from the UK during March.

Omega= 95.9210 OMEGA= 53.7126 i=127.9944 q= 1.359625 a=**********
e=1.000000 P=********* T= 1997 December 10.0770 Equinox= 2000
Magnitudes calculated from m= 7.9+5.0*Log(d)+10.0*Log(r)

December 1997 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	18 44.4	13.18	18 46.7	13.21	10.5	1.82	1.36	13.59	18.46 to 18.49	48	32	9	5	42	0	-11
7/ 8	18 44.2	11.15	18 46.6	11.18	10.6	1.90	1.36	13.39	Not Observable	43	76	59	4	38	0	-10

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
12/13	18 44.4	9.27	18 46.7	9.30	10.7	1.98	1.36	13.20	Not Observable	39	136	99	4	32	0	-9
17/18	18 44.6	7.50	18 47.0	7.53	10.8	2.05	1.36	13.00	Not Observable	35	140	85	3	26	0	-8
22/23	18 45.0	6.23	18 47.5	6.27	10.9	2.11	1.37	12.41	Not Observable	32	89	40	3	19	0	-7
27/28	18 45.5	5.05	18 48.0	5.08	11.0	2.16	1.39	12.22	Not Observable	29	35	3	2	10	0	-6

January 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	18 46.0	3.54	18 48.5	3.57	11.1	2.21	1.40	12.03	Not Observable	27	47	13	2	359	0	-5
6/ 7	18 46.4	2.48	18 49.0	2.52	11.2	2.24	1.42	11.43	Not Observable	26	111	66	2	348	0	-5
11/12	18 46.8	1.48	18 49.4	1.51	11.3	2.26	1.44	11.24	Not Observable	26	160	100	2	336	0	-5
16/17	18 47.1	0.52	18 49.7	0.55	11.4	2.28	1.47	11.05	Not Observable	27	115	83	2	325	0	-4
21/22	18 47.3	-0.01	18 49.9	0.02	11.4	2.28	1.50	10.45	Not Observable	29	59	39	2	314	0	-4
26/27	18 47.3	-0.51	18 49.9	-0.48	11.5	2.28	1.53	10.25	Not Observable	32	19	2	2	306	0	-4
31/32	18 47.0	-1.39	18 49.6	-1.35	11.6	2.26	1.56	10.06	Not Observable	35	82	18	2	298	0	-3

February 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
5/ 6	18 46.4	-2.25	18 49.1	-2.22	11.7	2.24	1.60	9.45	5.14 to 5.20	39	147	72	2	292	0	-3
10/11	18 45.5	-3.10	18 48.1	-3.07	11.8	2.21	1.64	9.25	4.55 to 5.21	43	141	100	2	287	-1	-3
15/16	18 44.1	-3.55	18 46.8	-3.51	11.8	2.17	1.68	9.04	4.35 to 5.21	48	84	83	2	283	-1	-3
20/21	18 42.2	-4.39	18 44.9	-4.36	11.9	2.13	1.72	8.42	4.15 to 5.21	53	26	37	2	280	-2	-3
25/26	18 39.7	-5.25	18 42.4	-5.22	11.9	2.08	1.76	8.20	3.54 to 5.20	58	49	0	2	277	-3	-3

March 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	18 36.5	-6.11	18 39.1	-6.08	12.0	2.02	1.81	7.57	3.32 to 5.20	63	122	24	2	275	-4	-3
7/ 8	18 32.3	-6.59	18 35.0	-6.57	12.0	1.96	1.85	7.33	3.10 to 5.19	69	164	77	2	273	-5	-4
12/13	18 27.2	-7.50	18 29.9	-7.48	12.1	1.89	1.90	7.08	2.46 to 5.18	75	106	100	2	271	-6	-4
17/18	18 20.9	-8.44	18 23.6	-8.42	12.1	1.83	1.95	6.42	2.21 to 5.16	81	46	81	2	270	-7	-4
22/23	18 13.2	-9.41	18 15.9	-9.40	12.1	1.76	1.99	6.15	1.54 to 5.15	88	21	33	2	269	-9	-4
27/28	18 3.9	-10.42	18 6.7	-10.42	12.1	1.69	2.04	5.46	1.26 to 5.13	95	95	0	2	268	-11	-5

April 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	17 53.0	-11.47	17 55.7	-11.48	12.2	1.63	2.09	5.15	0.56 to 5.12	103	169	30	2	268	-13	-5
6/ 7	17 40.1	-12.56	17 42.9	-12.58	12.2	1.57	2.14	4.43	0.25 to 5.10	111	122	80	1	268	-15	-5
11/12	17 25.1	-14.08	17 28.0	-14.10	12.2	1.52	2.19	4.08	23.51 to 5.08	119	59	100	1	268	-18	-5
16/17	17 8.2	-15.20	17 11.1	-15.23	12.3	1.48	2.24	3.31	23.16 to 5.07	128	6	78	1	269	-20	-6
21/22	16 49.4	-16.30	16 52.2	-16.35	12.3	1.45	2.30	2.53	22.40 to 5.05	138	76	27	1	270	-22	-5
26/27	16 29.0	-17.36	16 31.9	-17.42	12.4	1.44	2.35	2.13	22.02 to 5.04	147	156	0	1	272	-24	-5

May 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	16 7.5	-18.33	16 10.4	-18.41	12.5	1.44	2.40	1.32	21.24 to 5.03	157	129	36	0	275	-25	-4
6/ 7	15 45.8	-19.20	15 48.7	-19.29	12.6	1.46	2.45	0.50	20.47 to 4.53	167	63	82	0	280	-25	-3
11/12	15 24.4	-19.55	15 27.3	-20.06	12.8	1.49	2.50	0.09	20.10 to 4.08	176	6	100	0	304	-25	-2
16/17	15 4.1	-20.19	15 6.9	-20.30	12.9	1.55	2.55	23.29	19.35 to 3.22	173	69	73	0	80	-23	-1
21/22	14 45.4	-20.33	14 48.2	-20.45	13.1	1.62	2.61	22.50	19.03 to 2.38	165	142	20	0	91	-21	-1
26/27	14 28.6	-20.39	14 31.4	-20.52	13.3	1.70	2.66	22.14	18.53 to 1.55	156	139	2	0	96	-19	0
31/32	14 13.8	-20.40	14 16.6	-20.54	13.5	1.80	2.71	21.39	18.54 to 1.14	148	70	40	0	98	-17	0

TA format (example)

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                        Shanklin
970328.89 S    9.5 NP  20   T    10  75  2.5   2                Shanklin
961214.70 S    3.8 AA   8   B        20  6     7/  0.50   40   Baroni
```

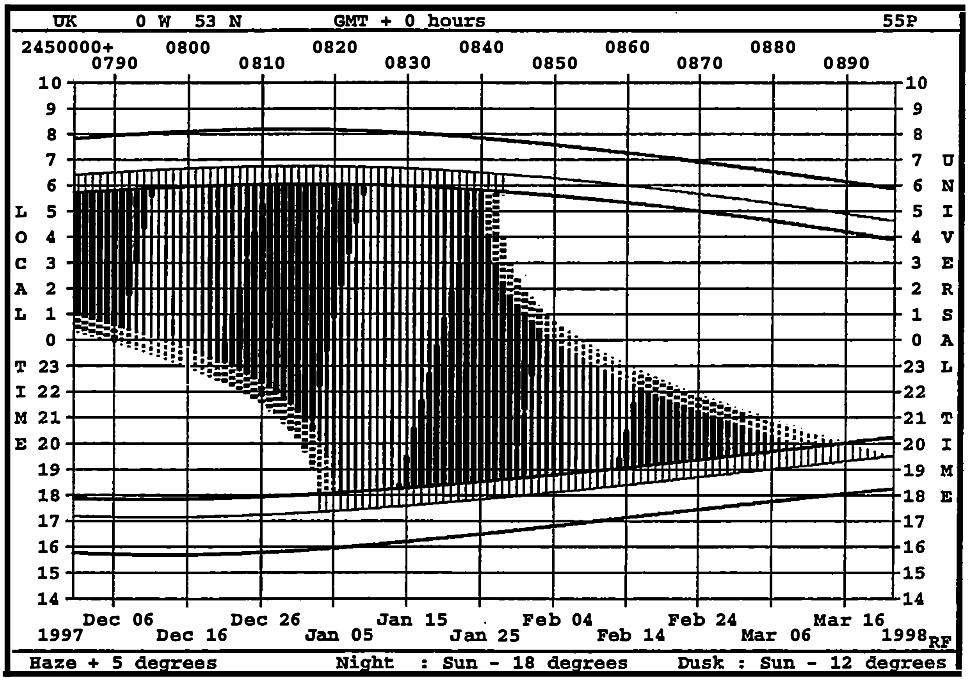
ICQ format (example)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
 991992    1992  5 18.94  S   9.3 AA   7.5R     50    6     4        135 ICQ XX BEA
  P1955A1  1955  6 18.08      5.0 BD   5  R      6    5    s5   0.75 335 ICQ XX STO01
```

Charts

In this issue there are visibility diagrams for comet 55P/Tempel-Tuttle and 103P/Hartley 2, produced using software written by Richard Fleet. The finder chart for comet 29P/Schwassmann-Wachmann 1 shows galaxies with magnitudes given immediately after the galaxy number. The finder chart for C/Hale-Bopp (1995 O1) shows stars down to 9th magnitude. Where possible stars from the AAVSO atlas (or other approved source) should be used as comparisons. Both these charts were produced using Megastar software.

The other comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet.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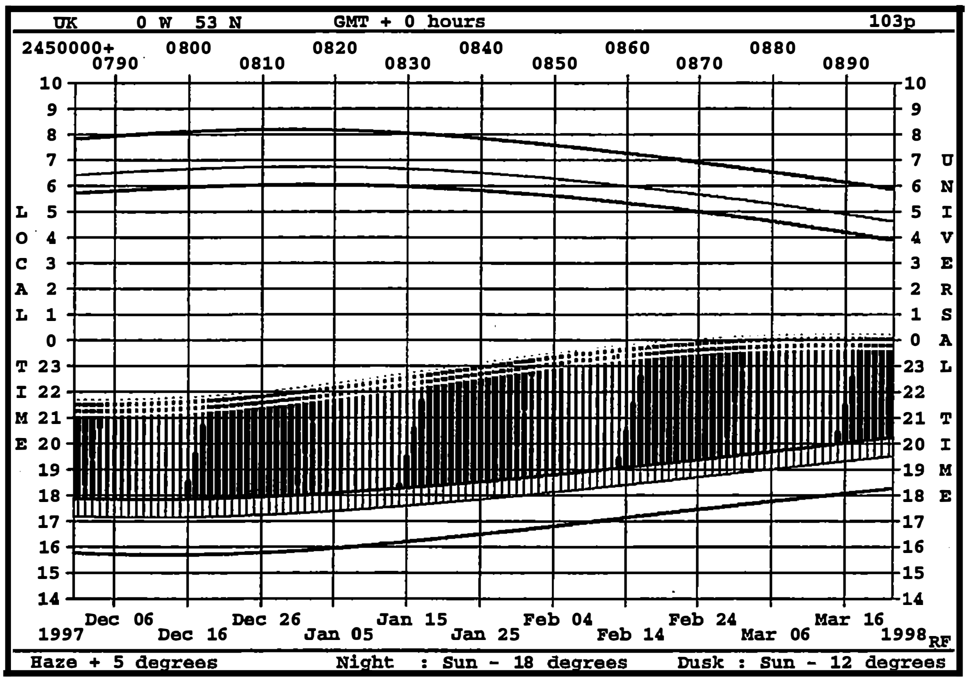
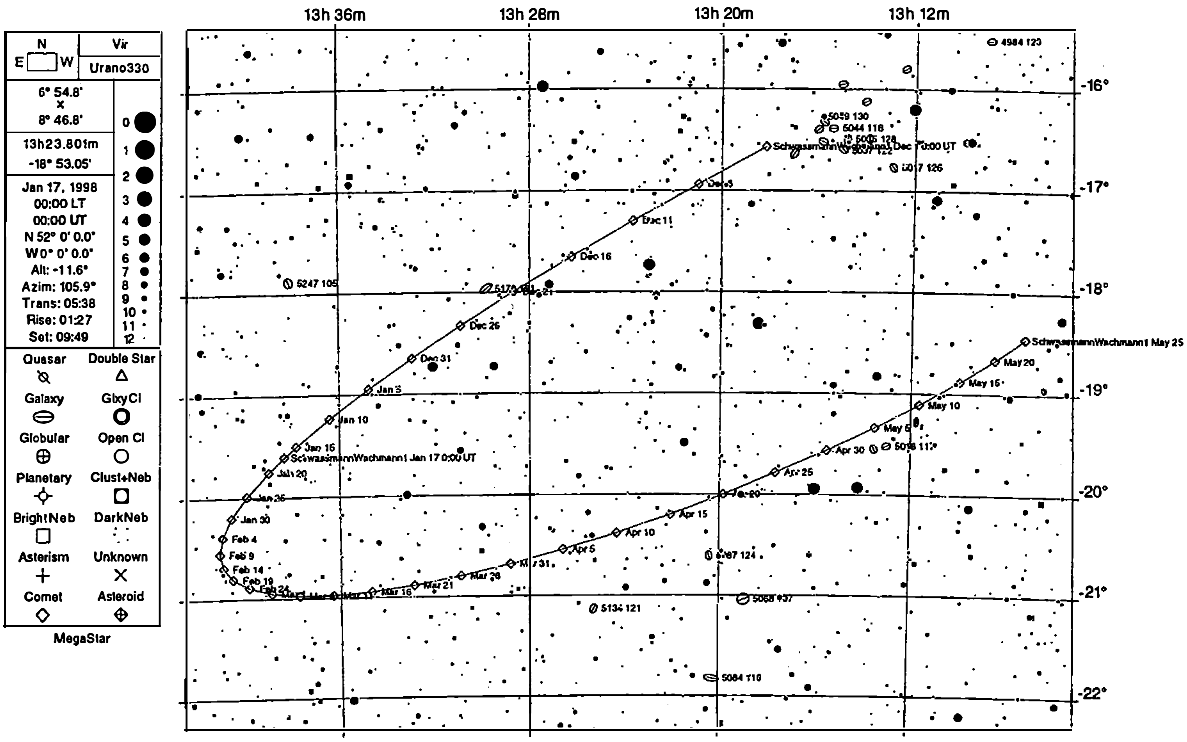
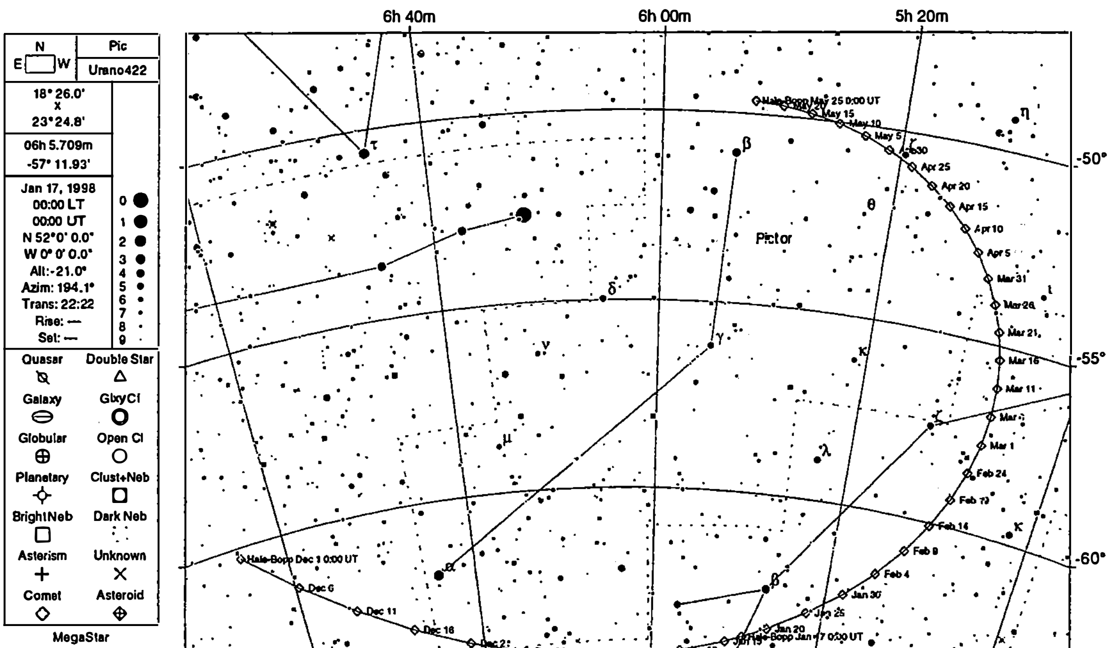
2450000+
0790 0800 0810 0820 0830 0840 0850 0860 0870 0880 0890
LOCAL TIME
UNIVERSAL TIME
Dec 06 Dec 16 Dec 26 Jan 05 Jan 15 Jan 25 Feb 04 Feb 14 Feb 24 Mar 06 Mar 16
1997 1998
RF
Haze + 5 degrees Night : Sun - 18 degrees Dusk : Sun - 12 degrees


UK 0 W 53 N GMT + 0 hours 103p
2450000+
0790 0800 0810 0820 0830 0840 0850 0860 0870 0880 0890
LOCAL TIME
UNIVERSAL TIME
Dec 06 Dec 16 Dec 26 Jan 05 Jan 15 Jan 25 Feb 04 Feb 14 Feb 24 Mar 06 Mar 16
1997 1998
RF
Haze + 5 degrees Night : Sun - 18 degrees Dusk : Sun - 12 degrees



Jan 17, 1998 0:00 29P/Schwassmann-Wachmann 1



Jan 17, 1998 0:00 C/Hale-Bopp (1995 O1)

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The most common ones are AA (AAVSO atlas), VB (BAA VS chart), HS (Hubble catalogue), SC (Sky Catalogue 2000).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

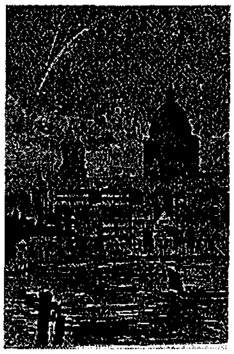
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f/ no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Ref	Comments



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 5, No 1 (Issue 9), 1998 May

A May Day in February!

Comet Section Meeting, Institute of Astronomy, Cambridge, 1998 February 14

The day started early for me, or perhaps I should say the previous day finished late as I was up till nearly 3am. This wasn't because the sky was clear or a Valentine's Ball, but because I'd been reffing an ice hockey match at Peterborough! Despite this I was at the IOA to welcome the first arrivals and to get things set up for the day, which was more reminiscent of May than February. The University now offers an undergraduate astronomy course and lectures are given in the Hoyle seminar room from 10:00 till 12:15, so the pattern of the event has changed a little from previous years, allowing a little more time for leisurely chat between the 50 or so participants.

After welcoming refreshments, members were able to tour the Royal Greenwich Observatory, perhaps for the last time, guided by Margaret Penston. Members of the Cambridge University Astronomical Society (CUAS) demonstrated the Northumberland and Thorrowgood refractors and the Schmidt telescope of the University Observatories. The Northumberland was trained on Venus, but unfortunately the Thorrowgood dome had suffered mechanical failure and the telescope could not be pointed at the Sun. After the tour, a buffet lunch, prepared by CUAS was available, though a few people were dragged off to a local pub. During lunch Roger Griffin kindly showed off the 36" reflector. Sales stands from the BAA, CUAS, David Early, Earth & Sky and TA attracted much attention and there were displays of the latest comet light curves and photographs of comet Hale-Bopp taken by Michael Hendrie and Glynn Marsh.

The formal session started after lunch, and I opened the talks with some comments on visual observation. Detailed instructions are given in the Section guide, so here I concentrated on what is done with the observations and why it is important to be accurate and objective when making them. The first task in observing a comet is finding it – not a problem with the likes of Hale-Bopp and Hyakutake, but a far harder task for the typical periodic comet. The ephemerides in *The Comet's Tale* and on the Section web page give an indication when it is possible to observe a given comet. They also give the position of the comet in B1950 co-ordinates (as used by the AAVSO atlas) and J2000 (as used by the Millennium atlas): if you use the wrong set you won't see the comet! You can use PC planetarium programs such as *Megastar* or *Guide* to produce accurate finder charts, however when you know exactly where to look it is important not to convince yourself that you can see something that isn't there. I sometimes wonder if some of the observations that I make of comets on the limit of the telescope and seeing conditions are figments of my imagination, despite the fact that they seem to lie on the light curve. The Tycho catalogue now gives a good source of magnitudes down to around 10.5 and these can be used to correct Guide Star magnitudes in the same field. If you haven't got access to this catalogue then you can always give a field sketch showing the stars you have used in the magnitude estimate and I will make the reduction. From these magnitude estimates I can build up a light curve which shows the variation in activity between different comets. Hale-Bopp has demonstrated that comets can stray up to a magnitude from the mean curve, and if such a part of the light curve is all that is used for the analysis, erroneous magnitude parameters will be determined. Measurements of the coma diameter tell me something about your observing conditions and also something about the physical size of the coma. Recent comets show a wide range of variation, with some having a diameter than appears to vary little with solar distance. The degree of condensation can vary dramatically and 73P/Schwassmann-Wachmann 3 was almost star like when it outburst, but gradually became more diffuse.

Continued on page 3

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way. Renewals should be sent to the Director and cheques made payable to the BAA. Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

The announcement on the IAUC of the likely close approach of asteroid FX11 has promoted a lot of bitter discussion. It is a pity that many of the contributors do not realise the amount of time and hard work that the team at CBAT devotes to verifying observations and claims of discovery. In this particular case it was fairly obvious to any regular observer that the initial observations showed a close approach, but few new observations were coming in and Brian Marsden wanted some immediate action before the asteroid faded. Goliath in the shape of NASA immediately stepped in, and is now threatening to control release of all future orbital predictions. Fortunately amateur astronomers and the internet make it unlikely that they would be able to keep such information to themselves. It is also worth remembering that Goliath came to an unexpected end!

Its been a very quiet six months for comet discoveries, with only SOHO producing them in abundance. The Section Meeting kept me busy for a while, but the winter has given me a chance to devote time to papers for the Journal. My paper on the comets of 1994 and Michael Hendrie's paper on comet Bennett have been accepted for publication. I have started on the comets of 1995 and if you have any material not previously submitted do let me have it. Michael Hendrie is well advanced on his papers on comets Kohoutek, and Kobayshi-Berger-Milon. Kenelm England is looking at the possibility of writing a paper on the Kreutz group comets. If anyone would like to contribute a paper to the Journal there are plenty of moderately bright comets which still await a report. I'd also love to see some contributions for the newsletter, as it is often a solo effort, with perhaps one or two member's contributions.

The Section meeting was a useful gathering and I was glad this time to have more of a chance to chat with you. The next big meeting is the International Workshop on Cometary Astronomy, which will take place over the weekend following the total eclipse next year. I'm arranging accommodation at a Cambridge College and there will be full details about booking in the next issue of the Newsletter. We hope to have many of the present day comet discoverers at the meeting, so it will be a chance to meet them, and to discuss ways of improving our observations. The stock of Section Observing Guides is probably sufficient to last the year, but it will soon be time to think about reprinting it. If you have any suggestions for changes or additions do let me know.

There is always a great desire to be the first to see a returning comet, the last to see a departing one, or to push the limits of the telescope and observers capability. The ready availability of PC planetarium programs with the ability to plot comet paths against Hubble or Hipparcos star fields make it very easy to observe exactly where a faint comet should be. Looking for this faint smudge of light at the limit of the telescope's light grasp it is possible to convince oneself that something is there and to produce an observation of it. It may well be there but such observations should always make it quite clear that there is some uncertainty by putting a colon (:) after the magnitude and noting the observation as reliability 3. Comets do outburst and others fade more slowly than expected, but quite a number of observations are appearing on the Internet, which appear to contradict CCD observations and visual observations made with larger apertures. These contradictory observations are often made with moderate apertures and the magnitudes quoted are usually at the limit of the telescope light grasp. They may be true, however the human imagination is a powerful thing.

Something that I have noted after using a computer at the end of an observing session and then going outside again, is that I can initially see the orange sodium sky glow quite clearly. As my eyes dark-adapt this appears to go away, but is presumably still there. I imagine that this change is due to the shift between photopic (daylight, 555-nm) and scotopic (dark, 510-nm) vision and it clearly has an implication for observing. Some comets may actually be easier to see before we are properly dark-adapted, or it may be possible to pick out features in the inner coma more easily. All comet magnitude estimates should be made with the eyes fully dark-adapted to the prevailing conditions.

Since the last newsletter observations or contributions have been received from the following BAA members:

Sally Beaumont, Paul Brierley, Denis Buczynski, Michael Foulkes, Maurice Gavin, David Graham, Werner Hasubick, Michael Hendrie, Guy Hurst, Nick James, Albert Jones, John Mackey, Nick Martin, Martin Mobberley, Bob Neville, Detlev Niechoy, Gabriel Oksa, Roy Panther, Jonathan Shanklin, James Smith, David Strange, S M Trafford, Dan Vidican, Alex Vincent, and Peter Wroath.

and also from: Jose Aguiar, Alexandr Baransky, John Bortle, Reinder Bouma, Matyas Csukas, Haakon Dahle, Stephen Getliffe, Guus Gilein, Bjoern Granslo, Valentin Grigore, Roberto Haver, Andreas Kammerer, Heinz Kerner, Atilla Kosa-Kiss, Martin Lehky, Romualdo Lourencon, Jean-Claude Merlin, Vasile Micu, Herman Mikuz, Andrew Pearce, Josep Trigo, Vince Tuboly, and Seichi Yoshida.

Comets under observation were: 29P/Schwassmann-Wachmann 1, 43P/Wolf-Harrington, 55P/Tempel-Tuttle, 62P/Tsuchinshan 1, 65P/Gunn, 69P/Taylor, 78P/Gehrels 2, 103P/Hartley 2, 104P/Kowal 2, 128P/Shoemaker-Holt 1, 129P/Shoemaker-Levy 3, 132P/Helin-Roman-Alu 2, C/Hale-Bopp (1995 O1), C/Mueller (1997 D1), C/Meunier-Dupouy (1997 J2), C/Utsunomiya (1997 T1) and C/Stonehouse (1998 H1).

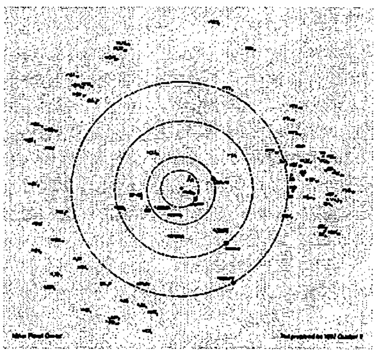
Jonathan Shanklin

Section Meeting

Continued from page 1

Guy Hurst spoke next about reporting the observations. He had received about 3500 observations of Hale-Bopp and although 90% of these came by e-mail a lot them did not use the TA or ICQ standard, or used malformed variants. [I have placed a data entry program, which produces the correct format output, on the Section web page, and it should be possible for observers to download this. Please send the TA output to Guy and the ICQ output to me. I can supply the program on a floppy for anyone who hasn't got web access]. Although the report forms help make analysis easier, they don't record all the information that the observer sees and a written description and drawing can help later analysis and interpretation. Tail reporting was a particular problem, some observers reporting an apparent length longer than would be seen from an infinitely long tail. A curved dust tail also presented problems: should the reported position angle refer to the start, middle or end of the tail? The ICQ procedure is to report the position angle that it leaves the nucleus, though this does not give a complete description. The ICQ procedure is also to report the longest tail as the main one, which can give inconsistent reporting when a variable length gas tail is seen with a dust tail. The apparent position angle of the tail also influences the perceived appearance and evening and morning impressions of Hale-Bopp were often quite different. Relatively few reports mentioned the inner coma detail, yet this was a prominent feature of the comet. The Millenium star atlas, based on the Tycho catalogue, is a good detailed map of the sky and the Tycho catalogue VT magnitudes are the recommended ones (coded as TT), though red stars should be avoided. The magnitude of the central condensation may be useful, though it should be made clear on the report form that this is not a total magnitude.

Mike Irwin from the Royal Greenwich Observatory takes part in a search program for Kuiper Belt Objects and explained how he goes about discovering these possibly cometary bodies. Pluto would not be classed as a planet if it were discovered today – it is just the largest of this class of solar system objects. Most KBOs are 10 times smaller and therefore reflect 100 times less light from the Sun and are similar in reflectivity to large lumps of coal. Most of the known ones are around 23rd mag in the R-band although the largest recently discovered reach 600 km diameter and as bright (sic!) as 20th mag. They have a mix of names, including centaurs, plutinos and cubewanos. Centaurs are KBOs between Uranus and Saturn, typically 50 - 100 km in diameter. The present distribution of finds is biased by the presence of the Milky Way, which makes it much harder to find them. The original KBO discoveries needed 2.2 – 2.5-m telescopes (Hawaii, INT, La Palma). Tombaugh who searched to 18th mag, discovered Pluto. Kowal extended the search to 20th mag and discovered Chiron. Luu and Jewitt used a large CCD which reached 25th mag and are now using four 4096x4096 arrays. The search has been technology driven and we have only recently had the necessary technology to carry out wide field surveys. To find one 22nd mag KBO we need to search one square degree. CCDs are also very good at detecting cosmic rays – about two per minute per square centimetre and these can mimic the objects being searched for. Real objects can be found by a number of methods: visual blinking can reveal significant motion in an hour (KBOs at 40 AU move at 3" per hour) and this has been the traditional method, even for professionals. Three frames are needed to avoid confusion with cosmic rays. An automated search subtracts pairs of images and looks for a high spot close to a low spot indicating movement between frames. Telescope time has to be carefully planned and search regions are selected to be near the zenith in a region with few bright stars and high background galactic absorption. Mike showed examples of images, including smearing and cosmic ray defects. The CBAT can predict future positions for a month or two on the basis of a circular orbit and so most aren't lost provided that there are follow up observations. There is a plan to change the naming convention for these bodies so that there isn't a wait of 250 years before naming takes place! Answering questions, he said that a sky survey plate was equivalent to a 4 Gb disk of CCD data. This again is part of the technology process as a night's CCD observing can produce up to 10 Gb of data. Detectors on a fixed telescope (ie not tracking at the sidereal rate) have problems with drift in non-equatorial fields and also if the telescope has aberrations.



Mike and his co-workers have recently discovered two more KBOs to add to those shown on this plot by the Minor Planet Centre. They lie at about 1 o'clock, just beyond the object shown well outside the orbit of Neptune.

After a break for tea, the theme switched to amateur CCD observations and Nick James put the BAA laptop through its paces for the first time in anger. After a few minor glitches with the IOA projection system, views of the laptop screen appeared on the main projection screen and the highly professional presentation commenced. Nick started by saying that you need to carry out careful calibration of the frames, with dark frames, flat fielding and correction for vignetting. Terry Platt's SX series was in use by Nick and Denis (and the Director and Assistant Director also confessed to owning them). The first step is to subtract a dark frame from the image to remove thermal noise. Next, the image is divided by a flat field, taken at twilight. A series of images, centred on the comet can be stacked together. Because of the small field of view of a CCD you are generally only looking at the central part of the coma. Here we are interested in high frequency structure, so we can use an unsharp mask. It is important not to saturate the images, and taking lots of images improves the signal to noise ratio which goes as $\sqrt{n}$. A linear stretch of the original image doesn't show any detail, but using an unsharp mask with a 15x15 median filter, dividing one by the other and then stretching does show the high frequency detail. Nick's image processed in this fashion showed that Hale-Bopp changed fairly dramatically in terms of jet structure at the end of 1997 January. It isn't always possible to see all the detail in one single image, and several different techniques may be needed. As well as processing CCD images it is possible to use similar techniques on scanned slides or negatives, and to remove the effects of vignetting (especially common in fast lenses). Offset guiding was a traditional photographic technique, but it is difficult and sometimes goes wrong. With CCDs short exposures can be stacked or made into a movie and Nick showed clips of 55P/Tempel-Tuttle taken by himself and Hale-Bopp taken by Terry Platt. He has written a batch program to process images to get the movie sequence, which makes life much easier. In response to a question Nick said that the SX is linear over 5 magnitudes with a V band filter.

The professional Starlink organisation has written image processing software which normally runs under the unix operating system, but a version is available which runs under PC linux. This has been made available to the amateur community and Nick is the UK amateur co-ordinator. He uses PISA for astrometry and photometry.

Bob Neville now started us thinking about CCD photometry. We have the problem of looking at a diffuse object through a light polluted atmosphere. The apparent brightness of a diffuse image changes with box size. Using an image of 81P/Wild 2 taken on 1997 March 1 as an example, he showed that a 1x1 box gave a magnitude of 14.5 for the central condensation. Increasing this to 5x5 gave a brighter value of 12.1, 11x11 gave 11.3 and 21x21 (equivalent to 1') 10.6, which was still 3 units (on a 256 scale) above the sky background of 20. He could actually see 3'x5' on the monitor so the total magnitude would be even brighter, however visual observers reported even larger coma sizes. He had tried a couple of mathematical models of the coma brightness:

$I_r = I_0 e^{-r}$ (a straight line on a log plot)

$I_r = I_0 (1/(1+r^2))$ (a damping curve on a log plot)

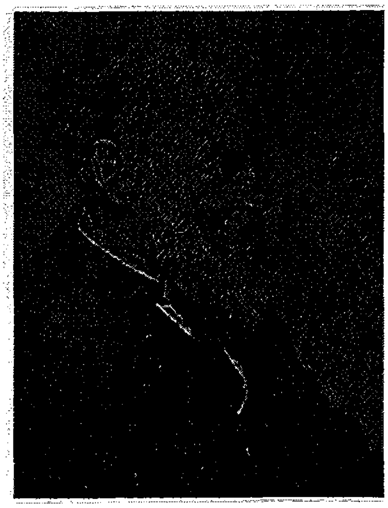
The observations suggest that a damping curve is more likely. Mathematically integrating this as a circularly symmetric function gives $\pi \ln(1+b^2)$, which doesn't converge, so a cut off is needed at some point, but could add to 3 – 4^m on the central value. The integral of the first function converges to 2π, which corresponds to approximately $+2^m$ on the central value of the 1x1 box. The model suggests that even if you sample down to 3% there could still be a 1^m error in the total magnitude. A 1 in 256 error in sky background introduces a significant error in the total magnitude. Results can be improved by:

1. Cooling a low noise chip.
2. Exposing the image as fully as possible.
3. Using a range of exposure times to avoid saturation.
4. Using LPR filters (note that the Johnson V magnitude band includes the sodium D line).
5. Careful attention to flat fielding.
6. Find an area with similar background to obtain sky subtraction.
7. Persuade software writers to produce variable size/shape aperture for photometry.

8. Try for darkest skies at midnight with the comet at the zenith!

Bob concluded by suggesting a project to try and correlate visual and CCD observations, particularly with a view to quantifying the degree of condensation in terms of photometric profiles.

Our final main speaker was Denis Buczynski who presented an illustrated history of the BAA involvement in cometary astrometry. Today, measurement of images is almost a kids computer game, with a click of the mouse and it is done. But it has taken some getting there and it was a very different storey in the past. Then it was a laborious task of using a measuring machine, now we can use a PC and make more, quicker, fainter and more accurate measurements. A C D Crommelin was the 3rd Director of the comet Section and reigned from 1897 to 1939 (I have no intention of serving this long!). His photograph clearly showed that it was essential to have a long white beard to be a Victorian professional astronomer.

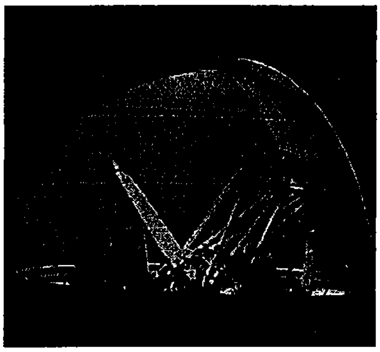


He predicted the return of 1P/Halley to within three days, which earned him an honorary degree from Oxford (despite being a Cambridge graduate). His main interest was positional measurement and there are few descriptive accounts of comets from this period. Observers used filar micrometer measurements, which have a personal error, need a time source and the positions of the reference stars. Denis commented that whilst researching his paper he found that old Journals record much more in the way of discussions at meetings, something that is rather lacking in modern times. [At this point I started making more note of discussions....]. Projection of a photograph onto graph paper was tried as a method, but the computation of positions was difficult and the observers of the time generally distrusted photographic methods. Gerald Merton (1945 – 1958) was a supporter of photographic methods which he said were twice as accurate as visual if done properly. Reginald L Waterfield, who had been observing comets since he was 13, made a plate measuring machine from bits cobbled together from the waste bins of Oxford and Cambridge Universities. He was active in the field from 1936 to 1986, despite being crippled by polio, and reported his first position in 1939. Very intricate steps had to be followed just to get the position of the reference stars (63 steps for just 3 stars), even before starting the positional measurement of the comet. Michael Candy was Director from 1958 – 1968 and discovered a comet in 1960 whilst testing an eyepiece. Brian Marsden, a Cambridge graduate, was a section member, working on comet orbits and now heads the CBAT. Michael Hendrie participated in Waterfield's observations and eventually built his own measuring machine and telescope. Harold Ridley used a Zeiss measuring machine, purchased by the BAA, which is now used by Glyn Marsh. Brian Manning became interested in measuring positions as a result of seeing measurements published in TA, and obtained very accurate results, receiving an IHW award. Denis started in 1984, encouraged by Waterfield and has continued to date. The number of measurements dropped in the 1970s, particularly after 1978 when they were no longer routinely reported on IAUC, however PCs have revolutionised the position. It is important to be timely, and the IHW asked for 48 hours turnaround, which was often bettered despite virtually all observations being photographic. Better catalogues have led to better positions. Before the PPM there were not many stars, hence a wide field was needed. The GSC has many stars and so CCDs became practical for astrometry on amateur telescopes. They also enabled shorter exposures to be used, so the problem of offset guiding was largely overcome and several people in the UK (including Mark Armstrong, Nick James, Stephen Laurie, John Mackey, Martin Mobberley, Bob Neville and Denis himself) are now contributing observations. Future improvements include new catalogues such as the USNO, GSC #2, and new software such as astrometrica. Easy electronic communication now makes astrometric observations almost routine, however there is a need to go to fainter magnitude comets. The BAA has a hard earned reputation and we should not rest on our laurels.

Nick James commented that the USNO catalogue was possibly not as good as it looked. Dennis Buczynski wondered if there was any point in photographic astrometry. Michael Hendrie thought probably not as CCDs were so much easier. Guy Hurst noted that not many, if any, positions were now reported photographically.

David Graham concluded the formal session with slides of his 6" reflector and 16" *f*/5 Newtonian that he'd used to view Hale-Bopp. He showed well executed drawings of the jets and shells seen with a magnification of x200 and described the experience of standing in a dark graveyard with the comet hanging over the church. His final slides showed the comet with bright zodiacal light.

It had been clear all day, so after downing a fortifying cup of tea or coffee we headed for the Northumberland and Thorrowgood telescopes, hoping to have views of Saturn and 55P/Tempel-Tuttle as the twilight faded. Saturn was easily acquired in the Northumberland, but I had trouble with 55P in the Thorrowgood. Using the traditional technique of star hopping I found the field relatively easily, but was a bit perplexed that the fainter stars seemed to be disappearing. A quick check of the OG showed it wasn't dewing up, but a look outside showed that cloud was coming in. The East was still clear, but we couldn't move the slit, so I took the group down to my 0.33-m Odyssey Dobsonian. I couldn't manage to find M35 in Gemini, but did succeed in locating M42!



The Northumberland refractor photographed on a time exposure by Neil Boyce and Tony Darlison

Thanks to all those making the journey to Cambridge, and particularly to the speakers, CUAS and the IOA for making it such a worthwhile meeting. There will be a meteor Section meeting here at the end of October and there is to be an ICQ International Workshop on Cometary Astronomy in August 1999 following the total eclipse.

Inevitably I was going to forget something, and I should have presented the Keedy award to Melvyn Taylor at the meeting. Fortunately Melvyn attended the out of London meeting in Birmingham at the end of April and I was able to present it to him then. Melvyn has been contributing observations to the Section for over 25 years and also makes extensive contributions to the Meteor and Variable Star Sections. Very often such stalwarts of the Association receive little thanks for all their hard work and the Keedy award makes a fitting tribute.

Jonathan Shanklin

Close-Approach Comets

The table lists close approaches to the Earth by comets observed prior to 1998 March 31 and those predicted to occur up to 2031. The table is sorted by close-approach distance from closest to farthest. Only past close-approach distances *less than* 0.11 AU are included in the table. The table is taken from the web page by Alan B. Chamberlin of the Solar System Dynamics Group at the Jet Propulsion Laboratory, with future predictions taken from the CBAT web page.

Name	Designation	Date of Close Earth Approach	Distance (AU)	(LD)	
Comet of 1491	C/1491 B1	1491-Feb-20.0	0.0094	3.7	*
Lexell	D/1770 L1	1770-Jul-01.7	0.0151	5.9	
Tempel-Tuttle	55P/1366 U1	1366-Oct-26.4	0.0229	8.9	
IRAS-Araki-Alcock	C/1983 H1	1983-May-11.5	0.0313	12.2	
Halley	1P/ 837 F1	837-Apr-10.5	0.0334	13.0	
Biela	3D/1805 V1	1805-Dec-09.9	0.0366	14.2	
Comet of 1743	C/1743 C1	1743-Feb-08.9	0.0390	15.2	
Pons-Winnecke	7P/	1927-Jun-26.8	0.0394	15.3	
Comet of 1014	C/1014 C1	1014-Feb-24.9	0.0407	15.8	*
Comet of 1702	C/1702 H1	1702-Apr-20.2	0.0437	17.0	
Comet of 1132	C/1132 T1	1132-Oct-07.2	0.0447	17.4	*
Comet of 1351	C/1351 W1	1351-Nov-29.4	0.0479	18.6	*
Comet of 1345	C/1345 O1	1345-Jul-31.9	0.0485	18.9	*
Comet of 1499	C/1499 Q1	1499-Aug-17.1	0.0588	22.9	*
Honda-Mrkos-Pajdusakova	45P/	2011-Aug-15.40	0.0601	23.4	
Schwassmann-Wachmann 3	73P/1930 J1	1930-May-31.7	0.0617	24.0	
Sugano-Saigusa-Fujikawa	C/1983 J1	1983-Jun-12.8	0.0628	24.4	
Comet of 1080	C/1080 P1	1080-Aug-05.7	0.0641	24.9	*
Great comet	C/1760 A1	1760-Jan-08.2	0.0681	26.5	
Comet of 1472	C/1471 Y1	1472-Jan-22.9	0.0690	26.9	*
Comet of 400	C/ 400 F1	400-Mar-31.1	0.0767	29.8	*
Schwassmann-Wachmann 3	73P/	2006-May-12.00	0.0816	31.8	
Honda-Mrkos-Pajdusakova	45P/	2017-Feb-11.38	0.0829	32.3	
Comet of 1556	C/1556 D1	1556-Mar-13.0	0.0835	32.5	*
Schweizer	C/1853 G1	1853-Apr-29.1	0.0839	32.7	
Bouvard-Herschel	C/1797 P1	1797-Aug-16.5	0.0879	34.2	
Halley	1P/ 374 E1	374-Apr-01.9	0.0884	34.4	
Halley	1P/ 607 H1	607-Apr-19.2	0.0898	34.9	
Comet of 568	C/ 568 O1	568-Sep-25.7	0.0918	35.7	*
Messier	C/1763 S1	1763-Sep-23.7	0.0934	36.3	
Tempel	C/1864 N1	1864-Aug-08.4	0.0964	37.5	
Wirtanen	46P/	2018-Dec-21.03	0.0977	38.1	
Schmidt	C/1862 N1	1862-Jul-04.6	0.0982	38.2	
Comet of 390	C/ 390 Q1	390-Aug-18.9	0.1002	39.0	*
Hyakutake	C/1996 B2	1996-Mar-25.3	0.1018	39.6	
Seki	C/1961 T1	1961-Nov-15.2	0.1019	39.7	
Hartley 2	103P/	2010-Oct-20.89	0.1198	46.7	
Tuttle-Giacobini-Kresak	41P/	2017-Mar 27.37	0.1362	53.1	

* - Distance is uncertain because the comet's orbit is relatively poorly determined.

LD Miss in earth-moon distance units

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, BAA Journals and Sky and Telescope.

150 Years Ago: Several issues of MN carried search ephemerides, based on computations by Mr Hind, for the expected return of the comet seen in 1264 and 1556. [No such comet was seen and the 12th Catalogue lists two separate comets with parabolic elements]. In January Professor Challis published a paper giving a method for computing a comet's orbit from three positions. Caroline Herschel died at Hanover on January 9th aged 98. She discovered eight comets, of which five carry her name (1786 P1 (Herschel), 1788 W1 (Messier), 1790 A1 (Herschel), 1790 H1 (Herschel), 1791 X1 (Herschel), 1793 S2 (Messier), 1795 V1 (2P/Encke), 1797 P1 (Bouvard-Herschel).

100 Years Ago: An address by Andrew C D Crommelin (the new Director of the Section) was published in the November Journal. He divided cometary work into: 1) Sweeping, estimating that 120 hours were required per comet, 2) Astrometry, 3) Visual physical observations, 4) Photography and 5) Computation of orbits and ephemerides. Interestingly even this long ago defocussing stars to make them comparable to the comet was recommended for making magnitude estimates, and the procedure was regarded as very difficult. Tail features were regarded as important, with photography recognised as a valuable tool for precise measurements. The December Journal included a list, prepared by W F Denning, of comets expected to return over the next couple of years, which was originally published in Nature. At the March meeting Crommelin castigated British observers for not discovering any comets when Mr Perrine in America had discovered five in two years.

50 Years Ago: Comet notes in the January Journal commented on the exceptional number of comets that had been under observation, though only two were bright enough for those with moderate equipment. Comet Reinmuth 1947j (44P/Reinmuth, 1947 R1) was found to be a periodic comet and there were attempts by E Rabe in Germany to link it to 1858 J1 (Tuttle) and 1907 L1 (Giacobini) however Gerald Merton was not convinced. [Crommelin had demonstrated that these two comets were linked in 1928, but it was not recovered. Lubor Kresak discovered a comet in 1951, which was identified with the lost comet and it is now known as 41P/Tuttle-Giacobini-Kresak.] A note in the February Journal recounted the tale of the German astronomer von Zach who had humorously advised Pons that comets were more numerous when there were many sunspots. Shortly afterwards a large group of spots had appeared and Pons went out and found a fine comet. The note pointed out that when one of the largest sunspots ever recorded was seen at the end of January 1946, 29P/Schwassmann-Wachmann 1 had brightened to 9th magnitude, so there might be some truth in the tale.

The meeting at the end of December (recorded in the April Journal) reported on 1947 X1 which had reached –3 on December 9. There had been a number of UK reports of the comet, but in fact the object seen was Venus. The Journal also notes that for the first time i as well as j had been used for comet designations. [In fact both were used in 1898, but generally j was omitted to avoid confusion, as was i on occasion.] The April meeting was the Exhibition meeting and "The Computing Section (which but rarely contributes to an exhibition) was represented by an unusual item in the form of a notebook of some 200 pages showing the calculations of the perturbations of Comet Gale, exhibited by the Rev Dr C Dinwoodie.".

Although not strictly relevant to comets my eye was caught by two other items. In 1948 May "The future of the present Royal Observatory buildings at Greenwich is still under consideration." and in 1948 June "Another factor which was taken into consideration was that owing to the brightness of modern street-lighting, the long exposures necessary for photographing the solar phenomena could not be given, and solar photography plays a large part in the life of the Observatory.".

The November issue of Sky & Telescope noted that publication of the Minor Planet Circulars had begun at the Cincinnati Observatory under the Directorship of Dr Paul Herget. The February issue had several pages devoted to 'The Great Comet of 1947' (1947 X1). It was widely seen in the Southern Hemisphere on the evening of December 8 as it emerged from perihelion. With a tail more than 25° long, and a magnitude near 0, it was a splendid sight. A few days later the nuclear condensation was observed to be double. The editorial also noted that Michiel John Bester, an assistant at Boyden Station had discovered three and shared a fourth of the year's 14 comets. A follow up article in the next issue looked in more detail at comets and their link to meteors. There was also more coverage of the Great Comet. One observer noted that the comet appeared distinctly pinkish to the naked eye.

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

Science 1997 December 12. J K Brown *et al* report on the radar detection of the nucleus and coma of comet Hyakutake (1996 B2). They used the Goldstone Deep Space Communications Complex in California to detect echoes from the nucleus and large grains in the comet's coma. These measurements suggest that the nucleus was quite small, only two to three kilometres in diameter, with a surface similar in consistency to loosely packed snow. The small size agrees with other measurements and explains the need for non-gravitational forces to fully represent the orbital motion, something quite rare in long period comets. The rotation period could not be measured, but other measurements suggest either 6.25 or 12.5 hours. The centimetre sized grains in the coma seem to be quite porous and were ejected at speeds of tens of metres per second, probably at an angle of some 40° to the sun. They are perhaps similar to very small lightly compacted snowballs, though there is also some evidence for much fluffier grains as well. Only five other comets have been detected by radar: 1P/Halley (15 x 8 km), 2P/Encke, 26P/Grigg-Skjellerup, Sugano-Saigusa-Fujikawa (< 1 km) and IRAS-Araki-Alcock (16 x 7 km).

Science 1998 April 3 and *Nature* 1998 April 23. A resume of highlights of the annual Lunar and Planetary Science Conference held in Houston in March reports on the possible recovery of dust from 73P/Schwassmann-Wachmann 3. A converted U2 spy plane has been collecting dust particles from high in the stratosphere for many years and some of them have filtered into the atmosphere from outer space. Many of these interplanetary dust particles (IDPs), have a fragile, highly porous structure and are thought to come from comets. Alfred Nier and Dennis Schlutter of the University of Minnesota analysed some collected in June and July 1991 and found that they were relatively low in helium, and more interestingly that the ratio of the helium-3 to helium-4 isotopes was the highest ever found in an IDP. This prompted Scott Messenger and Robert Walker to try and identify the source. The IDPs were minimally altered by heat, suggesting a low entry speed into the atmosphere. The low amount of helium suggested a relatively recent release of the material (within the last ten years, compared to the average lifetime of dust at 1 AU of 10,000 years), otherwise it would have picked up more from the solar wind. As radiation pressure always enlarges the orbit of dust particles, the source must come from closer to the sun than is the earth. Using these constraints, and the date of collection, they narrowed the field from 17 active earth crossing comets to four which have low eccentricity orbits. Of the four, only 73P/Schwassmann-Wachmann 3 approaches the earth at the right time (the others are 26P/Grigg-Skjellerup, P/Machholz 2 and 107P/Wilson-Harrington). Its dust trail intersects the earth in late May (producing the Tau Herculid meteor shower), which would allow just enough time for the IDPs to sink down to the stratosphere by June and July. This doesn't explain the strange isotope ratio and final explanation may have to wait until the CONTOUR spacecraft visits the comet in 2006. The comet makes a very close approach (0.082 AU) in May 2006 when it may attain 0^{th} magnitude, although the coma diameter will be very large.

A report posted on the ESO web pages gives some highlights of the recent conference on Hale-Bopp held in the Canary Islands. The original period of the comet was 4211 years and the future period is 2392 years. It may have passed very close to Jupiter on June 7, 2216 BC and the orbit is clearly evolving rapidly. The nucleus is probably around 50 km diameter, though the range of estimates varies between 40 and 80 km, with some suggestions that it may have an elongated shape or even have multiple components. It rotates with a period close to 11.34 hours, however the direction of the rotation axis has not yet been determined. Many molecules have been seen for the first time in the comet's spectrum, however it was a very dusty comet making the gaseous components harder to see. Peak dust production reached 400 tonnes per second, however the entire mass loss during the apparition is probably still less than 0.1% of the total mass. Generally the comet was quite similar to 1P/Halley and probably formed in the region between Uranus and Neptune; it showed many similarities with interplanetary and circumstellar dust. SOHO observed an enormous Lyman-alpha halo of hydrogen, about 150 million kilometres in diameter. The discovery of a neutral sodium tail is well known, but the origin of the sodium has still to be found. The comet will be studied for a long time to come and more results are likely to be published in scientific journals over the next decade.

NASA is giving people another chance to send their name to a comet and back. They are making a second microchip that will be carried on the STARDUST spacecraft that will be launched to comet 81P/Wild 2 in February 1999 and will return samples of the coma to earth for analysis. If you want to sign up, submit your name from http://stardust.jpl.nasa.gov/microchip/signup.html

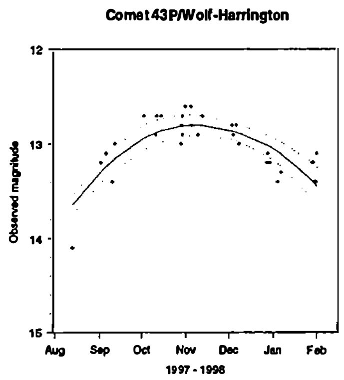
Jonathan Shanklin

Review of comet observations for 1997 November - 1998 April

The information in this report is a synopsis of material gleaned from IAU circulars 6771 - 6894 and The Astronomer (1997 November - 1998 April). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

29P/Schwassmann-Wachmann 1 was glimpsed by Andrew Pearce at 14th mag in his 0.41-m reflector at the end of December 1997. Further reports suggested that the comet brightened to around 12th mag in January and then faded to 14th mag. The second outburst of the year commenced in mid March according to IAUC 6844 and the comet brightened to around 12.5 before fading in April. This comet seems to spend a lot of time in outburst and is worth monitoring with CCD cameras on a regular basis. Observers are encouraged to check the comet at every opportunity over the apparition, although it is at rather low altitude for UK observers.

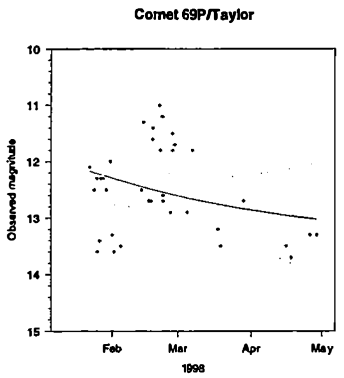
43P/Wolf-Harrington made an early morning apparition and consequently few observations were made. A small faint object, it peaked at around 13^{m} in early November and slowly faded, though its southern declination made it a difficult target for UK observers. Andrew Pearce made the final observation at the end of January. The 33 observations received so far give a preliminary aperture corrected light curve of: m = 9.9 + 5 log d + 6.1 log r



62P/Tsuchinshan 1 was reported at around 13th mag in March on the IAUC and on the CBAT web pages. Martin Lehky observed it at the end of the month.

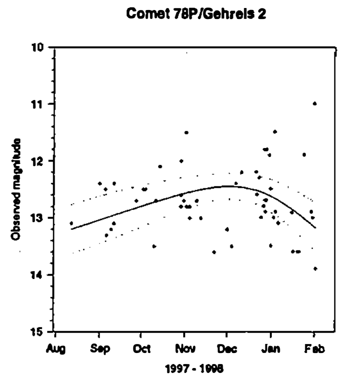
65P/Gunn was observed by Martin Lehky at the end of 1997, though at 15^{th} magnitude it was beyond the range of most observers.

69P/Taylor was found to be unexpectedly bright at 12^{th} magnitude in January. It seems to be slowly fading, though the actual light curve is rather indeterminate.



A series of Jupiter encounters last century reduced q from 3.1 to 1.6 AU and led to its discovery by Clement Taylor from South Africa in December 1915. It was quite bright, 9^{th} magnitude at best, and shortly after perihelion split into two fragments, each with a short tail. The secondary nucleus became brighter than the primary, but then rapidly faded and the primary also faded more rapidly than expected. The comet was then lost until 1977, when new orbital computations led to the recovery of the B component by Charles Kowal with the Palomar Schmidt. The A component was not found.

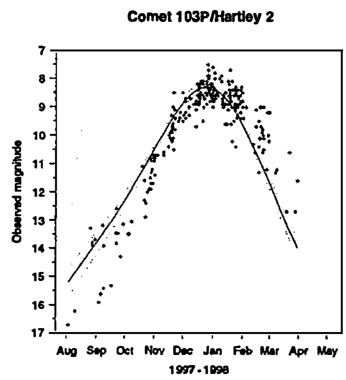
78P/Gehrels 2 peaked at around 12^{th} mag in December and the light curve suggests that it should have faded quite rapidly in the New Year. I made a final observation of it in early February, making it 13.9 in the Northumberland refractor and was unable to see it mid month under very good conditions. Reports on the Internet however, suggest that it remained brighter than 13^{th} magnitude into March. The 60 observations give a preliminary light curve of 10.1 + 5 log d + 5.0 log r, though the fit is not very good.

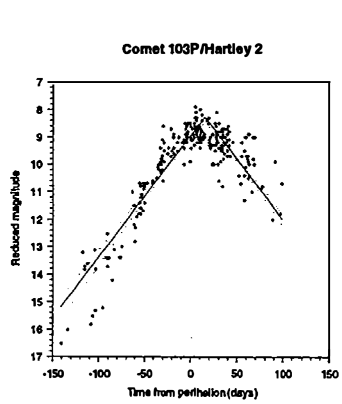


88P/Howell was brightening quite rapidly in the early spring according to estimates posted on the CBAT/ICQ web page. This suggested that the comet might be observable by the end of April and I made a tentative observation on April 28.9 with the Northumberland refractor, making it around 13.2:. Other observations will be needed to confirm this, but it should certainly be reasonably easily visible by the end of May.

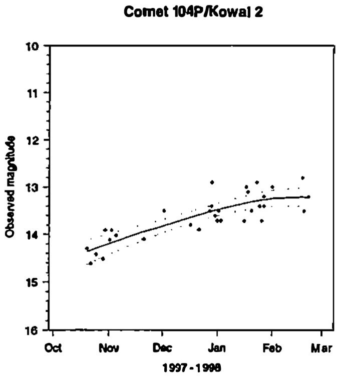
103P/Hartley 2 brightened very rapidly from around 16^{th} magnitude in August to a peak of near 8^{th} magnitude in early January, a week or so after perihelion. It then faded, a little more slowly than expected from the mean light curve using a log r fit. The light curve was more or less the same as at the last return, and its behaviour is fairly consistent. The comet seems to brighten more or less linearly with time, peaking a little after perihelion, then fading at the same rate. Observations received so far (257) give a preliminary standard light curve of 8.4 + 5 log d + 20.8 log r or a linear light curve of 8.3 + 5 log d + 0.044 abs (T-15) where T is the number of days after perihelion.

Comet 103P/Hartley 2 drawn by Nick Martin.





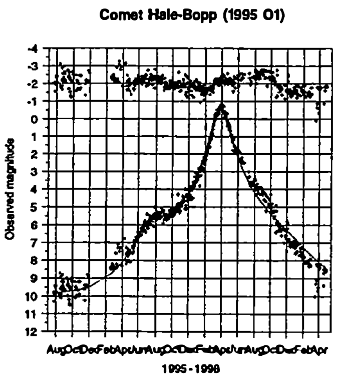
104P/Kowal 2 slowly brightened from around 14.5 in late October to a peak of near 13 when at perihelion at the beginning of March. It was then low in the twilight and this, combined with bad weather prevented many further observations. 33 observations give a preliminary light curve of 10.5 + 5 log d + 11.8 log r.



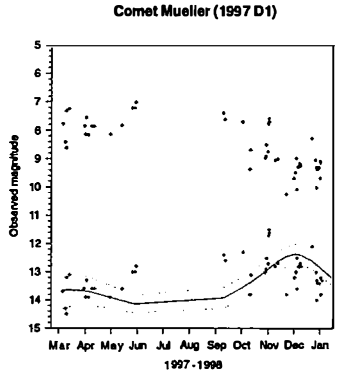
128P/Shoemaker-Holt 1 was observed by Martin Lehky at around 15th magnitude in late December.

129P/Shoemaker-Levy 3 was observed by Seiichi Yoshida at 14.5 at the end of January.

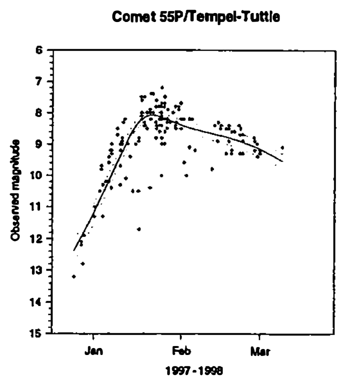
132P/Helin-Roman-Alu 2 was observed by Martin Lehky at around 15th magnitude during the autumn.



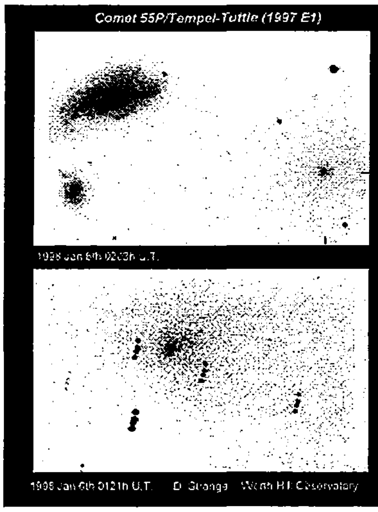
Hale-Bopp (1995 O1) is now a faint binocular object, but still reasonably easy for Southern Hemisphere observers and will continue to fade slowly. The observed arc covers 1008 days with observations made on 682 days. The equation -0.73 + 5 log d + 7.79 log r fits daily means very well, but there are long period variations about this mean light curve of around a magnitude. Between October 20 and the end of December the comet faded by about 1 mag relative to the mean curve.



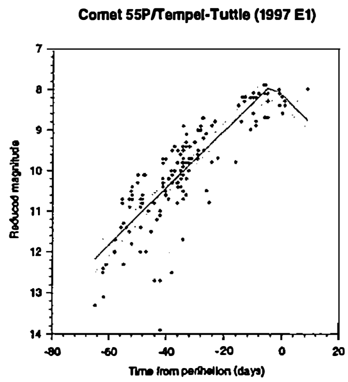
Mueller (1997 D1) was very difficult to see when it reappeared from conjunction and the early light curve overestimated its rate of brightening. The comet became difficult to see because it was very diffuse and the comet seemed to be becoming less active. The observations give a light curve of 9.5 + 5 log d + [5] log r though this is a very poor fit (curve near mag 13) and a better fit is given by either: a) 8.0 + 5 log d + [7.5] log r or b) 6.5 + 5 log d + [10] log r until October, followed by a fade of around 0.5 magnitude per month [shown as points near mag 8, data corrected for the distance from the earth].



55P/Tempel-Tuttle (1997 E1) was recovered visually in late December at around 13th mag. We will not see it again for another 33 years. It brightened rapidly and peaked at 8th magnitude in late January around the time of closest approach to the earth. It faded slowly as the distance from earth increased, although it was still approaching the sun. It dropped lower and lower into the twilight and was last seen around mid March at about 9.5. The 186 observations received so far give a light curve of 8.6 + 5 log d + 25.9 log r, which is similar to that of 103P/Hartley 2. A linear curve shows a rather rapid brightening with an equation of 7.9 + 5 log d + 0.071 abs (T+4). The Hubble Space Telescope has determined that the nucleus is only about three kilometres across.

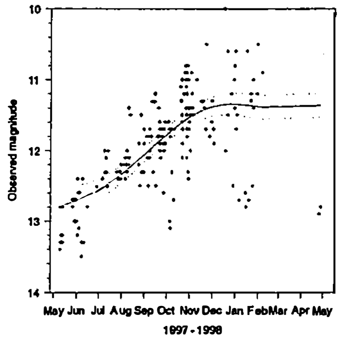


Comet 55P/Tempel-Tuttle imaged by David Strange. The two galaxies on the left of the upper frame are NGC 4490 (10.2) and NGC 4485 (12.3)



Meunier-Dupouy (1997 J2) moved from the evening sky to the morning sky at the end of January and since then has received very little attention. There is a lot of scatter in the observations, which makes the magnitude equation a little uncertain. The 190 observations received so far suggest a preliminary light curve of 5.0 + 5 log d + 7.4 log r. If this is followed the brightness won't vary much from 12^{th} magnitude over the coming year because the changing distances from earth and sun just about balance. It is a slow moving, distant comet and will remain on view until the end of the year.

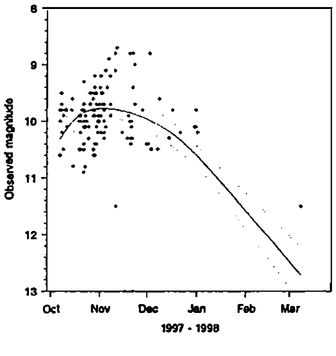
Comet Meunier-Dupouy (1997 J2)



Some confusion occurred with the naming of comet **1997 L1** and it is now **Zhu-Balam.** The comet was originally named Xinglong and thought to be a main belt asteroid, but was renamed in 1998 [IAUC 6811, 1998 January 23] after the discoverer and the person who pointed out that the object was cometary. J Zhu reported observations of 5 objects detected on June 4 by the Beijing Astronomical Observatory 0.6-m Schmidt during a search program. D D Balam of Victoria noted that one of them was clearly cometary with the 1.8-m reflector of the Dominion Astrophysical Observatory.

Utsunomiya (1997 T1) was followed into the twilight at the end of December, but very few observations were made after solar conjunction when it was in the morning sky. It was brightest at the beginning of November when it was around 9^{th} magnitude. The 122 observations suggest a light curve of 6.1 + 5 log d + 19.3 log r

Comet Utsunomiya (1997 T1)



1997 T3 was named **Lagerkvist-Carsenty** in early 1998. Uri Carsenty and Andreas Nathues, of the DLR Institute of Planetary Exploration, Berlin discovered a 19th mag cometary object on October 5.1 during the course of the Uppsala-DLR Trojan Survey, in collaboration with C-I Lagerkvist, S Mottola and G Hahn. [IAUC 6754, 1997 October 7]. The comet was not named until January 1998, when it was given the names of the discoverer and the person who found that it was a cometary object [IAUC 6811, 1998 January 23]

Jim Scotti recovered **134P/Kowal-Vavrova (1997 X2)** with the Spacewatch telescope at Kitt Peak on December 5.5 when it was 22nd mag. The predicted ephemeris required a correction of +5.3 days. [IAUC 6784, 1997 December 10]

A further twelve sungrazing comet fragments have been discovered by the LASCO coronographs on the SOHO spacecraft, bringing its total to 45 comets. The new comets are: 1997 H3, 1997 P3, 1997 S2, 1997 U1, 1997 W1, 1997 W2, 1997 X1, 1998 A1, 1998 E1, 1998 F1, 1998 G2 and (provisionally) 1997 G3. Brighter objects are often discovered in the real time data, but the fainter ones have to wait for the archival data to be searched which runs three or four months behind. More details are available on the Section web page.

135P/Shoemaker-Levy 8 (1998 B1) was recovered by Carl Hergenrother with the SAO 1.2-m reflector at Mt Hopkins on January 22 when it was 22nd magnitude [IAUC 6821, 1998 February 9]. The comet is unlikely to become bright enough for visual observation.

P/LINEAR (1998 G1) was discovered during CCD survey work by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory Experimental Test System 1.0-m f2.15 reflector on April 2.13 [IAUC 6863, 1998 April 6]. The asteroidal object had a retrograde near parabolic orbit and follow-up images by Warren Offutt of Cloudcroft, New Mexico showed a tail but no coma. Further astrometric observations showed that it is in an elliptical Halley type orbit with a period of 45.1 years. The comet is around 18th mag, but won't become much brighter than 17^{th} magnitude, when it reaches perihelion in November.

The most recent batch of MPC lists 35417 observations by the LINEAR team, with observations of 3424 asteroids of which 1463 are new discoveries! By contrast the same issue lists 'only' 2477 observations by the NEAT team, 1924 by Spacewatch and 1725 by LONEOS. British observers have 39 between them and no cometary astrometry is reported from the UK.

SOHO (SOHO-47 and provisionally 1998 G4) is the third non-Kreutz group comet discovered by the satellite. It was found over the Easter weekend by Kevin Schenk, but faded very rapidly. So far it has not been announced on IAUC.

Stonehouse (1998 H1) was discovered by Patrick Stonehouse of Wolverine, MI, USA on April 22.3. He was observing in Serpens Caput using a 0.44-m reflector when he noticed a diffuse object which showed motion. There was some confusion over the reported motion, but it was eventually confirmed by Alan Hale on April 26.3 [IAUC 6883, 1998 April 26]. The discovery magnitude was put at 12 - 13, though Hale estimated it at 10.7. I observed it with the Northumberland refractor on April 28.08 and made it 11.7, coma diameter 1.1', DC s3. It will fade quite rapidly, though a provisional ephemeris is given in the observing supplement.

As this issue went to press, the discovery of **SOHO (1998 J1)** was announced. This is the first comet discovered by the satellite likely to be visible from the ground. By the time this reaches you it will only be visible from the southern hemisphere, and a special supplement is included for our southern readers.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds

Comet Comments

Don Machholz

Comet Comments is a monthly column that I've been writing since 1978. I started writing it to inform other amateur astronomers of new comet discoveries and to provide information so that they can find the brighter comets. Each issue of Comet Comments is written three weeks before the "due" date, giving time for it to be distributed to the editors and placed into the newsletters. Comet Comments contains information about new comet discoveries, followed by comet news and observing tips for the comets currently visible. Carried in only one newsletter (the San Jose Astronomical Association's "Ephemeris") for the first two years, the column is now carried in some three dozen newsletters. It also appears on the Internet: America-On-Line displays it in their astronomy department (Keyword: Astronomy) and you can find it at: http://members.aol.com/cometcom/index.html.

JULY 1997: Of the 97 visual comet discovery events since 1/1/75, during which 73 comets were found and named, only four times was the comet found by accident. In early July 1975 Doug Berger and the late Dennis Milon found a comet while observing M 2. A comet hunter (Toru Kobayashi of Japan) had found it the previous day. Then, twenty years later Alan Hale and Thomas Bopp chanced upon a new comet near M 70.

AUGUST 1997: With Tabur's find, six of the last seven visually-discovered comets have been found south of the celestial equator; and 14 of the last 17 visually-discovered comets have been found in the morning sky.

SEPTEMBER 1997: Many people quote the 1700 hours it took me to find my first comet or the 1742 hours to find my second. This has been surpassed twice in recent years. In 1987 Noboru Nishikawa took 3024 hours in 2389 sessions to find his first comet (1987a). In 1990 Yuji Nakamura discovered his first comet after searching 2236.5 hours in 1558 sessions.

OCTOBER 1997: With so many comets from the Kreutz Sungrazing Group being discovered by the SOHO satellite, amateurs have taken a renewed interest in sweeping along the path by which these comets are arriving. That path is now in the morning sky, having been behind the sun this past summer. The comets are very faint in the weeks before perihelion and it may take CCD imaging to capture them. The brightest members, although rare, can still be discovered visually.

NOVEMBER 1997: Since the first day of 1975, 76 comets have been visually discovered. Some have been discovered by more than one person: ten by two visual discoverers and seven by three. This amounts to 100 visual discovery events. Thirty-two of those 76 comets were found in the evening sky with 44 found in the morning sky. Additionally, 42 were found in the north of the celestial equator with 34 found south. All of the 23 comets found by observers living south of the equator were found in the southern celestial sky. Northern Hemisphere observers found comets both north and south of the equator.

DECEMBER 1997: Since January 1975, 48 different individuals have visually discovered comets that now carry their names. What countries do they live in? Twenty-three are in Japan, nine reside in the USA, with four in Australia. Other countries represented are the old USSR, Canada, England, South Africa, Philippines, Italy, New Zealand and Norway. The most discovery events occurred in Japan (33) followed by the USA (30) and Australia (19).

JANUARY 1998: Of the last 100 visual comet discoveries, amateurs using binoculars made 28. The smallest pair of binoculars used was 7x35's by William Bradfield in 1980 to find a magnitude-six comet. Three were the 80mm size while six finds were made using binoculars with objectives of 110-120 mm. Four finds were made with my homemade binoculars (130mm), and half (14) of all binocular comet discoveries were made with 150mm (6-inch) binoculars.

FEBRUARY 1998: Of the last 100 visual comet discoveries, amateurs using refractor telescopes made 23. The smallest was Genichi Araki's 3" scope to find Comet IRAS-Araki-Alcock. Toshio Haneda used a 3.3" refractor to find his comet and three other instruments were from 4.8 to 5.2 inches in diameter. The remaining 18 refractors were 6" in size, with William Bradfield finding 12 comets since 1975 (and two before) with his 6" telescope.

MARCH 1998: Amateurs using reflectors made forty-eight of the last 100 visual comet discoveries. They range in size from 4" to 19.5". The most popular size (16" aperture) was used in 16 finds. These large reflectors were also efficient, averaging 231 hours per find compared with 391 hours for all visual comet discoveries. All five accidental comet discoveries (Berger, Milon, Hale, Bopp and Tillbrook) were made with reflector telescopes.

APRIL 1998: Of the 100 comets visually discovered since 1975, only one was found without the use of a reflector, refractor or binoculars. It was Merlin Kohler's comet discovery on Sept. 3, 1977. He used an 8" Dynascope Schmidt Cassegrain. This discovery took about forty hours of sweeping. Mr. Kohler is now retired and still living in Quincy, California.

Don's Comet Hunting Hours:
1975-1997: 6277.25
Hours through Mar. 1998: 21.50
Total hours at last discovery (10-8-94): 5589.00
Least hours in any month since I began comet hunting on 1/1/75: 4.00 (02/98), 4.50 (01/86), 5.50 (02/80)
Most hours in any month since I began comet hunting: 69.25 (05/76), 63.00 (05/78)

Introduction

This issue has ephemerides for comets:

- 21P/Giacobini-Zinner
- 29P/Schwassmann-Wachmann 1 (Southern Hemisphere)
- 88P/Howell (UK & Southern Hemisphere)
- 93P/Lovas 1
- C/Hale-Bopp (1995 O1) (Southern Hemisphere)
- C/Meunier-Dupouy (1997 J2)
- C/Stonehouse (1998 H1)

Current ephemerides are also available on the Section web page.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for 29P/Schwassmann-Wachmann 1 (Southern Hemisphere, 40° South)

Note: when in outburst the comet may be visible from the UK, although it is low in the southern sky.

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Omega= 47.1035 OMEGA=312.8163 i=  9.3850 q= 5.728744 a=  6.003041
 e=0.045693  P=   14.708  T= 2004 June      15.6870     Equinox= 2000
 Magnitudes calculated from m= 1.0+5.0*Log(d)+10.0*Log(r)
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Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
June 1998																
1/ 2	13 3.1	-17.52	13 5.7	-18.08	12.7	5.54	6.24	20.25	17.52 to 0.59	130	42	50	0	104	0	0
6/ 7	13 2.4	-17.42	13 5.1	-17.58	12.7	5.60	6.24	20.04	17.51 to 0.37	125	24	91	0	106	0	0
11/12	13 2.1	-17.33	13 4.7	-17.49	12.7	5.66	6.24	19.44	17.51 to 0.16	120	82	97	0	107	0	0
16/17	13 2.0	-17.25	13 4.6	-17.41	12.7	5.73	6.24	19.24	17.51 to 23.55	116	147	55	0	108	0	0
21/22	13 2.1	-17.19	13 4.7	-17.35	12.8	5.80	6.24	19.05	17.52 to 23.34	111	137	6	1	109	0	0
26/27	13 2.5	-17.14	13 5.1	-17.30	12.8	5.87	6.23	18.45	17.53 to 23.14	106	70	9	1	110	0	0
July 1998																
1/ 2	13 3.1	-17.10	13 5.8	-17.26	12.8	5.95	6.23	18.26	17.55 to 22.53	102	16	52	1	111	0	0
6/ 7	13 4.0	-17.08	13 6.7	-17.24	12.8	6.02	6.23	18.08	17.58 to 22.34	97	53	93	1	112	1	0
11/12	13 5.1	-17.08	13 7.8	-17.24	12.9	6.10	6.23	17.49	18.00 to 22.14	93	117	94	1	112	1	0
16/17	13 6.5	-17.09	13 9.2	-17.25	12.9	6.18	6.23	17.31	18.03 to 21.55	88	165	46	1	113	1	0
21/22	13 8.1	-17.11	13 10.7	-17.27	12.9	6.25	6.23	17.12	18.07 to 21.36	84	102	3	0	114	1	0
26/27	13 9.8	-17.15	13 12.5	-17.31	13.0	6.33	6.23	16.55	18.10 to 21.17	80	40	12	0	114	2	0
31/32	13 11.8	-17.20	13 14.5	-17.36	13.0	6.41	6.23	16.37	18.14 to 20.59	75	25	55	0	115	2	0
August 1998																
5/ 6	13 14.0	-17.27	13 16.7	-17.42	13.0	6.48	6.23	16.19	18.18 to 20.41	71	84	95	0	115	2	0
10/11	13 16.3	-17.35	13 19.0	-17.50	13.0	6.55	6.23	16.02	18.22 to 20.23	67	151	89	0	116	2	0
15/16	13 18.8	-17.44	13 21.5	-17.59	13.0	6.62	6.23	15.45	18.26 to 20.05	63	135	37	0	117	2	0
20/21	13 21.5	-17.54	13 24.2	-18.09	13.1	6.69	6.22	15.28	18.30 to 19.48	59	70	1	0	117	3	0
25/26	13 24.3	-18.05	13 27.0	-18.21	13.1	6.75	6.22	15.11	18.35 to 19.31	55	16	14	0	118	3	0
30/31	13 27.3	-18.18	13 30.0	-18.33	13.1	6.81	6.22	14.54	18.39 to 19.14	51	51	58	0	119	3	-1
September 1998																
4/ 5	13 30.4	-18.31	13 33.1	-18.46	13.1	6.87	6.22	14.37	18.44 to 18.58	47	114	97	0	120	3	-1
9/10	13 33.6	-18.45	13 36.3	-19.01	13.1	6.92	6.22	14.21	Not Observable	43	165	83	0	121	3	-1
14/15	13 36.9	-19.00	13 39.6	-19.15	13.2	6.97	6.22	14.05	Not Observable	39	103	30	0	122	3	-1
19/20	13 40.3	-19.16	13 43.1	-19.31	13.2	7.02	6.22	13.48	Not Observable	35	42	0	0	123	4	-1
24/25	13 43.8	-19.33	13 46.6	-19.48	13.2	7.06	6.22	13.32	Not Observable	31	22	16	0	125	4	-1

Ephemeris for 21P/Giacobini-Zinner (UK)

Omega=172.5433 OMEGA=195.3985 i= 31.8587 q= 1.033713 a= 3.521816
e=0.706483 P= 6.609 T= 1998 November 21.3169 Equinox= 2000
Magnitudes calculated from m= 9.0+5.0*Log(d)+15.0*Log(r)

August 1998 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	16 16.8	26.24	16 18.8	26.17	13.3	1.27	1.78	19.37	21.47 to 0.22	101	42	64	1	117	-1	-4
2/ 3	16 16.5	26.14	16 18.6	26.07	13.2	1.27	1.77	19.33	21.44 to 0.19	101	43	74	1	116	-1	-4
3/ 4	16 16.4	26.04	16 18.4	25.56	13.2	1.27	1.76	19.29	21.41 to 0.15	100	47	82	1	115	0	-4
4/ 5	16 16.2	25.53	16 18.3	25.46	13.2	1.27	1.75	19.25	21.38 to 0.12	99	53	89	1	114	0	-4
5/ 6	16 16.1	25.42	16 18.2	25.35	13.1	1.27	1.74	19.21	21.35 to 0.09	99	61	95	1	113	0	-4
6/ 7	16 16.1	25.31	16 18.2	25.24	13.1	1.27	1.73	19.17	21.32 to 0.06	98	71	99	1	113	0	-4
7/ 8	16 16.1	25.20	16 18.1	25.13	13.0	1.26	1.72	19.13	21.29 to 0.03	98	81	100	1	112	0	-4
8/ 9	16 16.1	25.08	16 18.2	25.01	13.0	1.26	1.71	19.09	21.27 to 23.60	97	92	99	1	111	0	-4
9/10	16 16.2	24.56	16 18.3	24.49	13.0	1.26	1.70	19.05	21.24 to 23.56	96	102	96	1	111	0	-4
10/11	16 16.3	24.44	16 18.4	24.37	12.9	1.26	1.69	19.01	21.21 to 23.53	96	113	89	1	110	0	-5
11/12	16 16.4	24.32	16 18.5	24.24	12.9	1.26	1.68	18.58	21.18 to 23.50	95	123	81	1	109	0	-5
12/13	16 16.6	24.19	16 18.7	24.12	12.9	1.25	1.68	18.54	21.15 to 23.47	95	132	71	1	109	1	-5
13/14	16 16.9	24.06	16 19.0	23.59	12.8	1.25	1.67	18.50	21.12 to 23.44	94	138	60	1	108	1	-5
14/15	16 17.2	23.53	16 19.3	23.46	12.8	1.25	1.66	18.46	21.09 to 23.41	94	141	48	1	107	1	-5
15/16	16 17.5	23.40	16 19.6	23.33	12.7	1.25	1.65	18.43	21.06 to 23.38	93	140	37	1	107	1	-5
16/17	16 17.9	23.26	16 20.0	23.19	12.7	1.25	1.64	18.39	21.03 to 23.35	92	135	26	1	106	2	-5
17/18	16 18.3	23.12	16 20.4	23.05	12.7	1.24	1.63	18.36	21.00 to 23.32	92	128	17	1	105	2	-5
18/19	16 18.7	22.58	16 20.8	22.51	12.6	1.24	1.62	18.32	20.58 to 23.29	91	119	10	1	105	2	-5
19/20	16 19.2	22.44	16 21.3	22.37	12.6	1.24	1.61	18.29	20.55 to 23.26	91	110	4	1	104	2	-5
20/21	16 19.7	22.30	16 21.9	22.23	12.5	1.24	1.60	18.25	20.52 to 23.23	90	100	1	2	103	3	-6
21/22	16 20.3	22.15	16 22.5	22.08	12.5	1.23	1.59	18.22	20.49 to 23.20	90	90	0	2	103	3	-6
22/23	16 21.0	21.60	16 23.1	21.53	12.5	1.23	1.58	18.19	20.46 to 23.18	89	81	0	2	102	3	-6
23/24	16 21.6	21.45	16 23.8	21.38	12.4	1.23	1.58	18.15	20.43 to 23.15	89	71	3	2	102	3	-6
24/25	16 22.3	21.30	16 24.5	21.23	12.4	1.23	1.57	18.12	20.40 to 23.12	88	62	8	2	101	4	-6
25/26	16 23.1	21.14	16 25.2	21.08	12.3	1.22	1.56	18.09	20.37 to 23.09	88	54	14	2	100	4	-6
26/27	16 23.9	20.59	16 26.0	20.52	12.3	1.22	1.55	18.06	20.35 to 23.06	87	47	21	2	100	4	-6
27/28	16 24.7	20.43	16 26.9	20.36	12.2	1.22	1.54	18.03	20.32 to 23.03	87	41	29	2	99	4	-6
28/29	16 25.6	20.27	16 27.8	20.20	12.2	1.22	1.53	17.60	20.29 to 23.01	86	37	38	2	99	5	-6
29/30	16 26.5	20.11	16 28.7	20.04	12.2	1.21	1.52	17.57	20.26 to 22.58	86	36	48	2	98	5	-6
30/31	16 27.5	19.54	16 29.7	19.48	12.1	1.21	1.51	17.54	20.23 to 22.55	85	39	58	2	98	5	-6
31/32	16 28.5	19.38	16 30.7	19.31	12.1	1.21	1.50	17.51	20.20 to 22.53	85	44	68	2	97	5	-6
September 1998																
1/ 2	16 29.5	19.21	16 31.7	19.15	12.0	1.20	1.50	17.48	20.18 to 22.50	85	51	77	2	97	6	-6
2/ 3	16 30.6	19.04	16 32.8	18.58	12.0	1.20	1.49	17.45	20.15 to 22.47	84	60	85	2	96	6	-7
3/ 4	16 31.7	18.47	16 33.9	18.41	11.9	1.20	1.48	17.42	20.12 to 22.45	84	71	92	2	96	6	-7
4/ 5	16 32.9	18.30	16 35.1	18.24	11.9	1.19	1.47	17.39	20.09 to 22.42	83	82	97	2	95	6	-7
5/ 6	16 34.1	18.12	16 36.3	18.06	11.8	1.19	1.46	17.37	20.07 to 22.39	83	93	100	2	95	7	-7
6/ 7	16 35.4	17.54	16 37.6	17.49	11.8	1.19	1.45	17.34	20.04 to 22.37	82	105	100	3	94	7	-7
7/ 8	16 36.7	17.37	16 38.9	17.31	11.8	1.18	1.44	17.31	20.01 to 22.34	82	116	97	3	94	7	-7
8/ 9	16 38.0	17.19	16 40.3	17.13	11.7	1.18	1.43	17.29	19.58 to 22.32	82	127	91	3	93	7	-7
9/10	16 39.4	17.00	16 41.6	16.55	11.7	1.18	1.43	17.26	19.56 to 22.29	81	137	83	3	93	8	-7
10/11	16 40.8	16.42	16 43.1	16.37	11.6	1.17	1.42	17.24	19.53 to 22.26	81	144	73	3	92	8	-7
11/12	16 42.3	16.24	16 44.5	16.18	11.6	1.17	1.41	17.21	19.50 to 22.24	80	147	62	3	92	8	-7
12/13	16 43.8	16.05	16 46.1	15.60	11.5	1.16	1.40	17.19	19.47 to 22.21	80	145	51	3	91	9	-7
13/14	16 45.4	15.46	16 47.6	15.41	11.5	1.16	1.39	17.16	19.45 to 22.19	80	139	40	3	91	9	-7
14/15	16 46.9	15.27	16 49.2	15.22	11.4	1.16	1.38	17.14	19.42 to 22.17	79	131	30	3	90	9	-7
15/16	16 48.6	15.07	16 50.9	15.02	11.4	1.15	1.37	17.12	19.39 to 22.14	79	122	20	3	90	9	-8
16/17	16 50.3	14.48	16 52.6	14.43	11.3	1.15	1.37	17.10	19.37 to 22.12	78	112	13	3	89	10	-8
17/18	16 52.0	14.28	16 54.3	14.24	11.3	1.14	1.36	17.07	19.34 to 22.09	78	102	7	4	89	10	-8
18/19	16 53.8	14.08	16 56.1	14.04	11.2	1.14	1.35	17.05	19.31 to 22.07	78	92	2	4	89	10	-8
19/20	16 55.6	13.48	16 57.9	13.44	11.2	1.13	1.34	17.03	19.29 to 22.04	77	82	0	4	88	11	-8
20/21	16 57.4	13.28	16 59.7	13.24	11.1	1.13	1.33	17.01	19.26 to 22.02	77	72	0	4	88	11	-8
21/22	16 59.3	13.08	17 1.6	13.03	11.1	1.12	1.32	16.59	19.24 to 21.60	77	63	1	4	87	11	-8
22/23	17 1.3	12.47	17 3.6	12.43	11.0	1.12	1.32	16.57	19.21 to 21.57	76	54	4	4	87	11	-8
23/24	17 3.3	12.26	17 5.6	12.22	11.0	1.12	1.31	16.55	19.18 to 21.55	76	45	9	4	87	12	-8
24/25	17 5.3	12.05	17 7.6	12.01	10.9	1.11	1.30	16.53	19.16 to 21.53	76	38	16	4	86	12	-8
25/26	17 7.4	11.44	17 9.7	11.40	10.9	1.11	1.29	16.51	19.13 to 21.50	75	32	23	5	86	12	-8
26/27	17 9.5	11.22	17 11.9	11.19	10.8	1.10	1.29	16.49	19.11 to 21.48	75	29	32	5	85	13	-8
27/28	17 11.7	11.00	17 14.0	10.57	10.8	1.10	1.28	16.48	19.08 to 21.46	75	30	41	5	85	13	-9
28/29	17 13.9	10.38	17 16.3	10.35	10.7	1.09	1.27	16.46	19.06 to 21.43	75	35	51	5	85	13	-9
29/30	17 16.2	10.16	17 18.5	10.13	10.7	1.09	1.26	16.44	19.03 to 21.41	74	43	61	5	84	13	-9
30/31	17 18.5	9.54	17 20.9	9.51	10.6	1.08	1.25	16.43	19.01 to 21.39	74	52	71	5	84	14	-9
October 1998																
1/ 2	17 20.8	9.31	17 23.2	9.28	10.6	1.08	1.25	16.41	18.58 to 21.37	74	63	81	6	84	14	-9
2/ 3	17 23.3	9.08	17 25.6	9.06	10.5	1.07	1.24	16.40	18.56 to 21.34	73	74	89	6	83	14	-9
3/ 4	17 25.7	8.45	17 28.1	8.43	10.5	1.06	1.23	16.38	18.53 to 21.32	73	86	95	6	83	15	-9
4/ 5	17 28.2	8.22	17 30.6	8.20	10.4	1.06	1.23	16.37	18.51 to 21.30	73	99	99	6	83	15	-9
5/ 6	17 30.8	7.58	17 33.2	7.56	10.4	1.05	1.22	16.35	18.49 to 21.28	73	112	100	6	82	15	-9
6/ 7	17 33.3	7.34	17 35.8	7.33	10.4	1.05	1.21	16.34	18.46 to 21.25	72	124	98	7	82	16	-9
7/ 8	17 36.0	7.10	17 38.4	7.09	10.3	1.04	1.20	16.33	18.44 to 21.23	72	136	94	7	82	16	-10
8/ 9	17 38.7	6.46	17 41.1	6.44	10.3	1.04	1.20	16.31	18.42 to 21.21	72	146	86	7	81	16	-10
9/10	17 41.4	6.21	17 43.9	6.20	10.2	1.03	1.19	16.30	18.39 to 21.19	72	154	77	7	81	17	-10
10/11	17 44.2	5.56	17 46.7	5.55	10.2	1.03	1.18	16.29	18.37 to 21.17	72	155	66	7	81	17	-10
11/12	17 47.1	5.31	17 49.5	5.30	10.1	1.02	1.18	16.28	18.35 to 21.14	71	150	55	8	80	17	-10
12/13	17 50.0	5.06	17 52.4	5.05	10.1	1.02	1.17	16.27	18.33 to 21.12	71	142	44	8	80	18	-10
13/14	17 52.9	4.40	17 55.4	4.40	10.0	1.01	1.16	16.26	18.30 to 21.10	71	133	34	8	80	18	-10
14/15	17 55.9	4.14	17 58.4	4.14	10.0	1.00	1.16	16.25	18.28 to 21.08	71	123	25	8	80	18	-10
15/16	17 59.0	3.48	18 1.5	3.48	9.9	1.00	1.15	16.24	18.26 to 21.06	71	113	17	9	79	19	-10
16/17	18 2.1	3.22	18 4.6	3.22	9.9	0.99	1.15	16.23	18.24 to 21.03	70	102	10	9	79	19	-11
17/18	18 5.2	2.55	18 7.7	2.55	9.8	0.99	1.14	16.23	18.22 to 21.01	70	92	5	9	79	19	-11
18/19	18 8.5	2.28	18 11.0	2.29	9.8	0.98	1.13	16.22	18.20 to 20.59	70	82	1	10	79	20	-11
19/20	18 11.7	2.01	18 14.2	2.02	9.7	0.98	1.13	16.21	18.17 to 20.57	70	72	0	10	78	20	-11
20/21	18 15.1	1.33	18 17.6	1.34	9.7	0.97	1.12	16.21	18.15 to 20.55	70	61	0	10	78	20	-11
21/22	18 18.4	1.05	18 21.0	1.07	9.7	0.97	1.12	16.20	18.13 to 20.52	69	51	2	10	78	21	-11
22/23	18 21.9	0.37	18 24.4	0.39	9.6	0.96	1.11	16.20	18.11 to 20.50	69	42	6	11	78	21	-11
23/24	18 25.4	0.09	18 27.9	0.11	9.6	0.96	1.11	16.19	18.09 to 20.48	69	32	11	11	78	21	-11
24/25	18 28.9	-0.20	18 31.5	-0.18	9.5	0.95	1.10	16.19	18.07 to 20.46	69	24	18	11	77	22	-11
25/26	18 32.5	-0.49	18 35.1	-0.46	9.5	0.95	1.10	16.18	18.05 to 20.44	69	19	26	12	77	22	-12
26/27	18 36.2	-1.18	18 38.8	-1.15	9.5	0.94	1.09	16.18	18.04 to 20.41	69	19	35	12	77	22	-12
27/28	18 39.9	-1.47	18 42.5	-1.44	9.4	0.94	1.09	16.18	18.02 to 20.39	69	25	45	12	77	23	-12

Ephemeris for 21P/Giacobini-Zinner (UK)

October 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
28/29	18 43.7	-2.17	18 46.3	-2.13	9.4	0.93	1.09	16.18	17.60 to 20.37	69	35	56	12	77	23	-12
29/30	18 47.5	-2.46	18 50.1	-2.43	9.3	0.93	1.08	16.18	17.58 to 20.35	68	46	66	13	76	23	-12
30/31	18 51.4	-3.16	18 54.0	-3.12	9.3	0.92	1.08	16.18	17.56 to 20.32	68	58	76	13	76	24	-12
31/32	18 55.4	-3.46	18 58.0	-3.42	9.3	0.92	1.07	16.18	17.55 to 20.30	68	70	86	13	76	24	-12

November 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	18 59.4	-4.17	19 2.0	-4.12	9.2	0.91	1.07	16.18	17.53 to 20.28	68	84	93	14	76	25	-12
2/ 3	19 3.5	-4.47	19 6.1	-4.43	9.2	0.91	1.07	16.18	17.51 to 20.26	68	97	98	14	76	25	-12
3/ 4	19 7.6	-5.18	19 10.2	-5.13	9.2	0.90	1.06	16.18	17.50 to 20.23	68	111	100	14	76	25	-12
4/ 5	19 11.8	-5.49	19 14.4	-5.44	9.1	0.90	1.06	16.18	17.48 to 20.21	68	125	100	14	76	26	-12
5/ 6	19 16.0	-6.20	19 18.7	-6.14	9.1	0.89	1.06	16.19	17.46 to 20.19	68	138	96	15	75	26	-12
6/ 7	19 20.3	-6.51	19 23.0	-6.45	9.1	0.89	1.05	16.19	17.45 to 20.16	68	151	89	15	75	26	-12
7/ 8	19 24.7	-7.22	19 27.4	-7.16	9.1	0.89	1.05	16.19	17.43 to 20.14	68	163	81	15	75	27	-12
8/ 9	19 29.1	-7.53	19 31.8	-7.47	9.0	0.88	1.05	16.20	17.42 to 20.12	68	169	71	15	75	27	-12
9/10	19 33.6	-8.24	19 36.3	-8.17	9.0	0.88	1.05	16.20	17.40 to 20.09	68	164	61	16	75	27	-13
10/11	19 38.1	-8.56	19 40.9	-8.48	9.0	0.88	1.04	16.21	17.39 to 20.07	68	154	50	16	75	28	-13
11/12	19 42.7	-9.27	19 45.5	-9.19	9.0	0.87	1.04	16.22	17.38 to 20.04	68	143	40	16	75	28	-12
12/13	19 47.4	-9.58	19 50.1	-9.50	9.0	0.87	1.04	16.22	17.36 to 20.02	68	133	31	16	75	28	-12
13/14	19 52.1	-10.29	19 54.8	-10.21	8.9	0.87	1.04	16.23	17.35 to 19.59	68	122	22	16	75	28	-12
14/15	19 56.9	-10.60	19 59.6	-10.52	8.9	0.87	1.04	16.24	17.34 to 19.57	68	111	15	16	74	29	-12
15/16	20 1.7	-11.31	20 4.4	-11.22	8.9	0.86	1.04	16.25	17.33 to 19.54	68	101	8	17	74	29	-12
16/17	20 6.6	-12.01	20 9.3	-11.52	8.9	0.86	1.04	16.26	17.31 to 19.52	68	90	4	17	74	29	-12
17/18	20 11.5	-12.32	20 14.3	-12.23	8.9	0.86	1.03	16.27	17.30 to 19.49	68	79	1	17	74	30	-12
18/19	20 16.5	-13.02	20 19.2	-12.53	8.9	0.86	1.03	16.28	17.29 to 19.47	68	69	0	17	74	30	-12
19/20	20 21.5	-13.32	20 24.3	-13.22	8.9	0.86	1.03	16.29	17.28 to 19.44	68	58	0	17	74	30	-12
20/21	20 26.6	-14.02	20 29.4	-13.51	8.9	0.85	1.03	16.30	17.27 to 19.41	68	47	3	17	74	30	-12
21/22	20 31.7	-14.31	20 34.5	-14.20	8.9	0.85	1.03	16.31	17.26 to 19.39	68	36	7	17	74	31	-12
22/23	20 36.9	-14.60	20 39.7	-14.49	8.9	0.85	1.03	16.33	17.25 to 19.36	68	25	13	17	74	31	-12
23/24	20 42.1	-15.28	20 44.9	-15.17	8.9	0.85	1.03	16.34	17.24 to 19.33	68	13	20	17	74	31	-11
24/25	20 47.3	-15.56	20 50.1	-15.45	8.9	0.85	1.04	16.35	17.24 to 19.31	68	2	29	17	74	31	-11
25/26	20 52.6	-16.24	20 55.4	-16.12	8.9	0.85	1.04	16.36	17.23 to 19.28	68	10	39	17	74	31	-11
26/27	20 58.0	-16.51	21 0.8	-16.39	8.9	0.85	1.04	16.38	17.22 to 19.25	68	22	50	17	73	31	-11
27/28	21 3.3	-17.17	21 6.1	-17.05	8.9	0.85	1.04	16.39	17.21 to 19.22	68	35	61	17	73	32	-10
28/29	21 8.7	-17.43	21 11.5	-17.30	8.9	0.85	1.04	16.41	17.21 to 19.19	68	48	72	17	73	32	-10
29/30	21 14.2	-18.08	21 17.0	-17.55	8.9	0.85	1.04	16.42	17.20 to 19.16	69	61	82	16	73	32	-10
30/31	21 19.6	-18.32	21 22.4	-18.20	8.9	0.85	1.04	16.44	17.20 to 19.13	69	75	90	16	73	32	-10

Ephemeris for 88P/Howell (UK)

Note: the comet may be fainter pre-perihelion than these predictions indicate.

Omega=234.9042 OMEGA= 57.6696 i= 4.3981 q= 1.406147 a= 3.143415
e=0.552669 P= 5.573 T= 1998 September 27.1793 Equinox= 2000
Magnitudes calculated from m= 7.7+5.0*Log(d)+15.0*Log(r)

June 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	12 53.3	-3.28	12 55.8	-3.44	11.9	1.09	1.85	20.15	22.40 to 23.03	123	33	50	2	114	0	-1
2/ 3	12 53.2	-3.32	12 55.8	-3.48	11.9	1.09	1.84	20.11	22.43 to 22.59	122	21	59	2	114	0	-1
3/ 4	12 53.1	-3.36	12 55.7	-3.52	11.9	1.10	1.84	20.07	22.46 to 22.55	121	9	68	2	114	0	-1
4/ 5	12 53.1	-3.40	12 55.7	-3.56	11.8	1.10	1.83	20.03	22.49 to 22.52	120	3	77	2	114	0	-1
5/ 6	12 53.2	-3.44	12 55.8	-4.01	11.8	1.10	1.83	19.59	Not Observable	119	14	84	2	114	0	-1
6/ 7	12 53.3	-3.49	12 55.9	-4.05	11.8	1.10	1.82	19.55	Not Observable	118	26	91	2	114	0	-1
7/ 8	12 53.4	-3.54	12 56.0	-4.10	11.8	1.11	1.81	19.51	Not Observable	117	38	96	2	114	0	-2
8/ 9	12 53.6	-3.59	12 56.1	-4.15	11.8	1.11	1.81	19.47	Not Observable	117	50	99	2	114	1	-2
9/10	12 53.8	-4.05	12 56.3	-4.21	11.8	1.11	1.80	19.44	Not Observable	116	63	100	2	113	1	-2
10/11	12 54.0	-4.10	12 56.6	-4.26	11.7	1.11	1.80	19.40	Not Observable	115	75	100	2	113	1	-2
11/12	12 54.3	-4.16	12 56.9	-4.32	11.7	1.12	1.79	19.36	Not Observable	114	88	97	2	113	1	-2
12/13	12 54.6	-4.22	12 57.2	-4.38	11.7	1.12	1.78	19.33	Not Observable	113	101	92	2	113	1	-2
13/14	12 54.9	-4.29	12 57.5	-4.45	11.7	1.12	1.78	19.29	Not Observable	112	114	85	2	113	2	-2
14/15	12 55.3	-4.35	12 57.9	-4.51	11.7	1.13	1.77	19.26	Not Observable	111	128	76	2	113	2	-2
15/16	12 55.8	-4.42	12 58.3	-4.58	11.7	1.13	1.77	19.22	Not Observable	111	141	66	2	113	2	-2
16/17	12 56.2	-4.49	12 58.8	-5.05	11.7	1.13	1.76	19.19	Not Observable	110	155	55	2	113	2	-2
17/18	12 56.7	-4.56	12 59.3	-5.12	11.6	1.14	1.75	19.15	Not Observable	109	169	44	2	113	3	-2
18/19	12 57.3	-5.03	12 59.9	-5.20	11.6	1.14	1.75	19.12	Not Observable	108	176	32	2	113	3	-3
19/20	12 57.9	-5.11	13 0.5	-5.27	11.6	1.14	1.74	19.08	Not Observable	108	162	22	2	113	3	-3
20/21	12 58.5	-5.19	13 1.1	-5.35	11.6	1.15	1.74	19.05	Not Observable	107	148	13	2	113	3	-3
21/22	12 59.1	-5.27	13 1.7	-5.43	11.6	1.15	1.73	19.02	Not Observable	106	134	6	2	113	4	-3
22/23	12 59.8	-5.35	13 2.4	-5.51	11.6	1.15	1.73	18.59	Not Observable	105	120	1	2	113	4	-3
23/24	13 0.6	-5.44	13 3.2	-5.60	11.5	1.16	1.72	18.55	Not Observable	105	106	0	2	113	4	-3
24/25	13 1.3	-5.52	13 3.9	-6.08	11.5	1.16	1.71	18.52	Not Observable	104	92	0	2	113	4	-3
25/26	13 2.1	-6.01	13 4.7	-6.17	11.5	1.16	1.71	18.49	Not Observable	103	79	4	2	113	5	-3
26/27	13 3.0	-6.10	13 5.6	-6.26	11.5	1.17	1.70	18.46	Not Observable	102	66	9	3	113	5	-3
27/28	13 3.9	-6.19	13 6.5	-6.35	11.5	1.17	1.70	18.43	Not Observable	102	53	16	3	112	5	-3
28/29	13 4.8	-6.29	13 7.4	-6.45	11.5	1.17	1.69	18.40	Not Observable	101	41	24	3	112	5	-3
29/30	13 5.7	-6.38	13 8.3	-6.54	11.5	1.18	1.69	18.37	Not Observable	100	29	33	3	112	5	-4
30/31	13 6.7	-6.48	13 9.3	-7.04	11.4	1.18	1.68	18.34	Not Observable	100	18	43	3	112	6	-4

Ephemeris for 88P/Howell (Southern Hemisphere, 40° South)

Note: the comet may be fainter pre-perihelion than these predictions indicate.

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Omega=234.9042 OMEGA= 57.6696 i=  4.3981 q= 1.406147 a=  3.143415
e=0.552669  P=     5.573  T= 1998 September 27.1793    Equinox= 2000
Magnitudes calculated from m= 7.7+5.0*Log(d)+15.0*Log(r)
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July 1998 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	13 7.7	-6.58	13 10.3	-7.14	11.4	1.18	1.68	18.31	17.55 to 23.06	99	7	52	3	112	6	-4
2/ 3	13 8.8	-7.08	13 11.4	-7.24	11.4	1.19	1.67	18.28	17.56 to 23.04	98	7	62	3	112	6	-4
3/ 4	13 9.9	-7.19	13 12.5	-7.35	11.4	1.19	1.67	18.25	17.56 to 23.02	98	18	71	3	112	6	-4
4/ 5	13 11.0	-7.29	13 13.6	-7.45	11.4	1.19	1.66	18.22	17.57 to 23.00	97	29	79	3	112	6	-4
5/ 6	13 12.1	-7.40	13 14.7	-7.56	11.4	1.20	1.65	18.20	17.57 to 22.58	96	41	87	3	112	7	-4
6/ 7	13 13.3	-7.51	13 15.9	-8.07	11.4	1.20	1.65	18.17	17.58 to 22.57	96	53	93	3	112	7	-4
7/ 8	13 14.5	-8.02	13 17.2	-8.18	11.3	1.20	1.64	18.14	17.58 to 22.55	95	65	97	3	112	7	-4
8/ 9	13 15.8	-8.13	13 18.4	-8.29	11.3	1.21	1.64	18.11	17.59 to 22.53	95	78	100	3	112	7	-4
9/10	13 17.1	-8.24	13 19.7	-8.40	11.3	1.21	1.63	18.09	17.59 to 22.52	94	91	100	3	112	7	-4
10/11	13 18.4	-8.36	13 21.0	-8.51	11.3	1.21	1.63	18.06	17.60 to 22.50	93	104	98	3	112	8	-4
11/12	13 19.8	-8.47	13 22.4	-9.03	11.3	1.22	1.62	18.04	18.00 to 22.48	93	117	94	3	112	8	-4
12/13	13 21.1	-8.59	13 23.8	-9.15	11.3	1.22	1.62	18.01	18.01 to 22.47	92	131	87	3	112	8	-4
13/14	13 22.6	-9.11	13 25.2	-9.27	11.3	1.22	1.61	17.58	18.02 to 22.45	92	144	79	3	112	8	-4
14/15	13 24.0	-9.23	13 26.6	-9.39	11.2	1.23	1.61	17.56	18.02 to 22.44	91	158	69	3	112	8	-5
15/16	13 25.5	-9.35	13 28.1	-9.51	11.2	1.23	1.60	17.54	18.03 to 22.42	91	171	57	3	112	9	-5
16/17	13 27.0	-9.48	13 29.6	-10.03	11.2	1.23	1.60	17.51	18.03 to 22.41	90	173	46	3	112	9	-5
17/18	13 28.5	-10.00	13 31.2	-10.15	11.2	1.23	1.59	17.49	18.04 to 22.40	90	160	34	3	112	9	-5
18/19	13 30.1	-10.13	13 32.8	-10.28	11.2	1.24	1.59	17.46	18.05 to 22.38	89	147	24	3	111	9	-5
19/20	13 31.7	-10.25	13 34.4	-10.41	11.2	1.24	1.59	17.44	18.05 to 22.37	89	133	15	3	111	9	-5
20/21	13 33.4	-10.38	13 36.0	-10.53	11.2	1.24	1.58	17.42	18.06 to 22.36	88	120	8	4	111	10	-5
21/22	13 35.0	-10.51	13 37.7	-11.06	11.1	1.25	1.58	17.39	18.07 to 22.34	88	107	3	4	111	10	-5
22/23	13 36.7	-11.04	13 39.4	-11.19	11.1	1.25	1.57	17.37	18.08 to 22.33	87	94	0	4	111	10	-5
23/24	13 38.5	-11.17	13 41.1	-11.32	11.1	1.25	1.57	17.35	18.08 to 22.32	87	81	0	4	111	10	-5
24/25	13 40.2	-11.31	13 42.9	-11.46	11.1	1.26	1.56	17.33	18.09 to 22.31	86	68	2	4	111	10	-5
25/26	13 42.0	-11.44	13 44.7	-11.59	11.1	1.26	1.56	17.31	18.10 to 22.30	86	56	6	4	111	10	-5
26/27	13 43.8	-11.58	13 46.5	-12.12	11.1	1.26	1.55	17.29	18.10 to 22.29	85	44	12	4	111	11	-5
27/28	13 45.7	-12.11	13 48.3	-12.26	11.1	1.26	1.55	17.26	18.11 to 22.28	85	33	19	4	111	11	-5
28/29	13 47.6	-12.25	13 50.2	-12.40	11.0	1.27	1.54	17.24	18.12 to 22.27	84	22	27	4	111	11	-5
29/30	13 49.5	-12.39	13 52.1	-12.53	11.0	1.27	1.54	17.22	18.13 to 22.26	84	11	36	4	111	11	-5
30/31	13 51.4	-12.52	13 54.1	-13.07	11.0	1.27	1.54	17.20	18.14 to 22.25	84	6	45	4	111	11	-5
31/32	13 53.4	-13.06	13 56.1	-13.21	11.0	1.28	1.53	17.18	18.14 to 22.24	83	14	55	4	111	12	-5
August 1998																
1/ 2	13 55.4	-13.20	13 58.1	-13.35	11.0	1.28	1.53	17.16	18.15 to 22.23	83	25	64	4	110	12	-5
2/ 3	13 57.4	-13.34	14 0.1	-13.49	11.0	1.28	1.52	17.15	18.16 to 22.22	82	37	74	4	110	12	-5
3/ 4	13 59.5	-13.48	14 2.2	-14.03	11.0	1.28	1.52	17.13	18.17 to 22.21	82	49	82	4	110	12	-5
4/ 5	14 1.6	-14.03	14 4.3	-14.17	11.0	1.29	1.52	17.11	18.17 to 22.20	81	61	89	4	110	12	-5
5/ 6	14 3.7	-14.17	14 6.4	-14.31	10.9	1.29	1.51	17.09	18.18 to 22.19	81	73	95	4	110	12	-5
6/ 7	14 5.8	-14.31	14 8.6	-14.45	10.9	1.29	1.51	17.07	18.19 to 22.19	81	86	99	4	110	13	-5
7/ 8	14 8.0	-14.45	14 10.7	-14.60	10.9	1.30	1.50	17.05	18.20 to 22.18	80	99	100	4	110	13	-5
8/ 9	14 10.2	-14.60	14 13.0	-15.14	10.9	1.30	1.50	17.04	18.21 to 22.17	80	113	99	4	110	13	-5
9/10	14 12.5	-15.14	14 15.2	-15.28	10.9	1.30	1.50	17.02	18.21 to 22.17	80	126	96	4	110	13	-6
10/11	14 14.7	-15.29	14 17.5	-15.42	10.9	1.30	1.49	17.00	18.22 to 22.16	79	140	89	4	110	13	-6
11/12	14 17.0	-15.43	14 19.8	-15.57	10.9	1.31	1.49	16.59	18.23 to 22.15	79	154	81	4	109	13	-6
12/13	14 19.4	-15.58	14 22.1	-16.11	10.9	1.31	1.49	16.57	18.24 to 22.15	78	166	71	4	109	13	-6
13/14	14 21.7	-16.12	14 24.5	-16.26	10.9	1.31	1.48	16.56	18.25 to 22.14	78	173	60	4	109	14	-6
14/15	14 24.1	-16.27	14 26.8	-16.40	10.8	1.31	1.48	16.54	18.25 to 22.13	78	163	48	4	109	14	-6
15/16	14 26.5	-16.41	14 29.3	-16.54	10.8	1.32	1.48	16.52	18.26 to 22.13	77	151	37	4	109	14	-6
16/17	14 28.9	-16.56	14 31.7	-17.09	10.8	1.32	1.47	16.51	18.27 to 22.12	77	138	26	5	109	14	-6
17/18	14 31.4	-17.10	14 34.2	-17.23	10.8	1.32	1.47	16.49	18.28 to 22.12	77	125	17	5	109	14	-6
18/19	14 33.9	-17.25	14 36.7	-17.38	10.8	1.33	1.47	16.48	18.29 to 22.11	76	112	10	5	109	14	-6
19/20	14 36.4	-17.39	14 39.2	-17.52	10.8	1.33	1.46	16.47	18.30 to 22.11	76	100	4	5	108	15	-6
20/21	14 39.0	-17.53	14 41.8	-18.06	10.8	1.33	1.46	16.45	18.30 to 22.11	76	88	1	5	108	15	-6
21/22	14 41.6	-18.08	14 44.4	-18.20	10.8	1.33	1.46	16.44	18.31 to 22.10	76	76	0	5	108	15	-6
22/23	14 44.2	-18.22	14 47.0	-18.35	10.8	1.34	1.46	16.43	18.32 to 22.10	75	64	0	5	108	15	-5
23/24	14 46.8	-18.37	14 49.7	-18.49	10.8	1.34	1.45	16.41	18.33 to 22.09	75	53	3	5	108	15	-5
24/25	14 49.5	-18.51	14 52.3	-19.03	10.8	1.34	1.45	16.40	18.34 to 22.09	75	41	8	5	108	15	-5
25/26	14 52.2	-19.05	14 55.1	-19.17	10.8	1.34	1.45	16.39	18.35 to 22.09	74	30	14	5	107	15	-5
26/27	14 55.0	-19.19	14 57.8	-19.31	10.7	1.35	1.45	16.38	18.36 to 22.08	74	20	21	5	107	16	-5
27/28	14 57.7	-19.33	15 0.6	-19.45	10.7	1.35	1.44	16.36	18.36 to 22.08	74	11	29	5	107	16	-5
28/29	15 0.5	-19.47	15 3.4	-19.59	10.7	1.35	1.44	16.35	18.37 to 22.08	74	9	38	5	107	16	-5
29/30	15 3.3	-20.01	15 6.2	-20.13	10.7	1.35	1.44	16.34	18.38 to 22.08	73	17	48	5	107	16	-5
30/31	15 6.2	-20.15	15 9.0	-20.26	10.7	1.36	1.44	16.33	18.39 to 22.07	73	28	58	5	107	16	-5
31/32	15 9.0	-20.29	15 11.9	-20.40	10.7	1.36	1.43	16.32	18.40 to 22.07	73	39	68	5	106	16	-5
September 1998																
1/ 2	15 11.9	-20.42	15 14.8	-20.53	10.7	1.36	1.43	16.31	18.41 to 22.07	73	51	77	5	106	16	-5
2/ 3	15 14.9	-20.56	15 17.8	-21.07	10.7	1.37	1.43	16.30	18.42 to 22.07	72	63	85	5	106	17	-5
3/ 4	15 17.8	-21.09	15 20.7	-21.20	10.7	1.37	1.43	16.29	18.43 to 22.07	72	76	92	5	106	17	-5
4/ 5	15 20.8	-21.23	15 23.7	-21.33	10.7	1.37	1.43	16.28	18.44 to 22.06	72	89	97	5	105	17	-5
5/ 6	15 23.8	-21.36	15 26.7	-21.46	10.7	1.37	1.42	16.27	18.44 to 22.06	72	103	100	5	105	17	-5
6/ 7	15 26.9	-21.49	15 29.8	-21.59	10.7	1.38	1.42	16.26	18.45 to 22.06	71	116	100	5	105	17	-5
7/ 8	15 29.9	-22.02	15 32.8	-22.12	10.7	1.38	1.42	16.25	18.46 to 22.06	71	130	97	5	105	17	-5
8/ 9	15 33.0	-22.14	15 35.9	-22.24	10.7	1.38	1.42	16.25	18.47 to 22.06	71	144	91	5	105	17	-5
9/10	15 36.1	-22.27	15 39.1	-22.37	10.7	1.39	1.42	16.24	18.48 to 22.06	71	158	83	5	104	18	-5
10/11	15 39.3	-22.39	15 42.2	-22.49	10.7	1.39	1.42	16.23	18.49 to 22.06	70	169	73	5	104	18	-5
11/12	15 42.5	-22.51	15 45.4	-23.01	10.7	1.39	1.42	16.22	18.50 to 22.06	70	170	62	5	104	18	-5
12/13	15 45.7	-23.03	15 48.6	-23.13	10.7	1.39	1.41	16.21	18.51 to 22.06	70	159	51	5	104	18	-5
13/14	15 48.9	-23.15	15 51.8	-23.24	10.7	1.40	1.41	16.21	18.52 to 22.05	70	147	40	5	103	18	-4
14/15	15 52.1	-23.27	15 55.1	-23.36	10.7	1.40	1.41	16.20	18.53 to 22.05	70	134	30	5	103	18	-4
15/16	15 55.4	-23.38	15 58.4	-23.47	10.7	1.40	1.41	16.19	18.54 to 22.05	69	122	20	5	103	18	-4
16/17	15 58.7	-23.49	16 1.7	-23.58	10.7	1.41	1.41	16.19	18.55 to 22.05	69	110	13	5	103	18	-4
17/18	16 2.0	-24.00	16 5.0	-24.08	10.7	1.41	1.41	16.18	18.56 to 22.05	69	99	7	5	102	18	-4
18/19	16 5.4	-24.11	16 8.4	-24.19	10.7	1.41	1.41	16.17	18.57 to 22.05	69	87	2	5	102	19	-4
19/20	16 8.7	-24.22	16 11.7	-24.29	10.7	1.42	1.41	16.17	18.58 to 22.05	69	76	0	5	102	19	-4
20/21	16 12.1	-24.32	16 15.1	-24.39	10.7	1.42	1.41	16.16	18.59 to 22.05	68	65	0	5	101	19	-4
21/22	16 15.5	-24.42	16 18.6	-24.49	10.7	1.42	1.41	16.16	18.60 to 22.05	68	54	1	5	101	19	-4
22/23	16 19.0	-24.52	16 22.0	-24.59	10.7	1.43	1.41	16.15	19.01 to 22.05	68	43	4	5	101	19	-4
23/24	16 22.4	-25.01	16 25.5	-25.08	10.7	1.43	1.41	16.15	19.02 to 22.05	68	32	9	5	101	19	-3

Ephemeris for 88P/Howell (Southern Hemisphere, 40° South)

September 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
24/25	16 25.9	-25.10	16 29.0	-25.17	10.7	1.44	1.41	16.14	19.03 to 22.05	68	22	16	5	100	19	-3
25/26	16 29.4	-25.19	16 32.5	-25.26	10.7	1.44	1.41	16.14	19.04 to 22.05	68	13	23	5	100	19	-3
26/27	16 33.0	-25.28	16 36.0	-25.34	10.7	1.44	1.41	16.14	19.05 to 22.05	67	9	32	5	100	19	-3
27/28	16 36.5	-25.36	16 39.6	-25.42	10.7	1.45	1.41	16.13	19.06 to 22.05	67	16	41	5	99	19	-3
28/29	16 40.1	-25.44	16 43.1	-25.50	10.7	1.45	1.41	16.13	19.07 to 22.05	67	26	51	5	99	20	-3
29/30	16 43.6	-25.52	16 46.7	-25.57	10.7	1.45	1.41	16.12	19.08 to 22.04	67	37	61	5	99	20	-3
30/31	16 47.2	-25.60	16 50.3	-26.05	10.7	1.46	1.41	16.12	19.09 to 22.04	67	49	71	5	98	20	-3

October 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	16 50.9	-26.07	16 53.9	-26.12	10.8	1.46	1.41	16.12	19.10 to 22.04	67	62	81	5	98	20	-2
2/ 3	16 54.5	-26.14	16 57.6	-26.18	10.8	1.47	1.41	16.12	19.11 to 22.04	66	75	89	5	98	20	-2
3/ 4	16 58.1	-26.20	17 1.2	-26.24	10.8	1.47	1.41	16.11	19.12 to 22.04	66	89	95	5	97	20	-2
4/ 5	17 1.8	-26.26	17 4.9	-26.30	10.8	1.48	1.41	16.11	19.13 to 22.04	66	103	99	5	97	20	-2
5/ 6	17 5.5	-26.32	17 8.6	-26.36	10.8	1.48	1.41	16.11	19.15 to 22.04	66	117	100	5	97	20	-2
6/ 7	17 9.2	-26.38	17 12.3	-26.41	10.8	1.48	1.41	16.10	19.16 to 22.03	66	131	98	5	96	20	-2
7/ 8	17 12.9	-26.43	17 16.0	-26.46	10.8	1.49	1.41	16.10	19.17 to 22.03	66	145	94	5	96	20	-2
8/ 9	17 16.6	-26.48	17 19.7	-26.51	10.8	1.49	1.41	16.10	19.18 to 22.03	66	158	86	5	96	20	-1
9/10	17 20.3	-26.52	17 23.4	-26.55	10.8	1.50	1.41	16.10	19.19 to 22.03	65	169	77	5	95	20	-1
10/11	17 24.1	-26.56	17 27.2	-26.59	10.8	1.50	1.41	16.10	19.20 to 22.02	65	169	66	4	95	20	-1
11/12	17 27.8	-26.60	17 30.9	-27.02	10.9	1.51	1.42	16.09	19.22 to 22.02	65	159	55	4	95	20	-1
12/13	17 31.6	-27.03	17 34.7	-27.05	10.9	1.51	1.42	16.09	19.23 to 22.02	65	147	44	4	94	20	-1
13/14	17 35.3	-27.06	17 38.5	-27.08	10.9	1.52	1.42	16.09	19.24 to 22.01	65	135	34	4	94	20	-1
14/15	17 39.1	-27.09	17 42.2	-27.10	10.9	1.52	1.42	16.09	19.25 to 22.01	65	124	25	4	94	20	-1
15/16	17 42.9	-27.11	17 46.0	-27.12	10.9	1.53	1.42	16.09	19.27 to 22.01	64	112	17	4	93	21	0
16/17	17 46.7	-27.13	17 49.8	-27.14	10.9	1.53	1.42	16.09	19.28 to 22.00	64	101	10	4	93	21	0
17/18	17 50.5	-27.15	17 53.6	-27.15	10.9	1.54	1.42	16.08	19.29 to 21.60	64	90	5	4	92	21	0
18/19	17 54.3	-27.16	17 57.4	-27.16	11.0	1.54	1.43	16.08	19.30 to 21.59	64	79	1	4	92	21	0
19/20	17 58.1	-27.16	18 1.2	-27.16	11.0	1.55	1.43	16.08	19.32 to 21.59	64	68	0	4	92	21	0
20/21	18 1.9	-27.17	18 5.0	-27.17	11.0	1.56	1.43	16.08	19.33 to 21.58	64	57	0	4	91	21	0
21/22	18 5.7	-27.17	18 8.8	-27.16	11.0	1.56	1.43	16.08	19.34 to 21.58	64	47	2	4	91	21	0
22/23	18 9.5	-27.17	18 12.6	-27.16	11.0	1.57	1.43	16.08	19.36 to 21.57	63	36	6	4	91	21	0
23/24	18 13.3	-27.16	18 16.4	-27.15	11.0	1.57	1.44	16.08	19.37 to 21.57	63	25	11	4	90	21	0
24/25	18 17.1	-27.15	18 20.2	-27.13	11.1	1.58	1.44	16.07	19.38 to 21.56	63	15	18	4	90	21	0
25/26	18 20.9	-27.13	18 24.0	-27.12	11.1	1.59	1.44	16.07	19.40 to 21.55	63	8	26	4	90	21	0
26/27	18 24.7	-27.11	18 27.8	-27.09	11.1	1.59	1.44	16.07	19.41 to 21.55	63	13	35	4	89	21	0
27/28	18 28.5	-27.09	18 31.6	-27.07	11.1	1.60	1.44	16.07	19.42 to 21.54	63	23	45	4	89	21	0
28/29	18 32.3	-27.07	18 35.4	-27.04	11.1	1.60	1.45	16.07	19.44 to 21.53	63	35	56	4	89	21	1
29/30	18 36.1	-27.04	18 39.2	-27.01	11.2	1.61	1.45	16.07	19.45 to 21.52	62	47	66	4	88	21	1
30/31	18 39.8	-27.00	18 43.0	-26.57	11.2	1.62	1.45	16.06	19.47 to 21.51	62	60	76	4	88	21	1
31/32	18 43.6	-26.57	18 46.7	-26.53	11.2	1.62	1.45	16.06	19.48 to 21.50	62	73	86	3	87	21	1

November 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	18 47.4	-26.53	18 50.5	-26.49	11.2	1.63	1.46	16.06	19.50 to 21.49	62	87	93	3	87	21	1
2/ 3	18 51.1	-26.48	18 54.3	-26.44	11.2	1.64	1.46	16.06	19.51 to 21.48	62	101	98	3	87	20	1
3/ 4	18 54.9	-26.44	18 58.0	-26.39	11.3	1.65	1.46	16.06	19.52 to 21.47	62	115	100	3	86	20	1
4/ 5	18 58.6	-26.38	19 1.7	-26.34	11.3	1.65	1.47	16.06	19.54 to 21.46	61	130	100	3	86	20	2
5/ 6	19 2.4	-26.33	19 5.5	-26.28	11.3	1.66	1.47	16.05	19.55 to 21.45	61	144	96	3	86	20	2
6/ 7	19 6.1	-26.27	19 9.2	-26.22	11.3	1.67	1.47	16.05	19.57 to 21.44	61	157	89	3	85	20	2
7/ 8	19 9.8	-26.21	19 12.9	-26.16	11.4	1.67	1.48	16.05	19.58 to 21.43	61	169	81	3	85	20	2
8/ 9	19 13.5	-26.15	19 16.6	-26.09	11.4	1.68	1.48	16.05	19.60 to 21.42	61	171	71	3	85	20	2
9/10	19 17.2	-26.08	19 20.2	-26.02	11.4	1.69	1.48	16.04	20.01 to 21.40	61	161	61	3	84	20	2
10/11	19 20.8	-26.01	19 23.9	-25.55	11.4	1.70	1.49	16.04	20.03 to 21.39	60	150	50	3	84	20	2
11/12	19 24.5	-25.53	19 27.6	-25.47	11.5	1.71	1.49	16.04	20.04 to 21.38	60	138	40	3	84	20	3
12/13	19 28.1	-25.46	19 31.2	-25.39	11.5	1.71	1.49	16.03	20.06 to 21.36	60	127	31	3	83	20	3
13/14	19 31.8	-25.38	19 34.8	-25.31	11.5	1.72	1.50	16.03	20.07 to 21.35	60	116	22	3	83	20	3
14/15	19 35.4	-25.29	19 38.4	-25.22	11.5	1.73	1.50	16.03	20.09 to 21.33	60	105	15	3	83	20	3
15/16	19 39.0	-25.21	19 42.0	-25.14	11.6	1.74	1.50	16.02	20.10 to 21.32	60	94	8	3	82	20	3
16/17	19 42.6	-25.12	19 45.6	-25.04	11.6	1.75	1.51	16.02	20.12 to 21.30	59	83	4	3	82	20	3
17/18	19 46.1	-25.03	19 49.2	-24.55	11.6	1.75	1.51	16.02	20.13 to 21.29	59	72	1	3	82	20	3
18/19	19 49.7	-24.53	19 52.7	-24.45	11.6	1.76	1.51	16.01	20.14 to 21.27	59	61	0	3	81	20	3
19/20	19 53.2	-24.43	19 56.2	-24.35	11.7	1.77	1.52	16.01	20.16 to 21.25	59	50	0	2	81	20	4
20/21	19 56.7	-24.33	19 59.7	-24.25	11.7	1.78	1.52	16.00	20.17 to 21.24	59	39	3	2	81	19	4
21/22	20 0.2	-24.23	20 3.2	-24.15	11.7	1.79	1.53	16.00	20.19 to 21.22	58	28	7	2	81	19	4
22/23	20 3.7	-24.13	20 6.7	-24.04	11.7	1.80	1.53	15.60	20.20 to 21.20	58	17	13	2	80	19	4
23/24	20 7.2	-24.02	20 10.2	-23.53	11.8	1.81	1.53	15.59	20.22 to 21.18	58	7	20	2	80	19	4
24/25	20 10.6	-23.51	20 13.6	-23.42	11.8	1.82	1.54	15.59	20.23 to 21.16	58	10	29	2	80	19	4
25/26	20 14.1	-23.39	20 17.0	-23.30	11.8	1.83	1.54	15.58	20.24 to 21.14	58	21	39	2	79	19	4
26/27	20 17.5	-23.28	20 20.4	-23.18	11.9	1.84	1.55	15.58	20.26 to 21.12	57	33	50	2	79	19	4
27/28	20 20.8	-23.16	20 23.8	-23.06	11.9	1.84	1.55	15.57	20.27 to 21.10	57	46	61	2	79	19	4
28/29	20 24.2	-23.04	20 27.2	-22.54	11.9	1.85	1.56	15.56	20.29 to 21.08	57	59	72	2	79	19	4
29/30	20 27.6	-22.52	20 30.5	-22.42	12.0	1.86	1.56	15.56	20.30 to 21.06	57	73	82	2	78	19	5
30/31	20 30.9	-22.40	20 33.8	-22.29	12.0	1.87	1.56	15.55	20.31 to 21.04	57	87	90	2	78	19	5

Ephemeris for 93P/Lovas 1 (UK)

Omega= 74.6516 OMEGA=340.5257 i= 12.1909 q= 1.670073 a= 4.349182
e=0.616003 P= 9.070 T= 1998 October 13.9337 Equinox= 2000
Magnitudes calculated from m= 8.0+5.0*Log(d)+15.0*Log(r)

July 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
20/21	2 23.9	20.43	2 26.7	20.57	13.4	1.83	1.88	6.32	Not Observable	77	46	8	1	253	12	7
21/22	2 26.1	21.01	2 28.9	21.15	13.4	1.82	1.88	6.31	Not Observable	77	59	3	1	253	13	7
22/23	2 28.3	21.19	2 31.2	21.33	13.4	1.81	1.87	6.29	Not Observable	78	72	0	1	253	13	7
23/24	2 30.6	21.37	2 33.4	21.50	13.3	1.79	1.87	6.27	Not Observable	78	84	0	1	253	13	7
24/25	2 32.8	21.55	2 35.7	22.08	13.3	1.78	1.87	6.26	Not Observable	78	96	2	1	253	13	7
25/26	2 35.1	22.13	2 38.0	22.26	13.3	1.77	1.86	6.24	1.60 to 2.06	79	108	6	1	253	13	7
26/27	2 37.4	22.31	2 40.2	22.44	13.3	1.76	1.86	6.22	1.55 to 2.09	79	120	12	1	253	13	7
27/28	2 39.7	22.49	2 42.5	23.02	13.2	1.74	1.85	6.21	1.50 to 2.12	80	131	19	1	254	13	7
28/29	2 42.0	23.07	2 44.8	23.19	13.2	1.73	1.85	6.19	1.46 to 2.15	80	142	27	1	254	13	7
29/30	2 44.3	23.25	2 47.2	23.37	13.2	1.72	1.84	6.17	1.41 to 2.17	80	152	36	1	254	13	7
30/31	2 46.6	23.43	2 49.5	23.55	13.1	1.71	1.84	6.16	1.37 to 2.20	81	161	45	1	254	13	7
31/32	2 48.9	24.00	2 51.8	24.13	13.1	1.70	1.84	6.14	1.32 to 2.23	81	167	55	1	254	13	7

Ephemeris for 93P/Lovas 1 (UK)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
August 1998																
1/ 2	2 51.3	24.18	2 54.2	24.30	13.1	1.69	1.83	6.13	1.28 to 2.26	81	165	64	1	254	13	7
2/ 3	2 53.6	24.36	2 56.5	24.48	13.0	1.67	1.83	6.11	1.23 to 2.29	82	156	74	1	254	13	7
3/ 4	2 55.9	24.54	2 58.9	25.06	13.0	1.66	1.82	6.09	1.19 to 2.31	82	146	82	1	255	13	7
4/ 5	2 58.3	25.12	3 1.2	25.23	13.0	1.65	1.82	6.08	1.14 to 2.34	82	134	89	1	255	13	7
5/ 6	3 0.7	25.29	3 3.6	25.41	13.0	1.64	1.82	6.06	1.10 to 2.37	83	122	95	1	255	13	7
6/ 7	3 3.1	25.47	3 6.0	25.59	12.9	1.63	1.81	6.05	1.06 to 2.39	83	110	99	1	255	13	7
7/ 8	3 5.5	26.05	3 8.4	26.16	12.9	1.62	1.81	6.03	1.01 to 2.42	83	97	100	1	255	13	7
8/ 9	3 7.9	26.22	3 10.8	26.34	12.9	1.61	1.80	6.02	0.57 to 2.45	84	84	99	1	255	13	7
9/10	3 10.3	26.40	3 13.2	26.51	12.8	1.59	1.80	6.00	0.53 to 2.47	84	70	96	1	255	13	7
10/11	3 12.7	26.58	3 15.7	27.09	12.8	1.58	1.80	5.59	0.49 to 2.50	84	57	89	1	256	13	7
11/12	3 15.1	27.15	3 18.1	27.26	12.8	1.57	1.79	5.57	0.44 to 2.53	85	44	81	1	256	13	7
12/13	3 17.6	27.33	3 20.6	27.43	12.8	1.56	1.79	5.56	0.40 to 2.55	85	31	71	1	256	13	7
13/14	3 20.0	27.50	3 23.0	28.01	12.7	1.55	1.79	5.54	0.36 to 2.58	86	20	60	1	256	13	7
14/15	3 22.5	28.08	3 25.5	28.18	12.7	1.54	1.78	5.53	0.32 to 3.00	86	15	48	1	256	13	7
15/16	3 24.9	28.25	3 28.0	28.35	12.7	1.53	1.78	5.51	0.28 to 3.03	86	19	37	1	256	13	7
16/17	3 27.4	28.42	3 30.5	28.52	12.6	1.52	1.77	5.50	0.24 to 3.05	87	29	26	1	256	13	7
17/18	3 29.9	28.59	3 33.0	29.09	12.6	1.51	1.77	5.48	0.20 to 3.08	87	41	17	1	257	13	7
18/19	3 32.4	29.17	3 35.5	29.26	12.6	1.50	1.77	5.47	0.16 to 3.10	87	53	10	1	257	13	7
19/20	3 34.9	29.34	3 38.0	29.43	12.6	1.49	1.76	5.45	0.11 to 3.12	88	65	4	1	257	13	7
20/21	3 37.4	29.51	3 40.5	30.00	12.5	1.48	1.76	5.44	0.07 to 3.15	88	76	1	1	257	13	7
21/22	3 39.9	30.08	3 43.0	30.17	12.5	1.47	1.76	5.43	0.03 to 3.17	88	88	0	1	257	13	7
22/23	3 42.5	30.25	3 45.6	30.34	12.5	1.46	1.75	5.41	23.60 to 3.20	89	100	0	1	257	13	7
23/24	3 45.0	30.42	3 48.1	30.51	12.5	1.45	1.75	5.40	23.56 to 3.22	89	111	3	2	257	13	7
24/25	3 47.5	30.58	3 50.7	31.07	12.4	1.44	1.75	5.38	23.52 to 3.24	89	122	8	2	258	13	6
25/26	3 50.1	31.15	3 53.2	31.24	12.4	1.43	1.75	5.37	23.48 to 3.27	90	132	14	2	258	13	6
26/27	3 52.6	31.32	3 55.8	31.40	12.4	1.42	1.74	5.36	23.44 to 3.29	90	142	21	2	258	13	6
27/28	3 55.2	31.48	3 58.4	31.57	12.4	1.41	1.74	5.34	23.40 to 3.31	90	152	29	2	258	13	6
28/29	3 57.8	32.04	4 0.9	32.13	12.3	1.40	1.74	5.33	23.36 to 3.33	91	160	38	2	258	13	6
29/30	4 0.3	32.21	4 3.5	32.29	12.3	1.39	1.73	5.31	23.32 to 3.36	91	163	48	2	258	13	6
30/31	4 2.9	32.37	4 6.1	32.45	12.3	1.38	1.73	5.30	23.28 to 3.38	92	160	58	2	259	13	6
31/32	4 5.5	32.53	4 8.7	33.01	12.2	1.37	1.73	5.29	23.25 to 3.40	92	152	68	2	259	13	6
September 1998																
1/ 2	4 8.1	33.09	4 11.3	33.17	12.2	1.36	1.73	5.27	23.21 to 3.42	92	141	77	2	259	13	6
2/ 3	4 10.7	33.25	4 13.9	33.33	12.2	1.35	1.72	5.26	23.17 to 3.44	93	130	85	2	259	13	6
3/ 4	4 13.3	33.41	4 16.5	33.48	12.2	1.34	1.72	5.25	23.13 to 3.46	93	118	92	2	259	13	6
4/ 5	4 15.9	33.57	4 19.2	34.04	12.2	1.33	1.72	5.23	23.10 to 3.49	93	105	97	2	259	13	6
5/ 6	4 18.5	34.12	4 21.8	34.19	12.1	1.32	1.72	5.22	23.06 to 3.51	94	92	100	2	259	13	6
6/ 7	4 21.1	34.28	4 24.4	34.34	12.1	1.32	1.71	5.21	23.02 to 3.53	94	79	100	2	260	13	6
7/ 8	4 23.8	34.43	4 27.0	34.50	12.1	1.31	1.71	5.20	22.58 to 3.55	94	65	97	2	260	13	6
8/ 9	4 26.4	34.58	4 29.7	35.05	12.1	1.30	1.71	5.18	22.55 to 3.57	95	52	91	2	260	13	6
9/10	4 29.0	35.13	4 32.3	35.20	12.0	1.29	1.71	5.17	22.51 to 3.59	95	39	83	2	260	13	6
10/11	4 31.6	35.29	4 34.9	35.35	12.0	1.28	1.70	5.16	22.48 to 4.01	96	28	73	2	260	13	6
11/12	4 34.3	35.43	4 37.6	35.49	12.0	1.27	1.70	5.14	22.44 to 4.03	96	20	62	2	260	13	6
12/13	4 36.9	35.58	4 40.2	36.04	12.0	1.26	1.70	5.13	22.40 to 4.05	96	20	51	2	260	13	6
13/14	4 39.5	36.13	4 42.8	36.18	11.9	1.26	1.70	5.12	22.37 to 4.07	97	27	40	2	261	13	6
14/15	4 42.1	36.27	4 45.5	36.33	11.9	1.25	1.70	5.10	22.33 to 4.09	97	36	30	2	261	13	6
15/16	4 44.8	36.42	4 48.1	36.47	11.9	1.24	1.70	5.09	22.30 to 4.11	97	47	20	2	261	13	5
16/17	4 47.4	36.56	4 50.7	37.01	11.9	1.23	1.69	5.08	22.26 to 4.13	98	58	13	2	261	13	5
17/18	4 50.0	37.10	4 53.4	37.15	11.9	1.22	1.69	5.06	22.22 to 4.15	98	70	7	2	261	13	5
18/19	4 52.6	37.24	4 56.0	37.29	11.8	1.22	1.69	5.05	22.19 to 4.17	99	81	2	2	261	12	5
19/20	4 55.2	37.38	4 58.6	37.42	11.8	1.21	1.69	5.04	22.15 to 4.19	99	92	0	2	261	12	5
20/21	4 57.9	37.51	5 1.2	37.56	11.8	1.20	1.69	5.02	22.12 to 4.21	99	102	0	2	261	12	5
21/22	5 0.5	38.05	5 3.9	38.09	11.8	1.19	1.69	5.01	22.08 to 4.22	100	113	1	2	262	12	5
22/23	5 3.1	38.18	5 6.5	38.22	11.8	1.19	1.68	4.60	22.05 to 4.24	100	123	4	2	262	12	5
23/24	5 5.6	38.32	5 9.1	38.35	11.7	1.18	1.68	4.58	22.01 to 4.26	101	133	9	2	262	12	5
24/25	5 8.2	38.45	5 11.7	38.48	11.7	1.17	1.68	4.57	21.58 to 4.28	101	143	16	2	262	12	5
25/26	5 10.8	38.58	5 14.2	39.01	11.7	1.16	1.68	4.56	21.54 to 4.30	101	151	23	2	262	12	5
26/27	5 13.4	39.11	5 16.8	39.14	11.7	1.16	1.68	4.54	21.51 to 4.32	102	157	32	2	262	12	5
27/28	5 15.9	39.23	5 19.4	39.26	11.7	1.15	1.68	4.53	21.47 to 4.34	102	159	41	2	262	12	5
28/29	5 18.5	39.36	5 21.9	39.38	11.7	1.14	1.68	4.52	21.44 to 4.35	103	154	51	2	262	12	5
29/30	5 21.0	39.48	5 24.5	39.51	11.6	1.14	1.68	4.50	21.40 to 4.37	103	146	61	2	262	12	5
30/31	5 23.5	40.00	5 27.0	40.03	11.6	1.13	1.68	4.49	21.37 to 4.39	104	136	71	2	262	12	5
October 1998																
1/ 2	5 26.0	40.12	5 29.5	40.14	11.6	1.12	1.67	4.47	21.34 to 4.41	104	125	81	2	262	11	5
2/ 3	5 28.5	40.24	5 32.0	40.26	11.6	1.11	1.67	4.46	21.30 to 4.43	104	112	89	2	263	11	4
3/ 4	5 31.0	40.36	5 34.5	40.38	11.6	1.11	1.67	4.44	21.27 to 4.44	105	99	95	2	263	11	4
4/ 5	5 33.4	40.47	5 36.9	40.49	11.6	1.10	1.67	4.43	21.23 to 4.46	105	86	99	2	263	11	4
5/ 6	5 35.9	40.59	5 39.4	41.00	11.5	1.09	1.67	4.41	21.20 to 4.48	106	73	100	2	263	11	4
6/ 7	5 38.3	41.10	5 41.8	41.11	11.5	1.09	1.67	4.40	21.16 to 4.50	106	59	98	2	263	11	4
7/ 8	5 40.7	41.21	5 44.2	41.22	11.5	1.08	1.67	4.38	21.13 to 4.52	107	47	94	2	263	11	4
8/ 9	5 43.1	41.32	5 46.6	41.33	11.5	1.08	1.67	4.37	21.09 to 4.53	107	35	86	2	263	11	4
9/10	5 45.4	41.43	5 49.0	41.44	11.5	1.07	1.67	4.35	21.06 to 4.55	108	26	77	2	263	11	4
10/11	5 47.8	41.54	5 51.3	41.54	11.5	1.06	1.67	4.34	21.03 to 4.57	108	23	66	2	263	10	4
11/12	5 50.1	42.04	5 53.6	42.05	11.5	1.06	1.67	4.32	20.59 to 4.59	109	27	55	2	263	10	4
12/13	5 52.4	42.15	5 55.9	42.15	11.5	1.05	1.67	4.30	20.56 to 5.00	109	35	44	2	263	10	4
13/14	5 54.6	42.25	5 58.2	42.25	11.4	1.05	1.67	4.29	20.52 to 5.02	110	44	34	2	263	10	4
14/15	5 56.9	42.35	6 0.4	42.35	11.4	1.04	1.67	4.27	20.49 to 5.04	110	55	25	2	263	10	4
15/16	5 59.1	42.45	6 2.7	42.45	11.4	1.03	1.67	4.25	20.45 to 5.06	111	65	17	2	263	10	4
16/17	6 1.2	42.55	6 4.8	42.55	11.4	1.03	1.67	4.24	20.42 to 5.07	111	76	10	2	263	9	4
17/18	6 3.4	43.05	6 7.0	43.04	11.4	1.02	1.67	4.22	20.38 to 5.09	112	87	5	2	263	9	4
18/19	6 5.5	43.14	6 9.1	43.13	11.4	1.02	1.67	4.20	20.35 to 5.11	112	97	1	2	263	9	3
19/20	6 7.6	43.24	6 11.2	43.23	11.4	1.01	1.67	4.18	20.31 to 5.12	113	108	0	2	262	9	3
20/21	6 9.6	43.33	6 13.2	43.32	11.4	1.01	1.67	4.16	20.28 to 5.14	113	118	0	2	262	9	3
21/22	6 11.6	43.42	6 15.2	43.41	11.4	1.00	1.67	4.14	20.24 to 5.16	114	128	2	2	262	9	3
22/23	6 13.6	43.51	6 17.2	43.50	11.3	1.00	1.67	4.12	20.20 to 5.18	114	137	6	2	262	8	3
23/24	6 15.5	43.60	6 19.2	43.58	11.3	0.99	1.67	4.10	20.17 to 5.19	115	145	11	2	262	8	3
24/25	6 17.4	44.08	6 21.1	44.07	11.3	0.99	1.67	4.08	20.13 to 5.21	115	152	18	2	262	8	3
25/26	6 19.3	44.17	6 22.9	44.15	11.3	0.98	1.67	4.06	20.10 to 5.23	116	155	26	2	262	8	3
26/27	6 21.1	44.25	6 24.7	44.24	11.3	0.98	1.68	4.04	20.06 to 5.24	117	153	35	2	262	8	3
27/28	6 22.8	44.34	6 26.5	44.32	11.3	0.97	1.68	4.02	20.02 to 5.26	117	146	45	2	261	7	3
28/29	6 24.6	44.42	6 28.2	44.40	11.3	0.97	1.68	3.60	19.59 to 5.28	118	137	56	2	261	7	3
29/30	6 26.3	44.50	6 29.9	44.48	11.3	0.96	1.68	3.57	19.55 to 5.29	118	127	66	2	261	7	3
30/31	6 27.9	44.58	6 31.5	44.55	11.3	0.96	1.68	3.55	19.51 to 5.31	119	115	76	2	261	7	3
31/32	6 29.5	45.05	6 33.1	45.03	11.3	0.95	1.68	3.53	19.48 to 5.33	120	102	86	2	260	7	3

Ephemeris for 93P/Lovas 1 (UK)

November 1998

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 31.0	45.13	6 34.7	45.10	11.3	0.95	1.68	3.50	19.44 to 5.34	120	89	93	2	260	6	3
2/ 3	6 32.5	45.20	6 36.2	45.18	11.3	0.94	1.68	3.48	19.40 to 5.36	121	76	98	2	260	6	3
3/ 4	6 33.9	45.28	6 37.6	45.25	11.3	0.94	1.68	3.45	19.36 to 5.38	121	63	100	2	260	6	3
4/ 5	6 35.3	45.35	6 39.0	45.32	11.3	0.94	1.69	3.43	19.33 to 5.39	122	50	100	2	259	6	2
5/ 6	6 36.7	45.42	6 40.4	45.39	11.3	0.93	1.69	3.40	19.29 to 5.41	123	39	96	2	259	5	2
6/ 7	6 38.0	45.49	6 41.7	45.46	11.2	0.93	1.69	3.38	19.25 to 5.43	123	30	89	2	259	5	2
7/ 8	6 39.2	45.55	6 42.9	45.52	11.2	0.92	1.69	3.35	19.21 to 5.44	124	27	81	2	258	5	2
8/ 9	6 40.4	46.02	6 44.1	45.59	11.2	0.92	1.69	3.32	19.17 to 5.46	125	29	71	2	258	5	2
9/10	6 41.5	46.08	6 45.2	46.05	11.2	0.92	1.69	3.29	19.13 to 5.47	125	37	61	2	257	4	2
10/11	6 42.6	46.15	6 46.3	46.11	11.2	0.91	1.70	3.26	19.09 to 5.49	126	46	50	2	257	4	2
11/12	6 43.6	46.21	6 47.3	46.17	11.2	0.91	1.70	3.24	19.05 to 5.51	127	56	40	2	256	4	2
12/13	6 44.5	46.27	6 48.2	46.23	11.2	0.91	1.70	3.21	19.01 to 5.52	127	66	31	2	256	4	2
13/14	6 45.4	46.33	6 49.1	46.29	11.2	0.90	1.70	3.17	18.57 to 5.54	128	77	22	2	255	3	2
14/15	6 46.3	46.38	6 50.0	46.35	11.2	0.90	1.70	3.14	18.53 to 5.55	129	87	15	2	255	3	2
15/16	6 47.0	46.44	6 50.7	46.40	11.2	0.90	1.71	3.11	18.49 to 5.57	129	98	8	2	254	3	2
16/17	6 47.7	46.49	6 51.5	46.45	11.2	0.89	1.71	3.08	18.45 to 5.58	130	108	4	2	254	3	2
17/18	6 48.4	46.54	6 52.1	46.50	11.2	0.89	1.71	3.05	18.41 to 5.60	131	118	1	2	253	2	2
18/19	6 49.0	46.59	6 52.7	46.55	11.2	0.89	1.71	3.01	18.37 to 6.01	132	128	0	2	252	2	2
19/20	6 49.5	47.04	6 53.2	46.60	11.2	0.88	1.71	2.58	18.33 to 6.03	132	137	0	2	252	2	1
20/21	6 50.0	47.08	6 53.7	47.04	11.2	0.88	1.72	2.54	18.29 to 6.04	133	145	3	2	251	1	1
21/22	6 50.4	47.12	6 54.1	47.09	11.3	0.88	1.72	2.51	18.25 to 6.06	134	150	7	2	250	1	1
22/23	6 50.7	47.16	6 54.5	47.13	11.3	0.88	1.72	2.47	18.21 to 6.07	135	152	13	2	249	1	1
23/24	6 51.0	47.20	6 54.8	47.16	11.3	0.88	1.72	2.44	18.17 to 6.09	135	149	20	2	249	1	1
24/25	6 51.2	47.24	6 55.0	47.20	11.3	0.87	1.73	2.40	18.13 to 6.10	136	142	29	2	248	0	1
25/26	6 51.4	47.27	6 55.2	47.23	11.3	0.87	1.73	2.36	18.09 to 6.11	137	133	39	2	247	0	1
26/27	6 51.5	47.30	6 55.3	47.26	11.3	0.87	1.73	2.32	18.05 to 6.13	138	122	50	2	246	0	1
27/28	6 51.6	47.33	6 55.3	47.29	11.3	0.87	1.73	2.28	18.01 to 6.14	138	110	61	2	245	0	1
28/29	6 51.6	47.36	6 55.3	47.32	11.3	0.87	1.74	2.25	17.57 to 6.15	139	98	72	2	244	0	1
29/30	6 51.5	47.38	6 55.2	47.34	11.3	0.87	1.74	2.20	17.53 to 6.17	140	85	82	2	243	0	0
30/31	6 51.4	47.40	6 55.1	47.36	11.3	0.86	1.74	2.16	17.49 to 6.18	141	72	90	2	242	0	0

Ephemeris for Hale-Bopp 1995 O1 (Southern Hemisphere, 40° South)

Note: the comet was running one magnitude fainter than these predictions in early April

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Omega=130.5767 OMEGA=282.4654 i= 89.4269 q= 0.913974 a=186.107514
 e=0.995089  P= 2538.902  T= 1997 April      1.1341     Equinox= 2000
Magnitudes calculated from m=-0.7+5.0*Log(d)+ 7.6*Log(r)
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Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
June 1998																
1/ 2	5 51.3	-49.40	5 52.5	-49.39	8.7	5.65	5.45	13.11	17.52 to 21.40							
									4.43 to 6.03	74	86	50	7	162	3	0
6/ 7	5 56.2	-49.43	5 57.4	-49.43	8.7	5.69	5.49	12.57	17.51 to 21.24							
									4.29 to 6.06	74	106	91	7	166	3	0
11/12	6 1.2	-49.50	6 2.4	-49.50	8.7	5.74	5.54	12.42	17.51 to 21.09							
									4.15 to 6.09	74	110	97	6	170	4	0
16/17	6 6.2	-49.60	6 7.4	-50.00	8.8	5.79	5.59	12.27	17.51 to 20.55							
									3.60 to 6.11	74	93	55	6	174	4	0
21/22	6 11.2	-50.12	6 12.4	-50.13	8.8	5.83	5.63	12.12	17.52 to 20.40							
									3.45 to 6.12	74	72	6	6	177	4	-1
26/27	6 16.2	-50.28	6 17.4	-50.29	8.9	5.88	5.68	11.58	17.53 to 20.27							
									3.29 to 6.13	74	74	9	6	181	3	-1
July 1998																
1/ 2	6 21.2	-50.47	6 22.4	-50.48	8.9	5.92	5.73	11.43	17.55 to 20.13							
									3.13 to 6.13	74	93	52	6	185	3	-1
6/ 7	6 26.1	-51.08	6 27.3	-51.10	9.0	5.97	5.77	11.28	17.58 to 20.00							
									2.56 to 6.12	74	108	93	5	189	3	-1
11/12	6 31.0	-51.33	6 32.2	-51.35	9.0	6.01	5.82	11.13	18.00 to 19.48							
									2.39 to 6.11	74	104	94	5	193	3	-2
16/17	6 35.8	-51.60	6 37.0	-52.03	9.0	6.05	5.87	10.58	18.03 to 19.35							
									2.22 to 6.09	75	84	46	5	196	3	-2
21/22	6 40.6	-52.30	6 41.7	-52.33	9.1	6.09	5.91	10.44	18.07 to 19.23							
									2.04 to 6.06	75	71	3	5	200	3	-2
26/27	6 45.3	-53.02	6 46.4	-53.05	9.1	6.13	5.96	10.28	18.10 to 19.12							
									1.45 to 6.03	75	81	12	5	204	3	-2
31/32	6 49.8	-53.37	6 50.9	-53.40	9.2	6.17	6.00	10.13	18.14 to 19.01							
									1.26 to 5.58	76	98	55	5	208	3	-2
August 1998																
5/ 6	6 54.2	-54.14	6 55.3	-54.18	9.2	6.21	6.05	9.58	18.18 to 18.50							
									1.06 to 5.54	76	107	95	5	212	3	-3
10/11	6 58.5	-54.53	6 59.5	-54.57	9.2	6.25	6.09	9.42	18.22 to 18.40							
									0.45 to 5.48	77	97	89	4	215	3	-3
15/16	7 2.6	-55.34	7 3.6	-55.39	9.3	6.29	6.14	9.27	18.26 to 18.30							
									0.23 to 5.43	77	79	37	4	219	2	-3
20/21	7 6.5	-56.18	7 7.5	-56.23	9.3	6.32	6.18	9.11	0.01 to 5.36	77	76	1	4	223	2	-3
25/26	7 10.3	-57.03	7 11.2	-57.08	9.4	6.36	6.23	8.55	23.37 to 5.29	78	87	14	4	227	2	-3
30/31	7 13.7	-57.50	7 14.6	-57.55	9.4	6.40	6.27	8.39	23.12 to 5.22	78	100	58	4	231	2	-3
September 1998																
4/ 5	7 16.9	-58.38	7 17.8	-58.44	9.4	6.44	6.32	8.22	22.46 to 5.14	79	103	97	4	235	2	-4
9/10	7 19.9	-59.28	7 20.7	-59.34	9.5	6.47	6.36	8.05	22.18 to 5.06	79	90	83	4	239	1	-4
14/15	7 22.5	-60.19	7 23.2	-60.25	9.5	6.51	6.40	7.48	21.48 to 4.58	79	79	30	4	244	1	-4
19/20	7 24.8	-61.11	7 25.4	-61.17	9.5	6.55	6.45	7.31	21.15 to 4.50	80	81	0	4	248	1	-4
24/25	7 26.6	-62.03	7 27.2	-62.10	9.6	6.59	6.49	7.13	20.38 to 4.41	80	91	16	4	252	1	-4
29/30	7 28.0	-62.57	7 28.6	-63.03	9.6	6.63	6.54	6.54	19.53 to 4.33	80	98	61	3	257	0	-4

Ephemeris for Hale-Bopp 1995 O1 (Southern Hemisphere, 40° South)

Note: the comet was running one magnitude fainter than these predictions in early April

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
October 1998																
4/ 5	7 29.0	-63.50	7 29.5	-63.56	9.6	6.67	6.58	6.36	19.13 to 4.24	81	97	99	3	261	0	-4
9/10	7 29.4	-64.43	7 29.8	-64.49	9.7	6.70	6.62	6.16	19.19 to 4.15	81	87	77	3	266	0	-4
14/15	7 29.3	-65.36	7 29.6	-65.42	9.7	6.74	6.67	5.56	19.25 to 4.07	81	83	25	3	271	0	-4
19/20	7 28.5	-66.28	7 28.7	-66.35	9.7	6.78	6.71	5.36	19.32 to 3.58	82	85	0	3	276	0	-4
24/25	7 27.1	-67.20	7 27.2	-67.26	9.8	6.82	6.75	5.14	19.38 to 3.50	82	91	18	3	281	0	-4
29/30	7 24.9	-68.10	7 24.9	-68.16	9.8	6.86	6.80	4.52	19.45 to 3.42	82	95	66	3	287	-1	-4
November 1998																
3/ 4	7 21.9	-68.58	7 21.7	-69.04	9.8	6.90	6.84	4.30	19.52 to 3.35	82	93	100	3	293	-1	-4
8/ 9	7 18.1	-69.44	7 17.8	-69.49	9.9	6.94	6.88	4.06	19.60 to 3.28	82	89	71	3	298	-1	-3
13/14	7 13.4	-70.27	7 13.0	-70.32	9.9	6.98	6.92	3.41	20.07 to 3.22	82	87	22	3	305	-1	-3
18/19	7 7.8	-71.07	7 7.2	-71.12	9.9	7.02	6.97	3.16	20.14 to 3.16	83	88	0	3	311	-2	-3
23/24	7 1.3	-71.44	7 0.6	-71.48	10.0	7.07	7.01	2.50	20.22 to 3.11	83	89	20	3	317	-2	-3
28/29	6 53.9	-72.17	6 53.1	-72.21	10.0	7.11	7.05	2.22	20.29 to 3.08	83	91	72	3	324	-2	-2

Ephemeris for Meunier-Dupouy 1997 J2 (UK)

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Omega=122.6770 OMEGA=148.8445 i= 91.2734 q= 3.051070 a=**********
e=1.000600  P=*********  T= 1998 March    10.4522    Equinox= 2000
Magnitudes calculated from m= 5.0+5.0*Log(d)+ 7.5*Log(r)
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June 1998 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
June 1998																
1/ 2	22 28.6	29.36	22 30.9	29.52	11.2	3.16	3.16	5.50	23.25 to 1.15	81	142	50	2	250	0	-1
2/ 3	22 28.6	29.33	22 31.0	29.48	11.2	3.15	3.16	5.46	23.22 to 1.13	82	143	59	2	249	0	-1
3/ 4	22 28.7	29.29	22 31.0	29.45	11.2	3.13	3.16	5.42	23.18 to 1.10	82	140	68	2	249	0	-1
4/ 5	22 28.7	29.25	22 31.0	29.41	11.2	3.12	3.17	5.38	23.14 to 1.08	83	135	77	2	248	0	-1
5/ 6	22 28.7	29.22	22 31.0	29.37	11.2	3.11	3.17	5.34	23.10 to 1.06	84	128	84	2	247	0	-1
6/ 7	22 28.6	29.18	22 31.0	29.33	11.2	3.10	3.17	5.30	23.07 to 1.03	85	120	91	2	247	0	-1
7/ 8	22 28.6	29.13	22 30.9	29.29	11.2	3.09	3.18	5.26	23.03 to 1.01	86	111	96	2	246	0	-1
8/ 9	22 28.5	29.09	22 30.8	29.24	11.2	3.08	3.18	5.22	22.59 to 0.59	86	101	99	2	246	0	-1
9/10	22 28.4	29.04	22 30.7	29.20	11.2	3.06	3.18	5.18	23.02 to 0.57	87	91	100	2	245	0	-1
10/11	22 28.3	28.60	22 30.6	29.15	11.2	3.05	3.18	5.14	23.04 to 0.55	88	81	100	2	244	0	-1
11/12	22 28.2	28.55	22 30.5	29.10	11.2	3.04	3.19	5.10	23.06 to 0.53	89	71	97	2	244	0	-2
12/13	22 28.0	28.50	22 30.3	29.05	11.2	3.03	3.19	5.06	23.09 to 0.51	90	61	92	2	243	0	-2
13/14	22 27.8	28.45	22 30.1	29.00	11.2	3.01	3.19	5.02	23.11 to 0.50	91	51	85	2	243	-1	-2
14/15	22 27.6	28.39	22 29.9	28.55	11.2	3.00	3.19	4.58	23.12 to 0.48	92	44	76	2	242	-1	-2
15/16	22 27.4	28.34	22 29.7	28.49	11.2	2.99	3.20	4.53	23.14 to 0.47	92	38	66	2	242	-1	-2
16/17	22 27.1	28.28	22 29.4	28.43	11.2	2.98	3.20	4.49	23.15 to 0.46	93	37	55	2	241	-1	-2
17/18	22 26.8	28.22	22 29.2	28.37	11.2	2.97	3.20	4.45	23.17 to 0.45	94	40	44	2	240	-1	-2
18/19	22 26.5	28.16	22 28.9	28.31	11.1	2.95	3.21	4.41	23.18 to 0.45	95	46	32	2	240	-1	-2
19/20	22 26.2	28.09	22 28.5	28.25	11.1	2.94	3.21	4.36	23.18 to 0.44	96	56	22	2	239	-1	-2
20/21	22 25.9	28.03	22 28.2	28.18	11.1	2.93	3.21	4.32	23.19 to 0.44	97	66	13	2	239	-1	-2
21/22	22 25.5	27.56	22 27.8	28.11	11.1	2.92	3.22	4.28	23.19 to 0.45	98	78	6	2	238	-2	-2
22/23	22 25.1	27.49	22 27.4	28.04	11.1	2.90	3.22	4.24	23.19 to 0.45	99	89	1	2	238	-2	-2
23/24	22 24.7	27.41	22 27.0	27.57	11.1	2.89	3.22	4.19	23.19 to 0.46	100	101	0	2	237	-2	-3
24/25	22 24.2	27.34	22 26.6	27.49	11.1	2.88	3.22	4.15	23.18 to 0.47	101	112	0	2	236	-2	-3
25/26	22 23.8	27.26	22 26.1	27.41	11.1	2.87	3.23	4.10	23.18 to 0.48	101	122	4	2	236	-2	-3
26/27	22 23.3	27.18	22 25.6	27.33	11.1	2.86	3.23	4.06	23.17 to 0.49	102	132	9	2	235	-2	-3
27/28	22 22.8	27.09	22 25.1	27.25	11.1	2.84	3.23	4.01	23.15 to 0.51	103	139	16	2	234	-2	-3
28/29	22 22.2	27.01	22 24.6	27.16	11.1	2.83	3.24	3.57	23.14 to 0.53	104	143	24	2	234	-2	-3
29/30	22 21.7	26.52	22 24.0	27.07	11.1	2.82	3.24	3.53	23.12 to 0.55	105	144	33	2	233	-3	-3
30/31	22 21.1	26.43	22 23.4	26.58	11.1	2.81	3.24	3.48	23.11 to 0.57	106	142	43	2	233	-3	-3
July 1998																
1/ 2	22 20.5	26.33	22 22.8	26.49	11.1	2.80	3.25	3.43	23.09 to 0.59	107	136	52	2	232	-3	-3
2/ 3	22 19.9	26.24	22 22.2	26.39	11.1	2.79	3.25	3.39	23.07 to 1.01	108	129	62	2	231	-3	-4
3/ 4	22 19.2	26.14	22 21.6	26.29	11.1	2.78	3.25	3.34	23.05 to 1.04	109	121	71	2	231	-3	-4
4/ 5	22 18.6	26.03	22 20.9	26.18	11.1	2.76	3.26	3.30	23.03 to 1.06	110	111	79	2	230	-3	-4
5/ 6	22 17.9	25.53	22 20.2	26.08	11.0	2.75	3.26	3.25	23.01 to 1.09	111	101	87	2	229	-3	-4
6/ 7	22 17.2	25.42	22 19.5	25.57	11.0	2.74	3.26	3.20	22.58 to 1.11	112	91	93	2	229	-4	-4
7/ 8	22 16.4	25.30	22 18.8	25.45	11.0	2.73	3.27	3.16	22.56 to 1.14	113	80	97	2	228	-4	-4
8/ 9	22 15.7	25.19	22 18.0	25.34	11.0	2.72	3.27	3.11	22.53 to 1.17	114	70	100	2	227	-4	-4
9/10	22 14.9	25.07	22 17.2	25.22	11.0	2.71	3.27	3.06	22.51 to 1.20	115	59	100	2	227	-4	-4
10/11	22 14.1	24.55	22 16.5	25.10	11.0	2.70	3.28	3.02	22.48 to 1.22	116	49	98	2	226	-4	-5
11/12	22 13.3	24.42	22 15.6	24.57	11.0	2.69	3.28	2.57	22.46 to 1.25	117	41	94	2	225	-4	-5
12/13	22 12.5	24.29	22 14.8	24.44	11.0	2.68	3.29	2.52	22.43 to 1.28	118	35	87	2	224	-4	-5
13/14	22 11.6	24.16	22 14.0	24.31	11.0	2.67	3.29	2.47	22.41 to 1.31	119	34	79	2	224	-4	-5
14/15	22 10.7	24.02	22 13.1	24.17	11.0	2.66	3.29	2.42	22.38 to 1.34	120	38	69	2	223	-4	-5
15/16	22 9.9	23.48	22 12.2	24.03	11.0	2.65	3.30	2.38	22.35 to 1.37	121	46	57	2	222	-5	-5
16/17	22 8.9	23.34	22 11.3	23.49	11.0	2.64	3.30	2.33	22.32 to 1.40	123	56	46	2	221	-5	-5
17/18	22 8.0	23.20	22 10.4	23.34	11.0	2.63	3.30	2.28	22.30 to 1.43	124	68	34	2	220	-5	-6
18/19	22 7.1	23.05	22 9.4	23.19	11.0	2.62	3.31	2.23	22.27 to 1.46	125	80	24	2	220	-5	-6
19/20	22 6.1	22.49	22 8.4	23.04	11.0	2.61	3.31	2.18	22.24 to 1.49	126	92	15	2	219	-5	-6
20/21	22 5.1	22.34	22 7.5	22.48	11.0	2.61	3.32	2.13	22.21 to 1.52	127	104	8	2	218	-5	-6
21/22	22 4.1	22.18	22 6.5	22.32	11.0	2.60	3.32	2.08	22.18 to 1.54	128	115	3	2	217	-5	-6
22/23	22 3.1	22.01	22 5.5	22.16	11.0	2.59	3.32	2.03	22.16 to 1.57	129	126	0	2	216	-5	-6
23/24	22 2.1	21.44	22 4.4	21.59	11.0	2.58	3.33	1.58	22.13 to 2.00	130	136	0	2	215	-5	-6
24/25	22 1.1	21.27	22 3.4	21.42	11.0	2.57	3.33	1.53	22.10 to 2.03	131	143	2	2	214	-6	-7
25/26	22 0.0	21.10	22 2.4	21.24	11.0	2.57	3.33	1.48	22.07 to 2.06	132	148	6	2	213	-6	-7
26/27	21 58.9	20.52	22 1.3	21.06	11.0	2.56	3.34	1.43	22.04 to 2.09	133	148	12	2	212	-6	-7
27/28	21 57.9	20.34	22 0.2	20.48	11.0	2.55	3.34	1.38	22.01 to 2.12	134	143	19	2	211	-6	-7
28/29	21 56.8	20.15	21 59.1	20.30	11.0	2.55	3.35	1.33	21.58 to 2.15	135	136	27	2	210	-6	-7
29/30	21 55.7	19.56	21 58.0	20.11	11.0	2.54	3.35	1.28	21.56 to 2.17	136	128	36	2	209	-6	-7
30/31	21 54.6	19.37	21 56.9	19.52	11.0	2.54	3.35	1.23	21.53 to 2.20	137	118	45	2	207	-6	-8
31/32	21 53.5	19.18	21 55.8	19.32	11.0	2.53	3.36	1.18	21.50 to 2.23	138	108	55	2	206	-6	-8

Ephemeris for Meunier-Dupouy 1997 J2 (UK)

August 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	21 52.3	18.58	21 54.7	19.12	11.0	2.53	3.36	1.13	21.47 to 2.26	139	97	64	1	205	-6	-8
2/ 3	21 51.2	18.38	21 53.6	18.52	11.0	2.52	3.37	1.08	21.44 to 2.29	141	87	74	1	204	-6	-8
3/ 4	21 50.1	18.17	21 52.4	18.31	11.0	2.52	3.37	1.03	21.41 to 2.31	142	75	82	1	202	-6	-8
4/ 5	21 48.9	17.56	21 51.3	18.10	11.0	2.51	3.37	0.58	21.38 to 2.34	143	64	89	1	201	-6	-8
5/ 6	21 47.8	17.35	21 50.2	17.49	11.0	2.51	3.38	0.53	21.35 to 2.37	144	53	95	1	199	-6	-8
6/ 7	21 46.6	17.14	21 49.0	17.28	11.0	2.51	3.38	0.48	21.32 to 2.39	144	42	99	1	197	-6	-8
7/ 8	21 45.5	16.52	21 47.9	17.06	11.0	2.50	3.39	0.43	21.29 to 2.42	145	34	100	1	196	-6	-9
8/ 9	21 44.3	16.30	21 46.7	16.44	11.0	2.50	3.39	0.38	21.27 to 2.45	146	29	99	1	194	-6	-9
9/10	21 43.2	16.08	21 45.6	16.22	11.0	2.50	3.39	0.32	21.24 to 2.47	147	30	96	1	192	-6	-9
10/11	21 42.0	15.45	21 44.4	15.59	11.0	2.50	3.40	0.27	21.21 to 2.50	148	37	89	1	190	-6	-9
11/12	21 40.9	15.22	21 43.3	15.36	11.0	2.49	3.40	0.22	21.18 to 2.53	149	48	81	1	188	-6	-9
12/13	21 39.7	14.59	21 42.1	15.13	11.0	2.49	3.41	0.17	21.15 to 2.55	150	60	71	1	186	-6	-9
13/14	21 38.6	14.36	21 41.0	14.50	11.0	2.49	3.41	0.12	21.12 to 2.58	151	73	60	1	184	-6	-9
14/15	21 37.4	14.13	21 39.8	14.26	11.0	2.49	3.42	0.07	21.09 to 3.00	151	86	48	1	181	-6	-9
15/16	21 36.3	13.49	21 38.7	14.02	11.0	2.49	3.42	0.02	21.06 to 3.03	152	98	37	1	179	-6	-9
16/17	21 35.1	13.25	21 37.5	13.39	11.0	2.49	3.42	23.57	21.03 to 3.05	153	111	26	1	176	-6	-9
17/18	21 34.0	13.01	21 36.4	13.14	11.0	2.49	3.43	23.52	21.00 to 3.08	153	123	17	1	173	-6	-10
18/19	21 32.8	12.37	21 35.3	12.50	11.0	2.50	3.43	23.47	20.58 to 3.10	154	135	10	1	170	-6	-10
19/20	21 31.7	12.12	21 34.1	12.26	11.0	2.50	3.44	23.42	20.55 to 3.12	154	145	4	1	167	-6	-10
20/21	21 30.6	11.48	21 33.0	12.01	11.0	2.50	3.44	23.37	20.52 to 3.15	155	153	1	1	164	-6	-10
21/22	21 29.5	11.23	21 31.9	11.36	11.0	2.50	3.45	23.31	20.49 to 3.17	155	156	0	1	161	-6	-10
22/23	21 28.4	10.58	21 30.8	11.12	11.0	2.51	3.45	23.26	20.46 to 3.20	156	152	0	1	158	-6	-10
23/24	21 27.3	10.33	21 29.7	10.47	11.0	2.51	3.46	23.21	20.43 to 3.22	156	145	3	1	155	-6	-10
24/25	21 26.2	10.08	21 28.7	10.22	11.0	2.51	3.46	23.16	20.40 to 3.24	156	135	8	1	151	-6	-10
25/26	21 25.2	9.43	21 27.6	9.57	11.1	2.52	3.46	23.11	20.37 to 3.27	156	125	14	1	148	-6	-10
26/27	21 24.1	9.18	21 26.6	9.31	11.1	2.52	3.47	23.06	20.35 to 3.29	156	114	21	1	145	-6	-10
27/28	21 23.1	8.53	21 25.5	9.06	11.1	2.53	3.47	23.01	20.32 to 3.31	156	103	29	1	141	-6	-10
28/29	21 22.0	8.28	21 24.5	8.41	11.1	2.53	3.48	22.56	20.29 to 3.33	156	91	38	1	138	-6	-10
29/30	21 21.0	8.03	21 23.5	8.16	11.1	2.54	3.48	22.51	20.26 to 3.27	155	80	48	1	135	-6	-10
30/31	21 20.0	7.38	21 22.5	7.51	11.1	2.55	3.49	22.47	20.23 to 3.19	155	68	58	1	132	-6	-10
31/32	21 19.0	7.13	21 21.5	7.26	11.1	2.55	3.49	22.42	20.20 to 3.11	155	57	68	1	129	-6	-10
September 1998																
1/ 2	21 18.1	6.48	21 20.5	7.00	11.1	2.56	3.50	22.37	20.18 to 3.04	154	45	77	1	126	-6	-10
2/ 3	21 17.1	6.22	21 19.6	6.35	11.1	2.57	3.50	22.32	20.15 to 2.56	154	33	85	1	123	-5	-10
3/ 4	21 16.2	5.57	21 18.7	6.10	11.1	2.58	3.51	22.27	20.12 to 2.49	153	24	92	1	120	-5	-10
4/ 5	21 15.3	5.33	21 17.8	5.45	11.2	2.58	3.51	22.22	20.09 to 2.41	153	20	97	1	117	-5	-10
5/ 6	21 14.4	5.08	21 16.9	5.20	11.2	2.59	3.52	22.17	20.07 to 2.34	152	25	100	1	115	-5	-10
6/ 7	21 13.5	4.43	21 16.0	4.56	11.2	2.60	3.52	22.12	20.04 to 2.26	151	36	100	1	113	-5	-10
7/ 8	21 12.6	4.18	21 15.1	4.31	11.2	2.61	3.52	22.08	20.01 to 2.18	151	49	97	1	110	-5	-10
8/ 9	21 11.8	3.54	21 14.3	4.06	11.2	2.62	3.53	22.03	19.58 to 2.11	150	63	91	1	108	-5	-10
9/10	21 10.9	3.29	21 13.5	3.42	11.2	2.63	3.53	21.58	19.56 to 2.03	149	77	83	1	106	-5	-10
10/11	21 10.1	3.05	21 12.7	3.18	11.2	2.64	3.54	21.53	19.53 to 1.56	148	91	73	1	104	-5	-10
11/12	21 9.4	2.41	21 11.9	2.53	11.2	2.66	3.54	21.49	19.50 to 1.48	147	105	62	1	103	-4	-10
12/13	21 8.6	2.17	21 11.1	2.30	11.3	2.67	3.55	21.44	19.47 to 1.41	146	119	51	1	101	-4	-9
13/14	21 7.8	1.53	21 10.4	2.06	11.3	2.68	3.55	21.39	19.45 to 1.33	145	132	40	1	99	-4	-9
14/15	21 7.1	1.30	21 9.7	1.42	11.3	2.69	3.56	21.35	19.42 to 1.25	144	144	30	1	98	-4	-9
15/16	21 6.4	1.06	21 9.0	1.19	11.3	2.70	3.56	21.30	19.39 to 1.18	143	156	20	1	96	-4	-9
16/17	21 5.7	0.43	21 8.3	0.55	11.3	2.72	3.57	21.25	19.37 to 1.10	143	164	13	1	95	-4	-9
17/18	21 5.1	0.20	21 7.6	0.32	11.3	2.73	3.57	21.21	19.34 to 1.03	142	163	7	1	94	-4	-9
18/19	21 4.4	-0.03	21 7.0	0.10	11.3	2.75	3.58	21.16	19.31 to 0.55	140	156	2	1	93	-3	-9
19/20	21 3.8	-0.25	21 6.4	-0.13	11.4	2.76	3.58	21.12	19.29 to 0.47	139	145	0	1	92	-3	-9
20/21	21 3.2	-0.47	21 5.8	-0.35	11.4	2.77	3.59	21.07	19.26 to 0.40	138	134	0	1	91	-3	-9
21/22	21 2.6	-1.09	21 5.2	-0.57	11.4	2.79	3.59	21.03	19.24 to 0.32	137	122	1	1	90	-3	-9
22/23	21 2.1	-1.31	21 4.7	-1.19	11.4	2.80	3.60	20.58	19.21 to 0.25	136	111	4	1	89	-3	-9
23/24	21 1.6	-1.53	21 4.1	-1.41	11.4	2.82	3.60	20.54	19.18 to 0.17	135	99	9	1	88	-3	-9
24/25	21 1.1	-2.14	21 3.6	-2.02	11.4	2.84	3.61	20.49	19.16 to 0.09	134	87	16	1	87	-3	-8
25/26	21 0.6	-2.35	21 3.2	-2.23	11.5	2.85	3.61	20.45	19.13 to 0.02	133	75	23	1	86	-3	-8
26/27	21 0.1	-2.56	21 2.7	-2.44	11.5	2.87	3.62	20.40	19.11 to 23.54	132	64	32	1	86	-2	-8
27/28	20 59.7	-3.17	21 2.3	-3.05	11.5	2.89	3.62	20.36	19.08 to 23.47	131	52	41	1	85	-2	-8
28/29	20 59.2	-3.37	21 1.9	-3.25	11.5	2.90	3.63	20.32	19.06 to 23.39	130	40	51	1	84	-2	-8
29/30	20 58.8	-3.57	21 1.5	-3.45	11.5	2.92	3.63	20.27	19.03 to 23.32	129	28	61	1	84	-2	-8
30/31	20 58.5	-4.17	21 1.1	-4.05	11.5	2.94	3.64	20.23	19.01 to 23.24	128	16	71	1	83	-2	-8
October 1998																
1/ 2	20 58.1	-4.36	21 0.7	-4.25	11.6	2.96	3.64	20.19	18.58 to 23.16	127	11	81	1	82	-2	-8
2/ 3	20 57.8	-4.56	21 0.4	-4.44	11.6	2.97	3.65	20.14	18.56 to 23.09	126	19	89	1	82	-2	-8
3/ 4	20 57.5	-5.15	21 0.1	-5.03	11.6	2.99	3.65	20.10	18.53 to 23.01	125	32	95	1	81	-1	-7
4/ 5	20 57.2	-5.33	20 59.8	-5.22	11.6	3.01	3.66	20.06	18.51 to 22.53	124	46	99	1	81	-1	-7
5/ 6	20 56.9	-5.52	20 59.6	-5.40	11.6	3.03	3.66	20.02	18.49 to 22.46	122	61	100	1	80	-1	-7
6/ 7	20 56.7	-6.10	20 59.3	-5.58	11.7	3.05	3.67	19.57	18.46 to 22.38	121	76	98	1	80	-1	-7
7/ 8	20 56.4	-6.28	20 59.1	-6.16	11.7	3.07	3.67	19.53	18.44 to 22.30	120	91	94	1	80	-1	-7
8/ 9	20 56.2	-6.45	20 58.9	-6.34	11.7	3.09	3.68	19.49	18.42 to 22.23	119	106	86	1	79	-1	-7
9/10	20 56.1	-7.03	20 58.7	-6.51	11.7	3.11	3.69	19.45	18.39 to 22.15	118	121	77	1	79	-1	-7
10/11	20 55.9	-7.20	20 58.6	-7.08	11.7	3.13	3.69	19.41	18.37 to 22.07	117	135	66	1	79	-1	-7
11/12	20 55.7	-7.37	20 58.4	-7.25	11.7	3.15	3.70	19.37	18.35 to 21.59	116	148	55	1	78	0	-6
12/13	20 55.6	-7.53	20 58.3	-7.41	11.8	3.17	3.70	19.33	18.33 to 21.51	115	161	44	1	78	0	-6
13/14	20 55.5	-8.09	20 58.2	-7.58	11.8	3.19	3.71	19.29	18.30 to 21.44	114	171	34	1	78	0	-6
14/15	20 55.4	-8.25	20 58.1	-8.14	11.8	3.21	3.71	19.25	18.28 to 21.36	113	169	25	1	77	0	-6
15/16	20 55.4	-8.41	20 58.1	-8.29	11.8	3.23	3.72	19.21	18.26 to 21.28	112	158	17	1	77	0	-6
16/17	20 55.3	-8.56	20 58.0	-8.45	11.8	3.25	3.72	19.17	18.24 to 21.20	111	146	10	1	77	0	-6
17/18	20 55.3	-9.12	20 58.0	-8.60	11.9	3.27	3.73	19.13	18.22 to 21.11	110	135	5	1	76	0	-6
18/19	20 55.3	-9.26	20 58.0	-9.15	11.9	3.29	3.73	19.09	18.20 to 21.03	109	123	1	1	76	0	-6
19/20	20 55.3	-9.41	20 58.0	-9.29	11.9	3.31	3.74	19.05	18.17 to 20.55	108	111	0	1	76	0	-6
20/21	20 55.4	-9.56	20 58.1	-9.44	11.9	3.34	3.74	19.01	18.15 to 20.47	107	99	0	1	76	0	-5
21/22	20 55.4	-10.10	20 58.1	-9.58	11.9	3.36	3.75	18.57	18.13 to 20.38	106	87	2	1	76	0	-5
22/23	20 55.5	-10.24	20 58.2	-10.12	12.0	3.38	3.75	18.53	18.11 to 20.29	105	75	6	1	75	0	-5
23/24	20 55.6	-10.37	20 58.3	-10.25	12.0	3.40	3.76	18.49	18.09 to 20.20	104	64	11	1	75	0	-5
24/25	20 55.7	-10.51	20 58.4	-10.39	12.0	3.42	3.77	18.46	18.07 to 20.11	102	52	18	1	75	0	-5
25/26	20 55.8	-11.04	20 58.5	-10.52	12.0	3.45	3.77	18.42	18.05 to 20.02	101	40	26	1	75	0	-5
26/27	20 55.9	-11.17	20 58.7	-11.05	12.0	3.47	3.78	18.38	18.04 to 19.52	100	27	35	1	75	0	-5
27/28	20 56.1	-11.29	20 58.8	-11.18	12.0	3.49	3.78	18.34	18.02 to 19.42	99	15	45	1	75	0	-5
28/29	20 56.3	-11.42	20 59.0	-11.30	12.1	3.51	3.79	18.30	17.60 to 19.32	98	4	56	1	74	1	-5
29/30	20 56.5	-11.54	20 59.2	-11.42	12.1	3.53	3.79	18.27	17.58 to 19.20	97	13	66	1	74	1	-5
30/31	20 56.7	-12.06	20 59.4	-11.54	12.1	3.56	3.80	18.23	17.56 to 19.08	96	26	76	1	74	1	-4
31/32	20 56.9	-12.18	20 59.6	-12.06	12.1	3.58	3.80	18.19	17.55 to 18.54	95	40	86	1	74	1	-4

Ephemeris for Meunier-Dupouy 1997 J2 (UK)

November 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	20 57.1	-12.29	20 59.9	-12.17	12.1	3.60	3.81	18.16	17.57 to 18.34	94	55	93	1	74	1	-4
2/ 3	20 57.4	-12.40	21 0.1	-12.29	12.2	3.62	3.82	18.12	Not Observable	93	70	98	1	74	1	-4
3/ 4	20 57.7	-12.52	21 0.4	-12.40	12.2	3.65	3.82	18.08	Not Observable	92	85	100	1	74	1	-4
4/ 5	20 58.0	-13.02	21 0.7	-12.51	12.2	3.67	3.83	18.05	Not Observable	91	101	100	1	74	1	-4
5/ 6	20 58.3	-13.13	21 1.0	-13.01	12.2	3.69	3.83	18.01	Not Observable	91	116	96	1	74	1	-4
6/ 7	20 58.6	-13.23	21 1.3	-13.12	12.2	3.72	3.84	17.57	Not Observable	90	130	89	1	74	1	-4
7/ 8	20 58.9	-13.34	21 1.7	-13.22	12.2	3.74	3.84	17.54	Not Observable	89	145	81	1	73	2	-4
8/ 9	20 59.3	-13.44	21 2.0	-13.32	12.3	3.76	3.85	17.50	Not Observable	88	159	71	1	73	2	-4
9/10	20 59.6	-13.54	21 2.4	-13.42	12.3	3.78	3.85	17.46	Not Observable	87	172	61	1	73	2	-4
10/11	20 60.0	-14.03	21 2.7	-13.51	12.3	3.81	3.86	17.43	Not Observable	86	175	50	1	73	2	-4
11/12	21 0.4	-14.13	21 3.1	-14.01	12.3	3.83	3.87	17.39	Not Observable	85	162	40	1	73	2	-3
12/13	21 0.8	-14.22	21 3.5	-14.10	12.3	3.85	3.87	17.36	Not Observable	84	150	31	1	73	2	-3
13/14	21 1.2	-14.31	21 4.0	-14.19	12.4	3.88	3.88	17.32	Not Observable	83	138	22	1	73	2	-3
14/15	21 1.6	-14.40	21 4.4	-14.28	12.4	3.90	3.88	17.29	Not Observable	82	126	15	1	73	2	-3
15/16	21 2.1	-14.49	21 4.8	-14.37	12.4	3.92	3.89	17.25	Not Observable	81	115	8	1	73	2	-3
16/17	21 2.5	-14.57	21 5.3	-14.45	12.4	3.94	3.89	17.22	Not Observable	80	103	4	1	73	2	-3
17/18	21 3.0	-15.06	21 5.7	-14.53	12.4	3.97	3.90	17.18	Not Observable	79	91	1	1	73	2	-3
18/19	21 3.4	-15.14	21 6.2	-15.02	12.4	3.99	3.91	17.15	Not Observable	78	79	0	1	73	2	-3
19/20	21 3.9	-15.22	21 6.7	-15.10	12.5	4.01	3.91	17.11	Not Observable	77	67	0	1	73	2	-3
20/21	21 4.4	-15.30	21 7.2	-15.17	12.5	4.03	3.92	17.08	Not Observable	76	55	3	1	73	3	-3
21/22	21 4.9	-15.37	21 7.7	-15.25	12.5	4.06	3.92	17.05	Not Observable	75	43	7	1	73	3	-3
22/23	21 5.5	-15.45	21 8.2	-15.33	12.5	4.08	3.93	17.01	Not Observable	74	31	13	1	73	3	-3
23/24	21 6.0	-15.52	21 8.8	-15.40	12.5	4.10	3.94	16.58	Not Observable	73	19	20	1	73	3	-3
24/25	21 6.5	-15.59	21 9.3	-15.47	12.5	4.12	3.94	16.54	Not Observable	73	6	29	1	73	3	-3
25/26	21 7.1	-16.06	21 9.9	-15.54	12.6	4.15	3.95	16.51	Not Observable	72	7	39	1	73	3	-2
26/27	21 7.7	-16.13	21 10.4	-16.01	12.6	4.17	3.95	16.48	Not Observable	71	20	50	1	73	3	-2
27/28	21 8.2	-16.20	21 11.0	-16.08	12.6	4.19	3.96	16.44	Not Observable	70	33	61	1	73	3	-2
28/29	21 8.8	-16.27	21 11.6	-16.14	12.6	4.21	3.96	16.41	Not Observable	69	47	72	1	73	3	-2
29/30	21 9.4	-16.33	21 12.2	-16.21	12.6	4.23	3.97	16.37	Not Observable	68	62	82	1	73	3	-2
30/31	21 10.0	-16.40	21 12.8	-16.27	12.6	4.26	3.98	16.34	Not Observable	67	76	90	1	73	3	-2

Ephemeris for Stonehouse 1998 H1 (UK)

Omega= 1.1460 OMEGA=222.1030 i=104.6680 q= 1.486780 a=**********
e=1.000000 P=********* T= 1998 April 14.2050 Equinox= 2000
Magnitudes calculated from m=10.0+5.0*Log(d)+10.0*Log(r)

May 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
11/12	13 50.1	39.49	13 52.3	39.34	11.3	0.77	1.54	22.34	21.39 to 2.14	119	60	100	3	157	-25	26
12/13	13 44.9	40.47	13 47.0	40.32	11.4	0.79	1.54	22.25	21.42 to 2.11	117	69	99	2	155	-24	23
13/14	13 39.9	41.39	13 42.0	41.24	11.4	0.81	1.54	22.16	21.44 to 2.08	116	78	95	2	153	-23	22
14/15	13 35.0	42.28	13 37.1	42.13	11.5	0.83	1.55	22.07	21.47 to 2.05	114	88	89	2	152	-22	20
15/16	13 30.3	43.13	13 32.4	42.57	11.6	0.85	1.55	21.58	21.50 to 2.02	112	98	82	2	150	-21	18
16/17	13 25.8	43.54	13 27.9	43.38	11.6	0.88	1.56	21.50	21.53 to 1.60	111	108	73	2	148	-20	17
17/18	13 21.4	44.31	13 23.6	44.16	11.7	0.90	1.56	21.42	21.56 to 1.57	109	117	63	2	146	-19	15
18/19	13 17.2	45.06	13 19.4	44.50	11.8	0.93	1.57	21.33	21.59 to 1.54	108	125	52	2	145	-18	14
19/20	13 13.2	45.37	13 15.4	45.22	11.8	0.95	1.57	21.26	22.02 to 1.51	106	131	41	2	143	-17	13
20/21	13 9.4	46.06	13 11.6	45.51	11.9	0.97	1.57	21.18	22.05 to 1.48	105	133	30	2	142	-16	12
21/22	13 5.7	46.33	13 8.0	46.17	12.0	1.00	1.58	21.10	22.08 to 1.45	104	132	20	2	140	-15	11
22/23	13 2.2	46.57	13 4.5	46.41	12.0	1.02	1.58	21.03	22.11 to 1.43	102	127	11	2	139	-14	10
23/24	12 58.9	47.20	13 1.1	47.04	12.1	1.05	1.59	20.55	22.14 to 1.40	101	120	4	2	137	-14	9
24/25	12 55.7	47.40	12 58.0	47.24	12.2	1.07	1.59	20.48	22.17 to 1.37	100	110	0	2	136	-13	8
25/26	12 52.7	47.59	12 54.9	47.43	12.2	1.10	1.60	20.41	22.20 to 1.34	98	100	0	2	135	-12	7
26/27	12 49.8	48.16	12 52.1	47.60	12.3	1.12	1.60	20.35	22.23 to 1.31	97	90	2	2	133	-12	7
27/28	12 47.0	48.32	12 49.3	48.16	12.4	1.15	1.61	20.28	22.26 to 1.29	96	79	6	2	132	-11	6
28/29	12 44.4	48.46	12 46.7	48.30	12.4	1.17	1.61	20.21	22.29 to 1.26	95	70	13	2	131	-10	6
29/30	12 41.9	48.59	12 44.3	48.43	12.5	1.20	1.62	20.15	22.32 to 1.23	94	62	21	2	130	-10	5
30/31	12 39.6	49.12	12 41.9	48.55	12.5	1.22	1.62	20.09	22.34 to 1.21	93	55	30	1	129	-9	5
31/32	12 37.4	49.23	12 39.7	49.06	12.6	1.25	1.63	20.03	22.37 to 1.18	92	50	40	1	127	-9	4
June 1998																
1/ 2	12 35.3	49.33	12 37.6	49.16	12.7	1.27	1.64	19.56	22.40 to 1.15	91	47	50	1	126	-8	4
2/ 3	12 33.3	49.42	12 35.7	49.26	12.7	1.30	1.64	19.51	22.43 to 1.13	90	47	59	1	125	-8	3
3/ 4	12 31.4	49.50	12 33.8	49.34	12.8	1.32	1.65	19.45	22.46 to 1.10	89	49	68	1	124	-7	3
4/ 5	12 29.6	49.58	12 32.0	49.42	12.8	1.34	1.65	19.39	22.49 to 1.08	88	54	77	1	123	-7	3
5/ 6	12 28.0	50.05	12 30.4	49.49	12.9	1.37	1.66	19.33	22.51 to 1.06	87	60	84	1	122	-6	2
6/ 7	12 26.4	50.12	12 28.8	49.55	12.9	1.39	1.67	19.28	22.54 to 1.03	86	67	91	1	121	-6	2
7/ 8	12 24.9	50.18	12 27.4	50.01	13.0	1.42	1.67	19.23	22.57 to 1.01	85	75	96	1	120	-5	2
8/ 9	12 23.6	50.23	12 26.0	50.06	13.0	1.44	1.68	19.17	22.59 to 0.59	84	83	99	1	119	-5	2
9/10	12 22.3	50.28	12 24.7	50.11	13.1	1.47	1.68	19.12	23.02 to 0.57	83	92	100	1	118	-5	2
10/11	12 21.1	50.32	12 23.5	50.16	13.2	1.49	1.69	19.07	23.04 to 0.55	82	101	100	1	117	-4	1
11/12	12 20.0	50.36	12 22.4	50.20	13.2	1.52	1.70	19.02	23.06 to 0.53	82	110	97	1	116	-4	1
12/13	12 18.9	50.40	12 21.4	50.23	13.3	1.54	1.70	18.57	23.09 to 0.51	81	118	92	1	116	-4	1
13/14	12 17.9	50.43	12 20.4	50.26	13.3	1.56	1.71	18.52	23.11 to 0.50	80	125	85	1	115	-3	1
14/15	12 17.1	50.46	12 19.5	50.29	13.4	1.59	1.72	18.47	23.12 to 0.48	79	130	76	1	114	-3	1
15/16	12 16.2	50.49	12 18.7	50.32	13.4	1.61	1.72	18.42	23.14 to 0.47	78	133	66	1	113	-3	1
16/17	12 15.5	50.51	12 17.9	50.34	13.5	1.64	1.73	18.38	23.15 to 0.46	78	133	55	1	112	-2	0
17/18	12 14.8	50.53	12 17.3	50.36	13.5	1.66	1.74	18.33	23.17 to 0.45	77	130	44	1	111	-2	0
18/19	12 14.2	50.55	12 16.6	50.38	13.5	1.68	1.75	18.28	23.18 to 0.45	76	124	32	1	110	-2	0
19/20	12 13.6	50.56	12 16.1	50.40	13.6	1.71	1.75	18.24	23.18 to 0.44	75	116	22	1	109	-2	0
20/21	12 13.1	50.58	12 15.6	50.41	13.6	1.73	1.76	18.20	23.19 to 0.44	75	107	13	1	109	-1	0
21/22	12 12.6	50.59	12 15.1	50.42	13.7	1.75	1.77	18.15	23.19 to 0.41	74	97	6	1	108	-1	0
22/23	12 12.2	51.00	12 14.7	50.43	13.7	1.77	1.77	18.11	23.19 to 0.33	73	87	1	1	107	-1	0

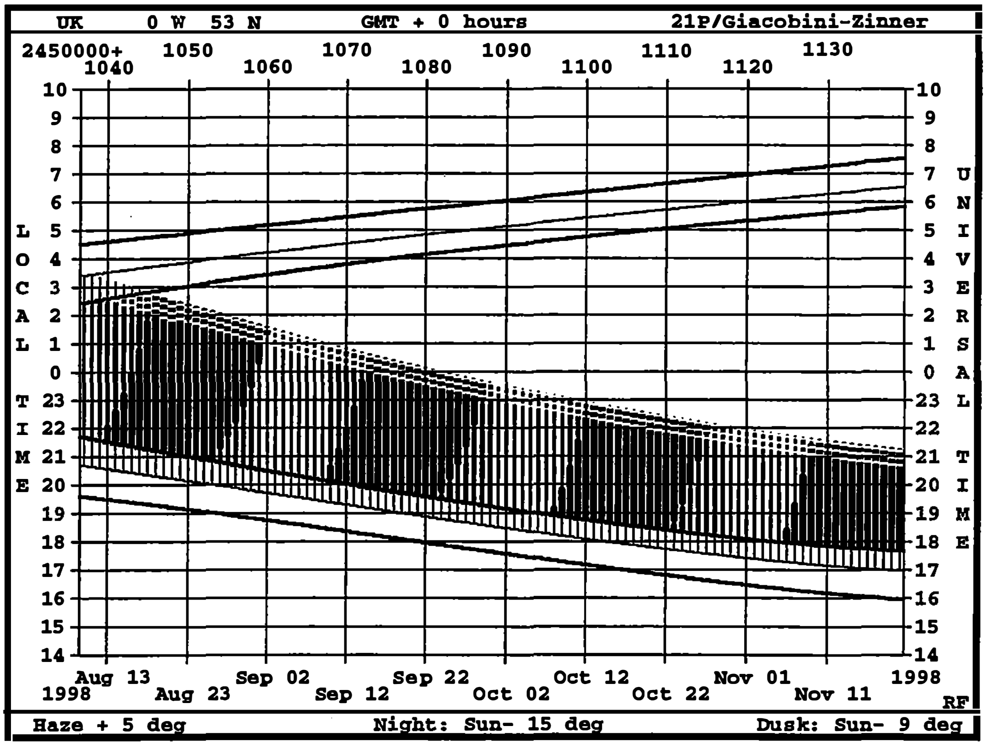
TA format (example)

```
               1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                       Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5   2              Shanklin
961214.70 S   3.8  AA   8   B       20  6      7/  0.50   40   Baroni
```

ICQ format (example)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC        m
 991992    1992  5 18.94  S  9.3 AA  7.5R     50   6    4        135 ICQ XX BEA
  P1955A1  1955  6 18.08     5.0 BD  5  R      6   5   s5   0.75 335 ICQ XX STO01
```

Charts



Visibility diagram for comet 21P/Giacobini-Zinner, produced using software written by Richard Fleet..

The listed comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet.

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are VT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

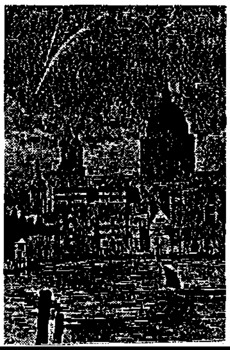
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 6, No 2 (Issue 10), 1998 October

THE EDGAR WILSON AWARD

IAUC 6936 [1998 June 11] announced the establishment of an annual Edgar Wilson Award for the discovery of comets by amateur astronomers. Made possible by a generous bequest, the first Edgar Wilson Award of around 12,000 pounds, will be shared among astronomers who discover one or more comets as amateurs using amateur equipment during the year beginning 1998 June 11. Long interested in astronomy himself, Wilson was from Louisville, Kentucky, and died in 1976. Not much is known about him; he inherited a large amount of money from his father and was something of a recluse. He also left donations to other groups, including some churches. The bequest stipulated that the awards were not to start until five years after the death of his brother Oscar, who died in 1993. The circular says:

The Award shall be allocated annually among the amateur astronomers who, using amateur equipment, have discovered one or more new comets. Only comets officially named for their discoverers shall be included in the annual count. Since particular recognition is to be given to the amateurs who discover the most comets, identical fractions of the total Award funds shall be allocated for each comet with an eligible discoverer, except that if the same comet is credited to more than one independent eligible discoverer, each discoverer shall receive a full fraction. If the discovery is made as the result of information produced or prepared by some other person, it shall not qualify for consideration. Eligible discoveries may be made by visual, photographic or electronic means.

The Award shall be administered by the Smithsonian Astrophysical Observatory (SAO), as the beneficiary under the Will of Edgar Wilson of Lexington, KY. This administration shall specifically be through the International Astronomical Union (IAU) Central Bureau for Astronomical Telegrams (CBAT), which, with the advice of the Small Bodies Names Committee (SBNC) of IAU Division III, has the responsibility for naming comets. The decisions of SAO (via the CBAT) regarding the Award are final.

It is anticipated that the funds available for the first annual Award shall be approximately US$20,000 (twenty thousand dollars). For the purpose of this Award, a year shall be the period of twelve months beginning and ending on June 11.0 UT. The first Award shall be for the year ending on 1999 June 11.0. The Award shall be announced and made during the month of July following the end of each period.

To be eligible for the Award an individual must demonstrate:
1. that he or she is acting in an amateur capacity, at least for the purpose of discovering the comet, and
2. that only amateur, privately-owned equipment was used for the discovery.

In years when there are no eligible comet discoverers, the Award shall be made instead to the amateur astronomer(s) judged by the CBAT to have made the greatest contribution toward promoting an interest in the study of comets.

SAO employees associated with the CBAT, SBNC members, as well as members of their immediate families, are not eligible for the Award.

The Edgar Wilson Award is international in scope, and nationals of no country are excluded from consideration. An observer who suspects he or she has discovered a comet shall ensure that his or her discovery report reaches the CBAT according to the usual procedures. The CBAT shall maintain the necessary records and may contact the discoverers for eligibility documentation.

If this award had been operating in recent years the number of eligible discoveries would be: 1995 award, 5; 1996 award, 6; 1997 award, 5; and 1998 award, 4.

Hypothetical Example
A rather contrived example shows most of the probable situations that can arise. In the year 2028, there were 13 discoveries of new comets:
C/2028 C1 (Papathanassiou); professional with professional telescope
C/2028 F1 (Oldfield); amateur
P/2028 F2 (Lennon-McCartney); two independent amateurs
C/2028 G1 (Harrison-Starr); two amateurs working together

Continued on page 3

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way. Renewals should be sent to the Director and cheques made payable to the BAA. Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

Next year we are hosting the International Workshop on Cometary Astronomy, which will take place over the weekend following the total eclipse (August 14 and 15). I've arranged accommodation at New Hall in Cambridge, though it will be possible to visit for the day. We hope to have many of the present day comet discoverers at the meeting, so it will be a chance to meet them, and to discuss ways of improving our observations. Lectures and workshops are scheduled for Saturday and Sunday and on Monday 16th there is a trip to Stonehenge when it will be possible to get inside the stone circle. Put the dates in your diary now and come and contribute to what should be an excellent meeting. It would help planning if you can let me know if you intend to come and if you want accommodation. Full board with shared facilities is £75 per day, with en-suite facilities £90 and day visitors pay £18 with lunch included. There is a £10 discount for sharing a twin room and I am prepared to negotiate occasional meals as required. These prices include a contribution towards the running costs of the conference. A booking form and provisional program will appear in the next newsletter, but advance booking through the ICQ web page (http://cfa-www.harvard.edu/cfa/ps/icq.html) may attract a discount.

Visitors who have indicated that they will be coming include Jose Aguiar (Brazil), Alexandr Baransky (Ukraine) Jose Carvajal (Spain), Tim Cooper (South Africa), Dan Green (USA), Gary Kronk (USA), Don Machholz (USA), Brian Marsden (USA), Herman Mikuz (Slovenia), Charles Morris (USA), Andrew Pearce (Australia), James Scotti (USA), David Seargent (Australia), Chris Spratt (Canada), Patrick Stonehouse (USA), Kesao Takamizawa (Japan) and we may also see Alan Hale (USA), Charles Kowal (USA), Albert Jones (New Zealand) and David Levy (USA).

We had a good display at the Exhibition Meeting, with comprehensive light curves from many of the recent comets. Michael Hendrie has continued with his work on some of the good comets of the last 40 years and the fruits of his labours will be seen in the Journal in due course. I haven't made much progress on the comets of 1995 since the last newsletter as work has kept me travelling, including an enjoyable three weeks in Tasmania and the North Island of New Zealand. I visited a few of the observatories and was able to make several observations of comet Williams. Skies from the rural locations were incredibly dark and on one occasion I was able to see the zodiacal cone rising from the horizon to the zenith, with the zodiacal band running to the other horizon. On the flight back I had a window seat on the north side between Los Angeles and London and had an impressive view of the aurora. Now I see why some observers complain that their comet observing is spoilt by the skyglow from the aurora!

I must confess that I haven't been to see Deep Impact or Armageddon, but from the reviews I don't think I've missed much. A better read is Bill Napier's first fictional book, entitled Nemesis. A review will appear in the December Journal, but I can recommend it as a Christmas present.

Since I wrote the last newsletter there has been a burst of comet discoveries from the LINEAR asteroid search program and details are given in the half yearly report. Despite the deep searches by the automated professional teams, amateurs are still discovering comets and perhaps the Edgar Wilson award described on the front page will encourage more people to attempt searches. I suspect that amateurs will soon only be left the twilight sky, but perhaps UK observers will have a free hand for the northern twilight zone during the summer months. SOHO, which is the leading comet 'discoverer' has been out of action since June, thanks to an error by the ground controllers, however contact has been restored and the coronagraphs are back into action.

Since the last newsletter observations or contributions have been received from the following BAA members: Sally Beaumont, Eric Dinham, Michael Foulkes, James Fraser, Werner Hasubick, Guy Hurst, Nick James, Albert Jones, John Mackey, Martin Mobberley, Gabriel Oksa, Jonathan Shanklin, Cliff Turk, Alex Vincent, and also from: Jose Aguiar, Alexandr Baransky, Nicolas Biver, John Bortle, Reinder Bouma, Tim Cooper, Stephen Getliffe, Mauritz Geyser, Bjoern Granslo, Roberto Haver, Andreas Kammerer, Heinz Kerner, Martin Lehky, Herman Mikuz, Andrew Pearce, Larry Robinson, Josep Trigo, Helio Vital, Seichi Yoshida (apologies for any omissions or miss-classifications).

Comets under observation were: 21P/Giacobini-Zinner, 29P/Schwassmann-Wachmann 1, 52P/Harrington-Abell, 62P/Tsuchinshan 1, 68P/Klemola, 69P/Taylor, 88P/Howell, 93P/Lovas 1, Hale-Bopp (1995 O1), Meunier-Dupouy (1997 J2), Utsunomiya (1997 T1), Stonehouse (1998 H1), SOHO (1998 J1), Mueller (1998 K1), LINEAR (1998 K5), LINEAR (1998 M2), LINEAR (1998 M5) and Williams (1998 P1).

You may have noted that this issue is dated October rather than November. I shall be away in the Antarctic from mid November until mid March and during this time Guy Hurst has agreed to look after any urgent correspondence. Please send any routine matters to me at the usual address or to my Antarctic address (its always nice to get mail!). In order to make life a little easier I have brought forward the publication date by a month and future issues will appear in April and October.

Jonathan Shanklin

Edgar Wilson Award

Continued from page 1

P/2028 K1 (SONOFLINEAR); professional
C/2028 L1 (Papathanassiou); naked-eye discovery by professional in an entirely amateur capacity
C/2028 M2 (Oldfield); amateur
P/2028 O1 (Hail-Caesar); independent amateur and professional discovery
C/2028 S2 (Jarre); amateur locating comet on Palomar Sky Survey V
C/2028 T1 (Harrison); amateur while observing with the 1.5-m at Palomar
P/2028 U1 (Harrison-Clapton); joint amateur and professional discovery with professional equipment
C/2028 U2 (Harrison-Clapton); joint amateur and professional discovery with amateur equipment in an entirely amateur capacity
C/2028 X3 (Starr); amateur

Comments:
In these examples the term 'amateur' alone means an amateur observing with amateur equipment. Similarly, 'professional' alone means a professional using professional equipment. C/2028 G1 was by a team and is eligible for one share. Although Papathanassiou is a professional, his discovery of C/2028 L1 is eligible because it was not using professional equipment. C/2028 O1: Hail is eligible because he is an amateur, Caesar is not because he is a professional. C/2028 S2 is not eligible because someone else prepared the information used for the discovery. P/2028 U1 is not eligible because the discovery was not made with amateur equipment. C/2028 U2 was by a team and is eligible for one share.

The shares per discovery are then as follows:

By comet		By discoverer		
C/2028 C1 (Papathanassiou)	0	Oldfield	2	= 1+1
C/2028 F1 (Oldfield)	1	Starr	1.5	= 0.5+1
P/2028 F2 (Lennon-McCartney)	1+1	McCartney	1	= 1
C/2028 G1 (Harrison-Starr)	0.5+0.5	Harrison	1	= 0.5+0+0+0.5
P/2028 K1 (SONOFLINEAR)	0	Lennon	1	= 1
C/2028 L1 (Papathanassiou)	1	Papathanassiou	1	= 0+1
C/2028 M2 (Oldfield)	1	Hail	1	= 1
P/2028 O1 (Hail-Caesar)	1+0	Clapton	0.5	= 0+0.5
C/2028 S2 (Jarre)	0	SONOFLINEAR	0	= 0
C/2028 T1 (Harrison)	0	Caesar	0	= 0
P/2028 U1 (Harrison-Clapton)	0+0	Jarre	0	= 0
C/2028 U2 (Harrison-Clapton)	0.5+0.5	Total	9	
C/2028 X3 (Starr)	1			
Total	9	Estimated Award per share = 20000/9 = c. US$ 2222		

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, BAA Journals and Sky and Telescope.

150 Years Ago: Mr Hind noted in June that Encke's comet would pass 0.038 AU from Mercury on November 22 and that observations in 1852 would help determine the mass of Mercury with considerable accuracy. *[Modern calculations give 0.039 AU on November 23. The comet has made 7 close encounters with Mercury since discovery, the closest being 0.035 AU on 1772 October 17.]* Observations by Professor Challis in Cambridge with the Northumberland refractor x120 showed 'The comet had the appearance of an extremely faint nebulosity of very large diameter, and its point of maximum brightness was so difficult to fix upon, that the observations are entitled to very little weight.'

100 Years Ago: John Grigg, a BAA Member from Thames, New Zealand was the first to observe comet 2P/Encke at its 1848 return when he saw it on June 7 at an altitude of only 3° above the horizon. He used an ephemeris which he had calculated himself to locate the comet. At the June meeting Mr Crommelin pointed out what a very memorable and sensational month it had been in the annals of cometary astronomy. He did not think that there was any previous month in the whole history of astronomy when three new comets and two periodic comets had all been detected in the space of eight days. In fact astronomical telegrams and postcards had been tumbling in upon them nearly as quickly as telegrams must tumble in upon newspaper editors at the time of a general election. He then gave details of the comets. Comet Coddington (1898 L1, now Coddington-Pauly) was discovered on a two hour exposure at the Lick Observatory. It was only the third comet to be discovered photographically; the previous two being comet D/Barnard 3 (1892 T1) and an eclipse comet discovered by Schaeberle on plates taken in Chile.

50 Years Ago: The annual report noted that the Section had been very active with nine comets observed by 25 Members (including some still active). A five page report on the comets of 1947 includes a description of comet 1946 P1 discovered by Albert Jones [who still contributes observations] and descriptions and light curves of several other comets. [The comets of that year are the earliest that we have report forms and magnitude estimates for, so if anyone has earlier material do let me have it.] The Southern Comet of 1947 (1947 X1) was not at first observable from the Royal Observatory at the Cape because Table Mountain was in the way! The comet was one of the brightest for years and compared with the Great January Comet of 1910 (1910 A1) and 1P/Halley as observed from Cambridge in 1910. At the AGM in October it was announced that comet Pons-Coggia-Winnecke-Forbes was to be renamed Crommelin as a posthumous honour in recognition of the valuable work that he had done on the identity of the comet. The Walter Goodacre Medal and Gift was presented to Dr Martin Davidson who was Director from 1936 to 1946.

Sky & Telescope reported on a paper presented at the 79th American Astronomical Society meeting on the link between comets and meteors which suggested that of the Jupiter family comets only 2P/Encke and 26P/Grigg-Skjellerup could produce meteor showers.

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

Z Sekanina, P W Chodas and D K Yeomans discuss **'Secondary fragmentation of comet Shoemaker-Levy 9 and the ramifications for the progenitor's breakup in July 1992'** in *Planetary & Space Science, 46 (1), 21, 1998.* They suggest that the 10-kilometre diameter progenitor was rotating rapidly with a period of about 5.5 hours. It cracked at perijove in July 1992, due to tidal stresses, but didn't begin to fragment until at least an hour later, when rotational forces began to separate the 12 on train fragments. The 13 off train fragments represent secondary breakup of some of these bodies, with separation occurring on the anti-solar side when thermal stresses have penetrated the nucleus.

Jonathan Shanklin

The following abstracts (some shortened further for publication) are taken from the Cambridge Conference Network (CCNet), which is a scholarly electronic network devoted to catastrophism, but which includes much information on comets. To subscribe, contact the moderator Benny J Peiser at <b.j.peiser@livjm.ac.uk>. Information circulated on this network is for scholarly and educational use only. The abstracts, taken from daily bulletins, may not be copied or reproduced for any other purposes without prior permission of the copyright holders. The electronic archive of the CCNet can be found at http://abob.libs.uga.edu/bobk/cccmenu.html

G. Michalak: **The orbit of comet Kritzinger (1914 F1). Nongravitational effects in the comet motion**. ACTA ASTRONOMICA, 1998, Vol.48, No.1, pp.103-112

Using all available observations of the one-apparition comet Kritzinger (1914 F1) we show that the gravitational solution makes (O - C) residuals non-randomly distributed. We therefore apply three other models of the comet motion: (i) with a displacement of the photometric center from the center of mass of the comet along the radius vector, (ii) with a change in the velocity vector due to a single outburst of the comet, and (iii) with Marsden's standard nongravitational parameters A(1), A(2), A(3). It turns out that models (ii) and (iii) fit the observations of comet Kritzinger equally well and give the same mean residual and the same (O - C) residual distributions. In consequence, from the quality of the fit we are not able to distinguish which of the two models is better. It is suspected that for some comets undergoing an outburst, the model (ii) can be an alternative to, usually applied, Marsden's model (iii).

M. Krolikowska, G. Sitarski, S. Szutowicz: **Forced precession model for three periodic comets: 30P/Reinmuth 1, 37P/Forbes, and 43P/Wolf-Harrington.** ACTA ASTRONOMICA, 1998, Vol.48, No.1, pp.91-102

The nongravitational motion of three short-period comets - discovered in the twenties and running on similar heliocentric orbits - has been investigated. We used Sekanina's forced precession model of the rotating cometary nucleus to include the nongravitational terms into equations of the comet's motion. Values of six precessional parameters: A, eta, I, phi, f(p) and s have been determined along with corrections to orbital elements from astrometric observations of the comets. We were able to link successfully all the observations of each comet over an interval of time spanning about seventy years. According to our solutions, the nucleus of comet Reinmuth 1 is oblate whereas those of comets Forbes and Wolf-Harrington are prolate along the spin-axis.

H.N. Zhou, W.F. Zhuang & Y. Wang: **New reductions of orbits based upon Chinese ancient cometary records.** PLANETARY AND SPACE SCIENCE, 1997, Vol.45, No.12, pp.1551-1555

From 146 B.C. to 1760 A.D., 363 sets of cometary observations for a total 88 different comets were recorded in Chinese Ancient Records of Celestial Phenomena. According to those records, we reduced apparent positions and mean equatorial coordinates (epoch 2000.0) for all more than three times recorded comets. Taking into account the perturbations of all nine planets and using the numerical method of N-body problem, the orbits of correlative comets were calculated. For thirty different comets, new orbits are presented for the first time.

Reading this paper I was intrigued with the concluding statement that none of the new orbits are included in the IAU catalogue. Looking more closely it became obvious why. Most of the orbits are based on only three, very imprecise positions, yet are given to high precision. They may give a rough indication of the orbit, but are clearly not good enough to warrant giving any of the comets anything other than an X designation.

L. Kolokolova & K. Jockers: **Composition of cometary dust from polarization spectra.** PLANETARY AND SPACE SCIENCE, 1997, Vol.45, No.12, pp.1543-1550

The wavelength dependence of the polarization ('polarization spectra') of cometary dust is discussed. It is shown that, in the case of large phase angles, the wavelength dependence of the polarization is mainly controlled by the complex refractive index of the particle material, whereas the spectral dependence of the intensity is also sensitive to the size of the particles. This suggests that observations of 'polarization spectra' may determine the composition of cometary dust. An attempt is made to find the composition of the cometary dust material by comparing the observed polarimetric data with laboratory measurements of complex refractive indices of possible cometary constituents. Silicates, graphite, metals, organics, water ice and their mixtures are considered. It is shown that astronomical silicate must be the most abundant constituent of cometary dust in the range of heliocentric distances from 0.8 to 1.8 AU, whereas the volume fraction of pure graphite or pure metals is less then 1%. A substance similar to that of F-type asteroids may be present in comets. There is evidence for an organic material that is being destroyed between heliocentric distances of 0.8-1.8 AU.

D. Lazzaro *et al*: **Photometric monitoring of 2060 Chiron's brightness at perihelion.** PLANETARY AND SPACE SCIENCE, 1997, Vol.45, No.12, pp.1607-1614

The results of photometric and spectroscopic observations of comet/asteroid 2060 Chiron carried on at the Observatorio do Pico-dos-Dias (Brazil) at the European Southern Observatory (Chile) and at the Mauna Kea Observatory (Hawaii) during 1996 are presented. The analysis of the photometric data shows that even at a minimum of brightness 2060 Chiron presents some activity. The absolute magnitude, H-v, varied from 6.79 in February to 6.22 in March. Therefore 2060 Chiron is still in a minimum of activity close to that of 1983-1985 and of 1994-1995.

C.M. Lisse *et al*: **Infrared observations of comets by COBE.** ASTROPHYSICAL JOURNAL, 1998, Vol.496, No.2 Pt1, pp.971-991

Comets C/Okazaki-Levy-Rudenko (1989r) (C/OLR), C/Austin (1989c1) 73P/Schwassmann-Wachmann 3 (P/SW3), and C/Levy (1990c) were detected by the COBE/Diffuse Infrared Background Experiment (DIRBE) with broadband photometry at 1-240 mu m between 1989 November and 1990 September. Extended dust tails were found at 12 and 25 mu m, with detailed structure due to variations in particle properties and mass-loss rate. Spectrophotometry of the central 42' x 42' was found to agree with that of a graybody of temperature 1.1 times the local blackbody temperature for C/OLR and C/Austin, while a nongraybody distribution with a spectral index of emissivity 0.26 +/- 0.15 and temperature 1.25 times the local temperature was found for C/Levy. A model using modified Mie dust particles composed of fractal mixtures of vacuum, silicates, and carbonaceous material was found to fit the observations. Comparison with IUE and ground-based observations indicates that large dark particles of radius greater than 20 mu m predominate by surface area for C/OLR and C/Austin, but 1-10 mu m particles predominate for C/Levy. The detection of P/SW3, an optically faint comet, was surprising, especially since four optically brighter comets were not detected by DIRBE. This may be related to the nuclear breakup observed during its next apparition. The total estimated mass loss from these comets in a perihelion passage is about 10 times larger than that expected from optical observations, and the loss rate is similar to that needed to supply the interplanetary dust cloud. No comet trails were detected to a limiting surface brightness of 1 MJy sr(-1), although large, beta < 5 x 10(4) particles, which could evolve into a dust trail, were detected in C/Austin.

P.L. Lamy *et al*: **The nucleus and inner coma of comet 46P/Wirtanen.** ASTRONOMY AND ASTROPHYSICS, 1998, Vol.335, No.2, pp.L25-L29

We report the detection of the nucleus of comet 46P/Wirtanen from analysis of images taken with the Planetary Camera (WFPC2) of the Hubble Space Telescope (HST) on 28 August 1996. The high spatial resolution (a WFPC2 pixel projects to 50 km at the distance of the comet) allowed us to separate the signal of the nucleus from that of the coma and to determine the Landolt V and R magnitudes of the nucleus. Assuming a spherical body with a geometric albedo of 0.04 and a phase coefficient of 0.04 mag/deg, we derived a radius of 0.60 +/- 0.02 km. The colour of the nucleus is moderately red with a gradient of 10% per 100 nm at optical wavelengths. From the lightcurve data we derived a rotational period of 6.0 +/- 0.3 hr and find that the ratio of the semi-axes of the assumed ellipsoidal body must satisfy a/b greater than or equal to 1.2. From an analysis of the dust coma, we derived that A f rho is 23 cm and that the dust production rate is 4 kg sec(-1).

M.E. Brown *et al*: **Sodium velocities and sources in Hale-Bopp.** ICARUS, 1998, Vol.134, No.2, pp.228-234

We use spatially resolved high-resolution spectra of the 5890 and 5896 Angstrom sodium D lines in the nuclear regions of Comet Hale-Bopp to determine the sources of cometary sodium. Comparison of the data to a Monte Carlo model of sodium dynamics suggests that the intensities and velocities of sodium in Hale-Bopp can be explained if 55% of the observed sodium is produced at the nucleus, the remaining 45% is produced in an extended source, and the sodium is accelerated by solar radiation pressure. Observations of H2O+ in Hale-Bopp and subsequent modeling of a plasma-derived sodium source show that this source produces sodium at higher velocities than those observed; any contribution from such a source must be small. The combined nucleus and extended sources of sodium which fit our data best would create a sodium tail at a scale 100 times larger than that of these observations identical in morphology and velocity to that observed in Hale-Bopp.

M. Fulle, H. Mikuz, M. Nonino, S. Bosio: **The death of comet Tabur 1996 Q1: The tail without the comet.** ICARUS, 1998, Vol.134, No.2, pp.235-248

After a normal brightness increase, Comet Tabur 1996 Q1 showed a remarkable photometric behaviour by rapidly fading in late October 1996. In this paper we analyse three CCD images of the remnant dust tail observed during the fading of the comet around perihelion and model them by means of the inverse dust tail model (M. Fulle, 1989, Astron. Astrophys. 217, 283-297). Assuming hemispherical sunward dust emission from the nucleus, satisfactory fits of the observed tail brightness distribution, turning axis and temporal fading allow us to conclude that only dust was observed, and contamination by gas and/or ions in the images is negligible. The model results include the temporal variation of the dust ejection velocity, the size distribution and dust mass loss rate. These values show a strong correlation during fading with strong drops consistent with the comet's deactivation. In particular, the slow increase of the dust mass loss rate in September and its low absolute values allow us to exclude outbursts preceding fading and to exclude that the disappearance was due to a complete nucleus disruption. In this case, the nucleus mean radius should have been no more than 350 m (for a nucleus bulk density of 100 kg m(-3)), which seems inconsistent with the observed water loss rate. A probable explanation of the comet fading is that the comet nucleus deactivation was due either to seasonal effects, putting all active areas in permanently night sides, or to the complete end of the whole nucleus surface activity (possibly due either to nucleus mantling or to the end of the ice reservoirs).

Brian G. Marsden. **Comet of 1680/81 not to yield end of world in 2255.**

The 575-year period, given by Halley and apparently embraced by Newton, for the celebrated 1680/1681 comet arose solely because of Halley's conviction that the same comet had previously appeared in 1106, 531 and 44 B.C., this last being supposedly the comet said to have appeared following the assassination of Julius Caesar.

It was proven by Cowell and Crommelin early in the twentieth century that the 531 (actually 530) comet is in fact an early apparition of Halley's 75-year-period comet. It was suspected by Kreutz, already a century ago, that the 1106 comet was a member of the sungrazing comet group that bears his name; while an actual proof of this seems not to be possible, my own study of the Kreutz comets, which have orbits significantly different from that of the 1680/1681 comet, has tended to support the Kreutz hypothesis. Finally, it was shown by Ramsey and Licht in their recent monograph on "Caesar's Comet" that Halley's scenario was completely wrong with regard to the month in which the object appeared, as well as to the time of day and position in the sky. So, while Halley's conjecture of the 575-year period was quite ingenious, all three pieces of earlier supporting evidence have now disappeared.

Furthermore, given the crudeness of the positional data available to them, there was no way that either Newton or Halley would have been able to say that the observations in 1680/1681 could not be satisfied by a parabola. Encke published a more thorough study of the 1680/1681 data in 1818, refining the comet's positions by means of more precise information about the positions of the reference stars to which the comet's positions were referred. As a result, he derived a nominal revolution period for the comet of more than 8000 years and suggested that a period of less than 2000 years would be an impossibility.

Whiston, the rather bizarre character who succeeded Newton in the Lucasian chair at Cambridge, took things to extremes and used the 575-year period to tie the comet to The Deluge (which he supposed to occur in 2349 B.C.) and predicted that the comet's next appearance in 2255 would signify the end of the world. If the world does end in 2255, it will not be because of the 1680/1681 comet.

M. Krolikowska, G. Sitarski, S. Szutowicz: **Model of the nongravitational motion for comet 32P/Comas Sola.** ASTRONOMY AND ASTROPHYSICS, 1998, Vol.335, No.2, pp.757-764

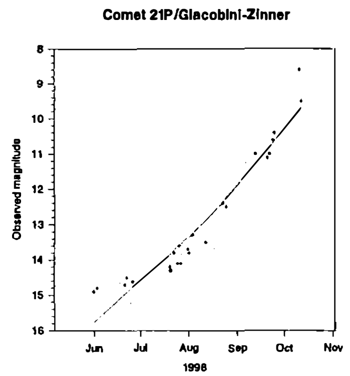
The nongravitational motion of the periodic comet Comas Sola is studied on the basis of positional observations made during nine consecutive revolutions around the Sun. Nongravitational effects in the comet motion have been examined for Sekanina's forced precession model of the rotating nucleus. We present three models which successfully link all the observed apparitions of the comet during 1926-1996. Two solutions (Models II and III) represent oblate spheroids and the third one (Model I)- a prolate spheroid (nucleus rotation around its longer axis). The best solution was obtained assuming that between the apparitions of 1935 and 1944 the displacement of the maximum value of the known function g(r) with respect to the perihelion time changed its value.

It appears that forced precession causes the moderate changes of the position of the rotation axis in space. The ratio of rotational period to radius of the nucleus was found for each model. The present precession models are in agreement with sizes and periods of rotation of other cometary nuclei deduced from observations. The obtained models give some strong constraints on the physical parameters of the nucleus of comet P/Comas Sola. Assuming a prolate spheroid for the nucleus of the comet, the expected rotational period is 14 +/- 4 hours for an equatorial radius of 2 km. For the same radius, the oblate Model II gives the much smaller rotational period of 2.4 +/- 0.4 hours. The polar radii are 2.2 km and 1.3 km for the prolate and oblate model, respectively.

Review of comet observations for 1998 May - 1998 September

The information in this report is a synopsis of material gleaned from IAU circulars 6895 – 7031 and The Astronomer (1998 May – 1998 September). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

21P/Giacobini-Zinner, the parent comet of the October Draconid meteors, should be visible until the end of the year. It is an evening object and at its best at the end of November. The comet was first discovered by Michael Giacobini at Nice observatory in December 1900 and was thought to have a period of 6.8 years. The next two returns were expected to be difficult to observe, but in October 1913, Ernst Zinner, of Bamberg, Germany, discovered a comet whilst observing variable stars in Scutum. This turned out to be the same comet, but the period had been incorrectly determined. The comet was missed at three unfavourable returns, so this is the thirteenth apparition of the comet. Early observations show the comet brightening rapidly with a light curve of 9.0 + 5 log d + 15.5 log r from 22 observations.



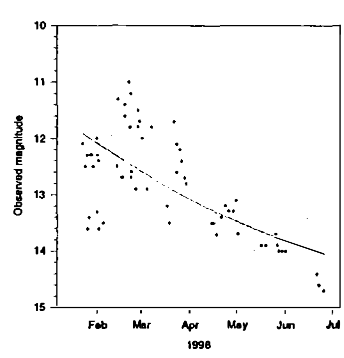
29P/Schwassmann-Wachmann 1 was really too low for reliable observation from the UK, though a few observations suggested that it outburst during May. This comet seems to spend a lot of time in outburst and is worth monitoring with CCD cameras on a regular basis. Observers are encouraged to check the comet at every opportunity over the apparition, although it will remain at low altitude for UK observers for several years to come.

52P/Harrington-Abell was discovered in outburst at 12th mag by Alain Maury, Observatoire de la Cote d'Azur, on CCD images taken on July 21.1 UT when its predicted magnitude was about 21. [IAUC 6975, 1998 July 25]. It is currently visible in the morning sky and still around 12th mag. It is not clear if the comet is continuing to brighten as it approaches the sun or if it is remaining at constant brightness.

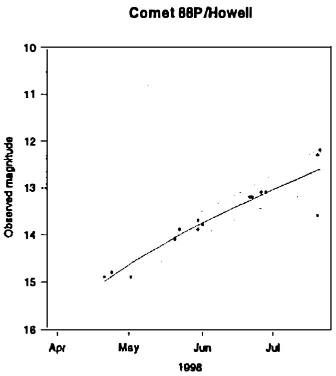
62P/Tsuchinshan 1 was around 13th mag during the spring. Few observers were able to follow it, and only Lehky and Hasubick contributed observations.

68P/Klemola was reported a little brighter than 14th mag by Lehky during July.

69P/Taylor continued to fade slowly although there is much scatter in the early part of the light curve. The equation 10.1 + 5 log d + 2.6 log r fits the 60 available observations.

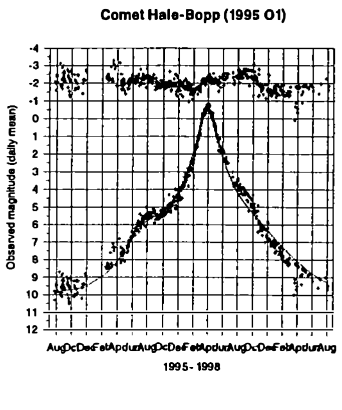


88P/Howell brightened quite rapidly during the spring and early summer but then moved too far south for general observation. Recent observations reported on the CBAT/ICQ web page put it at around 10th magnitude, but it will not be visible from the UK. The 15 observations so far received give a light curve of 8.0 + 5 log d + 20.7 log r.

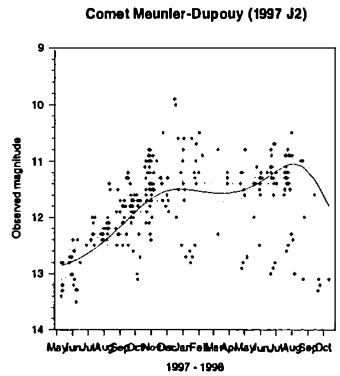


93P/Lovas 1 became visible in September and a few observations were reported to the ICQ/CBAT.

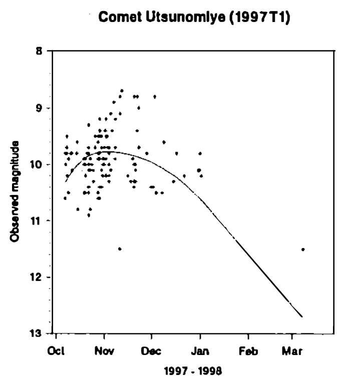
Hale-Bopp (1995 O1) is now a telescopic object, but still well placed for Southern Hemisphere observers. The observed arc now covers 1108 days with observations made on 697 days. The equation -0.73 + 5 log d + 7.81 log r fits daily means very well, but there are long period variations about this mean light curve of around a magnitude, which are shown plotted with an offset of -2.



Meunier-Dupouy (1997 J2) began to receive more attention from May onwards and peaked at 11th magnitude over the summer. There is a lot of scatter in the observations, which makes the magnitude equation a little uncertain, though individual observers are more self consistent. The 277 observations received so far suggest a preliminary light curve of 5.6 + 5 log d + 6.6 log r. The comet is now fading and UK observers will loose it after November.

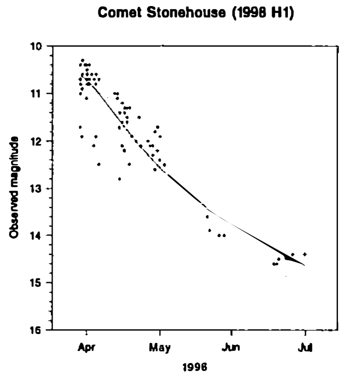


Utsunomiya (1997 T1) was followed until the end of May by Hasubick and Lehky. Very few observers got up to see it in the morning sky and only 9 observations were made when it was a morning object. The 130 available observations suggest a light curve of 6.6 + 5 log d + 16.4 log r

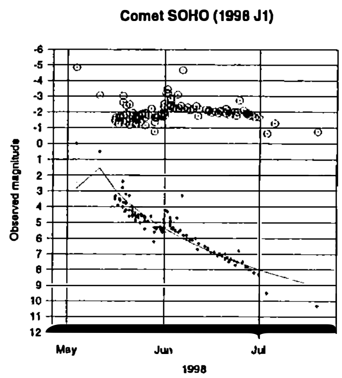


A further 9 sungrazing comet fragments have been discovered by the LASCO coronographs on the SOHO spacecraft, bringing its total to 55 comets. The new comets are: 1998 H2, 1998 J2, 1998 K7, 1998 K8, 1998 K9, 1998 K10, 1998 K11, 1998 L1 and 1998 M7. Contact with the spacecraft was lost on June 25 due to an error by ground controllers, however contact with it was eventually restored and operation of the coronographs resumed in mid October. More details are available on the Section web page.

Stonehouse (1998 H1) was only observed by Martin Lehky after May as it faded quickly and became large and diffuse. The 73 observations give an equation of 11.0 + 5 log d + 5.0 log r.



SOHO (1998 J1) was the first comet discovered by the satellite to be observed from the ground, though it was essentially only visible from the southern hemisphere. Initial magnitude estimates from the satellite suggested that it might reach –1 or brighter, however ground based estimates suggest that it was a couple of magnitudes fainter than this and the light curve casts doubt on some of the daylight observations that were reported. It underwent an outburst in late May, but faded very rapidly in late July. The 127 observations give an overall light curve of 6.2 + 5 log d + 6.3 log r and the residuals are shown centred on magnitude -2.



Mueller (1998 K1) was discovered by Jean Mueller during the 2nd Palomar Sky Survey on May 16.2 with the 1.2-m Oschin Schmidt. [IAUC 6908, 1998 May 18]. It was nearly 15th magnitude during May and June according to observations by Lehky.

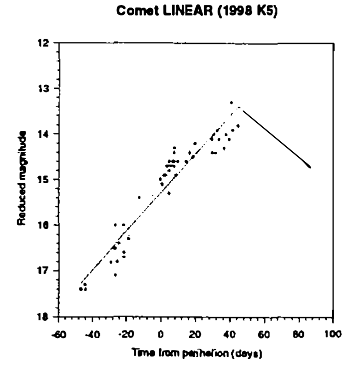
LINEAR (1998 K2) was one of 37 fast moving objects discovered during survey work on May 24 by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory ETS 1-m f2.15 reflector at Socorro, New Mexico. The MPC were able to link it with one of 25 fast movers discovered two nights earlier. [IAUC 6915, 1998 May 25]. The object was reported at 16th mag by LINEAR, but other observations have put it as bright as 13th mag. It is at high southern declination and was at perihelion in September.

LINEAR (1998 K3) was another fast moving object discovered during survey work, on May 23, by the Lincoln Laboratory Near Earth Asteroid Research Project with the ETS 1-m f2.15 reflector. On sending the first confirmatory observations on May 24.5 UT, F. B. Zoltowski (Woomera, 0.3-m Schmidt-Cassegrain) remarked on the "poor" nature of the images, and on May 25.5 he added that they were diffuse and difficult to measure (unlike those of the six other LINEAR objects he also observed at that time). Initial orbit computations at the Minor Planet Center suggested that the orbit was retrograde. In response to their request, M. Tichy (Klet, 0.6-m reflector), observing on May 25.9, also remarked that the object seemed slightly diffuse (coma about 8"). In better conditions on May 26.2, W. B. Offutt (Cloudcroft, 0.6-m reflector) remarked on a faint coma, some 3" in diameter, and a faint, but discernible, tail extending about 10" from the central condensation in p.a. approximately 120 deg. S. Nakano reports that A. Sugie (Dynic, 0.6-m reflector), observing on May 26.6, independently noted the object's cometary nature, with a 6"-8" coma and a 6" tail to the east. [IAUC 6916, 1998 May 26]. The object is 17th mag and will fade.

136P/Mueller 3 (1998 K4) was recovered on May 24.4 by J. V. Scotti of the Lunar and Planetary Laboratory, with the Spacewatch telescope on Kitt Peak. The comet, of mag 21, is very slightly diffuse, with a coma diameter of 12" on May 26.45 UT. The indicated correction to the prediction by S. Nakano on MPC 27081 is Delta T = -0.7 day. [IAUC 6919, 1998 May 26].

LINEAR (1998 K5) is yet another fast moving object discovered during survey work, on May 26, by the Lincoln Laboratory Near Earth Asteroid Research Project with the ETS 1-m f2.15 reflector. The high orbital eccentricity indicated in the early computations was the first clue that the object might be a comet, although there were the complications that the orbit has a low inclination and that, when asked, several observers felt that their data showed the object to be asteroidal in nature. The first observational indication of cometary character was provided by P. J. Shelus, who remarked that images obtained by J. G. Ries (McDonald, 0.76-m reflector, poor seeing) on May 29.39 UT seemed to show a tail to the south and west, roughly opposite the object's direction of motion. P. Pravec (Ondrejov, 0.65-m reflector) also remarked on the tail, consistently on co-added images and marginally on individual images, 0'.4 long in p.a. 235 deg on May 27.03, 0'.4 long in p.a. 225 deg on May 28.95 and 0'.3 long in p.a. 227 deg on May 29.97. On May 30.46 C. Veillet (Canada-France-Hawaii, 3.6-m reflector) noted a clear 30" tail on a 1-min exposure. S. Nakano reports that A. Sugie (Dynic, 0.6-m reflector, bad seeing), observing on May 27.58, independently noted (on four coadded frames) a 16" tail in p.a. 230 deg. [IAUC 6923, 1998 May 30]. The comet has a perihelion distance just inside the Earth's orbit, but is intrinsically very faint. The latest orbit gives a period of around 600 years.

I observed it on June 20.0 and was surprised how easy it was to see and how rapidly it is moving. I estimated it at 12.9 in the Northumberland x170. The motion was obvious within a minute - absolutely fascinating! Nick James obtained a CCD image of the comet on July 1.98.



The 49 observations received so far give a light curve of 15.1 + 5 log d + 2.8 log r, however this is not a good fit. A much better fit is given by a linear increase of brightness until some 50 days after perihelion with a light curve of 13.2 + 5 log d + 0.0424(T-50.1) where T is the number of days after perihelion.

137P/Shoemaker-Levy 2 (1998 K6) was recovered by C. W. Hergenrother with the Smithsonian Astrophysical Observatory's 1.2-m reflector at Mt. Hopkins on May 19. The comet appeared stellar at 21st mag, although the observations were made through moderate cirrus. The indicated correction to the prediction by S. Nakano on MPC 29881 is Delta T= -0.5 day. [IAUC 6928, 1998 June 2].

LINEAR (1998 M1) was discovered during survey work by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory ETS 1-m f2.15 reflector on June 16.2 [IAUC 6940, 1998 June 16]. CCD observations suggest it is around 16th mag, but it could be brighter to visual observers. The comet will fade.

LINEAR (1998 M2) was recorded during survey work by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory ETS 1-m f2.15 reflector on May 28.4 and discovered to be cometary on June 19.3 [IAUC 6949, 1998 June 20]. It reached 14^{th} magnitude during June and July, and several observers recorded it.

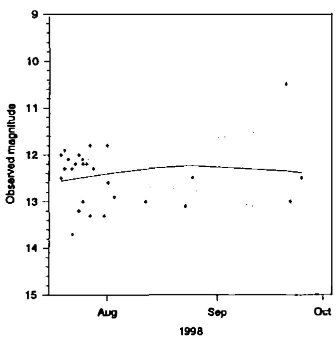
Larsen (1998 M3) was discovered by J Larsen with the 0.9-m Spacewatch telescope on June 24.3 but prediscovery observations made by LINEAR were found in images taken on

May 26.3. The comet is very distant with perihelion at 5.8 AU. It is around 18th magnitude and expected to fade.

LINEAR (1998 M4) was discovered during survey work by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory ETS 1-m f2.15 reflector on June 25.3 [IAUC 6954, 1998 June 27]. The comet is 17th mag and will fade.

LINEAR (1998 M5) was discovered during survey work by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory ETS 1-m f2.15 reflector on June 30.3 [IAUC 6959, 1998 July 1]. The comet could reach 9^{th} magnitude in January when it is at perihelion. The following month it passes very close to the pole. The light curve from the 28 observations received so far is not very well determined, but is fitted by 8.6 + 5 log d + 5 log r.

Comet LINEAR (1998 M5)



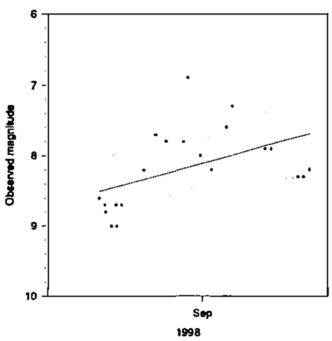
Montani (1998 M6) was announced on IAUC 6960 [1998 July 1]. It is a 19th mag object, discovered visually by Joe Montani on the display monitor during the course of routine Spacewatch observations with the 0.9-m telescope. The comet is a distant one and is expected to fade.

138P/Shoemaker-Levy 7 (1998 O1) was recovered by J. V. Scotti, Lunar and Planetary Laboratory, with the Spacewatch telescope on Kitt Peak on July 25.4 [IAUC 6979, 1998 July 27]. The comet was around 21st mag. The indicated correction to the prediction by B. G. Marsden on MPC 25183 was Delta T = -0.7 day. The comet is not expected to become significantly brighter.

Williams (1998 P1) Peter Williams of Heathcote (near Sydney) made a visual discovery of a new comet using a 0.30-m f/6 reflector (72x) on August 10.5. [IAUC 6986, 1998 August 11]. Unfortunately the comet is on the far side of the sun at perihelion in October and will fade from its present 8th magnitude as it enters the northern hemisphere skies.

The 21 pre-perihelion observations received so far give a light curve of 4.7 + 5 log d + 20.3 log r.

Comet Williams (1998 P1)



LINEAR (1998 Q1) was discovered during survey work by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory ETS 1-m f2.15 reflector on August 24.3 [IAUC 6995, 1998 August 25]. The comet is 15th mag and will fade.

LONEOS-Tucker (1998 QP54) was identified as a comet by Roy A. Tucker (Tucson, AZ) whilst carrying out a CCD asteroid-astrometry program with a 0.36-m f/11 Schmidt-Cassegrain at the Goodricke-Pigott Observatory. G. V. Williams, Minor Planet Center, then identified the comet with 1998 QP54, which had been reported by E. Bowell (observer W. D. Ferris, measurer B. W. Koehn) as an apparently quite ordinary minor planet in the course of LONEOS, the Lowell Observatory Near-Earth Object Search. Williams then also identified single-night observations (also on Aug. 28) by LINEAR as belonging to the same object. Information about the object was then placed in The NEO Confirmation Page. In response, J. Ticha reported observations made at the Klet Observatory that showed a faint coma (diameter 17") and a 35" tail in p.a. 226 deg, and L. Sarounova reported from the Ondrejov Observatory on a narrow tail 5' long in p.a. 135 deg and only a small coma. T. Spahr also reported observations from the Catalina Sky Survey. The comet is of short period, and it made a close approach to Jupiter early in 1992. It will fade from its current 16th mag.

1998 S1 was discovered by Jean Mueller on October 17 on a 30-min exposure taken on Oct 14 with the 1.2-m Oschin Schmidt telescope at Palomar by K. Rykoski and Mueller in the course of Palomar Outer Solar System Ecliptic Survey. The comet was confirmed on Oct 17 and Gareth Williams later identified it with minor planets observed by LINEAR on Sept 26 and 27 and LONEOS on Sept 17. The comet is of short period and had a close approach to Jupiter in 1992. It is 15th mag and will fade.

LINEAR (1998 T1) was discovered during survey work by the Lincoln Laboratory Near Earth Asteroid Research Project using the Lincoln Laboratory ETS 1-m f2.15 reflector on August 24.3 [IAUC 7024, 1998 October 8]. The comet is 15th mag and could reach 9^{th} magnitude when it is at perihelion next June, though it will not be visible from the UK.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds
or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Comet Prospects for 1999

The comet predicted to be brightest in 1999 is P/Machholz 2, which may reach 7^{th} magnitude. This comet split into several fragments at its discovery return in 1994 and both the ephemeris and expected magnitude are a little uncertain. A couple of long period comets discovered in previous years are still visible and there are several reasonable returns of short period comets. Recent theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. Last year 52P/Harrington-Abell was unexpectedly bright when it outburst several months before perihelion. Ephemerides for new and currently observable comets are published in the *Circulars*, Comet Section Newsletters and on the Section and CBAT web pages, with predictions for returns in the Handbook[1] and on Seiichi Yoshida's web pages[2]. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^{m} are given in the International Comet Quarterly Handbook[3]; details of subscription to the ICQ are available from the comet section Director. The section booklet on comet observing[4] is available from the BAA office or the Director.

Comet Hale-Bopp (1995 O1), the great comet of 1997, is fading slowly and could still be 11^{m} at the beginning of the year, fading to 13^{m} by the year's end. It is only observable from Southern Hemisphere locations as it loops round the Large Magellanic Cloud.

Comet LINEAR (1998 M5) is at perihelion in January at around 10^{th} magnitude and moves north from Lyra, passing very close to the pole in mid March. Heading south it passes through Camelopardalus and Lynx, reaching Cancer mid year when it will have faded to 13^{th} magnitude. It will then be too faint and close to the sun for further observation.

Southern Hemisphere observers should pick up comet LINEAR (1998 T1) in late April at 12^{th} magnitude as it heads south from solar conjunction. It reaches perihelion in Piscis Austrinus in late June when it will be at around 8^{th} magnitude. By July it is heading north, but fading and is unlikely to be seen from the UK.

21P/Giacobini-Zinner will still be visible at the beginning of the year in Cetus and Eridanus as it fades from 10^{th} magnitude. It fades quite rapidly and will be lost by the end of February. It is not well placed for observation from the UK, but will be visible from further south.

29P/Schwassmann-Wachmann 1 is an annual comet which has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^{m}. In the first half of 1998 it was in outburst on several occasions. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet. This year it is at opposition in May on the borders of Hydra and Libra. It is in solar conjunction in November, passing into Scorpius. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. Unfortunately opportunities for UK observers may be limited as its altitude does not exceed 15• from this country.

10P/Tempel 2 makes its 20th observed return since its discovery by William Tempel (Milan, Italy) as a 9th magnitude object in 1873. Several unfavourable returns were missed in the earlier years. The orbit is very stable, which is one reason why it is a favoured target for planned spacecraft missions. In 1983 the IRAS satellite detected an extensive dust trail behind the comet. Normally the light curve is highly asymmetric with a late turn on. There is a rapid rise in brightness as perihelion approaches, which continues more slowly for a couple more weeks after perihelion, followed by a slow decline until activity switches off. With a 5.5 year period alternate returns are favourable and this is one of them. The comet may be picked up in large telescopes in April when it is in Ophiuchus and it should reach 10^{th} magnitude in June. It is closest to the Earth in July (0.65 AU) when it could be 9^{th} magnitude and UK observers should be able to follow it until August, but it then moves too far south. More southerly observers may be able to observe it until the end of the year as it fades.

Donald Machholz discovered P/Machholz 2 (1994 P1) with his 0.25-m reflector at 10^{m} in August 1994. It proved to have multiple components, first reported by Michael Jager (Vienna, Austria). The four secondary components could all be described by the same orbit, but with perihelion delayed by up to half a day from the primary. At times there seemed to be a faint trail of material linking the components. The comet has a short period of 5.2 years with a perihelion distance of 0.75 AU and aphelion just inside the orbit of Jupiter. The orbit has been slowly evolving, with progressive changes occurring about every 50 years, thanks to approaches to Jupiter. The most recent close approach was in 1982. With a relatively stable perihelion distance, which is slowly increasing, it is perhaps surprising that the comet was not discovered earlier. There was a favourable return in autumn 1978 when it might have reached 8^{th} magnitude and very favourable returns in the autumns of 1920, 1937 and 1957 when it might have reached 6^{th} magnitude. The fact that it was not discovered at any of these returns suggests either that the orbital evolution is slightly inaccurate, or that the absolute magnitude at the 1994 return was not typical. At present the earth passes about 0.25 AU outside the descending node and the orbital evolution will slowly decrease this distance, raising the possibility of meteor shower from the comet in a few hundred years time.

This return is moderately favourable with the comet moving rapidly eastwards through Serpens (October), Scutum and Aquila (November), Aquarius and Capricornus (December) as it brightens from 14^{th} to 7^{th} magnitude. The date of perihelion is uncertain by up to a day and more accurate ephemerides will be available when the comet is recovered. UK observers should be able to observe it from November at 10^{th} magnitude, though more southerly observers may find it a month earlier.

52P/Harrington-Abell reaches perihelion and opposition in late January. This is the seventh observed return of the comet since its discovery in 1954 and it has never became brighter than 17^{th} magnitude at previous returns. Normally it would not be expected to get brighter than 15^{th} magnitude at this return, however it was found in outburst at 12^{th} magnitude in July 1998 and was 7 magnitudes brighter than expected. It will be well placed for UK observation, and if the outburst continues it could be visible in binoculars.

A number of fainter comets may be of interest to CCD observers. These include: Meunier-Dupouy (1997 J2) (fading from 13^{m} in January), 37P/Forbes (13^{m} between April and June), 88P/Howell (fading from 13^m in January), 93P/Lovas 1 (fading from 13^m in January), 95P/Chiron (16^m at opposition in late May in Libra) and 114P/Wiseman-Skiff (brightening from 14^m in November). Ephemerides for these can be found on the CBAT WWW pages. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically.

Several other comets return to perihelion during 1999, however they are unlikely to become bright enough to observe or are poorly placed. 4P/Faye, 9P/Tempel 1, 50P/Arend, 59P/Kearns-Kwee, 63P/Wild 1, 84P/Giclas and 102P/Shoemaker 1 have unfavorable returns. Spacewatch (1997 BA6), 60P/Tsuchinshan 2, 105P/Singer Brewster, 106P/Schuster, 135P/Shoemaker-Levy 8, 136P/Mueller 3, P/Bowell-Skiff, P/Shoemaker-Levy 6, P/Ge-Wang and D/Skiff-Kosai are intrinsically faint or distant comets. D/Schorr and D/Denning have not been seen for many years and are unlikely to be recovered.

Looking ahead, 2000 sees favourable returns of comets 2P/Encke, which may reach 9th magnitude and 73P/Schwassmann-Wachmann 3. The expected magnitude of 73P is uncertain because it outburst at the last return, but it could reach 7th magnitude.

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Jonathan Shanklin

Comets reaching perihelion in 1999

Comet	T	q	P	N	H1	K1
C/LINEAR (1998 M5)	Jan 24.5	1.74			5.5	10
52P/Harrington-Abell	Jan 27.9	1.76	7.53	6	13.5	15
60P/Tsuchinshan 2	Mar 08.2	1.77	6.79	5	10.5	15
D/Skiff-Kosai (1977 C1)	Mar 09.1	2.79	7.45	1	8.5	15
102P/Shoemaker 1	Mar 15.4	1.98	7.24	2	8.0	15
136P/Mueller 3	Mar 20.5	3.01	8.71	1	11.0	10
D/Schorr (1918 W1)	Apr 03.6	2.85	8.5	1	10.0	15
105P/Singer Brewster	Apr 06.4	2.03	6.44	2	12.5	15
P/Bowell-Skiff	Apr 27.6	1.97	16.1	1	11.5	15
P/Shoemaker-Levy 6	May 02.4	1.13	7.55	1	10.5	10
37P/Forbes	May 04.2	1.45	6.13	8	10.5	10
4P/Faye	May 06.1	1.66	7.52	19	6.0	20
C/LINEAR (1998 T1)	Jun 25.6	1.48			8.0	10
P/Ge-Wang	Jun 26.9	2.50	11.2	1	11.0	10
50P/Arend	Aug 03.8	1.92	8.24	6	9.5	15
84P/Giclas	Aug 25.1	1.85	6.96	4	8.7	15
10P/Tempel 2	Sep 08.4	1.48	5.47	19	5.0	25
59P/Kerns-Kwee	Sep 16.3	2.34	9.45	4	7.5	15
D/Denning (1894 F1)	Nov 20.3	1.08	7.2	1	10.5	15
C/Spacewatch (1997 BA6)	Nov 27.7	3.44			5.0	10
P/Machholz 2	Dec 07.5	0.75	5.21	1	12.5	30
135P/Shoemaker-Levy 8	Dec 10.6	2.72	7.49	1	6.5	20
106P/Schuster	Dec 16.2	1.55	7.29	2	10.0	15
63P/Wild 1	Dec 27.4	1.96	13.2	2	10.5	15

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 are given for each comet.

Note: $m_1 = H1 + 5.0 * \log(d) + K1 * \log(r)$

Special Supplement for Southern Hemisphere Observers

Ephemeris for SOHO 1998 J1 (Southern Hemisphere, 40° South)

Note: the orbit is provisional and positions may be inaccurate by the end of this ephemeris.

```
Omega=107.6490 OMEGA=355.0210 i= 68.3460 q= 0.150150 a=**********
e=1.000000  P=*********  T= 1998 May       8.3520    Equinox= 2000
Magnitudes calculated from m= 8.0+5.0*Log(d)+10.0*Log(r)
```

May 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
21/22	5 30.0	0.51	5 32.6	0.53	4.8	0.86	0.52	13.35	17.57 to 19.08	31	74	20	217	131	43	-49
22/23	5 36.7	-1.02	5 39.2	-1.01	5.1	0.87	0.55	13.37	17.57 to 19.16	33	62	11	187	132	41	-47
23/24	5 43.1	-2.52	5 45.6	-2.51	5.3	0.87	0.58	13.40	17.56 to 19.23	35	51	4	162	134	39	-45
24/25	5 49.2	-4.37	5 51.7	-4.36	5.5	0.88	0.60	13.42	17.56 to 19.30	36	40	0	142	136	38	-43
25/26	5 55.1	-6.18	5 57.6	-6.18	5.7	0.89	0.63	13.44	17.55 to 19.36	38	32	0	124	137	36	-42
26/27	6 0.9	-7.55	6 3.3	-7.55	6.0	0.90	0.66	13.46	17.55 to 19.41	40	28	2	109	138	35	-40
27/28	6 6.4	-9.27	6 8.8	-9.28	6.2	0.92	0.68	13.47	17.54 to 19.47	41	29	6	97	139	34	-38
28/29	6 11.8	-10.56	6 14.1	-10.57	6.3	0.93	0.71	13.49	17.54 to 19.52	42	34	13	86	140	32	-36
29/30	6 17.0	-12.20	6 19.3	-12.22	6.5	0.94	0.73	13.50	17.53 to 19.56	44	42	21	76	141	31	-35
30/31	6 22.0	-13.41	6 24.3	-13.43	6.7	0.96	0.76	13.51	17.53 to 20.00	45	50	30	68	142	30	-33
31/32	6 26.9	-14.59	6 29.2	-15.01	6.9	0.97	0.78	13.52	17.53 to 20.04	46	59	40	61	142	29	-32
June 1998																
1/ 2	6 31.7	-16.12	6 33.9	-16.15	7.1	0.99	0.81	13.53	17.52 to 20.08	48	68	50	55	143	28	-30
2/ 3	6 36.4	-17.23	6 38.6	-17.26	7.2	1.00	0.83	13.54	17.52 to 20.11	49	77	59	49	144	27	-29
3/ 4	6 40.9	-18.31	6 43.1	-18.34	7.4	1.02	0.86	13.54	17.52 to 20.14	50	85	68	45	144	26	-28
4/ 5	6 45.3	-19.35	6 47.5	-19.39	7.5	1.04	0.88	13.55	17.52 to 20.16	51	93	77	40	145	26	-26
5/ 6	6 49.7	-20.37	6 51.8	-20.41	7.7	1.05	0.90	13.55	17.51 to 20.19	52	101	84	37	145	25	-25
6/ 7	6 53.9	-21.36	6 56.0	-21.40	7.8	1.07	0.93	13.55	17.51 to 20.21	53	109	91	33	146	24	-24
7/ 8	6 58.0	-22.33	7 0.1	-22.37	8.0	1.09	0.95	13.55	17.51 to 20.23	54	116	96	30	146	23	-23
8/ 9	7 2.1	-23.27	7 4.2	-23.32	8.1	1.11	0.97	13.55	17.51 to 20.24	54	123	99	28	147	23	-22
9/10	7 6.1	-24.20	7 8.1	-24.25	8.2	1.13	1.00	13.55	17.51 to 20.26	55	128	100	25	147	22	-21
10/11	7 10.0	-25.10	7 12.0	-25.15	8.4	1.14	1.02	13.55	17.51 to 20.27	56	133	100	23	147	22	-20
11/12	7 13.8	-25.58	7 15.8	-26.03	8.5	1.16	1.04	13.55	17.51 to 20.28	57	135	97	21	148	21	-20
12/13	7 17.6	-26.44	7 19.6	-26.50	8.6	1.18	1.06	13.55	17.51 to 20.29	57	135	92	20	148	20	-19
13/14	7 21.2	-27.29	7 23.3	-27.35	8.7	1.20	1.08	13.55	17.51 to 20.30	58	132	85	18	149	20	-18
14/15	7 24.9	-28.12	7 26.9	-28.18	8.9	1.22	1.11	13.55	17.51 to 20.30	58	128	76	17	149	20	-17
15/16	7 28.5	-28.53	7 30.5	-28.60	9.0	1.24	1.13	13.54	17.51 to 20.30	59	122	66	15	149	19	-17
16/17	7 32.0	-29.33	7 34.0	-29.40	9.1	1.26	1.15	13.54	17.51 to 20.31	60	114	55	14	150	19	-16
17/18	7 35.4	-30.12	7 37.4	-30.19	9.2	1.28	1.17	13.53	17.51 to 20.31	60	106	44	13	150	18	-16
18/19	7 38.9	-30.49	7 40.8	-30.56	9.3	1.30	1.19	13.53	17.51 to 20.31	61	98	32	12	150	18	-15
19/20	7 42.2	-31.25	7 44.2	-31.33	9.4	1.31	1.21	13.52	17.51 to 20.30	61	89	22	11	151	17	-15
20/21	7 45.6	-32.00	7 47.5	-32.08	9.5	1.33	1.23	13.51	17.52 to 20.30	61	80	13	11	151	17	-14
21/22	7 48.8	-32.34	7 50.8	-32.42	9.6	1.35	1.25	13.51	17.52 to 20.30	62	72	6	10	152	17	-14
22/23	7 52.1	-33.07	7 54.0	-33.15	9.7	1.37	1.27	13.50	17.52 to 20.29	62	65	1	9	152	16	-13
23/24	7 55.3	-33.39	7 57.2	-33.47	9.8	1.39	1.29	13.49	17.52 to 20.28	63	59	0	9	152	16	-13
24/25	7 58.4	-34.10	8 0.3	-34.18	9.9	1.41	1.31	13.49	17.53 to 20.28	63	55	0	8	153	16	-12
25/26	8 1.5	-34.40	8 3.4	-34.49	10.0	1.43	1.33	13.48	17.53 to 20.27	63	52	4	8	153	16	-12
26/27	8 4.6	-35.10	8 6.5	-35.18	10.1	1.45	1.35	13.47	17.53 to 20.26	64	52	9	7	153	15	-12
27/28	8 7.7	-35.38	8 9.6	-35.47	10.2	1.47	1.37	13.46	17.54 to 20.25	64	53	16	7	154	15	-11
28/29	8 10.7	-36.06	8 12.6	-36.15	10.3	1.49	1.39	13.45	17.54 to 20.23	64	57	24	6	154	15	-11
29/30	8 13.7	-36.33	8 15.6	-36.43	10.4	1.51	1.41	13.44	17.54 to 20.22	64	61	33	6	154	14	-11
30/31	8 16.6	-36.60	8 18.5	-37.09	10.5	1.53	1.43	13.43	17.55 to 20.21	65	66	43	6	155	14	-11
July 1998																
1/ 2	8 19.6	-37.26	8 21.4	-37.35	10.6	1.55	1.45	13.42	17.55 to 20.19	65	71	52	5	155	14	-10
2/ 3	8 22.5	-37.51	8 24.3	-38.01	10.6	1.57	1.47	13.41	17.56 to 20.18	65	77	62	5	155	14	-10
3/ 4	8 25.3	-38.16	8 27.2	-38.26	10.7	1.59	1.49	13.40	17.56 to 20.16	65	83	71	5	156	14	-10
4/ 5	8 28.2	-38.40	8 30.0	-38.50	10.8	1.61	1.51	13.39	17.57 to 20.14	65	90	79	4	156	13	-10
5/ 6	8 31.0	-39.04	8 32.8	-39.14	10.9	1.63	1.52	13.38	17.57 to 20.13	66	96	87	4	156	13	-9
6/ 7	8 33.8	-39.27	8 35.6	-39.38	11.0	1.65	1.54	13.37	17.58 to 20.11	66	103	93	4	157	13	-9
7/ 8	8 36.6	-39.50	8 38.4	-40.01	11.1	1.67	1.56	13.35	17.58 to 20.09	66	109	97	4	157	13	-9
8/ 9	8 39.3	-40.13	8 41.2	-40.23	11.1	1.69	1.58	13.34	17.59 to 20.07	66	114	100	4	157	13	-9
9/10	8 42.1	-40.35	8 43.9	-40.45	11.2	1.71	1.60	13.33	17.59 to 20.05	66	119	100	3	158	12	-9
10/11	8 44.8	-40.56	8 46.6	-41.07	11.3	1.73	1.62	13.32	17.60 to 20.03	66	122	98	3	158	12	-9
11/12	8 47.4	-41.17	8 49.3	-41.29	11.4	1.75	1.64	13.30	18.00 to 20.01	66	124	94	3	159	12	-8
12/13	8 50.1	-41.38	8 52.0	-41.50	11.4	1.77	1.65	13.29	18.01 to 19.59	67	124	87	3	159	12	-8
13/14	8 52.8	-41.59	8 54.6	-42.10	11.5	1.79	1.67	13.28	18.02 to 19.56	67	122	79	3	159	12	-8
14/15	8 55.4	-42.19	8 57.2	-42.31	11.6	1.81	1.69	13.27	18.02 to 19.54	67	118	69	3	160	12	-8
15/16	8 58.0	-42.39	8 59.8	-42.51	11.6	1.83	1.71	13.25	18.03 to 19.52	67	113	57	3	160	12	-8
16/17	9 0.6	-42.59	9 2.5	-43.11	11.7	1.85	1.72	13.24	18.03 to 19.49	67	107	46	2	160	11	-8
17/18	9 3.2	-43.18	9 5.0	-43.30	11.8	1.87	1.74	13.23	18.04 to 19.47	67	100	34	2	161	11	-8
18/19	9 5.8	-43.37	9 7.6	-43.49	11.8	1.89	1.76	13.21	18.05 to 19.44	67	93	24	2	161	11	-7
19/20	9 8.3	-43.56	9 10.2	-44.08	11.9	1.91	1.78	13.20	18.05 to 19.42	67	86	15	2	161	11	-7
20/21	9 10.9	-44.15	9 12.7	-44.27	12.0	1.93	1.80	13.18	18.06 to 19.39	67	79	8	2	162	11	-7
21/22	9 13.4	-44.33	9 15.2	-44.46	12.0	1.95	1.81	13.17	18.07 to 19.37	67	73	3	2	162	11	-7
22/23	9 15.9	-44.51	9 17.7	-45.04	12.1	1.97	1.83	13.16	18.08 to 19.34	67	67	0	2	162	11	-7
23/24	9 18.4	-45.09	9 20.2	-45.22	12.2	1.99	1.85	13.14	18.08 to 19.31	67	63	0	2	163	11	-7
24/25	9 20.9	-45.27	9 22.7	-45.40	12.2	2.01	1.86	13.13	18.09 to 19.28	67	59	2	2	163	10	-7
25/26	9 23.4	-45.45	9 25.2	-45.58	12.3	2.03	1.88	13.11	18.10 to 19.26	67	58	6	2	163	10	-7
26/27	9 25.8	-46.02	9 27.7	-46.16	12.3	2.05	1.90	13.10	18.10 to 19.23	67	58	12	2	164	10	-7
27/28	9 28.3	-46.20	9 30.1	-46.33	12.4	2.07	1.91	13.08	18.11 to 19.20	67	59	19	1	164	10	-7
28/29	9 30.7	-46.37	9 32.6	-46.50	12.5	2.09	1.93	13.07	18.12 to 19.17	67	61	27	1	165	10	-7
29/30	9 33.2	-46.54	9 35.0	-47.07	12.5	2.11	1.95	13.05	18.13 to 19.14	67	65	36	1	165	10	-7
30/31	9 35.6	-47.11	9 37.4	-47.24	12.6	2.13	1.97	13.04	18.14 to 19.11	67	69	45	1	165	10	-7
31/32	9 38.0	-47.27	9 39.8	-47.41	12.6	2.15	1.98	13.02	18.14 to 19.08	67	74	55	1	166	10	-6

August	1998															
1/ 2	9 40.4	-47.44	9 42.2	-47.58	12.7	2.16	2.00	13.01	18.15 to 19.05	67	79	64	1	166	10	-6
2/ 3	9 42.8	-48.00	9 44.6	-48.14	12.7	2.18	2.02	12.59	18.16 to 19.02	67	85	74	1	166	9	-6
3/ 4	9 45.2	-48.16	9 47.0	-48.30	12.8	2.20	2.03	12.58	18.17 to 18.59	67	91	82	1	167	9	-6
4/ 5	9 47.5	-48.33	9 49.4	-48.47	12.8	2.22	2.05	12.56	18.17 to 18.56	67	98	89	1	167	9	-6
5/ 6	9 49.9	-48.49	9 51.8	-49.03	12.9	2.24	2.06	12.54	18.18 to 18.53	67	104	95	1	167	9	-6
6/ 7	9 52.3	-49.05	9 54.1	-49.19	13.0	2.26	2.08	12.53	18.19 to 18.49	67	110	99	1	168	9	-6
7/ 8	9 54.6	-49.20	9 56.5	-49.35	13.0	2.28	2.10	12.51	18.20 to 18.46	67	115	100	1	168	9	-6
8/ 9	9 56.9	-49.36	9 58.8	-49.50	13.1	2.30	2.11	12.50	18.21 to 18.43	67	119	99	1	168	9	-6
9/10	9 59.3	-49.52	10 1.2	-50.06	13.1	2.32	2.13	12.48	18.21 to 18.40	66	121	96	1	169	9	-6
10/11	10 1.6	-50.07	10 3.5	-50.22	13.2	2.34	2.15	12.46	18.22 to 18.36	66	122	89	1	169	9	-6
11/12	10 3.9	-50.23	10 5.8	-50.37	13.2	2.36	2.16	12.45	18.23 to 18.33	66	120	81	1	170	9	-6
12/13	10 6.2	-50.38	10 8.2	-50.53	13.3	2.38	2.18	12.43	18.24 to 18.30	66	117	71	1	170	9	-6
13/14	10 8.5	-50.53	10 10.5	-51.08	13.3	2.40	2.19	12.42	18.25 to 18.26	66	112	60	1	170	9	-6
14/15	10 10.8	-51.08	10 12.8	-51.23	13.4	2.42	2.21	12.40	Not Observable	66	107	48	1	171	9	-6
15/16	10 13.1	-51.23	10 15.1	-51.38	13.4	2.44	2.22	12.38	Not Observable	66	100	37	1	171	8	-6
16/17	10 15.4	-51.39	10 17.4	-51.54	13.5	2.46	2.24	12.37	Not Observable	66	94	26	1	171	8	-6
17/18	10 17.7	-51.53	10 19.7	-52.09	13.5	2.47	2.26	12.35	Not Observable	66	87	17	1	172	8	-6
18/19	10 20.0	-52.08	10 22.0	-52.24	13.5	2.49	2.27	12.33	Not Observable	66	81	10	1	172	8	-6
19/20	10 22.3	-52.23	10 24.3	-52.38	13.6	2.51	2.29	12.32	Not Observable	65	75	4	1	172	8	-6
20/21	10 24.6	-52.38	10 26.5	-52.53	13.6	2.53	2.30	12.30	Not Observable	65	69	1	1	173	8	-6
21/22	10 26.8	-52.53	10 28.8	-53.08	13.7	2.55	2.32	12.28	Not Observable	65	65	0	1	173	8	-6
22/23	10 29.1	-53.07	10 31.1	-53.23	13.7	2.57	2.33	12.27	Not Observable	65	62	0	1	174	8	-6
23/24	10 31.4	-53.22	10 33.4	-53.37	13.8	2.59	2.35	12.25	Not Observable	65	60	3	1	174	8	-6
24/25	10 33.6	-53.36	10 35.6	-53.52	13.8	2.61	2.36	12.23	Not Observable	65	59	8	1	174	8	-6
25/26	10 35.9	-53.51	10 37.9	-54.07	13.9	2.63	2.38	12.22	Not Observable	65	59	14	1	175	8	-6
26/27	10 38.1	-54.05	10 40.2	-54.21	13.9	2.65	2.39	12.20	Not Observable	65	61	21	1	175	8	-6
27/28	10 40.4	-54.20	10 42.4	-54.35	13.9	2.66	2.41	12.18	Not Observable	65	64	29	0	175	8	-5
28/29	10 42.6	-54.34	10 44.7	-54.50	14.0	2.68	2.43	12.17	Not Observable	64	68	38	0	176	8	-5
29/30	10 44.9	-54.48	10 46.9	-55.04	14.0	2.70	2.44	12.15	Not Observable	64	73	48	0	176	8	-5
30/31	10 47.1	-55.03	10 49.2	-55.19	14.1	2.72	2.46	12.13	Not Observable	64	78	58	0	177	8	-5
31/32	10 49.4	-55.17	10 51.4	-55.33	14.1	2.74	2.47	12.12	Not Observable	64	84	68	0	177	7	-5

Introduction

This issue has ephemerides for comets:

- 10P/Tempel 2 (UK)
- 21P/Giacobini-Zinner (UK & Southern Hemisphere)
- 29P/Schwassmann-Wachmann 1 (Southern Hemisphere)
- 37P/Forbes (Southern Hemisphere)
- 52P/Harrington-Abell
- 88P/Howell (Equator)
- 93P/Lovas 1 (UK)
- C/Hale-Bopp (1995 O1) (Southern Hemisphere)
- C/Meunier-Dupouy (1997 J2) (Equator)
- C/LINEAR (1998 M5) (UK)
- C/Williams (1998 P1) (UK)

Current ephemerides are also available on the Section web page.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for 10P/Tempel 2 (UK)

```
Omega=195.0229 OMEGA=118.2114 i= 11.9766 q= 1.481680 a=  3.105056
e=0.522817  P=     5.471  T= 1999 September  8.4206     Equinox= 2000
Magnitudes calculated from m= 5.0+5.0*Log(d)+25.0*Log(r)
```

April 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	17 6.1	-7.06	17 8.8	-7.10	14.0	1.50	2.12	4.29	Not Observable	114	53	99	0	268	6	1
6/ 7	17 11.0	-6.48	17 13.6	-6.51	13.8	1.43	2.09	4.14	Not Observable	118	13	70	1	266	6	1
11/12	17 15.3	-6.28	17 18.0	-6.31	13.5	1.35	2.06	3.59	Not Observable	121	68	22	1	264	5	1
16/17	17 19.2	-6.07	17 21.9	-6.10	13.2	1.28	2.03	3.43	Not Observable	125	138	1	1	262	4	1
21/22	17 22.5	-5.46	17 25.2	-5.49	12.9	1.21	2.00	3.27	2.21 to 3.12	128	146	41	1	259	4	1
26/27	17 25.2	-5.26	17 27.8	-5.28	12.7	1.15	1.97	3.10	1.28 to 2.58	132	84	89	1	257	3	1

Ephemeris for 21P/Giacobini-Zinner (UK)

```
Omega=172.5433 OMEGA=195.3985 i= 31.8587 q= 1.033713 a=  3.521816
e=0.706483  P=     6.609  T= 1998 November  21.3169     Equinox= 2000
Magnitudes calculated from m= 9.0+5.0*Log(d)+15.5*Log(r)
```

October 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
26/27	18 36.2	-1.18	18 38.8	-1.15	9.5	0.94	1.09	16.18	18.04 to 20.41	69	19	35	12	77	22	-12
27/28	18 39.9	-1.47	18 42.5	-1.44	9.4	0.94	1.09	16.18	18.02 to 20.39	69	25	45	12	77	23	-12
28/29	18 43.7	-2.17	18 46.3	-2.13	9.4	0.93	1.09	16.18	17.60 to 20.37	69	35	56	12	77	23	-12
29/30	18 47.5	-2.46	18 50.1	-2.43	9.4	0.93	1.08	16.18	17.58 to 20.34	68	46	66	13	76	23	-12
30/31	18 51.4	-3.16	18 54.0	-3.12	9.3	0.92	1.08	16.18	17.56 to 20.32	68	58	76	13	76	24	-12
31/32	18 55.4	-3.46	18 58.0	-3.42	9.3	0.92	1.07	16.18	17.55 to 20.30	68	70	86	13	76	24	-12
November 1998																
1/ 2	18 59.4	-4.17	19 2.0	-4.12	9.3	0.91	1.07	16.18	17.53 to 20.28	68	84	93	13	76	25	-12
2/ 3	19 3.5	-4.47	19 6.1	-4.43	9.2	0.91	1.07	16.18	17.51 to 20.25	68	97	98	14	76	25	-12
3/ 4	19 7.6	-5.18	19 10.2	-5.13	9.2	0.90	1.06	16.18	17.50 to 20.23	68	111	100	14	76	25	-12
4/ 5	19 11.8	-5.49	19 14.4	-5.44	9.2	0.90	1.06	16.18	17.48 to 20.21	68	125	100	14	76	26	-12

5/ 6	19 16.0	-6.20	19 18.7	-6.14	9.1	0.89	1.06	16.19	17.46 to 20.18	68	138	96	14	75	26	-12
6/ 7	19 20.3	-6.51	19 23.0	-6.45	9.1	0.89	1.05	16.19	17.45 to 20.16	68	151	89	15	75	26	-12
7/ 8	19 24.7	-7.22	19 27.4	-7.16	9.1	0.89	1.05	16.19	17.43 to 20.14	68	163	81	15	75	27	-12
8/ 9	19 29.1	-7.53	19 31.8	-7.47	9.0	0.88	1.05	16.20	17.42 to 20.11	68	169	71	15	75	27	-12
9/10	19 33.6	-8.24	19 36.3	-8.17	9.0	0.88	1.05	16.20	17.40 to 20.09	68	164	61	15	75	27	-13
10/11	19 38.1	-8.56	19 40.9	-8.48	9.0	0.88	1.04	16.21	17.39 to 20.07	68	154	50	16	75	28	-13
11/12	19 42.7	-9.27	19 45.5	-9.19	9.0	0.87	1.04	16.22	17.38 to 20.04	68	143	40	16	75	28	-12
12/13	19 47.4	-9.58	19 50.1	-9.50	9.0	0.87	1.04	16.22	17.36 to 20.02	68	133	31	16	75	28	-12
13/14	19 52.1	-10.29	19 54.8	-10.21	8.9	0.87	1.04	16.23	17.35 to 19.59	68	122	22	16	75	28	-12
14/15	19 56.9	-10.60	19 59.6	-10.52	8.9	0.87	1.04	16.24	17.34 to 19.57	68	111	15	16	74	29	-12
15/16	20 1.7	-11.31	20 4.4	-11.22	8.9	0.86	1.04	16.25	17.33 to 19.54	68	101	8	16	74	29	-12
16/17	20 6.6	-12.01	20 9.3	-11.52	8.9	0.86	1.04	16.26	17.31 to 19.52	68	90	4	17	74	29	-12
17/18	20 11.5	-12.32	20 14.3	-12.23	8.9	0.86	1.03	16.27	17.30 to 19.49	68	79	1	17	74	30	-12
18/19	20 16.5	-13.02	20 19.2	-12.53	8.9	0.86	1.03	16.28	17.29 to 19.47	68	69	0	17	74	30	-12
19/20	20 21.5	-13.32	20 24.3	-13.22	8.9	0.86	1.03	16.29	17.28 to 19.44	68	58	0	17	74	30	-12
20/21	20 26.6	-14.02	20 29.4	-13.51	8.9	0.85	1.03	16.30	17.27 to 19.41	68	47	3	17	74	30	-12
21/22	20 31.7	-14.31	20 34.5	-14.20	8.9	0.85	1.03	16.31	17.26 to 19.39	68	36	7	17	74	31	-12
22/23	20 36.9	-14.60	20 39.7	-14.49	8.9	0.85	1.03	16.33	17.25 to 19.36	68	25	13	17	74	31	-12
23/24	20 42.1	-15.28	20 44.9	-15.17	8.9	0.85	1.03	16.34	17.24 to 19.33	68	13	20	17	74	31	-11
24/25	20 47.3	-15.56	20 50.1	-15.45	8.9	0.85	1.04	16.35	17.24 to 19.30	68	2	29	17	74	31	-11
25/26	20 52.6	-16.24	20 55.4	-16.12	8.9	0.85	1.04	16.36	17.23 to 19.28	68	10	39	17	74	31	-11
26/27	20 58.0	-16.51	21 0.8	-16.39	8.9	0.85	1.04	16.38	17.22 to 19.25	68	22	50	17	73	31	-11
27/28	21 3.3	-17.17	21 6.1	-17.05	8.9	0.85	1.04	16.39	17.21 to 19.22	68	35	61	17	73	32	-10
28/29	21 8.7	-17.43	21 11.5	-17.30	8.9	0.85	1.04	16.41	17.21 to 19.19	68	48	72	17	73	32	-10
29/30	21 14.2	-18.08	21 17.0	-17.55	8.9	0.85	1.04	16.42	17.20 to 19.16	69	61	82	16	73	32	-10
30/31	21 19.6	-18.32	21 22.4	-18.20	8.9	0.85	1.04	16.44	17.20 to 19.13	69	75	90	16	73	32	-10
December 1998																
1/ 2	21 25.1	-18.56	21 27.9	-18.43	8.9	0.85	1.04	16.45	17.19 to 19.10	69	88	96	16	73	32	-9
2/ 3	21 30.6	-19.19	21 33.4	-19.06	9.0	0.85	1.05	16.47	17.19 to 19.06	69	102	100	16	73	32	-9
3/ 4	21 36.1	-19.42	21 38.9	-19.28	9.0	0.86	1.05	16.48	17.18 to 19.03	69	116	100	16	73	32	-9
4/ 5	21 41.7	-20.03	21 44.5	-19.49	9.0	0.86	1.05	16.50	17.18 to 18.60	69	130	98	15	73	32	-8
5/ 6	21 47.2	-20.24	21 50.0	-20.10	9.0	0.86	1.05	16.52	17.18 to 18.56	69	143	93	15	73	32	-8
6/ 7	21 52.8	-20.44	21 55.6	-20.30	9.1	0.86	1.06	16.53	17.17 to 18.53	69	155	86	15	73	32	-8
7/ 8	21 58.3	-21.03	22 1.1	-20.48	9.1	0.86	1.06	16.55	17.17 to 18.49	70	166	77	15	73	32	-7
8/ 9	22 3.9	-21.21	22 6.7	-21.06	9.1	0.87	1.06	16.56	17.17 to 18.45	70	171	67	15	73	32	-7
9/10	22 9.5	-21.38	22 12.2	-21.24	9.1	0.87	1.07	16.58	17.17 to 18.41	70	165	58	14	72	32	-7
10/11	22 15.1	-21.55	22 17.8	-21.40	9.2	0.87	1.07	16.60	17.17 to 18.37	70	155	48	14	72	32	-6
11/12	22 20.6	-22.10	22 23.4	-21.55	9.2	0.88	1.07	17.01	17.17 to 18.33	70	145	38	14	72	32	-6
12/13	22 26.2	-22.25	22 28.9	-22.10	9.2	0.88	1.08	17.03	17.17 to 18.28	70	134	29	13	72	32	-6
13/14	22 31.7	-22.39	22 34.5	-22.23	9.3	0.88	1.08	17.05	17.17 to 18.23	71	124	21	13	72	32	-5
14/15	22 37.3	-22.52	22 40.0	-22.36	9.3	0.89	1.09	17.06	17.17 to 18.18	71	114	13	13	72	31	-5
15/16	22 42.8	-23.03	22 45.5	-22.48	9.3	0.89	1.09	17.08	17.17 to 18.12	71	103	8	12	72	31	-4
16/17	22 48.3	-23.14	22 51.0	-22.58	9.4	0.90	1.10	17.09	17.18 to 18.06	71	93	3	12	72	31	-4
17/18	22 53.8	-23.24	22 56.5	-23.08	9.4	0.90	1.10	17.11	17.18 to 17.59	71	82	0	12	72	31	-4
18/19	22 59.2	-23.34	23 1.9	-23.17	9.5	0.91	1.10	17.12	17.18 to 17.50	71	71	0	12	72	31	-3
19/20	23 4.6	-23.42	23 7.3	-23.25	9.5	0.91	1.11	17.14	17.19 to 17.37	72	61	1	11	72	31	-3
20/21	23 10.0	-23.49	23 12.7	-23.33	9.5	0.92	1.12	17.15	Not Observable	72	50	4	11	72	30	-3
21/22	23 15.4	-23.55	23 18.1	-23.39	9.6	0.92	1.12	17.17	Not Observable	72	39	9	11	72	30	-2
22/23	23 20.7	-24.01	23 23.4	-23.44	9.6	0.93	1.13	17.18	Not Observable	72	29	16	10	72	30	-2
23/24	23 26.0	-24.06	23 28.7	-23.49	9.7	0.94	1.13	17.19	Not Observable	72	21	24	10	72	30	-1
24/25	23 31.3	-24.09	23 33.9	-23.53	9.7	0.94	1.14	17.21	Not Observable	72	17	34	10	72	29	-1
25/26	23 36.5	-24.12	23 39.1	-23.56	9.8	0.95	1.14	17.22	Not Observable	72	21	45	9	72	29	-1
26/27	23 41.7	-24.15	23 44.3	-23.58	9.8	0.96	1.15	17.23	Not Observable	73	30	57	9	72	29	0
27/28	23 46.8	-24.16	23 49.4	-23.59	9.9	0.96	1.15	17.24	Not Observable	73	42	68	9	72	29	0
28/29	23 51.9	-24.17	23 54.5	-23.60	9.9	0.97	1.16	17.25	Not Observable	73	54	78	9	72	29	0
29/30	23 57.0	-24.16	23 59.5	-23.60	10.0	0.98	1.17	17.27	Not Observable	73	66	87	8	72	28	0
30/31	0 2.0	-24.16	0 4.5	-23.59	10.0	0.98	1.17	17.28	Not Observable	73	79	94	8	72-	28	0
31/32	0 6.9	-24.14	0 9.5	-23.57	10.1	0.99	1.18	17.29	Not Observable	73	92	99	8	72	28	0

Ephemeris for 21P/Giacobini-Zinner (Southern Hemisphere, 40° South)

November 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	18 59.4	-4.17	19 2.0	-4.12	9.3	0.91	1.07	16.18	19.50 to 21.26	68	84	93	13	76	25	-12
2/ 3	19 3.5	-4.47	19 6.1	-4.43	9.2	0.91	1.07	16.18	19.51 to 21.28	68	97	98	14	76	25	-12
3/ 4	19 7.6	-5.18	19 10.2	-5.13	9.2	0.90	1.06	16.18	19.52 to 21.30	68	111	100	14	76	25	-12
4/ 5	19 11.8	-5.49	19 14.4	-5.44	9.2	0.90	1.06	16.18	19.54 to 21.33	68	125	100	14	76	26	-12
5/ 6	19 16.0	-6.20	19 18.7	-6.14	9.1	0.89	1.06	16.19	19.55 to 21.35	68	138	96	14	75	26	-12
6/ 7	19 20.3	-6.51	19 23.0	-6.45	9.1	0.89	1.05	16.19	19.57 to 21.38	68	151	89	15	75	26	-12
7/ 8	19 24.7	-7.22	19 27.4	-7.16	9.1	0.89	1.05	16.19	19.58 to 21.40	68	163	81	15	75	27	-12
8/ 9	19 29.1	-7.53	19 31.8	-7.47	9.0	0.88	1.05	16.20	19.60 to 21.43	68	169	71	15	75	27	-12
9/10	19 33.6	-8.24	19 36.3	-8.17	9.0	0.88	1.05	16.20	20.01 to 21.45	68	164	61	15	75	27	-13
10/11	19 38.1	-8.56	19 40.9	-8.48	9.0	0.88	1.04	16.21	20.03 to 21.48	68	154	50	16	75	28	-13
11/12	19 42.7	-9.27	19 45.5	-9.19	9.0	0.87	1.04	16.22	20.04 to 21.51	68	143	40	16	75	28	-12
12/13	19 47.4	-9.58	19 50.1	-9.50	9.0	0.87	1.04	16.22	20.06 to 21.53	68	133	31	16	75	28	-12
13/14	19 52.1	-10.29	19 54.8	-10.21	8.9	0.87	1.04	16.23	20.07 to 21.56	68	122	22	16	75	28	-12
14/15	19 56.9	-10.60	19 59.6	-10.52	8.9	0.87	1.04	16.24	20.09 to 21.59	68	111	15	16	74	29	-12
15/16	20 1.7	-11.31	20 4.4	-11.22	8.9	0.86	1.04	16.25	20.10 to 22.02	68	101	8	16	74	29	-12
16/17	20 6.6	-12.01	20 9.3	-11.52	8.9	0.86	1.04	16.26	20.12 to 22.04	68	90	4	17	74	29	-12
17/18	20 11.5	-12.32	20 14.3	-12.23	8.9	0.86	1.03	16.27	20.13 to 22.07	68	79	1	17	74	30	-12
18/19	20 16.5	-13.02	20 19.2	-12.53	8.9	0.86	1.03	16.28	20.14 to 22.10	68	69	0	17	74	30	-12
19/20	20 21.5	-13.32	20 24.3	-13.22	8.9	0.86	1.03	16.29	20.16 to 22.13	68	58	0	17	74	30	-12
20/21	20 26.6	-14.02	20 29.4	-13.51	8.9	0.85	1.03	16.30	20.17 to 22.16	68	47	3	17	74	30	-12
21/22	20 31.7	-14.31	20 34.5	-14.20	8.9	0.85	1.03	16.31	20.19 to 22.18	68	36	7	17	74	31	-12
22/23	20 36.9	-14.60	20 39.7	-14.49	8.9	0.85	1.03	16.33	20.20 to 22.21	68	25	13	17	74	31	-12
23/24	20 42.1	-15.28	20 44.9	-15.17	8.9	0.85	1.03	16.34	20.22 to 22.24	68	13	20	17	74	31	-11
24/25	20 47.3	-15.56	20 50.1	-15.45	8.9	0.85	1.04	16.35	20.23 to 22.27	68	2	29	17	74	31	-11
25/26	20 52.6	-16.24	20 55.4	-16.12	8.9	0.85	1.04	16.36	20.24 to 22.30	68	10	39	17	74	31	-11
26/27	20 58.0	-16.51	21 0.8	-16.39	8.9	0.85	1.04	16.38	20.26 to 22.32	68	22	50	17	73	31	-11
27/28	21 3.3	-17.17	21 6.1	-17.05	8.9	0.85	1.04	16.39	20.27 to 22.35	68	35	61	17	73	32	-10
28/29	21 8.7	-17.43	21 11.5	-17.30	8.9	0.85	1.04	16.41	20.29 to 22.38	68	48	72	17	73	32	-10
29/30	21 14.2	-18.08	21 17.0	-17.55	8.9	0.85	1.04	16.42	20.30 to 22.41	69	61	82	16	73	32	-10
30/31	21 19.6	-18.32	21 22.4	-18.20	8.9	0.85	1.04	16.44	20.31 to 22.43	69	75	90	16	73	32	-10
December 1998																
1/ 2	21 25.1	-18.56	21 27.9	-18.43	8.9	0.85	1.04	16.45	20.32 to 22.46	69	88	96	16	73	32	-9
2/ 3	21 30.6	-19.19	21 33.4	-19.06	9.0	0.85	1.05	16.47	20.34 to 22.49	69	102	100	16	73	32	-9
3/ 4	21 36.1	-19.42	21 38.9	-19.28	9.0	0.86	1.05	16.48	20.35 to 22.51	69	116	100	16	73	32	-9
4/ 5	21 41.7	-20.03	21 44.5	-19.49	9.0	0.86	1.05	16.50	20.36 to 22.54	69	130	98	15	73	32	-8
5/ 6	21 47.2	-20.24	21 50.0	-20.10	9.0	0.86	1.05	16.52	20.37 to 22.56	69	143	93	15	73	32	-8
6/ 7	21 52.8	-20.44	21 55.6	-20.30	9.1	0.86	1.06	16.53	20.38 to 22.58	69	155	86	15	73	32	-8
7/ 8	21 58.3	-21.03	22 1.1	-20.48	9.1	0.86	1.06	16.55	20.39 to 23.01	70	166	77	15	73	32	-7

8/ 9	22 3.9	-21.21	22 6.7	-21.06	9.1	0.87	1.06	16.56	20.41 to 23.03	70	171	67	15	73	32	-7
9/10	22 9.5	-21.38	22 12.2	-21.24	9.1	0.87	1.07	16.58	20.42 to 23.05	70	165	58	14	72	32	-7
10/11	22 15.1	-21.55	22 17.8	-21.40	9.2	0.87	1.07	16.60	20.43 to 23.07	70	155	48	14	72	32	-6
11/12	22 20.6	-22.10	22 23.4	-21.55	9.2	0.88	1.07	17.01	20.44 to 23.09	70	145	38	14	72	32	-6
12/13	22 26.2	-22.25	22 28.9	-22.10	9.2	0.88	1.08	17.03	20.44 to 23.11	70	134	29	13	72	32	-6
13/14	22 31.7	-22.39	22 34.5	-22.23	9.3	0.88	1.08	17.05	20.45 to 23.13	71	124	21	13	72	32	-5
14/15	22 37.3	-22.52	22 40.0	-22.36	9.3	0.89	1.09	17.06	20.46 to 23.14	71	114	13	13	72	31	-5
15/16	22 42.8	-23.03	22 45.5	-22.48	9.3	0.89	1.09	17.08	20.47 to 23.16	71	103	8	12	72	31	-4
16/17	22 48.3	-23.14	22 51.0	-22.58	9.4	0.90	1.10	17.09	20.48 to 23.18	71	93	3	12	72	31	-4
17/18	22 53.8	-23.24	22 56.5	-23.08	9.4	0.90	1.10	17.11	20.48 to 23.19	71	82	0	12	72	31	-4
18/19	22 59.2	-23.34	23 1.9	-23.17	9.5	0.91	1.10	17.12	20.49 to 23.20	71	71	0	12	72	31	-3
19/20	23 4.6	-23.42	23 7.3	-23.25	9.5	0.91	1.11	17.14	20.50 to 23.22	72	61	1	11	72	31	-3
20/21	23 10.0	-23.49	23 12.7	-23.33	9.5	0.92	1.12	17.15	20.50 to 23.23	72	50	4	11	72	30	-3
21/22	23 15.4	-23.55	23 18.1	-23.39	9.6	0.92	1.12	17.17	20.51 to 23.24	72	39	9	11	72	30	-2
22/23	23 20.7	-24.01	23 23.4	-23.44	9.6	0.93	1.13	17.18	20.51 to 23.24	72	29	16	10	72	30	-2
23/24	23 26.0	-24.06	23 28.7	-23.49	9.7	0.94	1.13	17.19	20.52 to 23.25	72	21	24	10	72	30	-1
24/25	23 31.3	-24.09	23 33.9	-23.53	9.7	0.94	1.14	17.21	20.52 to 23.26	72	17	34	10	72	29	-1
25/26	23 36.5	-24.12	23 39.1	-23.56	9.8	0.95	1.14	17.22	20.52 to 23.26	72	21	45	9	72	29	-1
26/27	23 41.7	-24.15	23 44.3	-23.58	9.8	0.96	1.15	17.23	20.53 to 23.27	73	30	57	9	72	29	0
27/28	23 46.8	-24.16	23 49.4	-23.59	9.9	0.96	1.15	17.24	20.53 to 23.27	73	42	68	9	72	29	0
28/29	23 51.9	-24.17	23 54.5	-23.60	9.9	0.97	1.16	17.25	20.53 to 23.27	73	54	78	9	72	29	0
29/30	23 57.0	-24.16	23 59.5	-23.60	10.0	0.98	1.17	17.27	20.53 to 23.28	73	66	87	8	72	28	0
30/31	0 2.0	-24.16	0 4.5	-23.59	10.0	0.98	1.17	17.28	20.53 to 23.28	73	79	94	8	72-	28	0
31/32	0 6.9	-24.14	0 9.5	-23.57	10.1	0.99	1.18	17.29	20.53 to 23.27	73	92	99	8	72	28	0
January 1999																
1/ 2	0 11.8	-24.12	0 14.3	-23.55	10.1	1.00	1.19	17.30	20.53 to 23.27	74	104	100	7	72	27	0
2/ 3	0 16.7	-24.09	0 19.2	-23.52	10.2	1.01	1.19	17.30	20.53 to 23.27	74	116	99	7	72	27	1
3/ 4	0 21.5	-24.05	0 24.0	-23.48	10.3	1.01	1.20	17.31	20.53 to 23.26	74	128	96	7	72	27	1
4/ 5	0 26.2	-24.01	0 28.7	-23.44	10.3	1.02	1.21	17.32	20.53 to 23.26	74	138	90	7	72	27	1
5/ 6	0 30.9	-23.56	0 33.4	-23.39	10.4	1.03	1.21	17.33	20.53 to 23.25	74	148	83	6	72	26	2
6/ 7	0 35.6	-23.50	0 38.1	-23.34	10.4	1.04	1.22	17.34	20.52 to 23.24	74	155	75	6	72	26	2
7/ 8	0 40.2	-23.44	0 42.7	-23.28	10.5	1.05	1.23	17.34	20.52 to 23.23	74	157	65	6	72	26	2
8/ 9	0 44.8	-23.38	0 47.2	-23.21	10.5	1.06	1.24	17.35	20.52 to 23.23	74	155	56	6	72	26	2
9/10	0 49.3	-23.30	0 51.7	-23.14	10.6	1.06	1.24	17.35	20.51 to 23.21	75	150	46	6	72	25	2
10/11	0 53.7	-23.23	0 56.2	-23.07	10.7	1.07	1.25	17.36	20.51 to 23.20	75	142	37	5	72	25	3
11/12	0 58.1	-23.15	1 0.6	-22.59	10.7	1.08	1.26	17.36	20.50 to 23.19	75	133	28	5	72	25	3
12/13	1 2.5	-23.06	1 4.9	-22.50	10.8	1.09	1.26	17.37	20.50 to 23.18	75	124	20	5	73	25	3
13/14	1 6.8	-22.57	1 9.2	-22.41	10.8	1.10	1.27	17.37	20.49 to 23.16	75	114	13	5	73	24	3
14/15	1 11.0	-22.48	1 13.4	-22.32	10.9	1.11	1.28	17.37	20.49 to 23.15	75	104	7	5	73	24	3
15/16	1 15.2	-22.38	1 17.7	-22.22	11.0	1.12	1.29	17.38	20.48 to 23.13	75	93	2	4	73	24	4
16/17	1 19.4	-22.28	1 21.8	-22.12	11.0	1.13	1.30	17.38	20.47 to 23.11	75	83	0	4	73	24	4
17/18	1 23.5	-22.17	1 25.9	-22.01	11.1	1.14	1.30	17.38	20.46 to 23.09	75	72	0	4	73	23	4
18/19	1 27.6	-22.06	1 30.0	-21.51	11.1	1.15	1.31	17.38	20.46 to 23.08	75	61	2	4	73	23	4
19/20	1 31.6	-21.55	1 34.0	-21.39	11.2	1.16	1.32	17.38	20.45 to 23.06	75	51	6	4	74	23	4
20/21	1 35.6	-21.43	1 38.0	-21.28	11.3	1.17	1.33	17.38	20.44 to 23.04	76	41	12	4	74	23	4
21/22	1 39.5	-21.31	1 41.9	-21.16	11.3	1.18	1.34	17.38	20.43 to 23.01	76	32	20	3	74	22	4
22/23	1 43.4	-21.19	1 45.8	-21.04	11.4	1.19	1.34	17.38	20.42 to 22.59	76	26	30	3	74	22	5
23/24	1 47.2	-21.07	1 49.6	-20.52	11.4	1.20	1.35	17.38	20.41 to 22.57	76	26	41	3	74	22	5
24/25	1 51.0	-20.54	1 53.4	-20.39	11.5	1.21	1.36	17.38	20.40 to 22.55	76	31	53	3	75	22	5
25/26	1 54.8	-20.41	1 57.1	-20.27	11.6	1.22	1.37	17.38	20.39 to 22.52	76	40	64	3	75	21	5
26/27	1 58.5	-20.28	2 0.9	-20.14	11.6	1.24	1.38	17.37	20.38 to 22.50	76	50	75	3	75	21	5
27/28	2 2.2	-20.15	2 4.5	-20.01	11.7	1.25	1.39	17.37	20.37 to 22.47	76	62	84	3	75	21	5
28/29	2 5.8	-20.02	2 8.2	-19.47	11.7	1.26	1.39	17.37	20.36 to 22.44	76	73	92	3	76	21	5
29/30	2 9.4	-19.48	2 11.7	-19.34	11.8	1.27	1.40	17.37	20.35 to 22.42	76	85	97	3	76	21	5
30/31	2 12.9	-19.34	2 15.3	-19.20	11.9	1.28	1.41	17.36	20.33 to 22.39	76	97	100	2	76	20	5
31/32	2 16.5	-19.20	2 18.8	-19.07	11.9	1.29	1.42	17.36	20.32 to 22.36	76	108	100	2	76	20	5
February 1999																
1/ 2	2 19.9	-19.06	2 22.3	-18.53	12.0	1.30	1.43	17.35	20.31 to 22.33	76	119	98	2	77	20	5
2/ 3	2 23.4	-18.52	2 25.7	-18.39	12.0	1.32	1.44	17.35	20.30 to 22.30	76	129	94	2	77	20	5
3/ 4	2 26.8	-18.38	2 29.1	-18.25	12.1	1.33	1.45	17.34	20.28 to 22.27	76	138	89	2	77	20	5
4/ 5	2 30.2	-18.24	2 32.5	-18.11	12.2	1.34	1.45	17.34	20.27 to 22.24	76	146	81	2	77	20	5
5/ 6	2 33.5	-18.09	2 35.8	-17.56	12.2	1.35	1.46	17.33	20.26 to 22.21	76	152	73	2	78	19	5
6/ 7	2 36.8	-17.55	2 39.2	-17.42	12.3	1.36	1.47	17.32	20.24 to 22.18	76	153	64	2	78	19	6
7/ 8	2 40.1	-17.41	2 42.4	-17.28	12.3	1.38	1.48	17.32	20.23 to 22.15	76	151	55	2	78	19	6
8/ 9	2 43.3	-17.26	2 45.7	-17.13	12.4	1.39	1.49	17.31	20.21 to 22.11	76	146	45	2	79	19	6
9/10	2 46.5	-17.11	2 48.9	-16.59	12.5	1.40	1.50	17.30	20.20 to 22.08	76	139	36	2	79	19	6
10/11	2 49.7	-16.57	2 52.1	-16.45	12.5	1.41	1.51	17.30	20.18 to 22.05	75	130	27	2	79	19	6
11/12	2 52.9	-16.42	2 55.2	-16.30	12.6	1.43	1.52	17.29	20.17 to 22.01	75	120	19	2	80	18	6
12/13	2 56.0	-16.27	2 58.3	-16.16	12.6	1.44	1.53	17.28	20.15 to 21.58	75	110	11	1	80	18	6
13/14	2 59.1	-16.13	3 1.4	-16.01	12.7	1.45	1.53	17.27	20.14 to 21.54	75	100	5	1	80	18	6
14/15	3 2.2	-15.58	3 4.5	-15.47	12.7	1.46	1.54	17.26	20.12 to 21.51	75	89	1	1	80	18	6
15/16	3 5.2	-15.43	3 7.5	-15.32	12.8	1.48	1.55	17.25	20.11 to 21.47	75	77	0	1	81	18	6
16/17	3 8.2	-15.29	3 10.6	-15.18	12.9	1.49	1.56	17.24	20.09 to 21.43	75	66	0	1	81	18	6
17/18	3 11.2	-15.14	3 13.5	-15.03	12.9	1.50	1.57	17.23	20.08 to 21.39	75	55	3	1	81	18	6
18/19	3 14.2	-14.60	3 16.5	-14.49	13.0	1.52	1.58	17.22	20.06 to 21.36	75	44	9	1	82	17	6
19/20	3 17.1	-14.45	3 19.5	-14.34	13.0	1.53	1.59	17.21	20.05 to 21.32	75	34	17	1	82	17	6
20/21	3 20.0	-14.31	3 22.4	-14.20	13.1	1.54	1.60	17.20	20.03 to 21.28	75	28	26	1	83	17	6
21/22	3 22.9	-14.16	3 25.3	-14.06	13.2	1.56	1.61	17.19	20.01 to 21.24	74	27	37	1	83	17	6
22/23	3 25.8	-14.02	3 28.1	-13.52	13.2	1.57	1.62	17.18	19.60 to 21.20	74	31	49	1	83	17	5
23/24	3 28.6	-13.48	3 31.0	-13.37	13.3	1.59	1.62	17.17	19.58 to 21.16	74	39	60	1	84	17	5
24/25	3 31.5	-13.33	3 33.8	-13.23	13.3	1.60	1.63	17.16	19.56 to 21.12	74	50	71	1	84	17	5
25/26	3 34.3	-13.19	3 36.6	-13.09	13.4	1.61	1.64	17.15	19.55 to 21.08	74	60	81	1	84	17	5
26/27	3 37.1	-13.05	3 39.4	-12.56	13.4	1.63	1.65	17.14	19.53 to 21.03	74	72	89	1	85	16	5
27/28	3 39.8	-12.51	3 42.2	-12.42	13.5	1.64	1.66	17.13	19.52 to 20.59	74	83	95	1	85	16	5
28/29	3 42.6	-12.37	3 44.9	-12.28	13.5	1.65	1.67	17.11	19.50 to 20.55	73	94	99	1	85	16	5

Ephemeris for 29P/Schwassmann-Wachmann 1 (Southern Hemisphere, 40° South)

Note: when in outburst the comet may be visible from the UK, although it is low in the southern sky.

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Omega= 47.1035 OMEGA=312.8163 i=  9.3850 q= 5.728744 a=  6.003041
 e=0.045693  P=  14.708  T= 2004 June      15.6870    Equinox= 2000
 Magnitudes calculated from m= 1.0+5.0*Log(d)+10.0*Log(r)
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December 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
21/22	14 49.9	-25.08	14 52.8	-25.21	13.1	6.89	6.20	8.51	Not Observable	42	78	9	0	278	3	-1
26/27	14 53.2	-25.27	14 56.1	-25.39	13.1	6.83	6.20	8.35	Not Observable	47	142	57	0	279	3	-1
31/32	14 56.4	-25.45	14 59.3	-25.57	13.1	6.77	6.20	8.18	Not Observable	51	142	99	0	280	3	-1
January 1999																

5/ 6	14 59.4	-26.02	15 2.4	-26.14	13.1	6.71	6.20	8.02	3.17 to 3.18	55	76	83	0	280	3	-1
10/11	15 2.3	-26.19	15 5.3	-26.31	13.0	6.64	6.20	7.45	2.58 to 3.24	59	20	37	0	281	3	-1
15/16	15 5.0	-26.36	15 8.0	-26.47	13.0	6.57	6.19	7.28	2.40 to 3.31	64	46	2	0	282	3	-1
20/21	15 7.6	-26.52	15 10.5	-27.03	13.0	6.49	6.19	7.11	2.21 to 3.38	68	109	12	0	282	2	-1
25/26	15 9.9	-27.07	15 12.9	-27.18	13.0	6.41	6.19	6.53	2.02 to 3.46	73	166	64	0	283	2	-1
30/31	15 12.0	-27.22	15 15.0	-27.33	12.9	6.34	6.19	6.36	1.42 to 3.53	77	110	100	0	283	2	-1
February 1999																
4/ 5	15 13.8	-27.36	15 16.8	-27.47	12.9	6.26	6.19	6.18	1.23 to 4.01	82	48	81	0	284	2	-1
9/10	15 15.5	-27.49	15 18.5	-28.00	12.9	6.17	6.19	5.60	1.03 to 4.09	86	20	36	1	285	1	-1
14/15	15 16.8	-28.02	15 19.8	-28.13	12.8	6.09	6.19	5.42	0.43 to 4.16	91	76	1	1	285	1	-1
19/20	15 17.9	-28.14	15 20.9	-28.24	12.8	6.01	6.19	5.23	0.23 to 4.23	96	142	17	1	286	1	0
24/25	15 18.7	-28.24	15 21.7	-28.35	12.8	5.93	6.19	5.04	0.02 to 4.30	100	142	71	1	287	0	0
March 1999																
1/ 2	15 19.2	-28.34	15 22.2	-28.45	12.7	5.85	6.18	4.45	23.42 to 4.37	105	78	100	1	288	0	0
6/ 7	15 19.4	-28.43	15 22.4	-28.54	12.7	5.77	6.18	4.25	23.21 to 4.43	110	22	80	1	289	0	0
11/12	15 19.3	-28.51	15 22.3	-29.01	12.7	5.70	6.18	4.06	22.59 to 4.49	115	46	34	1	290	0	0
16/17	15 18.9	-28.57	15 22.0	-29.08	12.7	5.63	6.18	3.45	22.38 to 4.55	120	110	0	0	291	0	0
21/22	15 18.2	-29.02	15 21.3	-29.13	12.6	5.56	6.18	3.25	22.16 to 5.00	125	164	23	0	292	0	0
26/27	15 17.3	-29.06	15 20.3	-29.17	12.6	5.49	6.18	3.04	21.55 to 5.05	130	106	77	0	294	-1	0
31/32	15 16.0	-29.08	15 19.1	-29.19	12.6	5.43	6.18	2.43	21.33 to 5.11	135	45	100	0	296	-1	0
April 1999																
5/ 6	15 14.5	-29.09	15 17.6	-29.20	12.6	5.38	6.18	2.22	21.11 to 5.16	140	23	79	0	298	-1	0
10/11	15 12.8	-29.09	15 15.8	-29.20	12.5	5.33	6.18	2.01	20.49 to 5.20	145	79	31	0	301	-1	0
15/16	15 10.9	-29.06	15 13.9	-29.17	12.5	5.29	6.17	1.39	20.26 to 5.25	150	146	0	0	305	-2	0
20/21	15 8.7	-29.03	15 11.8	-29.14	12.5	5.25	6.17	1.17	20.04 to 5.30	155	133	30	0	310	-2	0
25/26	15 6.5	-28.57	15 9.5	-29.09	12.5	5.22	6.17	0.55	19.42 to 5.34	159	69	81	0	317	-2	0
30/31	15 4.1	-28.51	15 7.1	-29.02	12.5	5.20	6.17	0.33	19.20 to 5.39	164	18	100	0	328	-2	0

Ephemeris for 37P/Forbes (Southern Hemisphere, 40° South)

```
Omega=310.7049 OMEGA=334.3674 i=  7.1627 q= 1.446025 a=  3.348226
e=0.568122  P=    6.127  T= 1999 May       4.1953     Equinox= 2000
Magnitudes calculated from m=10.5+5.0*Log(d)+10.0*Log(r)+0.000*Beta
```

April 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	20 21.5	-26.24	20 24.5	-26.14	13.1	1.50	1.49	7.45	3.02 to 5.12	70	98	99	1	254	19	5
6/ 7	20 38.9	-25.22	20 41.9	-25.11	13.0	1.47	1.48	7.43	2.59 to 5.17	71	44	70	1	253	19	5
11/12	20 56.0	-24.13	20 58.9	-24.01	12.9	1.43	1.47	7.40	2.57 to 5.21	71	17	22	1	251	19	5
16/17	21 12.7	-22.57	21 15.6	-22.45	12.9	1.41	1.46	7.37	2.56 to 5.26	72	84	1	1	250	19	6
21/22	21 28.9	-21.36	21 31.8	-21.23	12.8	1.38	1.45	7.33	2.54 to 5.31	73	152	41	1	249	18	6
26/27	21 44.7	-20.10	21 47.4	-19.56	12.8	1.35	1.45	7.29	2.53 to 5.35	74	146	89	1	249	18	7

Ephemeris for 52P/Harrington-Abell (UK)

Note: the comet is currently in outburst and may be fainter than predicted here.

```
Omega=138.9007 OMEGA=337.2884 i= 10.2186 q= 1.755986 a=  3.841680
e=0.542912  P=    7.530  T= 1999 January   27.8725     Equinox= 2000
Magnitudes calculated from m=12.0+5.0*Log(d)+ 0.0*Log(r)
```

November 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 49.6	38.39	6 53.0	38.35	12.5	1.27	1.94	4.09	21.46 to 5.34	118	93	93	1	267	6	1
6/ 7	6 56.6	39.01	7 0.1	38.57	12.4	1.21	1.92	3.56	21.26 to 5.43	121	27	89	1	266	6	1
11/12	7 3.0	39.23	7 6.4	39.19	12.3	1.16	1.90	3.43	21.06 to 5.51	124	50	40	1	265	6	1
16/17	7 8.6	39.45	7 12.1	39.40	12.2	1.11	1.88	3.29	20.45 to 5.58	128	105	4	1	263	5	1
21/22	7 13.4	40.05	7 16.8	39.60	12.1	1.06	1.87	3.14	20.24 to 6.06	132	154	7	1	262	4	1
26/27	7 17.2	40.25	7 20.6	40.19	12.0	1.01	1.85	2.58	20.02 to 6.13	135	129	50	1	259	3	1
December 1998																
1/ 2	7 20.0	40.42	7 23.5	40.36	11.9	0.97	1.84	2.41	19.39 to 6.19	139	63	96	1	256	2	1
6/ 7	7 21.8	40.57	7 25.3	40.50	11.9	0.94	1.82	2.23	19.16 to 6.25	143	25	86	1	252	1	1
11/12	7 22.5	41.08	7 26.0	41.02	11.8	0.90	1.81	2.04	18.52 to 6.30	147	77	38	1	247	0	0
16/17	7 22.1	41.14	7 25.6	41.08	11.7	0.87	1.80	1.44	18.28 to 6.34	151	131	3	1	240	0	0
21/22	7 20.8	41.15	7 24.3	41.09	11.6	0.85	1.79	1.23	18.05 to 6.37	155	152	9	1	231	-1	0
26/27	7 18.6	41.09	7 22.1	41.03	11.6	0.83	1.78	1.01	17.41 to 6.39	158	94	57	1	220	-2	0
31/32	7 15.8	40.54	7 19.3	40.48	11.6	0.82	1.77	0.38	17.27 to 6.40	161	30	99	1	205	-2	-1
January 1999																
5/ 6	7 12.6	40.31	7 16.1	40.25	11.5	0.81	1.77	0.15	17.32 to 6.39	162	52	83	1	188	-3	-1
10/11	7 9.4	39.58	7 12.8	39.53	11.5	0.80	1.76	23.52	17.38 to 6.38	162	109	37	1	169	-3	-2
15/16	7 6.2	39.17	7 9.7	39.12	11.5	0.80	1.76	23.30	17.44 to 6.35	160	158	2	1	152	-3	-3
20/21	7 3.6	38.28	7 7.0	38.23	11.5	0.81	1.76	23.07	17.51 to 6.12	157	121	12	1	139	-2	-4
25/26	7 1.6	37.32	7 5.0	37.27	11.6	0.82	1.76	22.46	17.59 to 5.43	153	55	64	1	128	-1	-4
30/31	7 0.6	36.30	7 3.9	36.26	11.6	0.83	1.76	22.25	18.07 to 5.14	150	25	100	1	121	-1	-5
February 1999																
4/ 5	7 0.5	35.25	7 3.8	35.20	11.7	0.85	1.76	22.05	18.15 to 4.46	145	84	81	1	115	0	-5
9/10	7 1.4	34.17	7 4.7	34.12	11.7	0.88	1.76	21.46	18.24 to 4.18	141	141	36	1	111	0	-5
14/15	7 3.3	33.07	7 6.6	33.02	11.8	0.91	1.76	21.28	18.32 to 3.51	137	151	1	1	108	2	-5
19/20	7 6.2	31.57	7 9.5	31.52	11.9	0.94	1.77	21.11	18.41 to 3.25	133	85	17	1	106	3	-5
24/25	7 10.1	30.47	7 13.3	30.42	11.9	0.98	1.78	20.56	18.50 to 2.60	129	19	71	1	104	4	-5
March 1999																
1/ 2	7 14.8	29.38	7 18.0	29.33	12.0	1.01	1.78	20.41	18.59 to 2.35	126	51	100	1	103	5	-5
6/ 7	7 20.3	28.30	7 23.4	28.24	12.1	1.06	1.79	20.26	19.08 to 2.11	122	111	80	1	102	6	-5
11/12	7 26.4	27.23	7 29.5	27.17	12.2	1.10	1.80	20.13	19.18 to 1.49	119	167	34	1	102	6	-5
16/17	7 33.1	26.17	7 36.2	26.10	12.3	1.15	1.81	19.60	19.27 to 1.26	115	125	0	1	102	7	-5
21/22	7 40.3	25.12	7 43.4	25.05	12.4	1.20	1.83	19.47	19.37 to 1.04	112	55	23	1	102	8	-5
26/27	7 48.0	24.09	7 51.0	24.01	12.5	1.25	1.84	19.35	19.47 to 0.43	109	14	77	1	102	8	-5
31/32	7 56.0	23.05	7 59.0	22.57	12.6	1.31	1.86	19.23	19.57 to 0.22	106	75	100	1	102	9	-5
April 1999																
5/ 6	8 4.3	22.03	8 7.3	21.54	12.7	1.36	1.87	19.12	20.08 to 0.02	104	132	79	1	103	9	-5
10/11	8 12.9	21.01	8 15.8	20.51	12.8	1.42	1.89	19.01	20.19 to 23.41	101	168	31	1	103	9	-5
15/16	8 21.6	19.59	8 24.5	19.49	12.9	1.48	1.90	18.50	20.31 to 23.21	98	100	0	1	104	10	-5
20/21	8 30.5	18.57	8 33.3	18.47	12.9	1.55	1.92	18.39	20.43 to 23.01	95	28	30	1	104	10	-5
25/26	8 39.4	17.55	8 42.3	17.44	13.0	1.61	1.94	18.28	20.55 to 22.40	93	36	81	1	105	10	-5
30/31	8 48.5	16.54	8 51.3	16.42	13.1	1.68	1.96	18.17	21.08 to 22.20	90	94	100	1	106	10	-5

Ephemeris for 88P/Howell (Equator)

Omega=234.9042 OMEGA= 57.6696 i= 4.3981 q= 1.406147 a= 3.143415
e=0.552669 P= 5.573 T= 1998 September 27.1793 Equinox= 2000
Magnitudes calculated from m= 8.0+5.0*Log(d)+20.7*Log(r)

November 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	18 47.4	-26.53	18 50.5	-26.49	12.5	1.63	1.46	16.06	18.37 to 20.07	62	87	93	2	87	20	2
6/ 7	19 6.1	-26.27	19 9.2	-26.22	12.6	1.67	1.47	16.05	18.38 to 20.02	61	157	89	1	85	20	2
11/12	19 24.5	-25.53	19 27.6	-25.47	12.7	1.71	1.49	16.04	18.39 to 19.57	60	138	40	1	84	20	2
16/17	19 42.6	-25.12	19 45.6	-25.04	12.9	1.75	1.51	16.02	18.40 to 19.51	59	83	4	1	82	20	3
21/22	20 0.2	-24.23	20 3.2	-24.15	13.1	1.79	1.53	16.00	18.41 to 19.45	58	28	7	1	81	20	4
26/27	20 17.5	-23.28	20 20.4	-23.18	13.2	1.84	1.55	15.58	18.43 to 19.38	57	33	50	1	79	19	4
December 1998																
1/ 2	20 34.2	-22.27	20 37.1	-22.17	13.4	1.88	1.57	15.54	18.45 to 19.30	56	101	96	1	78	19	5
6/ 7	20 50.4	-21.22	20 53.3	-21.10	13.6	1.93	1.59	15.51	18.48 to 19.21	55	169	86	1	77	18	5
11/12	21 6.2	-20.12	21 9.0	-20.00	13.8	1.99	1.62	15.47	18.50 to 19.12	54	130	38	1	75	18	5
16/17	21 21.4	-18.60	21 24.2	-18.47	14.0	2.04	1.64	15.42	18.53 to 19.01	53	74	3	1	75	18	6
21/22	21 36.2	-17.44	21 39.0	-17.30	14.2	2.10	1.67	15.37	Not Observable	51	16	9	0	74	17	6
26/27	21 50.5	-16.26	21 53.2	-16.12	14.4	2.15	1.70	15.32	Not Observable	50	48	57	0	73	17	6
31/32	22 4.3	-15.07	22 7.0	-14.53	14.6	2.21	1.72	15.26	Not Observable	48	117	99	0	72	16	6

Ephemeris for 93P/Lovas 1 (UK)

Omega= 74.6516 OMEGA=340.5257 i= 12.1909 q= 1.670073 a= 4.349182
e=0.616003 P= 9.070 T= 1998 October 13.9337 Equinox= 2000
Magnitudes calculated from m= 8.0+5.0*Log(d)+15.0*Log(r)

December 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 51.2	47.42	6 55.0	47.38	11.3	0.86	1.75	2.12	17.45 to 6.19	142	59	96	2	241	0	0
6/ 7	6 49.5	47.45	6 53.3	47.41	11.4	0.86	1.76	1.51	17.26 to 6.25	145	34	86	1	234	-1	0
11/12	6 46.7	47.40	6 50.5	47.37	11.4	0.86	1.78	1.28	17.17 to 6.30	149	84	38	1	226	-2	0
16/17	6 43.1	47.26	6 46.8	47.23	11.5	0.87	1.80	1.05	17.18 to 6.34	152	135	3	1	216	-3	-1
21/22	6 38.8	47.02	6 42.6	46.59	11.6	0.88	1.82	0.41	17.20 to 6.37	155	143	9	1	204	-3	-2
26/27	6 34.4	46.28	6 38.1	46.26	11.7	0.89	1.84	0.17	17.23 to 6.39	157	86	57	1	189	-3	-2
31/32	6 30.1	45.46	6 33.8	45.43	11.8	0.91	1.86	23.53	17.27 to 6.40	157	29	99	1	174	-3	-3
January 1999																
5/ 6	6 26.2	44.56	6 29.8	44.54	12.0	0.94	1.88	23.29	17.32 to 6.39	156	61	83	1	159	-3	-4
10/11	6 22.9	43.60	6 26.6	43.58	12.1	0.97	1.90	23.06	17.38 to 6.22	155	117	37	1	145	-2	-4
15/16	6 20.5	42.59	6 24.1	42.57	12.3	1.00	1.93	22.44	17.44 to 5.45	152	157	2	1	134	-2	-5
20/21	6 19.0	41.55	6 22.6	41.54	12.5	1.04	1.95	22.23	17.51 to 5.08	148	112	12	1	125	-1	-5
25/26	6 18.5	40.51	6 22.0	40.49	12.6	1.09	1.98	22.03	17.59 to 4.33	145	48	64	1	119	0	-5
30/31	6 18.9	39.46	6 22.4	39.44	12.8	1.14	2.00	21.43	18.07 to 3.58	141	33	100	1	113	0	-5
February 1999																
4/ 5	6 20.2	38.42	6 23.7	38.40	13.0	1.20	2.03	21.25	18.15 to 3.24	137	92	81	1	109	1	-5
9/10	6 22.4	37.40	6 25.8	37.38	13.2	1.26	2.06	21.07	18.24 to 2.51	133	147	36	1	106	2	-5
14/15	6 25.3	36.40	6 28.7	36.38	13.4	1.32	2.09	20.50	18.32 to 2.19	129	143	1	1	104	2	-5
19/20	6 29.0	35.42	6 32.3	35.40	13.6	1.39	2.12	20.34	18.41 to 1.48	125	78	17	1	102	3	-4
24/25	6 33.2	34.47	6 36.6	34.44	13.8	1.46	2.14	20.19	18.50 to 1.17	121	17	71	0	101	4	-4

Ephemeris for Hale-Bopp 1995 O1 (Southern Hemisphere, 40° South)

Omega=130.5767 OMEGA=282.4654 i= 89.4269 q= 0.913974 a=186.107514
e=0.995089 P= 2538.902 T= 1997 April 1.1341 Equinox= 2000
Magnitudes calculated from m=-0.7+5.0*Log(d)+ 7.8*Log(r)

December 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 49.1	-72.34	6 48.2	-72.38	10.2	7.13	7.08	2.06	20.32 to 3.06	83	92	96	2	328	-3	-2
6/ 7	6 40.4	-72.60	6 39.4	-73.03	10.2	7.18	7.12	1.37	20.38 to 3.04	83	92	86	2	335	-3	-2
11/12	6 31.2	-73.20	6 30.0	-73.22	10.3	7.22	7.16	1.08	20.44 to 3.03	83	91	38	2	343	-3	-1
16/17	6 21.4	-73.35	6 20.2	-73.37	10.3	7.26	7.20	0.39	20.48 to 3.04	83	88	3	2	350	-3	-1
21/22	6 11.3	-73.45	6 10.1	-73.46	10.3	7.30	7.24	0.09	20.51 to 3.06	83	86	9	2	357	-3	0
26/27	6 1.2	-73.50	5 60.0	-73.50	10.4	7.34	7.29	23.39	20.53 to 3.09	83	88	57	2	5	-3	0
31/32	5 51.3	-73.49	5 50.0	-73.48	10.4	7.39	7.33	23.09	20.53 to 3.13	83	93	99	2	13	-3	0
January 1999																
5/ 6	5 41.6	-73.43	5 40.4	-73.41	10.4	7.43	7.37	22.40	20.53 to 3.18	83	95	83	2	20	-3	0
10/11	5 32.5	-73.32	5 31.4	-73.30	10.5	7.47	7.41	22.11	20.51 to 3.24	83	92	37	2	27	-3	0
15/16	5 24.1	-73.17	5 23.0	-73.14	10.5	7.51	7.45	21.43	20.48 to 3.31	83	87	2	2	34	-3	1
20/21	5 16.5	-72.58	5 15.5	-72.54	10.5	7.56	7.49	21.16	20.44 to 3.38	83	83	12	2	41	-2	1
25/26	5 9.7	-72.35	5 8.8	-72.32	10.5	7.60	7.53	20.49	20.39 to 3.46	83	87	64	2	48	-2	1
30/31	5 3.9	-72.10	5 3.1	-72.06	10.6	7.64	7.58	20.24	20.33 to 3.53	83	96	100	2	54	-2	2
February 1999																
4/ 5	4 58.9	-71.43	4 58.2	-71.38	10.6	7.68	7.62	19.59	20.27 to 4.01	83	98	81	2	60	-1	2
9/10	4 54.9	-71.13	4 54.3	-71.09	10.6	7.72	7.66	19.36	20.20 to 4.09	83	92	36	2	66	-1	2
14/15	4 51.7	-70.43	4 51.2	-70.38	10.7	7.76	7.70	19.13	20.12 to 4.16	83	84	1	2	72	-1	2
19/20	4 49.3	-70.11	4 48.9	-70.06	10.7	7.80	7.74	18.51	20.05 to 4.23	83	82	17	2	78	-1	2
24/25	4 47.6	-69.39	4 47.3	-69.34	10.7	7.84	7.78	18.30	19.56 to 4.30	83	90	71	2	83	0	2
March 1999																
1/ 2	4 46.7	-69.07	4 46.5	-69.02	10.7	7.88	7.82	18.09	19.48 to 4.37	83	99	100	2	88	0	2
6/ 7	4 46.4	-68.35	4 46.3	-68.29	10.8	7.92	7.86	17.49	19.40 to 4.43	83	98	80	1	93	0	2
11/12	4 46.7	-68.03	4 46.6	-67.58	10.8	7.96	7.90	17.30	19.31 to 4.49	83	90	34	1	98	0	2
16/17	4 47.5	-67.32	4 47.5	-67.27	10.8	8.00	7.94	17.11	19.23 to 4.04	83	81	0	1	103	0	2
21/22	4 48.8	-67.02	4 48.9	-66.57	10.9	8.04	7.98	16.53	19.14 to 3.23	83	83	23	1	107	0	2
26/27	4 50.6	-66.33	4 50.7	-66.28	10.9	8.08	8.02	16.35	19.06 to 2.48	83	94	77	1	112	0	2
31/32	4 52.7	-66.06	4 52.9	-66.01	10.9	8.11	8.06	16.17	18.58 to 2.17	83	100	100	1	116	1	2
April 1999																
5/ 6	4 55.3	-65.40	4 55.4	-65.35	10.9	8.15	8.10	16.00	18.50 to 1.48	84	97	79	1	121	1	2
10/11	4 58.1	-65.15	4 58.3	-65.11	11.0	8.19	8.14	15.43	18.42 to 1.21	84	87	31	1	125	1	2
15/16	5 1.2	-64.52	5 1.5	-64.48	11.0	8.22	8.18	15.27	18.35 to 0.56	84	79	0	1	129	1	1

20/21	5 4.6	-64.31	5 4.9	-64.27	11.0	8.26	8.22	15.10	18.28 to 0.32	84	86	30	1	133	1	1
25/26	5 8.2	-64.12	5 8.5	-64.09	11.0	8.30	8.26	14.54	18.22 to 0.09	84	97	81	1	137	1	1
30/31	5 12.0	-63.55	5 12.3	-63.52	11.1	8.33	8.30	14.38	18.16 to 23.47							
									5.29 to 5.39	85	100	100	1	141	2	1

Ephemeris for 1997 J2 Meunier-Dupouy (Equator)

Omega=122.6768 OMEGA=148.8447 i= 91.2734 q= 3.051075 a=**********
e=1.000579 P=********* T= 1998 March 10.4520 Equinox= 2000
Magnitudes calculated from m= 5.6+5.0*Log(d)+ 6.6*Log(r)

November 1998

										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
1/ 2	20 57.1	-12.29	20 59.9	-12.17	12.2	3.60	3.81	18.16	18.37 to 22.33	94	55	93	1	74	1	4
6/ 7	20 58.6	-13.23	21 1.3	-13.12	12.3	3.72	3.84	17.57	18.38 to 22.12	90	130	89	1	74	1	-4
11/12	21 0.4	-14.13	21 3.1	-14.01	12.4	3.83	3.87	17.39	18.39 to 21.52	85	162	40	1	73	2	-4
16/17	21 2.5	-14.57	21 5.3	-14.45	12.5	3.94	3.89	17.22	18.40 to 21.32	80	103	4	1	73	2	-3
21/22	21 4.9	-15.37	21 7.7	-15.25	12.6	4.06	3.92	17.05	18.41 to 21.12	75	43	7	1	73	2	-3
26/27	21 7.7	-16.13	21 10.4	-16.01	12.6	4.17	3.95	16.48	18.43 to 20.52	71	20	50	1	73	3	-3
December 1998																
1/ 2	21 10.6	-16.46	21 13.4	-16.33	12.7	4.28	3.98	16.31	18.45 to 20.33	66	91	96	1	73	3	-2
6/ 7	21 13.8	-17.15	21 16.6	-17.02	12.8	4.38	4.01	16.14	18.48 to 20.14	62	164	86	1	73	3	-2
11/12	21 17.2	-17.41	21 20.0	-17.28	12.9	4.49	4.04	15.58	18.50 to 19.56	57	133	38	1	73	4	-2
16/17	21 20.8	-18.04	21 23.6	-17.51	12.9	4.59	4.07	15.42	18.53 to 19.37	53	74	3	1	74	4	-1
21/22	21 24.5	-18.25	21 27.3	-18.12	13.0	4.69	4.10	15.26	18.55 to 19.19	49	13	9	0	74	4	-1
26/27	21 28.4	-18.44	21 31.2	-18.31	13.1	4.78	4.13	15.10	18.57 to 19.01	44	54	57	0	75	4	-1
31/32	21 32.4	-19.01	21 35.2	-18.47	13.1	4.87	4.16	14.54	Not Observable	40	125	99	0	76	4	-1

Ephemeris for LINEAR (1998 M5) (UK)

Omega=101.2672 OMEGA=333.3792 i= 82.2329 q= 1.742469 a=471.958017
e=0.996308 P=10253.097 T= 1999 January 24.5346 Equinox= 2000
Magnitudes calculated from m= 6.4+5.0*Log(d)+10.0*Log(r)

October 1998

										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
26/27	18 56.1	37.04	18 57.8	37.08	11.0	1.93	2.09	16.37	18.04 to 23.53	85	56	35	3	70	-4	-2
27/28	18 55.1	36.58	18 56.9	37.02	11.0	1.93	2.08	16.32	18.02 to 23.48	84	57	45	3	69	-4	-2
28/29	18 54.2	36.53	18 56.0	36.57	11.0	1.94	2.07	16.27	17.60 to 23.43	83	60	56	3	68	-4	-2
29/30	18 53.4	36.49	18 55.1	36.52	11.0	1.94	2.06	16.23	17.58 to 23.38	83	64	66	3	67	-4	-2
30/31	18 52.6	36.44	18 54.3	36.48	11.0	1.95	2.06	16.18	17.56 to 23.33	82	71	76	3	66	-4	-1
31/32	18 51.8	36.39	18 53.6	36.43	11.0	1.95	2.05	16.13	17.55 to 23.28	81	78	86	3	65	-3	-1
November 1998																
1/ 2	18 51.1	36.35	18 52.8	36.39	11.0	1.96	2.05	16.09	17.53 to 23.24	81	86	93	3	64	-3	-1
2/ 3	18 50.4	36.31	18 52.2	36.35	11.0	1.96	2.04	16.04	17.51 to 23.19	80	95	98	3	63	-3	-1
3/ 4	18 49.8	36.27	18 51.5	36.31	10.9	1.97	2.03	15.59	17.50 to 23.14	79	103	100	3	62	-3	-1
4/ 5	18 49.1	36.24	18 50.9	36.27	10.9	1.97	2.03	15.55	17.48 to 23.09	79	111	100	3	61	-3	-1
5/ 6	18 48.6	36.20	18 50.3	36.24	10.9	1.97	2.02	15.50	17.46 to 23.05	78	118	96	3	60	-2	-1
6/ 7	18 48.0	36.17	18 49.8	36.20	10.9	1.98	2.01	15.46	17.45 to 23.00	78	122	89	3	59	-2	-1
7/ 8	18 47.5	36.14	18 49.3	36.18	10.9	1.98	2.01	15.41	17.43 to 22.56	77	124	81	3	58	-2	-1
8/ 9	18 47.1	36.11	18 48.8	36.15	10.9	1.99	2.00	15.37	17.42 to 22.51	76	124	71	4	57	-2	-1
9/10	18 46.6	36.09	18 48.4	36.12	10.9	1.99	1.99	15.33	17.40 to 22.47	76	122	61	4	56	-2	-1
10/11	18 46.2	36.07	18 48.0	36.10	10.9	2.00	1.99	15.28	17.39 to 22.43	75	117	50	4	55	-2	0
11/12	18 45.8	36.05	18 47.6	36.08	10.9	2.00	1.98	15.24	17.38 to 22.39	75	112	40	4	54	-1	0
12/13	18 45.5	36.03	18 47.3	36.06	10.9	2.00	1.98	15.20	17.36 to 22.34	74	106	31	4	53	-1	0
13/14	18 45.2	36.01	18 47.0	36.05	10.9	2.01	1.97	15.15	17.35 to 22.30	74	100	22	4	52	-1	0
14/15	18 44.9	36.00	18 46.7	36.04	10.8	2.01	1.96	15.11	17.34 to 22.26	73	93	15	4	51	-1	0
15/16	18 44.7	35.59	18 46.4	36.03	10.8	2.01	1.96	15.07	17.33 to 22.22	73	86	8	4	50	-1	0
16/17	18 44.4	35.59	18 46.2	36.02	10.8	2.02	1.95	15.03	17.31 to 22.18	72	79	4	4	49	-1	0
17/18	18 44.2	35.58	18 46.0	36.02	10.8	2.02	1.95	14.59	17.30 to 22.15	72	73	1	4	48	0	0
18/19	18 44.1	35.58	18 45.8	36.01	10.8	2.02	1.94	14.54	17.29 to 22.11	71	67	0	4	47	0	0
19/20	18 43.9	35.58	18 45.7	36.02	10.8	2.02	1.94	14.50	17.28 to 22.07	71	62	0	4	46	0	0
20/21	18 43.8	35.59	18 45.6	36.02	10.8	2.03	1.93	14.46	17.27 to 22.03	70	58	3	4	45	0	0
21/22	18 43.7	35.60	18 45.5	36.03	10.8	2.03	1.93	14.42	17.26 to 21.60	70	56	7	4	44	0	0
22/23	18 43.6	36.01	18 45.4	36.04	10.8	2.03	1.92	14.38	17.25 to 21.56	69	55	13	4	43	0	0
23/24	18 43.6	36.02	18 45.4	36.05	10.8	2.03	1.91	14.34	17.24 to 21.53	69	57	20	4	42	0	0
24/25	18 43.6	36.04	18 45.3	36.07	10.7	2.03	1.91	14.30	17.24 to 21.49	69	60	29	4	41	0	0
25/26	18 43.6	36.06	18 45.3	36.09	10.7	2.03	1.90	14.26	17.23 to 21.46	68	64	39	4	40	0	0
26/27	18 43.6	36.08	18 45.4	36.11	10.7	2.03	1.90	14.22	17.22 to 21.43	68	70	50	4	39	0	0
27/28	18 43.6	36.11	18 45.4	36.14	10.7	2.04	1.89	14.19	17.21 to 21.39	68	77	61	4	38	0	1
28/29	18 43.7	36.14	18 45.5	36.17	10.7	2.04	1.89	14.15	17.21 to 21.36	67	85	72	4	37	0	1
29/30	18 43.8	36.17	18 45.5	36.20	10.7	2.04	1.88	14.11	17.20 to 21.33	67	93	82	4	36	0	1
30/31	18 43.9	36.20	18 45.6	36.24	10.7	2.04	1.88	14.07	17.20 to 21.30	67	101	90	4	35	0	1
December 1998																
1/ 2	18 44.0	36.24	18 45.8	36.28	10.7	2.04	1.87	14.03	17.19 to 21.27	66	109	96	4	34	0	1
2/ 3	18 44.2	36.29	18 45.9	36.32	10.7	2.04	1.87	13.59	17.19 to 21.24	66	115	100	4	33	0	1
3/ 4	18 44.3	36.33	18 46.1	36.37	10.7	2.04	1.87	13.56	17.18 to 21.21	66	120	100	4	32	0	1
4/ 5	18 44.5	36.38	18 46.2	36.41	10.6	2.04	1.86	13.52	17.18 to 21.18	66	123	98	4	31	0	2
5/ 6	18 44.7	36.43	18 46.4	36.47	10.6	2.04	1.86	13.48	17.18 to 21.16							
									6.21 to 6.24	65	124	93	4	30	0	2
6/ 7	18 44.9	36.49	18 46.6	36.52	10.6	2.04	1.85	13.44	17.17 to 21.13							
									6.16 to 6.25	65	122	86	4	29	1	2
7/ 8	18 45.1	36.55	18 46.9	36.58	10.6	2.04	1.85	13.41	17.17 to 21.10							
									6.11 to 6.26	65	118	77	4	28	1	2
8/ 9	18 45.4	37.01	18 47.1	37.05	10.6	2.03	1.84	13.37	17.17 to 21.08							
									6.06 to 6.27	65	113	67	4	27	1	2
9/10	18 45.6	37.08	18 47.4	37.11	10.6	2.03	1.84	13.33	17.17 to 21.05							
									6.01 to 6.28	65	107	58	4	26	1	2
10/11	18 45.9	37.15	18 47.6	37.18	10.6	2.03	1.84	13.30	17.17 to 21.03							
									5.57 to 6.29	64	101	48	4	25	1	2
11/12	18 46.2	37.22	18 47.9	37.26	10.6	2.03	1.83	13.26	17.17 to 21.00							
									5.52 to 6.30	64	95	38	4	24	1	3
12/13	18 46.5	37.30	18 48.2	37.33	10.6	2.03	1.83	13.22	17.17 to 20.58							
									5.47 to 6.31	64	88	29	4	23	1	3
13/14	18 46.8	37.38	18 48.6	37.42	10.5	2.03	1.82	13.19	17.17 to 20.56							
									5.42 to 6.32	64	82	21	4	22	1	3

14/15	18 47.2	37.47	18 48.9	37.50	10.5	2.02	1.82	13.15	17.17 to 20.53	5.37 to 6.32	64	76	13	4	21	1	3
15/16	18 47.5	37.55	18 49.2	37.59	10.5	2.02	1.82	13.11	17.17 to 20.51	5.32 to 6.33	64	70	8	4	20	1	3
16/17	18 47.9	38.05	18 49.6	38.08	10.5	2.02	1.81	13.08	17.18 to 20.49	5.26 to 6.34	64	66	3	5	18	1	3
17/18	18 48.3	38.14	18 50.0	38.18	10.5	2.02	1.81	13.04	17.18 to 20.47	5.21 to 6.35	64	62	0	5	17	1	4
18/19	18 48.7	38.24	18 50.4	38.28	10.5	2.01	1.81	13.01	17.18 to 20.45	5.16 to 6.35	64	59	0	5	16	1	4
19/20	18 49.1	38.35	18 50.8	38.39	10.5	2.01	1.80	12.57	17.19 to 20.44	5.11 to 6.36	64	58	1	5	15	1	4
20/21	18 49.5	38.46	18 51.2	38.49	10.5	2.01	1.80	12.54	17.19 to 20.42	5.05 to 6.36	64	59	4	5	14	2	4
21/22	18 49.9	38.57	18 51.6	39.01	10.5	2.00	1.80	12.50	17.20 to 20.40	5.00 to 6.37	64	61	9	5	13	2	4
22/23	18 50.4	39.09	18 52.0	39.13	10.4	2.00	1.79	12.47	17.20 to 20.39	4.55 to 6.37	64	65	16	5	12	2	4
23/24	18 50.8	39.21	18 52.5	39.25	10.4	1.99	1.79	12.43	17.21 to 20.37	4.49 to 6.38	64	70	24	5	11	2	5
24/25	18 51.3	39.33	18 53.0	39.37	10.4	1.99	1.79	12.40	17.21 to 20.36	4.44 to 6.38	64	75	34	5	10	2	5
25/26	18 51.8	39.46	18 53.4	39.50	10.4	1.99	1.78	12.36	17.22 to 20.34	4.38 to 6.39	64	82	45	5	9	2	5
26/27	18 52.3	39.60	18 53.9	40.04	10.4	1.98	1.78	12.33	17.23 to 20.33	4.32 to 6.39	64	89	57	5	8	2	5
27/28	18 52.8	40.14	18 54.4	40.18	10.4	1.98	1.78	12.29	17.23 to 20.32	4.27 to 6.39	64	96	68	5	7	2	5
28/29	18 53.3	40.28	18 54.9	40.32	10.4	1.97	1.78	12.26	17.24 to 20.31	4.21 to 6.39	64	103	78	5	6	2	5
29/30	18 53.8	40.43	18 55.4	40.47	10.4	1.97	1.77	12.22	17.25 to 20.30	4.15 to 6.39	64	109	87	5	5	2	6
30/31	18 54.3	40.58	18 55.9	41.02	10.3	1.96	1.77	12.19	17.26 to 20.29	4.09 to 6.40	64	114	94	5	4	2	6
31/32	18 54.8	41.14	18 56.5	41.18	10.3	1.96	1.77	12.16	17.27 to 20.29	4.03 to 6.40	64	117	99	5	3	2	6
January 1999																	
1/ 2	18 55.4	41.30	18 57.0	41.34	10.3	1.95	1.77	12.12	17.28 to 20.28	3.56 to 6.40	65	119	100	5	2	2	6
2/ 3	18 55.9	41.47	18 57.5	41.51	10.3	1.94	1.76	12.09	17.29 to 20.27	3.50 to 6.40	65	118	99	5	1	2	6
3/ 4	18 56.5	42.04	18 58.1	42.08	10.3	1.94	1.76	12.05	17.30 to 20.27	3.44 to 6.40	65	116	96	5	0	2	7
4/ 5	18 57.1	42.22	18 58.7	42.26	10.3	1.93	1.76	12.02	17.31 to 20.27	3.37 to 6.39	65	113	90	5	359	2	7
5/ 6	18 57.7	42.40	18 59.2	42.44	10.3	1.93	1.76	11.59	17.32 to 20.27	3.30 to 6.39	65	108	83	5	358	2	7
6/ 7	18 58.3	42.59	18 59.8	43.03	10.3	1.92	1.76	11.55	17.33 to 20.27	3.24 to 6.39	66	103	75	5	357	2	7
7/ 8	18 58.9	43.18	19 0.4	43.23	10.3	1.91	1.76	11.52	17.34 to 20.27	3.17 to 6.39	66	98	65	5	356	2	8
8/ 9	18 59.5	43.38	19 1.0	43.42	10.2	1.91	1.75	11.49	17.35 to 20.28	3.10 to 6.38	66	93	56	5	355	2	8
9/10	19 0.1	43.58	19 1.6	44.03	10.2	1.90	1.75	11.45	17.36 to 20.28	3.02 to 6.38	66	87	46	6	354	2	8
10/11	19 0.7	44.19	19 2.2	44.24	10.2	1.89	1.75	11.42	17.38 to 20.29	2.55 to 6.38	67	82	37	6	354	2	8
11/12	19 1.4	44.41	19 2.9	44.45	10.2	1.89	1.75	11.39	17.39 to 20.30	2.47 to 6.37	67	78	28	6	353	2	8
12/13	19 2.0	45.03	19 3.5	45.07	10.2	1.88	1.75	11.35	17.40 to 20.31	2.39 to 6.37	67	74	20	6	352	2	9
13/14	19 2.7	45.25	19 4.1	45.30	10.2	1.87	1.75	11.32	17.41 to 20.33	2.31 to 6.36	67	70	13	6	351	2	9
14/15	19 3.3	45.49	19 4.8	45.53	10.2	1.86	1.75	11.29	17.43 to 20.35	2.23 to 6.35	68	68	7	6	350	2	9
15/16	19 4.0	46.12	19 5.4	46.17	10.2	1.86	1.75	11.25	17.44 to 20.37	2.14 to 6.35	68	66	2	6	349	2	9
16/17	19 4.7	46.37	19 6.1	46.42	10.2	1.85	1.75	11.22	17.46 to 20.39	2.05 to 6.34	68	66	0	6	348	2	10
17/18	19 5.3	47.02	19 6.8	47.07	10.1	1.84	1.74	11.19	17.47 to 20.42	1.56 to 6.33	69	67	0	6	347	2	10
18/19	19 6.0	47.28	19 7.4	47.32	10.1	1.83	1.74	11.16	17.48 to 20.46	1.46 to 6.33	69	69	2	6	346	2	10
19/20	19 6.7	47.54	19 8.1	47.59	10.1	1.82	1.74	11.12	17.50 to 20.49	1.35 to 6.32	69	72	6	6	345	2	10
20/21	19 7.4	48.21	19 8.8	48.26	10.1	1.82	1.74	11.09	17.51 to 20.54	1.24 to 6.31	70	76	12	6	344	2	11
21/22	19 8.1	48.48	19 9.5	48.53	10.1	1.81	1.74	11.06	17.53 to 20.59	1.13 to 6.30	70	80	20	6	344	2	11
22/23	19 8.9	49.17	19 10.2	49.22	10.1	1.80	1.74	11.03	17.54 to 21.05	1.00 to 6.29	71	85	30	6	343	2	11
23/24	19 9.6	49.46	19 10.9	49.51	10.1	1.79	1.74	10.59	17.56 to 21.12	0.46 to 6.28	71	90	41	6	342	2	12
24/25	19 10.3	50.15	19 11.6	50.20	10.1	1.78	1.74	10.56	17.57 to 21.21	0.31 to 6.27	71	95	53	6	341	2	12
25/26	19 11.1	50.45	19 12.3	50.51	10.1	1.78	1.74	10.53	17.59 to 21.32	0.14 to 6.26	72	99	64	6	340	2	12
26/27	19 11.8	51.16	19 13.1	51.22	10.0	1.77	1.74	10.50	18.00 to 21.47	23.53 to 6.25	72	103	75	6	339	2	12
27/28	19 12.6	51.48	19 13.8	51.53	10.0	1.76	1.74	10.46	18.02 to 22.11	23.22 to 6.24	73	105	84	6	339	2	13
28/29	19 13.3	52.21	19 14.5	52.26	10.0	1.75	1.74	10.43	18.04 to 6.22		73	107	92	6	338	2	13
29/30	19 14.1	52.54	19 15.3	52.59	10.0	1.74	1.74	10.40	18.05 to 6.21		74	108	97	6	337	2	13
30/31	19 14.9	53.28	19 16.0	53.33	10.0	1.74	1.74	10.37	18.07 to 6.20		74	107	100	6	336	2	14
31/32	19 15.6	54.02	19 16.8	54.08	10.0	1.73	1.75	10.34	18.09 to 6.18		75	106	100	7	335	2	14
February 1999																	
1/ 2	19 16.4	54.38	19 17.5	54.43	10.0	1.72	1.75	10.30	18.10 to 6.17		75	104	98	7	334	2	14
2/ 3	19 17.2	55.14	19 18.3	55.19	10.0	1.71	1.75	10.27	18.12 to 6.16		75	102	94	7	334	2	15
3/ 4	19 18.0	55.51	19 19.0	55.56	10.0	1.70	1.75	10.24	18.14 to 6.14		76	99	89	7	333	2	15
4/ 5	19 18.8	56.28	19 19.8	56.34	10.0	1.69	1.75	10.21	18.15 to 6.13		76	96	81	7	332	2	15
5/ 6	19 19.7	57.07	19 20.6	57.13	10.0	1.69	1.75	10.18	18.17 to 6.11		77	93	73	7	331	2	16
6/ 7	19 20.5	57.46	19 21.4	57.52	10.0	1.68	1.75	10.15	18.19 to 6.10		77	90	64	7	331	2	16
7/ 8	19 21.3	58.26	19 22.2	58.32	10.0	1.67	1.75	10.12	18.20 to 6.08		78	88	55	7	330	2	16
8/ 9	19 22.2	59.07	19 23.0	59.13	9.9	1.66	1.75	10.08	18.22 to 6.06		78	86	45	7	329	2	17

9/10	19 23.0	59.48	19 23.8	59.54	9.9	1.65	1.76	10.05	18.24 to 6.05	79	84	36	7	328	2	17
10/11	19 23.9	60.31	19 24.6	60.37	9.9	1.65	1.76	10.02	18.25 to 6.03	79	83	27	7	327	2	17
11/12	19 24.7	61.14	19 25.4	61.20	9.9	1.64	1.76	9.59	18.27 to 6.01	80	82	19	7	327	2	18
12/13	19 25.6	61.58	19 26.2	62.04	9.9	1.63	1.76	9.56	18.29 to 5.60	80	82	11	7	326	2	18
13/14	19 26.5	62.43	19 27.1	62.49	9.9	1.63	1.76	9.53	18.31 to 5.58	81	81	5	7	325	2	18
14/15	19 27.4	63.29	19 27.9	63.35	9.9	1.62	1.76	9.50	18.32 to 5.56	81	82	1	7	324	2	19
15/16	19 28.3	64.15	19 28.8	64.21	9.9	1.61	1.77	9.47	18.34 to 5.54	82	82	0	7	324	2	19
16/17	19 29.3	65.02	19 29.6	65.09	9.9	1.60	1.77	9.43	18.36 to 5.52	82	83	0	7	323	2	19
17/18	19 30.2	65.50	19 30.5	65.57	9.9	1.60	1.77	9.40	18.38 to 5.50	83	84	3	7	322	2	20
18/19	19 31.1	66.39	19 31.3	66.46	9.9	1.59	1.77	9.37	18.39 to 5.48	83	85	9	7	321	2	20
19/20	19 32.1	67.29	19 32.2	67.35	9.9	1.59	1.78	9.34	18.41 to 5.46	84	85	17	7	321	2	20
20/21	19 33.1	68.19	19 33.1	68.26	9.9	1.58	1.78	9.31	18.43 to 5.44	84	86	26	7	320	2	21
21/22	19 34.1	69.10	19 34.0	69.17	9.9	1.57	1.78	9.28	18.45 to 5.42	85	87	37	7	319	2	21
22/23	19 35.1	70.02	19 34.9	70.09	9.9	1.57	1.78	9.25	18.47 to 5.40	85	87	49	7	319	2	21
23/24	19 36.2	70.55	19 35.8	71.02	9.9	1.56	1.79	9.22	18.48 to 5.38	86	87	60	7	318	2	21
24/25	19 37.2	71.48	19 36.7	71.55	9.9	1.56	1.79	9.19	18.50 to 5.36	86	87	71	7	317	2	22
25/26	19 38.3	72.42	19 37.7	72.49	9.9	1.56	1.79	9.16	18.52 to 5.34	87	88	81	7	316	2	22
26/27	19 39.5	73.37	19 38.6	73.44	9.9	1.55	1.80	9.13	18.54 to 5.32	87	88	89	7	316	2	22
27/28	19 40.7	74.33	19 39.6	74.40	9.9	1.55	1.80	9.10	18.56 to 5.30	87	88	95	7	315	1	23
28/29	19 41.9	75.29	19 40.6	75.36	9.9	1.54	1.80	9.07	18.57 to 5.28	88	89	99	7	314	1	23
March	1999															
1/ 2	19 43.2	76.25	19 41.6	76.32	9.9	1.54	1.81	9.04	18.59 to 5.25	88	90	100	7	313	1	23
2/ 3	19 44.6	77.22	19 42.7	77.30	9.9	1.54	1.81	9.01	19.01 to 5.23	89	91	100	7	313	1	23
3/ 4	19 46.0	78.20	19 43.8	78.28	9.9	1.53	1.81	8.58	19.03 to 5.21	89	92	97	7	312	1	24
4/ 5	19 47.6	79.19	19 44.9	79.26	9.9	1.53	1.82	8.56	19.05 to 5.19	89	94	93	7	311	1	24
5/ 6	19 49.4	80.17	19 46.2	80.25	9.9	1.53	1.82	8.53	19.07 to 5.16	90	96	87	7	311	1	24
6/ 7	19 51.3	81.17	19 47.5	81.24	9.9	1.53	1.82	8.50	19.08 to 5.14	90	98	80	7	310	1	24
7/ 8	19 53.6	82.16	19 49.0	82.24	9.9	1.53	1.83	8.48	19.10 to 5.12	90	100	72	7	309	1	24
8/ 9	19 56.3	83.17	19 50.6	83.24	9.9	1.53	1.83	8.45	19.12 to 5.09	91	102	63	6	309	1	25
9/10	19 59.7	84.17	19 52.7	84.25	10.0	1.53	1.84	8.43	19.14 to 5.07	91	104	54	6	308	2	25
10/11	20 4.3	85.18	19 55.3	85.26	10.0	1.53	1.84	8.42	19.16 to 5.05	91	105	44	6	308	2	25
11/12	20 11.0	86.18	19 59.0	86.27	10.0	1.53	1.84	8.41	19.18 to 5.02	91	106	34	6	308	2	25
12/13	20 22.5	87.19	20 5.7	87.28	10.0	1.53	1.85	8.43	19.20 to 4.60	92	106	25	6	308	3	25
13/14	20 48.5	88.19	20 23.0	88.29	10.0	1.53	1.85	8.52	19.22 to 4.57	92	106	17	6	309	4	25
14/15	22 45.3	89.16	22 20.3	89.31	10.0	1.53	1.86	9.59	19.23 to 4.55	92	104	9	6	321	6	23
15/16	5 13.5	89.17	6 42.5	89.14	10.0	1.54	1.86	19.15	19.25 to 4.52	92	102	4	6	106	-68	2
16/17	6 54.6	88.24	7 36.0	88.18	10.0	1.54	1.87	19.55	19.27 to 4.50	92	98	0	6	116	17	-23
17/18	7 16.7	87.24	7 42.4	87.17	10.1	1.54	1.87	19.60	19.29 to 4.47	92	94	0	6	117	6	-25
18/19	7 26.9	86.23	7 45.9	86.16	10.1	1.54	1.87	20.00	19.31 to 4.45	93	89	2	6	118	4	-25
19/20	7 33.2	85.21	7 48.3	85.14	10.1	1.55	1.88	19.59	19.33 to 4.42	93	83	6	6	118	3	-25
20/21	7 37.5	84.20	7 50.2	84.12	10.1	1.55	1.88	19.57	19.35 to 4.40	93	77	14	6	117	2	-25
21/22	7 40.7	83.18	7 51.9	83.10	10.1	1.56	1.89	19.55	19.37 to 4.37	93	72	23	6	117	2	-25
22/23	7 43.4	82.16	7 53.3	82.08	10.1	1.56	1.89	19.53	19.39 to 4.35	93	67	34	6	116	2	-25
23/24	7 45.6	81.14	7 54.7	81.06	10.2	1.57	1.90	19.50	19.41 to 4.32	93	63	45	6	116	2	-25
24/25	7 47.6	80.13	7 55.9	80.05	10.2	1.58	1.90	19.48	19.43 to 4.29	93	61	56	5	115	2	-25
25/26	7 49.4	79.12	7 57.1	79.04	10.2	1.58	1.91	19.45	19.45 to 4.27	93	60	67	5	115	2	-25
26/27	7 51.0	78.11	7 58.3	78.03	10.2	1.59	1.91	19.42	19.47 to 4.24	93	61	77	5	114	2	-25
27/28	7 52.5	77.10	7 59.4	77.02	10.2	1.60	1.92	19.39	19.49 to 4.22	92	64	85	5	113	2	-25
28/29	7 53.9	76.10	8 0.5	76.02	10.3	1.61	1.93	19.36	19.51 to 4.19	92	68	92	5	113	2	-25
29/30	7 55.3	75.10	8 1.5	75.02	10.3	1.61	1.93	19.34	19.53 to 4.16	92	73	97	5	112	2	-24
30/31	7 56.6	74.11	8 2.6	74.03	10.3	1.62	1.94	19.31	19.55 to 4.14	92	79	100	5	112	2	-24
31/32	7 57.8	73.12	8 3.6	73.04	10.3	1.63	1.94	19.28	19.57 to 4.11	92	86	100	5	111	2	-24
April	1999															
1/ 2	7 59.0	72.14	8 4.6	72.05	10.4	1.64	1.95	19.25	19.60 to 4.08	92	93	99	5	111	2	-24
2/ 3	8 0.2	71.16	8 5.6	71.07	10.4	1.65	1.95	19.22	20.02 to 4.05	91	100	97	5	110	2	-24
3/ 4	8 1.4	70.18	8 6.6	70.10	10.4	1.66	1.96	19.19	20.04 to 4.03	91	107	92	5	110	2	-23
4/ 5	8 2.5	69.21	8 7.6	69.13	10.5	1.67	1.96	19.16	20.06 to 4.00	91	114	86	5	109	2	-23
5/ 6	8 3.6	68.25	8 8.6	68.16	10.5	1.69	1.97	19.13	20.08 to 3.57	91	120	79	5	109	2	-23
6/ 7	8 4.7	67.29	8 9.6	67.20	10.5	1.70	1.98	19.10	20.10 to 3.55	90	126	70	4	108	2	-23
7/ 8	8 5.8	66.34	8 10.6	66.25	10.5	1.71	1.98	19.07	20.12 to 3.52	90	130	61	4	108	2	-22
8/ 9	8 6.9	65.40	8 11.5	65.31	10.6	1.72	1.99	19.04	20.15 to 3.49	90	133	52	4	107	2	-22
9/10	8 7.9	64.46	8 12.5	64.37	10.6	1.74	1.99	19.01	20.17 to 3.46	89	134	41	4	107	2	-22
10/11	8 9.0	63.53	8 13.5	63.43	10.6	1.75	2.00	18.58	20.19 to 3.43	89	132	31	4	106	2	-22
11/12	8 10.0	63.00	8 14.4	62.51	10.7	1.76	2.01	18.55	20.21 to 3.41	89	127	22	4	106	2	-21
12/13	8 11.1	62.08	8 15.4	61.59	10.7	1.78	2.01	18.52	20.24 to 3.38	88	120	13	4	105	3	-21
13/14	8 12.1	61.17	8 16.4	61.07	10.7	1.79	2.02	18.49	20.26 to 3.35	88	112	6	4	105	3	-21
14/15	8 13.1	60.26	8 17.3	60.17	10.7	1.81	2.03	18.46	20.28 to 3.32	87	102	2	4	105	3	-21
15/16	8 14.1	59.36	8 18.3	59.27	10.8	1.82	2.03	18.43	20.31 to 3.29	87	91	0	4	104	3	-20
16/17	8 15.2	58.47	8 19.2	58.38	10.8	1.84	2.04	18.40	20.33 to 3.27	86	80	1	4	104	3	-20
17/18	8 16.2	57.59	8 20.2	57.49	10.8	1.85	2.04	18.37	20.35 to 3.24	86	69	5	4	104	3	-20
18/19	8 17.2	57.11	8 21.2	57.01	10.9	1.87	2.05	18.34	20.38 to 3.21	86	58	11	4	103	3	-19
19/20	8 18.2	56.23	8 22.1	56.14	10.9	1.88	2.06	18.31	20.40 to 3.18	85	49	20	3	103	3	-19
20/21	8 19.2	55.37	8 23.1	55.27	10.9	1.90	2.06	18.28	20.43 to 3.15	85	41	30	3	103	3	-19
21/22	8 20.2	54.51	8 24.0	54.41	11.0	1.92	2.07	18.26	20.45 to 3.12	84	37	41	3	102	3	-19
22/23	8 21.2	54.06	8 25.0	53.56	11.0	1.93	2.08	18.23	20.47 to 3.10	84	36	52	3	102	3	-18
23/24	8 22.2	53.22	8 25.9	53.12	11.0	1.95	2.08	18.20	20.50 to 3.07	83	40	63	3	102	3	-18
24/25	8 23.2	52.38	8 26.9	52.28	11.1	1.97	2.09	18.17	20.52 to 3.04	83	46	73	3	102	3	-18
25/26	8 24.1	51.55	8 27.9	51.45	11.1	1.99	2.10	18.14	20.55 to 3.01	82	54	81	3	101	3	-17
26/27	8 25.1	51.12	8 28.8	51.02	11.1	2.01	2.11	18.11	20.58 to 2.58	81	63	89	3	101	3	-17
27/28	8 26.1	50.30	8 29.8	50.20	11.2	2.02	2.11	18.08	21.00 to 2.55	81	73	94	3	101	3	-17
28/29	8 27.1	49.49	8 30.7	49.39	11.2	2.04	2.12	18.05	21.03 to 2.52	80	83	98	3	101	3	-17
29/30	8 28.1	49.08	8 31.7	48.58	11.2	2.06	2.13	18.02	21.05 to 2.47	80	92	100	3	100	4	-16
30/31	8 29.1	48.29	8 32.6	48.18	11.3	2.08	2.13	17.59	21.08 to 2.34	79	103	100	3	100	4	-16

Ephemeris for comet Williams (1998 P1)

Omega=294.4661 OMEGA=156.3791 i=145.7305 q= 1.146815 a=**********
e=1.000000 P=********* T= 1998 October 17.8340 Equinox= 2000
Magnitudes calculated from m= 4.7+5.0*Log(d)+20.3*Log(r)

November 1998 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
11/12	13 22.6	-21.32	13 25.3	-21.48	8.0	2.05	1.22	10.02	Not Observable	24	57	40	14	265	-1	5
12/13	13 22.4	-21.19	13 25.1	-21.35	8.0	2.04	1.22	9.57	Not Observable	25	46	31	14	266	-1	5
13/14	13 22.2	-21.06	13 24.9	-21.21	8.0	2.03	1.23	9.53	Not Observable	26	35	22	15	268	-1	5
14/15	13 22.0	-20.52	13 24.7	-21.08	8.1	2.02	1.23	9.49	Not Observable	27	25	15	15	269	-1	5
15/16	13 21.7	-20.39	13 24.4	-20.55	8.1	2.02	1.24	9.45	Not Observable	28	17	8	15	271	-1	5
16/17	13 21.5	-20.26	13 24.2	-20.41	8.1	2.01	1.24	9.41	Not Observable	29	16	4	15	272	-1	5
17/18	13 21.2	-20.12	13 23.9	-20.28	8.2	2.00	1.25	9.37	Not Observable	30	22	1	15	273	-1	5
18/19	13 21.0	-19.58	13 23.7	-20.14	8.2	1.99	1.26	9.32	Not Observable	31	32	0	15	274	-1	5
19/20	13 20.7	-19.44	13 23.4	-19.60	8.2	1.98	1.26	9.28	Not Observable	32	43	0	15	275	-1	5

20/21	13 20.4	-19.30	13 23.1	-19.46	8.3	1.97	1.27	9.24	Not Observable	33	54	3	15	276	-1	5
21/22	13 20.1	-19.16	13 22.8	-19.32	8.3	1.96	1.28	9.20	Not Observable	34	66	7	15	277	-1	5
22/23	13 19.8	-19.02	13 22.5	-19.17	8.4	1.95	1.28	9.15	Not Observable	35	78	13	15	278	-1	5
23/24	13 19.5	-18.47	13 22.2	-19.03	8.4	1.94	1.29	9.11	Not Observable	37	90	20	15	279	-1	6
24/25	13 19.1	-18.33	13 21.8	-18.48	8.4	1.93	1.30	9.07	Not Observable	38	103	29	15	280	-2	6
25/26	13 18.8	-18.18	13 21.5	-18.33	8.5	1.92	1.30	9.03	Not Observable	39	116	39	15	280	-2	6
26/27	13 18.4	-18.02	13 21.1	-18.18	8.5	1.91	1.31	8.58	Not Observable	40	129	50	15	281	-2	6
27/28	13 18.0	-17.47	13 20.7	-18.03	8.5	1.90	1.32	8.54	6.11 to 6.14	41	142	61	15	282	-2	6
28/29	13 17.6	-17.31	13 20.3	-17.47	8.6	1.88	1.33	8.50	6.05 to 6.15	42	155	72	14	283	-2	6
29/30	13 17.2	-17.15	13 19.8	-17.31	8.6	1.87	1.34	8.45	5.59 to 6.17	43	165	82	14	283	-2	6
30/31	13 16.7	-16.59	13 19.4	-17.15	8.6	1.86	1.34	8.41	5.53 to 6.18	44	165	90	14	284	-2	6
December 1998																
1/ 2	13 16.2	-16.43	13 18.9	-16.59	8.7	1.84	1.35	8.36	5.47 to 6.19	46	154	96	14	284	-2	6
2/ 3	13 15.7	-16.26	13 18.4	-16.42	8.7	1.83	1.36	8.32	5.41 to 6.20	47	140	100	14	285	-2	6
3/ 4	13 15.2	-16.09	13 17.9	-16.25	8.8	1.82	1.37	8.27	5.35 to 6.22	48	126	100	14	285	-3	7
4/ 5	13 14.7	-15.51	13 17.4	-16.07	8.8	1.80	1.38	8.23	5.29 to 6.23	49	111	98	14	286	-3	7
5/ 6	13 14.1	-15.34	13 16.8	-15.49	8.8	1.79	1.38	8.18	5.22 to 6.24	50	97	93	13	286	-3	7
6/ 7	13 13.5	-15.15	13 16.2	-15.31	8.9	1.77	1.39	8.14	5.16 to 6.25	52	83	86	13	287	-3	7
7/ 8	13 12.9	-14.57	13 15.6	-15.13	8.9	1.76	1.40	8.09	5.10 to 6.26	53	69	77	13	287	-3	7
8/ 9	13 12.3	-14.38	13 14.9	-14.54	8.9	1.74	1.41	8.05	5.03 to 6.27	54	56	67	13	288	-3	7
9/10	13 11.6	-14.18	13 14.2	-14.34	9.0	1.73	1.42	8.00	4.57 to 6.28	55	43	58	13	288	-4	8
10/11	13 10.9	-13.58	13 13.5	-14.14	9.0	1.71	1.43	7.55	4.51 to 6.29	57	31	48	12	288	-4	8
11/12	13 10.1	-13.38	13 12.7	-13.54	9.0	1.69	1.44	7.51	4.44 to 6.30	58	20	38	12	289	-4	8
12/13	13 9.3	-13.17	13 12.0	-13.33	9.1	1.68	1.45	7.46	4.37 to 6.31	59	11	29	12	289	-4	8
13/14	13 8.5	-12.55	13 11.1	-13.11	9.1	1.66	1.46	7.41	4.30 to 6.32	61	12	21	12	289	-5	8
14/15	13 7.6	-12.33	13 10.3	-12.49	9.2	1.65	1.47	7.36	4.24 to 6.32	62	21	13	12	290	-5	9
15/16	13 6.7	-12.11	13 9.4	-12.27	9.2	1.63	1.48	7.32	4.17 to 6.33	63	32	8	11	290	-5	9
16/17	13 5.8	-11.47	13 8.4	-12.03	9.2	1.61	1.48	7.27	4.10 to 6.34	65	44	3	11	290	-5	9
17/18	13 4.8	-11.23	13 7.4	-11.39	9.3	1.59	1.49	7.22	4.02 to 6.35	66	57	0	11	291	-6	9
18/19	13 3.8	-10.59	13 6.4	-11.15	9.3	1.58	1.50	7.17	3.55 to 6.35	67	69	0	11	291	-6	10
19/20	13 2.7	-10.33	13 5.3	-10.49	9.3	1.56	1.51	7.12	3.48 to 6.36	69	82	1	11	291	-6	10
20/21	13 1.6	-10.07	13 4.2	-10.23	9.4	1.54	1.52	7.07	3.40 to 6.36	70	95	4	10	291	-6	10
21/22	13 0.4	-9.40	13 3.0	-9.56	9.4	1.53	1.53	7.02	3.33 to 6.37	72	108	9	10	292	-7	11
22/23	12 59.1	-9.13	13 1.7	-9.29	9.4	1.51	1.54	6.56	3.25 to 6.37	73	121	16	10	292	-7	11
23/24	12 57.8	-8.44	13 0.4	-9.00	9.4	1.49	1.55	6.51	3.17 to 6.38	75	134	24	10	292	-8	11
24/25	12 56.5	-8.15	12 59.1	-8.31	9.5	1.47	1.56	6.46	3.09 to 6.38	76	148	34	10	292	-8	12
25/26	12 55.1	-7.44	12 57.7	-8.00	9.5	1.46	1.57	6.40	3.01 to 6.39	78	162	45	9	292	-8	12
26/27	12 53.6	-7.13	12 56.2	-7.29	9.5	1.44	1.58	6.35	2.53 to 6.39	79	174	57	9	292	-9	13
27/28	12 52.0	-6.41	12 54.6	-6.57	9.6	1.42	1.59	6.30	2.44 to 6.39	81	167	68	9	293	-9	13
28/29	12 50.4	-6.07	12 53.0	-6.24	9.6	1.40	1.60	6.24	2.36 to 6.39	82	153	78	9	293	-10	13
29/30	12 48.7	-5.33	12 51.3	-5.49	9.6	1.39	1.61	6.18	2.27 to 6.39	84	138	87	9	293	-10	14
30/31	12 46.9	-4.57	12 49.5	-5.14	9.7	1.37	1.62	6.13	2.18 to 6.40	86	122	94	8	293	-11	14
31/32	12 45.1	-4.20	12 47.7	-4.37	9.7	1.35	1.63	6.07	2.09 to 6.40	87	107	99	8	293	-11	15
January 1999																
1/ 2	12 43.2	-3.43	12 45.7	-3.59	9.7	1.33	1.64	6.01	2.00 to 6.40	89	92	100	8	293	-12	15
2/ 3	12 41.1	-3.03	12 43.7	-3.20	9.7	1.32	1.66	5.55	1.51 to 6.40	91	77	99	8	293	-12	16
3/ 4	12 39.0	-2.23	12 41.6	-2.39	9.8	1.30	1.67	5.49	1.41 to 6.40	93	62	96	7	293	-13	16
4/ 5	12 36.8	-1.41	12 39.4	-1.58	9.8	1.28	1.68	5.43	1.32 to 6.39	94	48	90	7	293	-13	17
5/ 6	12 34.6	-0.58	12 37.1	-1.15	9.8	1.27	1.69	5.37	1.22 to 6.39	96	34	83	7	293	-14	17
6/ 7	12 32.2	-0.14	12 34.7	-0.30	9.9	1.25	1.70	5.30	1.12 to 6.39	98	20	75	7	293	-14	18
7/ 8	12 29.7	0.32	12 32.2	0.16	9.9	1.24	1.71	5.24	1.01 to 6.39	100	7	65	7	293	-15	19
8/ 9	12 27.1	1.19	12 29.6	1.03	9.9	1.22	1.72	5.17	0.51 to 6.38	102	6	56	6	292	-16	19
9/10	12 24.4	2.08	12 26.9	1.52	9.9	1.21	1.73	5.11	0.40 to 6.38	104	19	46	6	292	-16	20
10/11	12 21.6	2.58	12 24.1	2.42	10.0	1.19	1.74	5.04	0.30 to 6.38	106	32	37	6	292	-17	20
11/12	12 18.6	3.50	12 21.2	3.33	10.0	1.18	1.75	4.57	0.19 to 6.37	108	44	28	6	292	-18	21
12/13	12 15.6	4.43	12 18.1	4.26	10.0	1.17	1.76	4.50	0.07 to 6.37	110	57	20	6	291	-19	22
13/14	12 12.4	5.37	12 15.0	5.21	10.1	1.15	1.77	4.43	23.56 to 6.36	112	70	13	5	291	-19	22
14/15	12 9.1	6.33	12 11.7	6.16	10.1	1.14	1.78	4.36	23.44 to 6.35	114	84	7	5	290	-20	23
15/16	12 5.7	7.30	12 8.2	7.13	10.1	1.13	1.79	4.28	23.33 to 6.35	116	97	2	5	290	-21	23
16/17	12 2.1	8.29	12 4.7	8.12	10.1	1.12	1.81	4.21	23.21 to 6.34	118	111	0	5	289	-21	24
17/18	11 58.4	9.28	12 1.0	9.12	10.2	1.11	1.82	4.13	23.09 to 6.33	121	125	0	4	289	-22	24
18/19	11 54.6	10.29	11 57.2	10.13	10.2	1.10	1.83	4.05	22.56 to 6.33	123	139	2	4	288	-23	25
19/20	11 50.6	11.31	11 53.2	11.14	10.3	1.09	1.84	3.57	22.44 to 6.32	125	153	6	4	287	-24	25
20/21	11 46.5	12.34	11 49.1	12.17	10.3	1.08	1.85	3.49	22.31 to 6.31	127	167	12	4	286	-25	26
21/22	11 42.3	13.38	11 44.9	13.21	10.3	1.07	1.86	3.41	22.18 to 6.30	129	171	20	4	285	-25	26
22/23	11 37.9	14.42	11 40.5	14.26	10.4	1.07	1.87	3.33	22.05 to 6.29	132	159	30	3	284	-26	26
23/24	11 33.4	15.48	11 36.0	15.31	10.4	1.06	1.88	3.24	21.52 to 6.28	134	144	41	3	282	-27	27
24/25	11 28.8	16.53	11 31.4	16.37	10.4	1.06	1.89	3.16	21.39 to 6.27	136	129	53	3	281	-27	27
25/26	11 24.0	17.59	11 26.6	17.42	10.5	1.05	1.90	3.07	21.26 to 6.26	139	114	64	3	279	-28	27
26/27	11 19.1	19.05	11 21.7	18.48	10.5	1.05	1.92	2.58	21.12 to 6.25	141	98	75	2	277	-29	27
27/28	11 14.0	20.10	11 16.7	19.54	10.6	1.05	1.93	2.49	20.59 to 6.24	143	83	84	2	274	-29	27
28/29	11 8.9	21.16	11 11.5	20.59	10.6	1.05	1.94	2.40	20.45 to 6.22	145	68	92	2	272	-30	27
29/30	11 3.6	22.20	11 6.3	22.04	10.7	1.05	1.95	2.31	20.32 to 6.21	147	53	97	2	269	-30	26
30/31	10 58.2	23.24	11 0.9	23.08	10.7	1.05	1.96	2.22	20.18 to 6.20	149	38	100	2	265	-30	26
31/32	10 52.7	24.28	10 55.4	24.12	10.8	1.05	1.97	2.12	20.05 to 6.18	151	25	100	2	262	-31	26
February 1999																
1/ 2	10 47.1	25.30	10 49.9	25.14	10.8	1.05	1.98	2.03	19.51 to 6.17	153	16	98	1	257	-31	25
2/ 3	10 41.5	26.30	10 44.2	26.14	10.9	1.06	1.99	1.53	19.38 to 6.16	155	18	94	1	253	-31	25
3/ 4	10 35.7	27.29	10 38.5	27.14	11.0	1.06	2.01	1.44	19.25 to 6.14	157	28	89	1	247	-31	24
4/ 5	10 29.9	28.27	10 32.7	28.11	11.0	1.07	2.02	1.34	19.12 to 6.13	158	40	81	1	241	-31	23
5/ 6	10 24.1	29.22	10 26.9	29.07	11.1	1.08	2.03	1.24	18.59 to 6.11	159	53	73	1	234	-31	23
6/ 7	10 18.2	30.16	10 21.1	30.01	11.2	1.08	2.04	1.14	18.46 to 6.10	160	66	64	1	227	-31	22
7/ 8	10 12.3	31.08	10 15.2	30.53	11.2	1.09	2.05	1.04	18.34 to 6.08	161	79	55	1	219	-31	21
8/ 9	10 6.4	31.57	10 9.3	31.42	11.3	1.10	2.06	0.55	18.22 to 6.06	161	91	45	1	211	-31	20
9/10	10 0.5	32.44	10 3.4	32.30	11.4	1.12	2.07	0.45	18.24 to 6.05	161	104	36	1	203	-31	19
10/11	9 54.6	33.29	9 57.5	33.15	11.4	1.13	2.08	0.35	18.25 to 6.03	160	116	27	1	195	-30	18
11/12	9 48.7	34.12	9 51.6	33.58	11.5	1.14	2.10	0.25	18.27 to 6.01	160	129	19	1	188	-30	17
12/13	9 42.8	34.52	9 45.8	34.38	11.6	1.16	2.11	0.15	18.29 to 5.60	159	141	11	1	181	-29	16
13/14	9 37.1	35.30	9 40.1	35.17	11.7	1.17	2.12	0.06	18.31 to 5.58	158	152	5	1	174	-29	15
14/15	9 31.3	36.06	9 34.4	35.53	11.7	1.19	2.13	23.56	18.32 to 5.56	157	158	1	1	169	-28	14
15/16	9 25.7	36.40	9 28.8	36.26	11.8	1.20	2.14	23.47	18.34 to 5.54	155	157	0	1	164	-28	13
16/17	9 20.1	37.11	9 23.3	36.58	11.9	1.22	2.15	23.37	18.36 to 5.52	154	148	0	1	159	-27	13
17/18	9 14.7	37.40	9 17.8	37.27	12.0	1.24	2.16	23.28	18.38 to 5.50	152	136	3	1	155	-26	12
18/19	9 9.4	38.07	9 12.5	37.55	12.0	1.26	2.17	23.18	18.39 to 5.48	151	122	9	1	151	-26	11
19/20	9 4.1	38.32	9 7.3	38.20	12.1	1.28	2.19	23.09	18.41 to 5.46	149	108	17	1	148	-25	10
20/21	8 59.0	38.55	9 2.2	38.43	12.2	1.30	2.20	23.00	18.43 to 5.38	148	94	26	1	145	-24	9
21/22	8 54.0	39.16	8 57.2	39.05	12.3	1.32	2.21	22.51	18.45 to 5.28	146	79	37	1	142	-24	8
22/23	8 49.2	39.36	8 52.4	39.24	12.4	1.34	2.22	22.43	18.47 to 5.17	144	66	49	1	139	-23	8
23/24	8 44.5	39.54	8 47.7	39.42	12.4	1.36	2.23	22.34	18.48 to 5.07	143	52	60	1	137	-22	7
24/25	8 39.9	40.10	8 43.2	39.59	12.5	1.39	2.24	22.25	18.50 to 4.56	141	40	71	1	135	-21	6
25/26	8 35.5	40.25	8 38.8	40.14	12.6	1.41	2.25	22.17	18.52 to 4.45	139	29	81	1	133	-21	6
26/27	8 31.2	40.38	8 34.5	40.28	12.7	1.43	2.27	22.09	18.54 to 4.34	138	23	89	1	131	-20	5
27/28	8 27.0	40.50	8 30.4	40.40	12.8	1.46	2.28	22.01	18.56 to 4.23	136	25	95	1	129	-19	5
28/29	8 23.0	41.01	8 26.4	40.51	12.9	1.48	2.29	21.53	18.57 to 4.12	135	33	99	1	127	-18	4

TA format (example)

```
               1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                        Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5   2               Shanklin
961214.70 S   3.8  AA   8   B       20  6      7/  0.50   40   Baroni
```

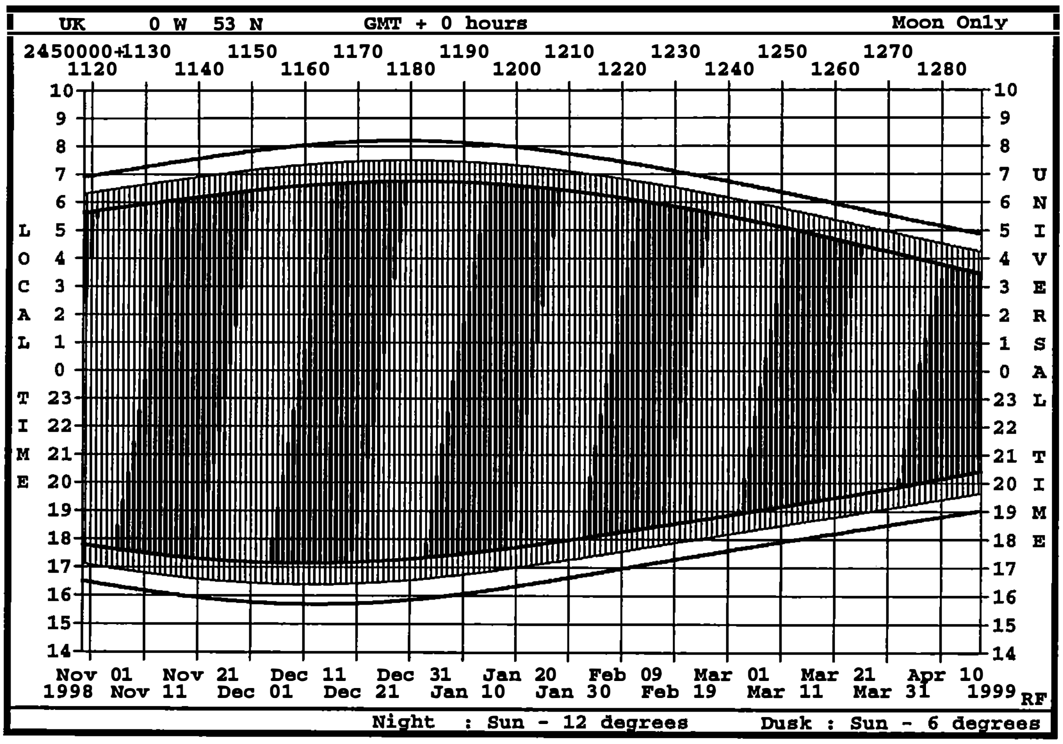
ICQ format (example)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC      m
 991992    1992  5 18.94  S  9.3 AA  7.5R     50   6    4        135 ICQ XX BEA
  P1955A1  1955  6 18.08      5.0 BD  5  R      6   5   s5   0.75 335 ICQ XX STO01
```

Charts

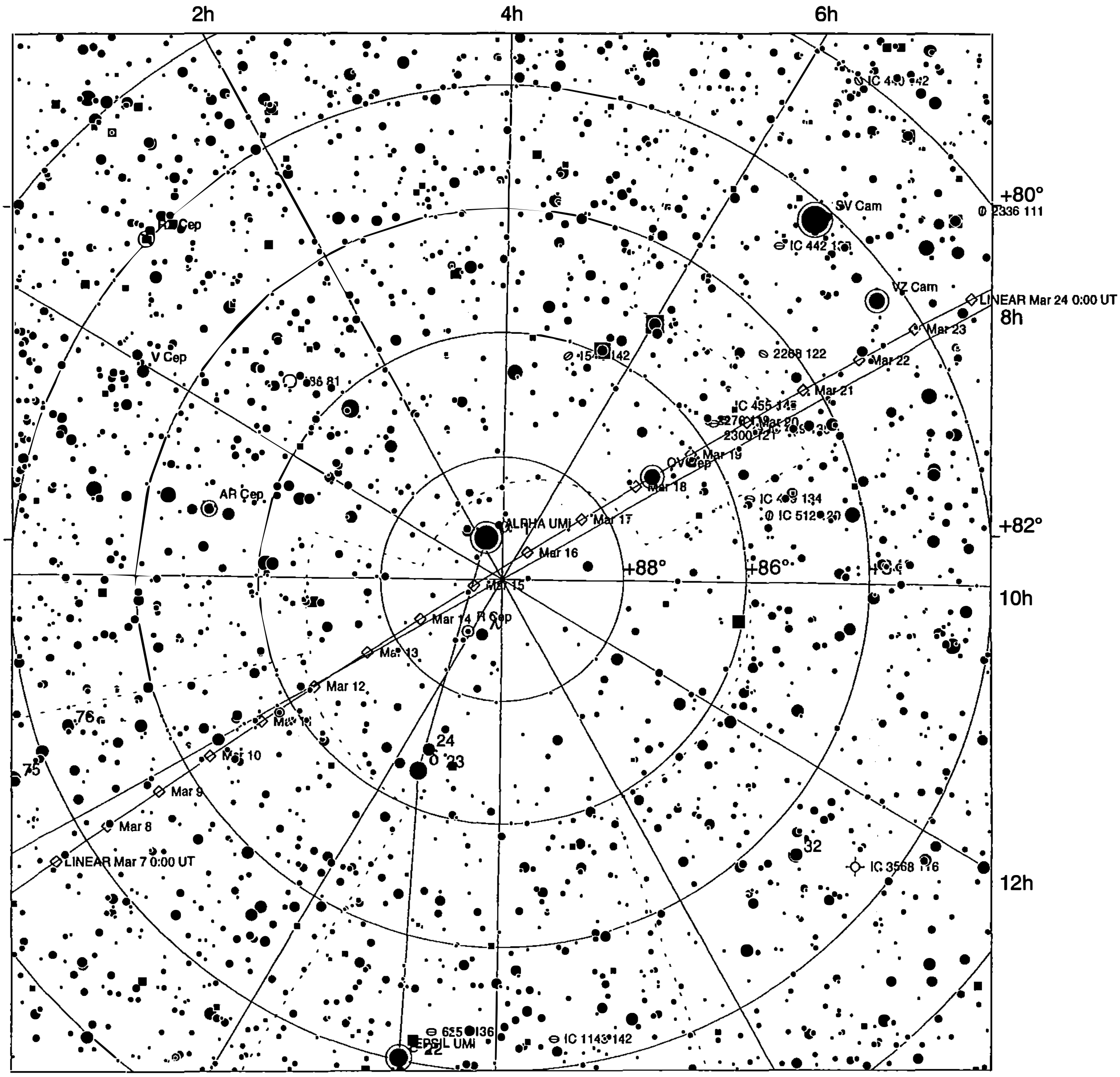
The diagram on this page shows when the moon interferes with observations and was produced using software written by Richard Fleet. There is no moon in the dark regions and the moon will only interfere a little in the grey shaded regions.

The listed comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet. Overleaf a chart shows the path of comet LINEAR (1998 M5) as it passes over the north pole. Magnitude estimates should use the north polar sequence shown in the Section Guide.



MegaStar

S / W E	0 1 2 3 4 5 6 7 8 9 10	16° 49.5' x 15° 56.4'	03h 56m 29.2s +89° 34' 33"	Oct 11, 1998 22:00 LT 22:00 UT N 52° 0' 0.0" W 0° 0' 0.0" Alt: 52.1° Azim: 0.6° Trans: 02:39 Rise: --- Set: ---
Galaxy	Glxy Cl	Globular	Open Cl	Planetary
Clust+Neb	UMi / Uranometria 1			
Bright Neb	Dark Neb	Asterism	Unknown	Quasar
Dbl Star	Comet	Asteroid		



Comet LINEAR (1998 M5)

Oct 11, 1998 22:00

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are VT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

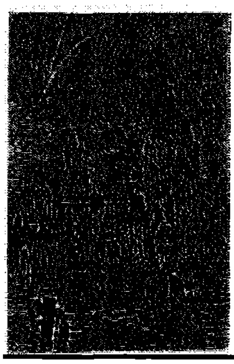
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 6, No 1 (Issue 11), 1999 April

INTERNATIONAL WORKSHOP ON COMETARY ASTRONOMY

The BAA Comet Section is very pleased to be hosting the second International Workshop on Cometary Astronomy. This will be held at New Hall Cambridge from August 14 to 16. The meeting aims to bring together professional and amateur observers and as many comet discoverers as possible.

The first IWCA was held at Selvino, Italy in February 1994 and details appeared in the Comet's Tale for 1994 May. Four previous American Workshops on Cometary Astronomy had been held in the U.S.A., but had not attracted much attention in Europe.

The 1994 meeting marked the 15th anniversary of the ICQ and attracted a good attendance of active observers. Presentations on the work of various national observing groups were given, along with talks by individuals on their own particular programs. Of greater importance were sessions which focussed on observing methodologies and these lead to significant improvements in the quality of observations.

Since then we have had two very bright comets which presented new problems in observation. There has been a huge growth in the Internet, enabling rapid dissemination of observations and the suspicion that this may bias observers. Planetarium programs using the Guide Star Catalogue now give observers precise finder charts enabling them to observe much fainter comets than in the past.

These new problems need new solutions and hopefully discussion at the meeting will lead to some conclusions that further improve our observing standards. However, observers generally have very fixed views so expect some heated arguments!

Although many amateurs observe comets for their own satisfaction, it can add enjoyment if you know that your observations are contributing to the scientific understanding of comets. To this end a number of leading professionals will be at the meeting, explaining how our observations are used and what additional observations would help with their research.

Bearing all this in mind the meeting has three main goals: 1) improving the acquisition of cometary information. 2) increasing understanding as to what science can be gained through observing comets by both amateurs and professionals. 3) providing a forum in which cometary astronomers can meet others from distant geographical locations and discuss various issues.

The format of the meeting will be to have selected invited talks, open panel discussions, contributed talks and poster sessions. Speakers scheduled to appear include Doug Biesecker (SOHO comets), Nicolas Biver (visual magnitudes and CO outgassing beyond 3 AU), Stephane Garro (French archival observations), Dan Green (comet photometry), Eleanor Helin (comet searching/discovery at Palomar and with NEAT), Gary Kronk (Cometography), Brian Marsden (amateur contributions), Herman Mikuz (CCD photometry), Charles Morris (possibly on web issues), Mahendra Singh (comet spectroscopy).

The college bar will be open in the evenings for informal discussion. If it is clear there will be opportunity to use the two historic refractors at the University Observatory.

Cambridge has many sites of astronomical interest and there will be free time for participants to explore at their leisure. Many famous scientists with comet connections studied at Cambridge including Newton, Herschel, Challis and more recently Lyttleton.

To conclude the meeting I have arranged a trip to Stonehenge on the Monday evening, when we will be allowed in to the inner circle to view the stones close up. There have been some suggestions that Stonehenge was first constructed as either a comet or meteor observatory! Numbers for this visit have to be restricted and those attending the meeting will have priority.

A registration form is enclosed, so take the time to fill it in now and come and enjoy what should be a very interesting meeting. The latest details will be posted on the Section web page.

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way. Renewals should be sent to the Director and cheques made payable to the BAA. Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

I returned from my 11th visit to the Antarctic in March. It was a very busy stay at Halley station where I was forecasting for our aircraft operations in addition to my expected tasks of installing a new automatic weather station and carrying out an inspection and calibration of the instrument which measures ozone. The forecasting was quite successful and we had no aborted flights during the 8 weeks of operations.

On the flight down to Antarctica I had a window seat (thanks to a kindly RAF airman) and was able to see the spectacular return of the Leonids. At its best we saw one fireball every 10 seconds and I logged over 300 meteors. The peak was much earlier than predicted by the experts so who knows where the best location for the 1999 return will be.

I saw a number of other interesting phenomena during my stay: a brilliant halo display which included Hevelius' parhelia, the parhelic circle and a circumzenithal arc with supernumery colours, a fogbow, miraging, iridescence on clouds, a 40 knot blizzard and a very weak aurora.

On passage I was able to complete drafts for papers on the comets of 1995, 1996 and 1997 and an outline of 1998 which will appear in the Journal in due course. I also entered another 2267 observations into the Section database, this time of the long period comets of the 1980s. This task is now almost completed and I only have to enter the observations of these long period comets which solely appeared in TA. I have not typed up all the observations in the files because some had already been sent to the ICQ by Michael Hendrie and I did not want to duplicate his typing. I suspect, however, that I may not hold all the observation forms from some observers and that they may have gone missing before I took over as Director. If anyone wants a list of magnitude observations that I hold, please let me know.

The computer archive currently has over 26,000 visual magnitude observations by 617 observers at 338 cometary apparitions. 117 observers have made only one observation, 376 fewer than 11 and only 54 have made more than 100. Major contributions include 2433 from myself, 884 from Albert Jones, 549 from Roy Panther, 504 from Tony Tanti, 370 from Guy Hurst, 351 from Werner Hasubick, 225 from Melvyn Taylor, 224 from Michael Gainsford, 171 from Gabriel Oksa, 151 from Michael Hendrie, 136 from Frank Ventura, 125 from Sally Beaumont, 104 from George Alcock and 98 from James Fraser. Over the years many non and former BAA Members have also contributed observations, in particular TA contributors and the Australian comet section, including Andrew Pearce (1187), John Bortle (989), Martin Lehky (697), Herman Mikuz (625), Alexandr Baransky (621), Bjorn Granslo (481), David Seargent (475), Graham Keitch (460), Vittorio Zannotta (410), Graham Wolf (406), Jose Aguiar (375), Reinder Bouma (364), Atilla Kosa-Kiss (334), Chris Spratt (316) and Paul Camilleri (281). For most observers these are not the full total that they have made as it excludes those sent to the ICQ prior to the commencement of the archive. If any readers would like to add to their totals by sending me observations in ICQ format either via email or on floppy disc I'll be very pleased to include them.

As described on the front page, we are hosting the International

Workshop on Cometary Astronomy in August, and I hope to see as many of you there as possible. Don't miss it, who knows where the next one will be!

Visitors who have indicated that they will be coming include Jose Aguiar (Brazil), Alexandr Baransky (Ukraine), Doug Biesecker (USA/UK), Giuseppe Canonaco (Belgium), Jose Carvajal (Spain), Tim Cooper (South Africa), Stephane Garro (France), Dan Green (USA), Werner Hasubick (Germany), Michael Jager (Austria), Gary Kronk (USA), William Liller (Chile), Don Machholz (USA), Brian Marsden (USA), Herman Mikuz (Slovenia), Charles Morris (USA), Andrew Pearce (Australia), James Scotti (USA), David Seargent (Australia), Chris Spratt (Canada), Patrick Stonehouse (USA), Kesao Takamizawa (Japan).

Since the last newsletter (which was incorrectly numbered volume 6 instead of 5) observations or contributions have been received from the following BAA members: Sally Beaumont, David Briggs, Denis Buczynski, David Clegg, Werner Hasubick, Guy Hurst, Nick James, John Lewis, John Mackey, Gabriel Oksa, Jonathan Shanklin, David Strange, Melvyn Taylor and Alex Vincent

and also from: Alexandr Baransky, Sandro Baroni, John Bortle, Reinder Bouma, Stephen Getliffe, Roberto Haver, Aymen Mohamed Ibrahem, Andreas Kammerer, Heinz Kerner, Atilla Kosa-Kiss, Martin Lehky, Jean-Claude Merlin, Herman Mikuz, Andrew Pearce and Seiichi Yoshida (apologies for any omissions or miss-classifications).

Comets under observation were: 4P/Faye, 10P/Tempel 2, 21P/Giacobini-Zinner, 29P/Schwassmann-Wachmann 1, 37P/Forbes, 52P/Harrington-Abell, 59P/Kearns-Kwee, 60P/Tsuchinshan 2, 65P/Gunn, 74P/Smirnova-Chernykh, 88P/Howell, 93P/Lovas 1, 95P/Chiron, 139P/Vaisala-Oterma, 140P/Bowell-Skiff, Hale-Bopp (1995 O1), Spacewatch (1997 BA6), Meunier-Dupouy (1997 J2), Mueller (1998 K1), LINEAR (1998 K5), LINEAR (1998 M2), Larsen (1998 M3), LINEAR (1998 M5), Williams (1998 P1), LONEOS-Tucker (1998 QP54), P/LINEAR-Mueller (1998 S1), LINEAR (1998 T1), P/Mueller 6 (1998 U2), P/Jager (1998 U3), LINEAR (1998 U5), Spahr (1998 W1), LINEAR (1998 W3), P/ODAS (1998 X1), P/LINEAR (1998 Y1), P/Li (1998 Y2), Tilbrook (1999 A1), Hermann (1999 D1) and Li (1999 E1).

Many of the fainter comets were observed only by Seiichi Yoshida who is using a CCD camera on an 18 cm reflector to very good effect. I hope to see many more CCD observations from UK observers in the next edition, though I can't set an example as my camera has been 'borrowed' to help test equipment for Gemini!

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, BAA Journals and Sky & Telescope.

150 Years Ago: Francis De Vico died on 1848 November 15. He discovered 6 comets and was awarded the King of Denmark's Gold Medal four times in 1846 for his telescopic discoveries. He died of typhus on a visit to England and was buried in the cemetery of the Roman Catholic chapel in Chelsea.

100 Years Ago: An interim report on Brooks' comet 1898I appears in the December Journal. It was conspicuous in early November and the reports suggest that it was a little fainter than M13. [*only Messier objects were used for comparisons, a practice that is not recommended today.*]. In the January Journal Mr Crommelin reported that plates taken to determine the Leonid radiant had also revealed a new comet. Ten comets were observed in 1898, a record, beating that of 1858 when eight were observed. In March a review of "Remarkable Comets" by W T Lynn, noted that comets were probably attracted into the orbit of meteor swarms, rather than the meteors forming from comets. At the Conversazione (an evening exhibition meeting) Mr Crommelin gave a lecture on comets and recommended more use of photography in the observation and discovery of comets. In the intervals between lectures, the Blue Anglo-Hungarian Band played music and there was the chance to view the exhibits. A note on comet seeking recommends the use of one eye for solar observing and the other for comets and nebulae, and never looking at strong light such as the sun or electric arcs.

50 Years Ago: The November meeting had several reports on the eclipse comet, which was one of the brightest of the century (further reports appeared in Sky & Telescope). Next month, Dr Merton gave a talk on comets. In response to a question he commented "We do need careful observations of its magnitude. Most of those who sent the first reports appear to have been so moved at the splendid sight this comet made that they omitted to record precise information of physical details." The January Journal contains an abstract of a paper on cometary statistics which appeared in Bulletin No 283 of the New South Wales branch. Details of this also appeared in Sky & Telescope. The March Journal has a report of a lecture given by Dr J G Porter to the Newcastle-on-Tyne Astronomical Society. At this time the 'sandbank' theory of comets was popular and he suggested that Halley's comet might consist of $3x10^{13}$ tons of blocks of meteoric material scattered over a space about 20 miles in diameter. [*Giotto showed that the comet was a single nucleus x miles long, weighing some x tons*]. Sky & Telescope was running a series of articles entitled 'Terminology Talks'. Several of these focussed on comets. In December there was a short article on the great comet of 1882, including some recollections from Americans who had seen it. [*Perhaps older readers would like to contribute recollections of the Eclipse comet, or other bright comets seen over 25 years ago*]. An explanation of comet terminology again likened the comet's nucleus to a swarm of meteorites extending over a few thousand miles, with considerable space between the individual particles. Finally 1948 equaled the record number of comets with 14.

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

Jonathan Shanklin

The following abstracts (some shortened further for publication) are taken from the Cambridge Conference Network (CCNet), which is a scholarly electronic network devoted to catastrophism, but which includes much information on comets. To subscribe, contact the moderator Benny J Peiser at <b.j.peiser@livjm.ac.uk>. Information circulated on this network is for scholarly and educational use only. The abstracts, taken from daily bulletins, may not be copied or reproduced for any other purposes without prior permission of the copyright holders. The electronic archive of the CCNet can be found at http://abob.libs.uga.edu/bobk/cccmenu.html

M. Fulle, G. Cremonese, C. Bohm: **The preperihelion dust environment of C/1995 O1 Hale-Bopp from 13 to 4 AU.** ASTRONOMICAL JOURNAL, 1998, Vol.116, No.3, pp.1470-1477

Two UK Schmidt plates of comet Hale-Bopp dust tail taken in 1996 May are analyzed by means of the inverse dust tail model. The dust tail fits are the only available tools providing estimates of the ejection velocity, the dust-loss rate, and the size distribution of the dust grains ejected during years preceding the comet discovery. These quantities describe the comet dust environment driven by CO sublimation between 1993 and 1996, when the comet approached the Sun from 13 to 4 AU. The outputs of the model are consistent with the available coma photometry, quantified by the Af rho quantity. The dust mass loss rate increases from 500 to 8000 kg s(-1), these values being inversely proportional to the dust albedo, assumed here to be 10%. Therefore, the mass ratio between icy grains and CO results is at least 5. Higher values of the dust-to-gas ratio are probable, because the model infers the dust-loss rate over a limited size range, up to 1 mm sized grains, and because the power-law index of the differential size distribution ranges between -3.5 and -4.0, so that most of the dust mass was ejected in the largest boulders that Hale-Bopp was able to eject. The dust ejection velocity close to the observations, between 7 and 4 AU, was close to 100 m s(-1) for grains 10 mu m in size, much higher than that predicted by R. F. Probstein's theory, thus confirming previous results of Neck-Line photometry. This result is an indicator of CO superheating with respect to a free sublimating CO ice, in agreement with the high observed CO velocity. The fundamental result of the paper is that such a high dust velocity remained constant between 13 and 4 AU, thus providing a strong constraint to all models of the CO-driven activity of the comet during its approach to the Sun: CO superheating must have been active since 13 AU from the Sun. It might be provided by the abundant dust itself, or by seasonal effects heating the subsurface layers, as was suggested for comet 29P/Schwassmann-Wachmann 1. Another similarity between the two comets is provided by the power-law index of the time-averaged size distributions: -3.6 +/- 0.1 for C/1995O1 and -3.3 +/- 0.3 for 29P/SW1. However, other characteristics of the dust environments are very different, so that, in general, it is impossible to distinguish a CO-driven comet from a typical water-driven one.
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P.L. Lamy, I. Toth, H.A. Weaver: **Hubble Space Telescope observations of the nucleus and inner coma of comet 19P/Borrelly.** ASTRONOMY AND ASTROPHYSICS, 1998, Vol.337, No.3, pp.945-954

The nucleus of comet 19P/Borrelly was detected using the Planetary Camera (WFPC2) of the Hubble Space Telescope (HST). During the time of our observations, the comet was 0.62 AU from the Earth, 1.40 AU from the Sun, and had a solar phase angle of 38 degrees. The high spatial resolution of the HST images allowed us to discriminate clearly between the signal from the nucleus and that from the coma. The lightcurve of the nucleus indicates that it is a highly elongated body rotating with a synodic period of 25.0 +/- 0.5 hr. Assuming that the nucleus has a geometric albedo of 4% and is a prolate spheroid with a rotational axis pointing in the direction determined by Sekanina (1979), we derive that its semi-axes are 4.4 +/- 0.3 km and 1.8 +/- 0.15 km. The corresponding fractional active area of similar to 8% suggests a moderately active comet. The highly anisotropic coma is dominated by a strong sunward fan, and the dust production rate exhibited signs of temporal variability throughout our observations.
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W. Waniak, S. Zola: **Dust emission for Comets Shoemaker-Levy 1991a1 and McNaught-Russell 1993v.** ICARUS, 1998, Vol.136, No.2, pp.280-297

We present CCD photometric results for the dust comae of the dynamically new Comet Shoemaker-Levy 1991a1, carried out at heliocentric distances from 1.2 to 0.8 AU pre-perihelion, and the high-eccentricity, long-period Comet McNaught-Russell 1993v obtained at a heliocentric distance close to 1.0 AU post-perihelion. Maps of the directional distribution of the dust emission rate from these cometary nuclei were obtained using the directional deconvolution method (Waniak 1994, Icarus 111, 237-245). For Comet Shoemaker-Levy the prominent region of enhanced dust production was situated between the solar terminator and the nucleocentric meridian opposite the subsolar point. Activity in this region on the night side of the nucleus may be explained both by the heating of the nucleus' surface by scattered visible and reemitted infrared radiation, which is produced by the dust coma, or by non-solar radiation sources of energy, such as chemical reactions or phase transitions. During the period of observations the dust emission rate for this region decreased in comparison with that of another region of enhanced dust production situated on the

subsolar hemisphere. For Comet McNaught-Russell two active regions were also visible, although the subsolar region was much more active than that on the night side of the nucleus. For both comets, dust was emitted from the entire surface of the nucleus at a level no lower than 30% of the maximum value for the active regions. The total (integrated over a 4 pi solid angle) dust emission rate for Comet Shoemaker-Levy changed as r(h)(-2.3) for the observed range of heliocentric distance r(h). For both comets, the ejection velocity of submicron dust particles was of the order of 0.1 km sec(-1) and the power-law size distribution of dust particles (a(-n)) had a mean value of exponent n equal to 2.9. The power-law dependence of the ejection velocity upon the beta parameter (nu similar to beta(k)) was specified by a mean value of k close to 0.18.
(C) 1998 Academic Press.

P. Wiegert & S. Tremaine: **The evolution of long-period comets.** ICARUS, 1999, Vol.137, No.1, pp.84-121

We study the evolution of long-period comets by numerical integration of their orbits, a more realistic dynamical approach than the Monte Carlo and analytic methods previously used to study this problem. We follow the comets from their origin in the Oort cloud until their final escape or destruction, in a model solar system consisting of the Sun, the four giant planets and the Galactic tide. We also examine the effects of nongravitational forces as well as the gravitational forces from a hypothetical solar companion or circumsolar disk. We confirm the conclusion of Oort and other investigators that the observed distribution of long-period comet orbits does not match the expected steady-state distribution unless there is fading or some similar physical process that depletes the population of older comets. We investigate several simple fading laws, We can match the observed orbit distribution if the fraction of comets remaining observable after m apparitions is proportional to m(-0.6+/-0.1) (close to the fading law originally proposed by Whipple 1962); or if approximately 95% of comets live for only a few (similar to 6) returns and the remainder last indefinitely, Our results also yield statistics such as the expected perihelion distribution, distribution of aphelion directions, frequency of encounters with the giant planets and the rate of production of Halley-type comets.
(C) 1999 Academic Press.

P. Gronkowski & J. Smela: **The cometary outbursts at large heliocentric distances.** ASTRONOMY AND ASTROPHYSICS, 1998, Vol.338, No.2, pp.761-766

A model is presented explaining changes in cometary brightness during an outburst at large heliocentric distances. It is shown that a combination of the following effects can explain the main characteristics of outburst at large heliocentric distances: the specific exothermic processes in cometary nucleus (as the HCN polymerisation and the crystallization of the water amorphous ice, connected with the ejection of the large quantities of dust) and the sublimation of CO or CO2 from the comet's nucleus. The obtained results are in good agreement with observations.
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Z. Sekanina: **A double nucleus of comet Evans-Drinkwater (1996 J1).** ASTRONOMY AND ASTROPHYSICS, 1998, Vol.339, No.1, pp.L25-L28

The nucleus of comet C/1996 J1, whose duplicity was first detected in early May 1997, similar to 4 months after perihelion, is found to have split nontidally similar to 70 days before perihelion at 1.65 AU from the Sun. The secondary nucleus, discovered when in outburst and subsequently observed for 8-1/2 months, had separated from the primary nucleus at a rate of 1.7 m/s and drifted away from it with a radial nongravitational deceleration of similar to 31 x 10(-5) the Sun's attraction, typical for the short-lived companions. At the time of splitting, this dynamically new comet was near conjunction with the Sun and therefore unobservable from Earth. In late 1997 and early 1998, when last seen, the companion was greater than or similar to 100 times fainter relative to the primary component than it had been when first reported.
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A. Brunini & M.D. Melita: **On the existence of a primordial cometary belt between Uranus and Neptune**. ICARUS, 1998, Vol.135, No.2, pp.408-414

The existence of stable orbits in the interplanetary region between Uranus and Neptune over the lifetime of the Solar System has been reported by Holman (1997, Nature 387, 785-788). A long-term integration of test particles in that zone resulted in a number of surviving bodies with semimajor axis roughly between 24 and 27 AU, and eccentricities and inclinations smaller than 10(-2) and 1 degrees, respectively. According to up-to-date surveys, the total mass of this putative belt has been estimated as less than or equal to 10(-3) M+ and it would be composed of objects with radius smaller than 50 km. In this work we assess the plausibility of the existence of a real population of objects in such a belt. Time-reversal arguments rule out the possibility of capture in such long-term stable orbits, for example, of objects escaped from the Kuiper belt. So if a real population exists nowadays, it should have undergone the conditions of planetesimal accretion in the region. Hence, we have studied the orbital evolution of test particles under different kinds of plausible primordial scenarios. The conditions considered were mutual collisions and gravitational encounters, planetary migration and the presence of an adjacent Pluto-sized object. Under none of these conditions have we obtained a surviving substantial population on the reported belt region, from which it is concluded that, at present time, it would be very unlikely to find a substantial number of primordial objects in those long-term stable orbits.
(C) 1998 Academic Press.

Z. Sekanina: **Multiple fragmentation of comet P/Machholz 2 (1994 P1).** ASTRONOMY AND ASTROPHYSICS, 1999, Vol.342, No.1, pp.285-299

Discovered in August of 1994, periodic comet Machholz 2 consisted of five condensations, A-E, of which D later became double. They were lined up along their common heliocentric orbit (with A being the leading and brightest component) and connected by a trail of material, suggesting that the comet's nuclear fragmentation was accompanied by a copious release of large dust particles. The earliest breakup is found to have occurred in late 1987, similar to 600 days before the comet's 1989 perihelion, giving birth to fragment B and the grand precursor of A. The precursors of A and D and fragments A and C appear to have originated, respectively, similar to 5 days prior to and right at perihelion. The last breakup episode during that same return to the Sun was the separation of E, probably from the precursor of D, similar to 600 days after perihelion. The division of D into D-1 and D-2 is the only event analysed in this paper that occurred one revolution later, in 1994. The circumstances and implications of this fragmentation sequence are examined in detail and predictions are presented for 1999/2000.

Review of comet observations for 1998 October - 1999 March

The information in this report is a synopsis of material gleaned from IAU circulars 7030 – 7138 and The Astronomer (1998 October – 1999 March). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

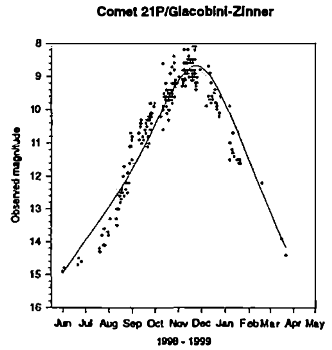
4P/Faye was observed several times over the winter as it slowly brightened to around 13th mag. Perihelion is not until May, but this is a poor return and further observations are unlikely, though observers with large apertures may glimpse it in the autumn.

10P/Tempel 2 makes its 20th observed return since its discovery by William Tempel (Milan, Italy) as a 9th magnitude object in 1873. Several unfavourable returns were missed in the earlier years. The orbit is very stable, which is one reason why it is a favoured target for planned spacecraft missions. In 1983 the IRAS satellite detected an extensive dust trail behind the comet.

Traditionally the light curve is regarded as highly asymmetric with a late turn on. There is a rapid rise in brightness as perihelion approaches, which continues more slowly for a couple more weeks after perihelion, followed by a slow decline until activity switches off. An alternative view is that the light curve is linear with a peak about a month after perihelion, which at this return occurs in early September.

With a 5.5 year period alternate returns are favourable and this is one of them. A CCD observation by Seiichi Yoshida in late March put it at 18th mag. The comet may be picked up in large telescopes in April when it is in Ophiuchus and it should reach 10th magnitude in June. It is closest to the Earth in July (0.65 AU) when it could be 9th magnitude and UK observers should be able to follow it until August, but it then moves too far south. More southerly observers may be able to observe it until the end of the year as it fades.

21P/Giacobini-Zinner, the parent comet of the October Draconid meteors, remained visible until March, though most observers lost it in December. Observations show the comet brightened very rapidly with distance from sun and earth changing in step. The 214 observations give a light curve of 8.3 + 5 log d + 11.4 log r.



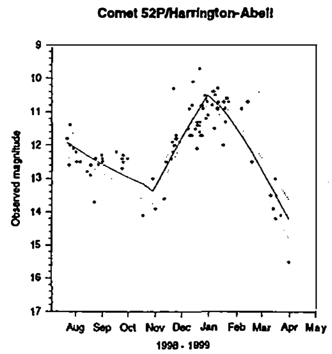
29P/Schwassmann-Wachmann 1 has frequent outbursts and over the past couple of years seems to be more often active than not, though it rarely gets brighter than 12m. It is possible that its pattern of behaviour is changing. This year Andrew Pearce detected a major outburst at the end of March.

It is at opposition in May on the borders of Hydra and Libra and reaches solar conjunction in November. Observers are encouraged to check the comet at every opportunity over the apparition, although it will remain at low altitude for UK observers for several years to come. It is worth monitoring with CCD cameras on a regular basis.

37P/Forbes will be 13m between April and June. Andrew Pearce picked up the comet at 13.5 in the second half of March.

52P/Harrington-Abell was discovered in outburst at 12th magnitude by Alain Maury, Observatoire de la Cote d'Azur, on CCD images taken on July 21.1. It slowly faded, but then underwent a second outburst in October that peaked some 29 days before perihelion, which was in late January. This is the seventh observed return of the comet since its discovery in 1954 and it has never became brighter than 17th magnitude at previous returns. Normally it would have been expected to get no brighter than 15th magnitude at this return, but peaked near 10th magnitude at the turn of the year.

Observations received so far (90) give an uncorrected preliminary light curve for the second outburst of 10.9 + 5 log d + 0.0299 abs(t - T + 28.5)



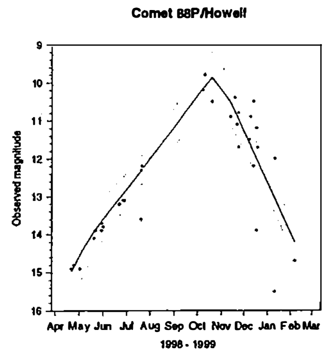
59P/Kearns-Kwee was observed by Werner Hasubick in January at 15th mag. This is rather brighter than expected and it could reach 12th mag towards the end of the year.

60P/Tsuchinshan 2 is yet another faint object imaged by Seiichi Yoshida at 16th mag, which is as bright as it will get.

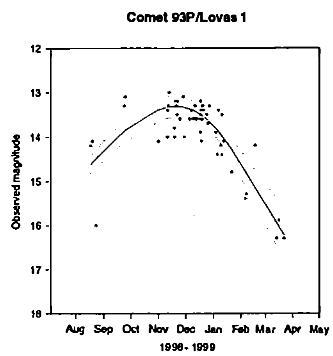
65P/Gunn remains on view to CCD observers, although it is only 17th mag.

Another faint object is **74P/Smirnova-Chernykh** which doesn't reach perihelion until January 2001 but has already been imaged by Seiichi Yoshida at 16th mag.

88P/Howell reached a peak magnitude of around 10 in the autumn, but was essentially a southern hemisphere object. The 33 observations received so far give a preliminary light curve of 8.8 + 5 log d + 0.0319 abs(t - T - 27.8)

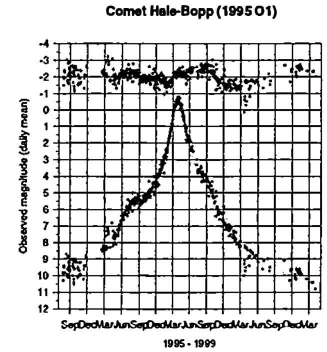


93P/Lovas 1 was quite well observed and faded from 13th mag at the turn of the year. The 53 observations give a preliminary light curve of 9.3 + 5 log d + 13.8 log r

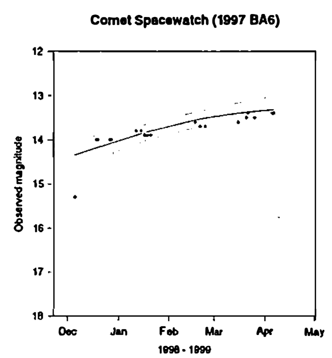


Comet/Asteroid **95P/Chiron** will be 16m when at opposition in late May in Libra. Seiichi Yoshida imaged it near 17th mag in the first quarter of the year.

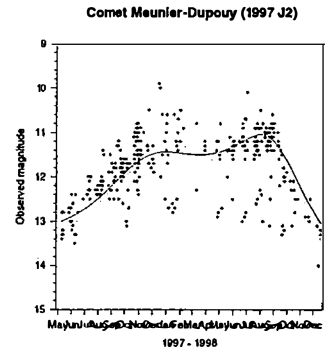
Hale-Bopp (1995 O1) is now a telescopic object, but still well placed for Southern Hemisphere observers as it loops round the Large Magellanic Cloud. Somewhat to my surprise I was able to glimpse it in 20x80 binoculars from the Falkland Islands in mid November at 10.5 but it will reach 13th mag by the end of this year. The observed arc now covers 1349 days with observations made on 734 days. The equation -0.69 + 5 log d + 7.66 log r fits daily means very well, but there are long period variations about this mean light curve of around a magnitude, which are shown plotted with an offset of -2. It is currently a little brighter than indicated by the equation.



Spacewatch (1997 BA6). The orbit of this comet is very eccentric, with a period near 4500 years and a semi-major axis of several hundred AU. Currently it is 13th mag and is at high southern declination. It is heading for perihelion at 3.4 AU in 1999 December when it may be around 12th mag.



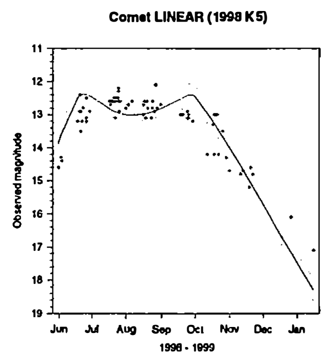
Meunier-Dupouy (1997 J2) faded away and no observations were received after December. The 359 observations received so far suggest a preliminary light curve of 5.1 + 5 log d + 5.8 log r.



Mueller (1998 K1) was imaged by Seiichi Yoshida over the winter, but is now fainter than 18th mag.

LINEAR (1998 K5) was a little fainter and a little more diffuse in mid October compared to the early autumn. By the end of October it was still 14th mag, but becoming larger and more diffuse and faded rapidly in November. The light curve is very unusual and the comet's absolute magnitude seems to have peaked some 73 days after perihelion. The combination of changing distance from earth, with the late peak in brightness kept the magnitude nearly constant from July to October.

The 71 observations analysed give a preliminary light curve of 13.1 + 5 log d + 0.0298 abs(t - T - 73.0).

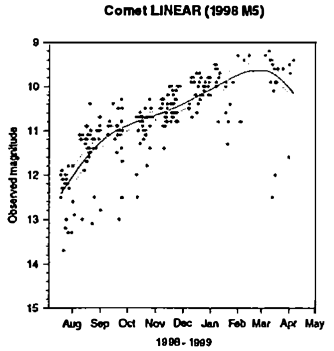


LINEAR (1998 M2) was imaged a couple of times by Seiichi Yoshida over the winter, but was too faint for most other observers.

Larsen (1998 M3) was also imaged by Seiichi Yoshida, this time at 18th mag.

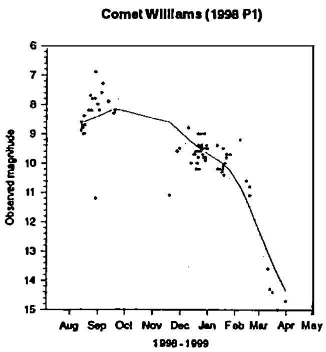
LINEAR (1998 M5) was at perihelion in January at around 10th magnitude and moved north from Lyra, passing very close to the pole in mid March. At this point its motion effectively cancelled out the earth's rotation and imaging was possible with a fixed mounting. Heading south it passes through Camelopardalus and Lynx, reaching Cancer mid year when it will have faded to 13th magnitude. It will then be too faint and close to the sun for further observation.

Observations received so far (225) give a preliminary light curve of 6.2 + 5 log d + 7.4 log r



Williams (1998 P1) was recovered after perihelion by Andrew Pearce in late November but its rapid fade had already begun and it was nearly 10^{th} mag. This fade continued, though some observers reported surprisingly bright magnitudes as late as March.

The 82 observations received so far give a light curve of 5.1 + 5 log d + 15.5 log r.



LONEOS Tucker (1998 QP54) was another target for Seiichi Yoshida, and was recorded at 16^{th} mag in December. Martin Lehky and Werner Hasubick also recorded it visually at near 15^{th} mag earlier in the autumn.

P/LINEAR-Mueller (1998 S1) faded from 14^{th} mag in November to 16^{th} mag in February.

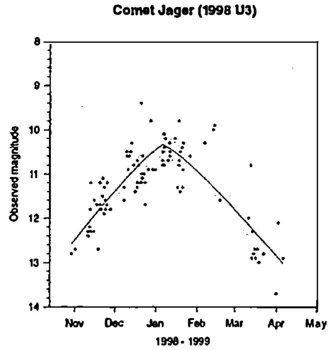
LINEAR (1998 T1) was discovered during survey work whilst still a long way from perihelion. Several observers recorded it over the winter whilst near 14^{th} mag. The light curve is not very well defined yet, but it should reach 9^{th} magnitude when it is at perihelion in June, though it will not be visible from the UK.

LINEAR (1998 U1) is yet another comet discovered by LINEAR. The object, discovered on October 18, was reported as asteroidal and fast-moving, and a request for further observations was placed on The NEO Confirmation Page. From the confirmatory observations, made at four observatories on October 20 and 21, it quickly became clear that the object had a retrograde, nearly parabolic orbit. Referring to the observations made with the 0.65-m f/3.6 reflector at the Ondrejov Observatory on October 20.9 UT, P. Pravec noted that a faint tail was visible on individual 3-min exposures with a clear filter. The tail, extending 16" in p.a. 60 deg, was confirmed on co-addition of six frames. [IAUC 7033, 1998 October 21]. The comet is faint and distant and past perihelion.

P/Mueller 6 (1998 U2) was discovered by Jean Mueller on plates taken by herself on Oct 21.3 (and with K. Rykoski on Oct. 22) with the 1.2-m Oschin Schmidt Telescope in the course of the Palomar Outer Solar System Ecliptic Survey. The comet had a strong condensation and a short, faint tail to the southeast. [IAUC 7035, 1998 October 22]. Prediscovery images from September 14 were found in LONEOS data and the comet is an intrinsically faint periodic object found at a favourable opposition. Seiichi Yoshida made a single observation in December when it was 17^{th} mag.

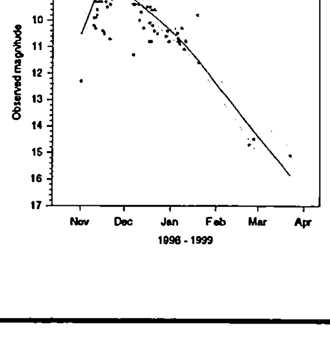
P/Jager (1998 U3) was discovered by TA correspondent Michael Jager on 16- and 9-min Technical Pan film exposures with a 0.25-m *f*/2.8 Schmidt camera. The comet had a 1'-2' coma with condensation and a tail several arcmin long in p.a. 275-281 deg and was around 12th mag. [IAUC 7038, 1998 October 25]. Nick James imaged the comet on October 26. I observed it on October 29.1, making it around 12.5 in the Northumberland refractor x105, DC s3 and diameter around 1'. It reached a very broad peak of 10^{th} mag between December and February.

Observations received so far (94) give a preliminary light curve of 9.8 + 5 log d + 0.0201 abs(t - T + 27.8). This suggests that it will now fade quite rapidly.



P/Spahr 1 (1998 U4) was discovered by Timothy B Spahr of the University of Arizona on October 27.4 on CCD images taken with the Catalina Sky Survey 0.41-m f3 Schmidt. It was 17th mag and was confirmed by Spacewatch Telescope images. [IAUC 7042, 1998 October 29]. The preliminary orbit is a distant elliptical one and the comet did not become any brighter.

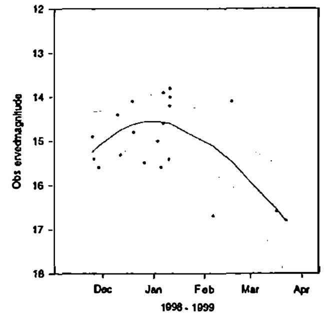
LINEAR (1998 U5) was another object discovered by LINEAR that was later identified as a comet. [IAUC 7044, 1998 October 31]. On November 1.18 I estimated it at 12.3, rather brighter than 1998 U3. It brightened explosively and reached 8^{th} mag just over a fortnight later.



Observations received so far (119) give a preliminary light curve of 6.1 + 5 log d + 28.9 log r. Although it faded quite quickly, very few observations were made after December

P/LINEAR (1998 VS24). On further examining the Nov. 10-11 observations, published on MPS 3154, of an apparently unremarkable asteroidal discovery from the LINEAR program, G. V. Williams made identifications with isolated sets of observations from Visnjan on Oct. 24, 28 (the latter having been published on MPS 2894 as one of two objects that were both erroneously identified with 1998 UD19) and Nov. 26. The resulting orbit was very cometary in form, with a period of 9.6 years. Furthermore, he recognized that the object had made an extremely close approach (< 0.01 AU) to Jupiter in Oct. 1971, with additional approaches to 0.5-0.7 AU in both 1983 and 1995. It is a distant intrinsically faint object, so of no concern for the moment.

P/Spahr 2 (1998 W1) Timothy B Spahr of the University of Arizona discovered another comet on November 16.4 on CCD images taken with the Catalina Sky Survey 0.41-m f3 Schmidt. It was 16th mag but there was no visible tail, with the round coma 18" in diameter [IAUC 7052, 1998 November 17]. It reached perihelion in January and was no brighter than 15[th] mag on CCD images, but visual observers made it as bright as 14[th] mag.



P/Hergenrother (1998 W2) C W Hergenrother found a comet on CCD images obtained by Timothy B. Spahr on Nov. 22.10 in the course of the Catalina Sky Survey. The comet was 17th magnitude and will fade. The comet was a short period one, almost at perihelion. [IAUC 7057, 1998 November 23]

LINEAR (1998 W3) The LINEAR Team discovered an object that had unusual motion on November 25.3 and placed the information in The NEO Confirmation Page. On reporting astrometric follow-up, G. Hug, Farpoint Observatory, Eskridge, KS, noted the object's appearance was probably cometary, a point confirmed by other observers on request from the Central Bureau, and by the near-parabolic retrograde orbit, which showed it to be a distant object. [IAUC 7063, 1998 November 28]. Seiichi Yoshida was able to image it on several occasions and Martin Lehky also recorded it visually near 15[th] mag.

139P/Vaisala-Oterma (1998 WG22) Precise positions of 1939 TN, an apparently asteroidal object discovered by Y. Vaisala at Turku on 1939 Oct. 7 and observed by him and L. Oterma on three more nights over a 35-day arc, were published in 1979 in Turku Obs. Report R10 and on MPC 4811. The orbit computation by Oterma suggested to her that the object was a comet, and in a communication to the Minor Planet Center in 1981 she remarked that a careful reexamination of the plates suggested that the object was perhaps somewhat diffuse. The introduction to the 1982 edition of the Catalogue of Cometary Orbits quotes her conclusion that the object was probably a comet, but the object was not actually listed as one. On MPEC 1998-X19, the object is identified by S. Nakano, Sumoto, with 1998 WG22, a 19th mag apparently asteroidal object observed by the LINEAR program on Nov. 18.26 and 21:

Fortuitously, this object was located only 4' from the result of integrating forward from 1939 the orbital elements by Brian Marsden on MPC 6815. Further LINEAR observations were made on Nov. 24. On observing the object with the 1.8-m reflector at the Dominion Astrophysical Observatory on Dec. 6.3 UT, D. Balam noted (in FWHM 3".1 seeing) an 8" coma and a tail extending 18" in p.a. 260 deg. On Dec. 7.1 W. Offutt, Cloudcroft, observing between clouds, also remarked on a tail (or antitail) extending 17" in p.a. 257 deg, but no coma was noted. M. Tichy, observing in poor conditions at Klet on Dec. 7.9, remarked on a possible 6" coma.

The object's cometary nature seems now reasonably assured and it has a period of 9.55 years [IAUC 7064, 1998 December 7]. Seiichi Yoshida was able to observe it at 18[th] mag shortly after discovery.

P/ODAS (1998 X1) The Observatoire de la Cote d'Azur-Deutsches Zentrum fur Luft und Raumfahrt Asteroid Survey (ODAS) discovered an 18th magnitude comet on December 15.17 with the 0.90-m Caussols Schmidt camera. The orbit is of short period (6.8 years), with perihelion having occurred in July. [IAUC 7067, 1998 December 17]. Once again Seiichi Yoshida successfully imaged it.

140P/Bowell-Skiff (1998 X2). G. V. Williams, Minor Planet Center, rediscovered comet P/1983 C1 (= 1983c = 1983 II) in the course of his processing of two-night "asteroid" data obtained by the LINEAR program on Dec. 14 and 17. The indicated correction to the prediction on MPC 27081 (ephemeris on MPC 32547) was Delta T = +17.3 days. [IAUC 7076, 1998 December 28]. Seiichi Yoshida has again been successful at imaging it, at around 16[th] mag and it could brighten a little further.

D/LINEAR (1998 Y1) LINEAR discovered another faint periodic comet on December 22.31 [IAUC 7072, 1998 December 24]. Perihelion occurred a month earlier and it is not due to return for over 100 years. Because it is a one apparition comet with a period which is a substantial fraction of the notional upper limit of 200 years it has been given a D/ designation. Seiichi Yoshida was able to observe it on several occasions between discovery and early February.

P/Li (1998 Y2) Weidong Li, Department of Astronomy, University of California at Berkeley, reported his discovery of a comet in the course of the Lick Observatory Supernova Search (cf. IAUC 6627; with the participation of M. Papenkova, E. Halderson, M. Modjaz, T. Shefler, J. Y. King, R. R. Treffers and A. V. Filippenko). The object was found automatically by the Katzman Automatic Imaging

Telescope in the field of NGC 1041, but it was immediately recognized as a comet by Li, who then used the equipment to make a deliberate confirmatory observation, as well as follow-up observations on the following night. [IAUC 7075, 1998 December 28]. The comet is periodic with a period of about 15.2 years. Seiichi Yoshida has imaged it on several occasions at around 16th mag. Martin Lehky observing visually made it over two magnitudes brighter.

Tilbrook (1999 A1) Justin Tilbrook (Clare, South Australia) discovered a second comet on January 12.49 with his 0.2-m f6 reflector x70. [IAUC 7084, 1999 January 13]. Although it had perihelion inside the earth's orbit and was relatively close, it was intrinsically quite faint and faded after discovery. Andrew Pearce made some early observations, reporting it at a little fainter than 10th magnitude. Moving south, it will not be visible from the Northern Hemisphere.

SOHO (1999 C1). Having been restored to operation in October SOHO was quickly disabled again by gyro failures. Ground controllers managed to get round the problems and it returned to the fray in early February when it quickly discovered another Kreutz group fragment.

Hermann (1999 D1) S M Hermann of the LONEOS team discovered a comet on images taken on February 20.4 [IAUC 7111, 1999 February 20]. It is an intrinsically faint short period comet. It faded after discovery, but not before it had been imaged by Seiichi Yoshida.

Li (1999 E1) Weidong Li and M. Modjaz, Department of Astronomy, University of California at Berkeley discovered a 17th mag comet in the course of the Lick Observatory Supernova Search on March 13.18 [IAUC 7126, 1999 March 16]. The object was found automatically by the Katzman Automatic Imaging Telescope (KAIT), recorded by Modjaz as a supernova candidate, and recognized by Li as a comet. Li then used the equipment to make confirmatory observations three nights later. The comet shows an apparent tail in p.a. about 120 deg. It is in a distant parabolic orbit and will fade, though Seiichi Yoshida imaged it at 15th mag just over a week after discovery.

P/Machholz 2 has not yet been recovered, though recovery is not really expected until late spring. It may reach 7th magnitude in the late autumn. This comet split into several fragments at its discovery return in 1994 and both the ephemeris and expected magnitude are a little uncertain. The date of perihelion is uncertain by up to a day and more accurate ephemerides will be published when the comet is recovered. UK observers should be able to observe it from November at 10th magnitude, though more southerly observers may find it a month earlier.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Comet Hunting Notes

Don Machholz

JULY 1998: **At what declination (number of degrees north or south of the equator) do amateur astronomers visually discover comets?** The finds range from +72 degrees to -62 degrees. From 1975 to the present, of the 43 comets found in the Northern Hemisphere, seven were found north of +45 degrees. Sixteen were between +20 and +45 degrees and the remaining 20 were found between the celestial equator and +20 degrees. As for the 34 southern comets, five were found south of -45 degrees while 16 more were between -20 and -45 degrees. The remaining 13 Southern Hemisphere comets were found between the celestial equator and -20 degrees.

AUGUST 1998: The Edgar Wilson Award has been announced for amateurs who discover comets. A cash award of about $20,000 will be distributed each June 12 among those finding comets during the previous year. The rules are few. The comet must be named after you and you must be using your own equipment in an amateur capacity. The discovery may be made by visual, photographic, or electronic means. The amount an individual receives depends upon the number of comet finds during the year. For example, in the past twenty years, any individual who found a comet would have received between $1500 and $20,000 for that comet find.

SEPTEMBER 1998: While comet hunting I've always recorded the number of meteors I happen to observe passing through my field of view. On June 16 of this year I recorded my 10,000 telescopic meteor. The span of time was 6314 hours over the course of 23 years. The number of meteors I see per hour in the morning sky averages 1.9 while the evening sky averages 0.9. I also record the number of artificial satellites I see. The hourly rates for these has increased, and now exceeds the meteor rates. I made my 10,000 satellite sighting about a year ago.

OCTOBER 1998: Williams' comet discovery on August 10 brings the total number of Australian visual comet discoverers to five, this is now half the number of Americans (10) who have visually found comets since 1975. There are only two other Southern Hemisphere comet discoverers: Austin of New Zealand and Campos of South Africa. All 24 comets found by these seven men were discovered south of the celestial equator, 23 being found by only one discoverer. Peter Williams is the first person to qualify for the Edgar Wilson Award: a cash sum of about $20,000 to be divided up among all the amateurs who discover comets before June 11, 1999.

NOVEMBER 1998: **As seen from the earth, how far are comets from the sun when first discovered?** This angle, called elongation, has been calculated for the 78 comets found visually by amateurs since 1975. It ranges from 22 to 171 degrees. Over half of the comets have been found within 58 degrees of the sun. Seventy of the seventy-eight were found within 92 degrees of the sun. Why are they found at such small elongations? Not only do comet hunters concentrate their searches on areas near the sun, but comets generally become brightest in those regions.

DECEMBER 1998: Williams, Jager and Tucker are all now eligible for the Wilson Comet award. Each amateur used a different methods to find "their" comets: visual, photographic and CCD.

JANUARY 1999: Father Leo Boethin of the Philippines passed away on Sept.15. He was the discoverer of Periodic Comet Boethin (85P/) on Jan. 4, 1975. It orbits the sun every eleven years.

FEBRUARY 1999: **In which month do amateur astronomers visually discover the most comets?** Of the 79 comets found in the past 24 years, 12 were found in July while 10 were found in January. In last place is both February and April with three finds each.

MARCH 1999: Five of the last seven visual discoveries (covering 2.5 years) have been made by Southern Hemisphere observers, all from Australia, and all five comets being found south of the celestial equator. Two were accidental finds (by Williams and Tilbrook), with Tilbrook then finding one more and Tabur finding two.

APRIL 1999: Of the 79 visual comet discoveries since 1975, 30 (38%) have been made in the first half of the year, with 49 finds in the second half. Subdividing the year into quarters, the first quarter has 18 discoveries, the second has 12, the third has 26 and the last three months of the year yields 23 finds.

Don's Comet Hunting Hours:

Comet Hunting Hours 1975-1998: 6468.00

Hours January through February 1999: 26.25

Total hours at last discovery (10-8-94): 5589.00

Least hours in any month since he began comet hunting on 1/1/75: 4.00 (02/98), 4.50 (01/86), 5.50 (02/80)

Most hours in any month since he began comet hunting: 69.25 (05/76), 63.00 (05/78)

These notes are taken from Comet Comments by Don Machholz, which is published on the Internet.

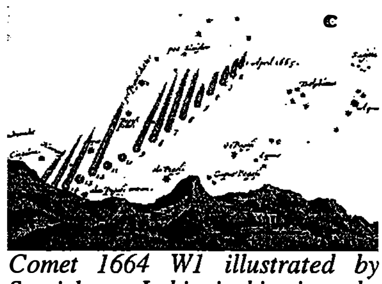
A Brief History of Comets I (until 1950)

The following text is taken from the ESO web page and is adapted from a major review on Comets, prepared by Michel C. Festou (Observatoire Midi-Pyrenees, Toulouse, France), Hans Rickman (Astronomiska Observatoriet, Uppsala, Sweden) and Richard M. West (European Southern Observatory, Garching, Germany) and published in the review journal Astronomy & Astrophysics Reviews (A&AR) (Part I, Vol. 4 pp. 363-447, 1993)

The present account deals with the period up to around 1950. It includes some references to major papers in this period (by author of year of publication), but the original version of this review in Astronomy & Astrophysics Reviews must be consulted for the full details about these.

Introduction The history of cometary astronomy is naturally divided into five major periods, the transitions being marked by important new insights. Before 1600, comets were essentially considered to be heavenly omens and were not yet clearly established as celestial (astronomical), rather than meteorological phenomena in the terrestrial atmosphere. Then followed two centuries of mostly positional measurements with emphasis on the motions and the orbits, lasting until the early 19th century, when the era of cometary physics was inaugurated, in particular by the passage of P/Halley in 1835. The next major step forward occurred in 1950 with the sudden emergence of the modern picture of comets as being essentially very old solar system objects made of primordial ice and dust, generally in unstable orbits and intensively interacting with the solar electromagnetic and corpuscular radiation. Finally, the space missions to P/Giacobini-Zinner in 1985 and especially to P/Halley in 1986 provided the first in situ observations of comets and dramatically widened our scientific horizon, but also posed many new questions which are yet to be answered.

Before 1950: The main events
The word comet, now used in all European languages, comes from Greek (kometes= `the hairy one'), but the earliest extant records of cometary observations date from around -1000 in China and probably from about the same time in Chaldea (on the territory of present-day Iraq). Ideas about the true nature of comets are available from the time of the rise of Hellenistic natural philosophy at about -550 when the Pythagoreans considered comets to be a kind of (wandering) planets that were seen rather infrequently and mostly near the horizon in the morning or evening sky. Aristotle in his Meteorology (ca. -330) relegated comets to the lowest, `sublunar' sphere in his system of spherical shells and described them as `dry and warm exhalations' in the upper atmosphere. There is no mention of comets in Ptolemy's Almagest, presumably because they were not considered of celestial origin, but he described them in astrological terms in his Tetrabiblos. The Aristotelian view on comets was dogmatically upheld during the following millennium; the first doubts seem to have been expressed by Thomas Aquinas and also by Roger Bacon in his Opus Tertium from 1267, but like their predecessors they strongly believed comets to be evil omens.



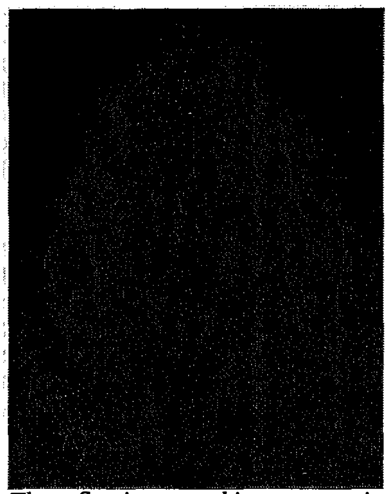
Comet 1664 W1 illustrated by Stanislaw Lubieniecki in the Theatrum Cometicum, published in 1667. Observations of it lead to many advances in cometary science. It also presaged the plague of London.

Finally, Paolo Toscanelli observed P/Halley in 1456 and several other comets between 1433 and 1472 with improved accuracy, inaugurating the renaissance of European observational astronomy after the long period of dormancy. The decisive demonstration was delivered by Tycho Brahe (and confirmed by a few other observers, especially Michael Mästlin), on the basis of extensive observations of the bright comet which first appeared in late 1577. He showed that the horizontal parallax of this comet was certainly smaller than 15 arcmin, corresponding to a distance in excess of 230 Earth radii, or four times the distance to the Moon. The question of how comets move arose as a natural consequence and in 1610, the amateur Sir William Lower proposed that they do so in very elongated ellipses, while Robert Hooke and Giovanni Borelli suggested that cometary orbits may be parabolic. Georg Dörffel was the first to specifically state that the two bright comets seen in 1680 and 1681 are one and the same before and after its perihelion passage, and that it moved along a parabola with the Sun in the focal point. Isaac Newton in Principia (1687), applied his new theory of gravitation to show that the 1680 comet moved in an elliptical, albeit very nearly parabolic orbit and that it passed only about 0.0016 AU above the surface of the Sun. Edmond Halley (1705) computed the orbits of a dozen well-observed comets and demonstrated the periodical nature of the bright comet of 1682. `Halley's Comet', as it was from now on called, was telescopically recovered in December 1758 by Johann Palitzsch; this proved conclusively the validity of Newton's law of gravity out to the distance of the aphelion at 35 AU, more than three times the distance of Saturn, the outermost planet known at that time.

18th century cometary astronomy is characterised by the gradual development of improved methods for orbital computations and at the beginning of the 19th century, this had become a straightforward, if still somewhat arduous task, in particular when planetary perturbations were taken into account by means of iterative corrections. Some basic features of the orbital distribution of comets were established, e.g. the extremely broad range of orbital periods, over which the different objects are scattered. While some comets turned out to have orbits virtually indistinguishable from parabolas, others were confined to the inner solar system in the vicinity of Jupiter's orbit or inside of it. As time passed, a concentration of comets moving in similar orbits with fairly low inclinations and with aphelia close to Jupiter's orbit became more and more obvious; this concentration became known as the Jupiter family. It either called for a continuing ejection from Jupiter or for a mechanism of dynamical evolution, called `capture', whereby the comets would become concentrated into such orbits. It was realized that comets in general, and Jupiter family members in particular, suffer by far the largest orbital perturbations due to the action by Jupiter, and the restricted three-body problem (Sun-Jupiter-comet) therefore offered an interesting approximation for the study of their dynamical behaviour.

After Halley, Johann F. Encke was the second to successfully predict the return of a comet (in 1822) which as a consequence now carries his name. It turned out to have, and still has, the shortest period of all known comets, 3.3 years, and it was soon found to arrive systematically about 0.1 days earlier at perihelion than predicted, even when taking all planetary perturbations into account. Inspired by his observations of an asymmetric distribution of luminous matter in the head of P/Halley in 1835, Friedrich W. Bessel interpreted this as a Sun-oriented asymmetric outflow and suggested that a non-gravitational effect might arise due to the rocket-type impulse imparted by such an outflow. As a consequence, such perihelion shifts as observed for P/Encke might arise.

During the next decades, progressively more sophisticated instrumentation became available and the road was opened for a more physical approach to the study of comets. Comet tails were explained by Heinrich W.M. Olbers (1812) and Bessel (1836) by assuming that they were made of solid particles on which was acting a repulsive force directed anti-sunward. The close connection between comets and meteors was demonstrated by Giovanni Schiaparelli (1866, 1867) who found that the orbits of the Perseid and the Leonid meteor streams coincide with those of comets P/Swift-Tuttle (1862 III) and P/Tempel-Tuttle (1866 I), respectively. In 1835, P/Halley became the first comet in which detailed structures were extensively observed, in particular by John Herschel, Bessel and Friedrich G.W. Struve, who described jets, cones and streamers, cf. the Atlas by Donn et al. (1986). This led Bessel (1836) to postulate the ejection of material in the direction of the Sun which was then somehow forced back in the opposite direction by an unknown repulsive force. Feodor A. Bredikhin (quoted by Jaegermann, 1903) further developed this interpretation into the Bessel-Bredikhin' mechanical model which remained in use until the late 1950's. Sir Arthur Eddington (1910), introduced the fountain model of particle ejection in which the parabolas represent the outer envelopes of particle trajectories emitted from the sunlit hemisphere of the nucleus or surfaces of high density of matter. One of the repulsive forces acting on the dust was identified by Svante Arrhenius (1900) as the radiation pressure by sunlight. The corresponding theory was further developed by Karl Schwarzschild (1901) and extended to molecules by Peter Debye (1909).



The Section archives contain many reprints, some dating back to the early 19th century. This drawing of comet Donati was made by G P Bond on 1858 October 2 using the great refractor at Harvard Observatory and is from the Mathematical Monthly of December 1858.

The first spectroscopic observations of comets were made by Giovanni Donati (1864) and by Sir William Huggins (1868) who visually compared the spectrum of comet Winnecke (1868 II) with flame spectra and found that the bands seen in the comet and in the flame, now known as the `carbon' or `Swan bands', were similar. Subsequent observations showed that these bands were present in all comet spectra and that carbon was therefore an important constituent of comets. Spectroscopy soon became the standard technique for studying the light of comets and new emissions were discovered at an increasing rate; Baldet (1926) published a detailed description of the spectra of about 40 comets, obtained since 1864, together with a complete bibliography of all comets observed until that time by spectroscopy. Schwarzschild and Kron (1911) studied the intensity distribution in P/Halley's straight tail during the 1910 passage and suggested that the emission could be explained by the effect of absorption of solar light, followed by re-emission, i.e. fluorescence. Polydor Swings (1941) solved the long-standing problem of why the violet CN bands (3875 A) in cometary spectra did not resemble CN laboratory spectra and varied in appearance: because of the crowding of absorption lines in the solar spectrum, the intensity at the exciting wavelengths critically depends on the doppler shift caused by the comet's motion relative to the Sun and so determines the strength of the fluorescence emission lines in the comet's spectrum; this is now known as the Swings effect.

1950 - 1951: Two crucial years

A major revolution in cometary science took place in 1950-51, with the formulation within a short time span of three fundamental ideas: 1) the icy conglomerate (`dirty snowball') model of the cometary nucleus by Fred Whipple (1950), 2) the identification from kinematic studies of the existence of a distant reservoir of comets, now known as the Oort cloud, by Jan Hendrik Oort (1950), and 3) the explanation of the motions in cometary plasma tails as due to interaction with the solar wind by Ludwig Biermann (1951). Interestingly, none of these ideas resulted directly from new observational evidence, and important parts of them had been proposed earlier, but it was the first time that the known facts were effectively combined to reveal the new picture.

The icy conglomerate nucleus

Karl Wurm, in a series of enlightening papers published between 1932 and 1939, suggested that, because the observed cometary radicals and ions are not chemically stable, these species must be created by pure photochemistry of more stable molecules residing inside the nucleus, cf. for instance the reviews by Wurm (1943) and Swings (1943). In the 1940's, Swings contributed significantly to the development of ideas along Wurm's line of thinking and his key role appears to have been overlooked in the later literature. The presence of CO, C2N2, CH4, CO2, N2 and NH3 was invoked on the basis that CO+, CN, CH, CO2+, N2+ and NH were identified in comet spectra, respectively. Swings proposed many possible and reasonable candidates as parent molecules, among others CH4 since CH2 was held responsible for the emission recorded in the 4000-4100 A interval, as well as H2O, following the discovery of the OH 3090 A ultraviolet emission in 1941 by Swings, and despite the fact that the low vapor pressure of water was considered a serious problem when explaining the observed presence of the OH emission far from the Sun. In 1948, he came very close to actually proposing an icy model for the nucleus by suggesting that the mentioned molecules could exist in the solid state in the nucleus.

Swings (1942) also suggested that molecules similar to those found in meteorites were possibly stored in the nucleus by occlusion. This idea was quantitatively (and most probably, independently) explored by Boris Yu. Levin (1943), who developed the desorption theory of outgassing from the surface of meteoritic material to demonstrate that his sand bank model for the nucleus had a solid basis. However, although the average desorption heat, about 6000 cal/mole, as deduced empirically from the observed brightness/heliocentric distance relation, was in agreement with the laboratory values for the cometary molecules mentioned above, the amount of material that could be desorbed from a sand bank with an expected cometary mass fell far short of explaining the persistence of comae over several months at single passages, or indeed, the survival of comets like P/Halley or P/Encke for many apparitions.

Since the mid-19th century, a great deal of research had concentrated on understanding the nature of the central source of gas and dust in comets. Transits of comets across the solar disk had never shown any dark silhouette, proving the absence of any extended, optically thick object. Seeing-limited observations of comets passing near the Earth showed a central, unresolved light source of dimensional upper limits in the 10-100 km range (Nicolaus B. Richter, 1963). Upper limits to cometary masses had been estimated for instance from the absence of evidence for mutual gravitational attraction of the components of P/Biela in 1846 or of any influence on the Earth's orbit at very close passages like that of P/Lexell in 1770; in the end, masses in the 1012 - 1017 kg range were estimated (Whipple 1961). Comets were obviously small and light bodies, possibly even without a solid nucleus at the center. At the end of the 1940's, the nature of the nucleus was still a subject of much speculation and no consensus had been reached. In an attempt to put together all known facts about the cometary nucleus, and with particular attention to the long-standing problem of explaining the non-gravitational perihelion shifts, Whipple (1950, 1951) laid the foundations for the model of an icy conglomerate, solid nucleus. Building on the idea dating back to Pierre S. de Laplace (1813) and Bessel (1836), Whipple described the nucleus as a mixture of ices from which the gases in the coma are produced by sublimation in increasing quantities as the comet approaches the Sun and the nucleus surface temperature rises, and meteoritic dust that is released from the nucleus when these ices evaporate. This model had the virtue of explaining at once several observed features: 1) the large gas production rates, for which the desorption model was totally inadequate, 2) the observed jet-like structures in the coma and the erratic activity, impossible to produce if the nucleus were a cloud of particles, 3) the observed non-gravitational forces by means of momentum transfer by the outflow of gas from the nucleus, the net effect on the orbital motion being dependent, among others, on the sense of the nuclear spin and the direction of the spin axis, 4) the fact that most comets which pass extremely close to the Sun, e.g. the Kreutz sungrazing group, apparently may survive such approaches intact and with little change after perihelion, and 5) the fact that comets are the sources of meteor streams. Items 2-4 gave particularly strong arguments for a solid nucleus rather than a sand bank structure.

Many of the late 19th century comets showed intricate structure near to the nucleus. These illustrations of 1881 K1 and 1881 N1 were made by Otto Boeddicker using the 3 foot reflector of the Earl of Rosse at Birr Castle, which is perhaps better known for deep sky observations. This reprint is from the Scientific Transactions of the Royal Dublin Society for August 1882.

The Whipple model quickly won general acceptance and was gradually refined during the following decades. It had, however, some shortcomings; the main one was pinpointed by Whipple himself as being the large difference between the latent heats of vaporization of the various ices. As a consequence the highly volatile material should be rapidly removed from the surface layer of the nucleus long before perihelion, in contradiction to the observation of radicals and ions like CH and CH+ near the Sun. This objection was tentatively removed when Armand Delsemme and Swings (1952) noticed that almost all parent molecules (except NH3) required to explain the observed radicals and ions in comets could co-exist in the nucleus in the form of solid clathrate hydrates. In this way, the highly volatile material does not disappear too rapidly and is also freed together with less volatile molecules; this explains why the spectrum remains more or less similar throughout the comet apparition.

The Oort Cloud Many orbital studies of individual comets with particular attention to the influence of planetary perturbations were carried out at several observatories during the first decades of the 20th century. They were naturally followed by statistical considerations about the distribution and dynamical origin of comets, including the question of whether or not some comets have 'original' hyperbolic orbits (reciprocal semi-major axis 1/aorig < 0) and are therefore of interstellar origin. The work at the Copenhagen Observatory by Elis Strömgren (beginning in about 1910) and his associates is typical of such studies and showed the absence of originally hyperbolic orbits, all observed orbits of this type having been caused by planetary perturbations. Sinding (1948) produced a list with the values of 1/aorig for 21 long-period comets which together with the work by van Woerkom (1948) formed the basis for Oort's famous paper (1950) on the existence of a cometary reservoir in the outer reaches of the solar system. The idea of a cloud of distant hypothetical comets, stable against stellar perturbations, and its necessity in case many observed comets would have 1/aorig 10000 AU, had been expressed earlier by Ernst J. Öpik (1932).

Based on van Woerkom's (1948) theory of the orbital diffusion caused by planetary perturbations, Oort found that the number of comets with very small values of 1/aorig is much larger than one would expect, when comparing with the neighbouring, long-period elliptical orbits. This suggested that many of the comets become unobservable after their first passage through the inner solar system. In a subsequent study, Oort and Schmidt (1951) distinguished between 'new comets' (those coming directly from the Oort cloud, making their first visit near the Sun) and 'old comets' (those returning on elliptic orbits). The former appeared to be dustier and brighten more slowly than the latter. These tentative conclusions have later been revisited and modified, and the role of stellar perturbations in providing new comets has been reconsidered. However, the basic concept of the Oort cloud as an outer halo of the solar system has been substantiated by later studies, based on improved samples of cometary orbits.

The solar wind The tails of comets have been the objects of many investigations. It is exactly these appendices that make comets so impressive to the layman, and astronomers of all times have been struck by the fact that the tails may vary so dramatically from one object to another. In the early 20th century, perhaps the strangest characteristic was the enormous repulsive force found to act on straight comet tails in the anti-solar direction.

Already in 1859, Richard Carrington (1859) suspected a physical connection between the major solar flare observed in the morning of Sept. 1, and enhanced magnetic activity on the Earth some hours thereafter. Ideas about the possible existence of a stream of particles from the Sun, perhaps electrically charged, emerged towards the end of the 19th century, in particular to explain the excitation of molecules and ions observed in cometary comae. It was also found that cometary ion tails (formerly Type I) develop closer to the Sun than dust tails (formerly Type II). However, it was only 50 years later that Cuno Hoffmeister (1943) provided the crucial observations of a gas tail aberration of about 6o, i.e. the angle between the observed tail and the anti-solar direction. This was correctly interpreted by Biermann (1951) in terms of interaction between the cometary ions in the tail and the solar wind, a stream of electrically charged particles from the Sun with velocities of several hundred km/sec. His derived plasma densities were unrealistically high, since electrons were thought to accelerate the cometary ions, but Hannes Alfven (1957) settled this problem by introducing the notion of an interplanetary magnetic field which is carried along with the solar wind. Its existence was soon thereafter confirmed by experiments onboard some of the first spacecraft launched after the space age opened in late 1957 (Lunik I and II, Explorer X, Mariner II, etc.). Still, for quite some time, cometary ion tails were the only well-distributed solar wind probes in interplanetary space and they remain so outside the ecliptic. Another important result of Alfven's study is that an ion tail must be considered as part of the comet since it is magnetically connected to the cometary head.

To be continued

Introduction

This issue has ephemerides for comets:

- 10P/Tempel 2 (UK & Southern Hemisphere)
- 29P/Schwassmann-Wachmann 1 (Southern Hemisphere)
- C/Hale-Bopp (1995 O1) (Southern Hemisphere)
- C/LINEAR (1998 M5) (UK)
- C/LINEAR (1998 T1) (Southern Hemisphere)
- C/Jager (1998 U3) (UK & Southern Hemisphere)

Current ephemerides are also available on the Section web page.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for 10P/Tempel 2 (UK)

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Omega=195.0027 OMEGA=118.2156 i= 11.9762 q= 1.481761 a=  3.105629
 e=0.522879  P=     5.473  T= 1999 September  8.3927     Equinox= 2000
 Magnitudes calculated from m= 8.2+5.0*Log(d)+ 0.0289*Abs(Date-T - 31.5)
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April 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
24/25	17 24.2	-5.34	17 26.8	-5.36	13.4	1.17	1.98	3.17	Not Observable	131	108	73	1	258	3	1
25/26	17 24.7	-5.30	17 27.4	-5.32	13.3	1.16	1.98	3.13	Not Observable	131	96	81	1	257	3	1
26/27	17 25.2	-5.26	17 27.8	-5.28	13.3	1.15	1.97	3.10	Not Observable	132	84	89	1	257	3	1
27/28	17 25.6	-5.22	17 28.3	-5.24	13.2	1.14	1.96	3.06	Not Observable	133	72	94	1	256	2	1
28/29	17 26.1	-5.18	17 28.7	-5.20	13.2	1.12	1.96	3.03	2.32 to 2.52	134	61	98	1	255	2	1
29/30	17 26.5	-5.14	17 29.1	-5.16	13.1	1.11	1.95	2.59	2.13 to 2.49	134	50	100	1	255	2	1
30/31	17 26.9	-5.10	17 29.5	-5.12	13.1	1.10	1.95	2.56	1.58 to 2.47	135	38	100	1	254	2	1
May 1999																
1/ 2	17 27.2	-5.06	17 29.9	-5.08	13.0	1.09	1.94	2.52	1.45 to 2.44	136	28	99	1	253	2	1
2/ 3	17 27.5	-5.02	17 30.2	-5.04	13.0	1.07	1.94	2.48	1.33 to 2.41	137	19	95	1	253	2	1
3/ 4	17 27.8	-4.58	17 30.5	-5.01	12.9	1.06	1.93	2.45	1.23 to 2.38	137	14	91	1	252	1	1
4/ 5	17 28.1	-4.55	17 30.8	-4.57	12.9	1.05	1.92	2.41	1.12 to 2.35	138	18	84	1	251	1	1
5/ 6	17 28.3	-4.51	17 31.0	-4.53	12.8	1.04	1.92	2.37	1.02 to 2.32	139	27	76	1	251	1	1
6/ 7	17 28.6	-4.48	17 31.2	-4.50	12.8	1.03	1.91	2.34	0.53 to 2.29	140	37	68	1	250	1	1
7/ 8	17 28.7	-4.45	17 31.4	-4.47	12.7	1.02	1.91	2.30	0.44 to 2.26	141	49	58	1	249	1	1
8/ 9	17 28.9	-4.41	17 31.5	-4.44	12.7	1.01	1.90	2.26	0.35 to 2.23	141	61	47	1	248	0	1
9/10	17 29.0	-4.38	17 31.7	-4.40	12.6	0.99	1.90	2.22	0.27 to 2.20	142	74	37	1	247	0	1
10/11	17 29.1	-4.35	17 31.8	-4.38	12.6	0.98	1.89	2.18	0.18 to 2.18	143	87	26	1	246	0	1
11/12	17 29.2	-4.33	17 31.8	-4.35	12.5	0.97	1.88	2.14	0.10 to 2.15	144	101	17	1	246	0	1
12/13	17 29.2	-4.30	17 31.8	-4.32	12.5	0.96	1.88	2.11	0.02 to 2.12	144	115	9	1	245	0	1
13/14	17 29.2	-4.28	17 31.8	-4.30	12.4	0.95	1.87	2.07	23.54 to 2.09	145	129	3	1	244	0	1
14/15	17 29.2	-4.25	17 31.8	-4.27	12.3	0.94	1.87	2.03	23.46 to 2.06	146	143	0	1	243	0	0
15/16	17 29.1	-4.23	17 31.7	-4.25	12.3	0.93	1.86	1.59	23.39 to 2.03	147	156	0	1	242	0	0
16/17	17 29.0	-4.21	17 31.6	-4.23	12.2	0.92	1.86	1.55	23.31 to 2.00	148	165	3	1	240	0	0
17/18	17 28.9	-4.19	17 31.5	-4.21	12.2	0.91	1.85	1.51	23.24 to 1.57	148	162	9	1	239	0	0
18/19	17 28.7	-4.18	17 31.4	-4.20	12.1	0.90	1.85	1.46	23.17 to 1.55	149	151	17	1	238	0	0
19/20	17 28.5	-4.17	17 31.2	-4.19	12.1	0.89	1.84	1.42	23.09 to 1.52	150	138	27	1	237	-1	0
20/21	17 28.3	-4.15	17 31.0	-4.18	12.0	0.89	1.84	1.38	23.02 to 1.49	151	125	37	1	235	-1	0
21/22	17 28.1	-4.15	17 30.7	-4.17	12.0	0.88	1.83	1.34	22.55 to 1.46	151	112	48	1	234	-1	0
22/23	17 27.8	-4.14	17 30.4	-4.16	11.9	0.87	1.82	1.30	22.48 to 1.43	152	100	58	1	232	-1	0
23/24	17 27.5	-4.14	17 30.1	-4.16	11.9	0.86	1.82	1.25	22.41 to 1.40	153	87	68	1	231	-1	0
24/25	17 27.2	-4.14	17 29.8	-4.16	11.8	0.85	1.81	1.21	22.35 to 1.38	154	76	77	1	229	-2	0

25/26	17 26.8	-4.14	17 29.4	-4.16	11.8	0.84	1.81	1.17	22.28 to 1.35	154	64	85	1	228	-2	0
26/27	17 26.4	-4.14	17 29.1	-4.17	11.7	0.83	1.80	1.13	22.22 to 1.32	155	52	91	1	226	-2	0
27/28	17 26.0	-4.15	17 28.6	-4.17	11.7	0.83	1.80	1.08	22.25 to 1.29	156	41	96	1	224	-2	0
28/29	17 25.6	-4.16	17 28.2	-4.19	11.6	0.82	1.79	1.04	22.28 to 1.27	156	30	99	1	222	-2	0
29/30	17 25.1	-4.18	17 27.7	-4.20	11.6	0.81	1.79	0.59	22.31 to 1.24	157	21	100	1	220	-2	0
30/31	17 24.6	-4.19	17 27.2	-4.22	11.5	0.80	1.78	0.55	22.34 to 1.21	158	15	100	1	217	-3	0
31/32	17 24.1	-4.22	17 26.7	-4.24	11.5	0.80	1.78	0.51	22.37 to 1.19	158	17	98	1	215	-3	0
June	1999															
1/ 2	17 23.5	-4.24	17 26.2	-4.26	11.4	0.79	1.77	0.46	22.40 to 1.16	159	26	94	1	212	-3	-1
2/ 3	17 23.0	-4.27	17 25.6	-4.29	11.4	0.78	1.77	0.42	22.42 to 1.14	159	36	88	1	210	-3	-1
3/ 4	17 22.4	-4.30	17 25.0	-4.32	11.3	0.78	1.76	0.37	22.45 to 1.11	160	48	81	1	207	-3	-1
4/ 5	17 21.8	-4.33	17 24.4	-4.36	11.3	0.77	1.76	0.32	22.48 to 1.09	160	60	72	1	204	-3	-1
5/ 6	17 21.1	-4.37	17 23.8	-4.40	11.2	0.76	1.75	0.28	22.51 to 1.06	161	72	63	1	201	-3	-1
6/ 7	17 20.5	-4.42	17 23.2	-4.44	11.2	0.76	1.75	0.23	22.54 to 1.04	161	85	52	1	198	-4	-1
7/ 8	17 19.8	-4.46	17 22.5	-4.49	11.2	0.75	1.74	0.19	22.56 to 1.02	161	98	41	1	194	-4	-1
8/ 9	17 19.1	-4.51	17 21.8	-4.54	11.1	0.74	1.74	0.14	22.59 to 0.59	162	112	30	1	191	-4	-2
9/10	17 18.4	-4.57	17 21.1	-4.60	11.1	0.74	1.73	0.09	23.01 to 0.57	162	126	20	1	188	-4	-2
10/11	17 17.7	-5.03	17 20.4	-5.05	11.0	0.73	1.73	0.05	23.04 to 0.55	162	140	11	1	184	-4	-2
11/12	17 17.0	-5.09	17 19.7	-5.12	11.0	0.73	1.72	0.00	23.06 to 0.53	162	154	4	1	180	-4	-2
12/13	17 16.3	-5.16	17 18.9	-5.19	10.9	0.72	1.72	23.55	23.08 to 0.52	162	165	0	1	177	-4	-2
13/14	17 15.5	-5.23	17 18.2	-5.26	10.9	0.72	1.71	23.51	23.10 to 0.50	162	165	0	1	173	-4	-2
14/15	17 14.8	-5.30	17 17.4	-5.33	10.8	0.71	1.71	23.46	23.12 to 0.49	162	154	2	1	169	-4	-3
15/16	17 14.0	-5.38	17 16.7	-5.41	10.8	0.71	1.70	23.41	23.14 to 0.47	162	140	7	1	166	-4	-3
16/17	17 13.2	-5.47	17 15.9	-5.50	10.8	0.70	1.70	23.37	23.15 to 0.46	162	127	14	1	162	-4	-3
17/18	17 12.5	-5.56	17 15.1	-5.59	10.7	0.70	1.69	23.32	23.16 to 0.45	161	113	23	1	159	-4	-3
18/19	17 11.7	-6.05	17 14.4	-6.08	10.7	0.70	1.69	23.27	23.17 to 0.45	161	100	32	1	156	-4	-3
19/20	17 10.9	-6.15	17 13.6	-6.18	10.6	0.69	1.69	23.23	23.18 to 0.44	160	87	43	1	152	-4	-4
20/21	17 10.2	-6.25	17 12.9	-6.28	10.6	0.69	1.68	23.18	23.19 to 0.44	160	75	53	1	149	-4	-4
21/22	17 9.4	-6.35	17 12.1	-6.39	10.6	0.69	1.68	23.13	23.19 to 0.45	160	63	63	1	146	-4	-4
22/23	17 8.7	-6.46	17 11.4	-6.50	10.5	0.68	1.67	23.08	23.19 to 0.45	159	51	72	1	144	-4	-4
23/24	17 7.9	-6.58	17 10.6	-7.01	10.5	0.68	1.67	23.04	23.19 to 0.46	158	39	80	2	141	-4	-4
24/25	17 7.2	-7.10	17 9.9	-7.13	10.4	0.68	1.66	22.59	23.18 to 0.46	158	28	87	2	138	-4	-4
25/26	17 6.5	-7.22	17 9.2	-7.26	10.4	0.67	1.66	22.54	23.18 to 0.48	157	17	93	2	136	-4	-5
26/27	17 5.8	-7.35	17 8.5	-7.38	10.4	0.67	1.65	22.50	23.17 to 0.49	156	11	97	2	134	-4	-5
27/28	17 5.1	-7.48	17 7.8	-7.52	10.3	0.67	1.65	22.45	23.16 to 0.50	156	15	100	2	132	-4	-5
28/29	17 4.4	-8.01	17 7.1	-8.05	10.3	0.67	1.65	22.41	23.14 to 0.52	155	25	100	2	130	-4	-5
29/30	17 3.8	-8.15	17 6.5	-8.19	10.3	0.67	1.64	22.36	23.13 to 0.54	154	36	99	2	128	-4	-5
30/31	17 3.1	-8.29	17 5.9	-8.33	10.2	0.66	1.64	22.31	23.11 to 0.56	154	48	96	2	126	-3	-5
July	1999															
1/ 2	17 2.5	-8.44	17 5.3	-8.48	10.2	0.66	1.63	22.27	23.09 to 0.58	153	61	91	2	124	-3	-6
2/ 3	17 2.0	-8.59	17 4.7	-9.03	10.2	0.66	1.63	22.22	23.07 to 1.01	152	73	85	2	123	-3	-6
3/ 4	17 1.4	-9.14	17 4.1	-9.18	10.1	0.66	1.63	22.18	23.05 to 1.03	151	86	76	3	121	-3	-6
4/ 5	17 0.9	-9.30	17 3.6	-9.34	10.1	0.66	1.62	22.13	23.03 to 1.06	150	99	66	3	120	-3	-6
5/ 6	17 0.4	-9.46	17 3.1	-9.50	10.1	0.66	1.62	22.09	23.01 to 1.08	149	113	56	3	119	-3	-6
6/ 7	16 59.9	-10.02	17 2.7	-10.06	10.0	0.66	1.61	22.05	22.59 to 1.11	149	126	44	3	117	-2	-6
7/ 8	16 59.5	-10.19	17 2.2	-10.23	10.0	0.66	1.61	22.00	22.56 to 1.09	148	140	33	3	116	-2	-6
8/ 9	16 59.1	-10.36	17 1.8	-10.40	10.0	0.65	1.61	21.56	22.54 to 1.03	147	154	22	3	115	-2	-7
9/10	16 58.7	-10.53	17 1.5	-10.57	9.9	0.65	1.60	21.52	22.52 to 0.57	146	168	13	3	114	-2	-7
10/11	16 58.4	-11.10	17 1.2	-11.15	9.9	0.65	1.60	21.47	22.49 to 0.52	145	171	6	3	113	-1	-7
11/12	16 58.1	-11.28	17 0.9	-11.32	9.9	0.65	1.59	21.43	22.46 to 0.46	144	159	1	4	112	-1	-7
12/13	16 57.9	-11.46	17 0.6	-11.50	9.8	0.65	1.59	21.39	22.44 to 0.40	144	145	0	4	111	-1	-7
13/14	16 57.6	-12.04	17 0.4	-12.08	9.8	0.65	1.59	21.35	22.41 to 0.34	143	131	1	4	110	-1	-7
14/15	16 57.5	-12.23	17 0.3	-12.27	9.8	0.65	1.58	21.31	22.38 to 0.28	142	116	4	4	109	0	-7
15/16	16 57.4	-12.41	17 0.2	-12.46	9.8	0.66	1.58	21.27	22.36 to 0.23	141	103	10	4	108	0	-7
16/17	16 57.3	-13.00	17 0.1	-13.04	9.7	0.66	1.58	21.23	22.33 to 0.17	140	89	18	4	108	0	-7
17/18	16 57.3	-13.19	17 0.1	-13.23	9.7	0.66	1.57	21.19	22.30 to 0.11	139	76	27	4	107	0	-7
18/19	16 57.3	-13.38	17 0.1	-13.43	9.7	0.66	1.57	21.15	22.28 to 0.05	139	64	37	5	106	0	-7
19/20	16 57.4	-13.58	17 0.2	-14.02	9.7	0.66	1.57	21.11	22.25 to 23.59	138	52	47	5	106	0	-8
20/21	16 57.5	-14.17	17 0.3	-14.21	9.6	0.66	1.56	21.07	22.22 to 23.53	137	40	56	5	105	0	-8
21/22	16 57.7	-14.37	17 0.5	-14.41	9.6	0.66	1.56	21.03	22.19 to 23.47	136	28	66	5	104	1	-8
22/23	16 57.9	-14.56	17 0.7	-15.01	9.6	0.66	1.56	20.60	22.16 to 23.41	135	16	74	5	104	1	-8
23/24	16 58.1	-15.16	17 1.0	-15.20	9.6	0.66	1.55	20.56	22.13 to 23.35	134	5	82	5	103	1	-8
24/25	16 58.5	-15.36	17 1.3	-15.40	9.5	0.67	1.55	20.52	22.11 to 23.29	134	8	89	6	103	1	-8
25/26	16 58.8	-15.56	17 1.7	-16.00	9.5	0.67	1.55	20.49	22.08 to 23.23	133	19	95	6	102	2	-8
26/27	16 59.2	-16.16	17 2.1	-16.20	9.5	0.67	1.55	20.45	22.05 to 23.17	132	31	98	6	102	2	-8
27/28	16 59.7	-16.36	17 2.6	-16.40	9.5	0.67	1.54	20.42	22.02 to 23.11	131	44	100	6	101	2	-8
28/29	17 0.3	-16.56	17 3.1	-17.00	9.4	0.67	1.54	20.38	21.59 to 23.05	131	56	100	6	101	3	-8
29/30	17 0.8	-17.16	17 3.7	-17.20	9.4	0.67	1.54	20.35	21.56 to 22.58	130	69	98	6	100	3	-8
30/31	17 1.5	-17.36	17 4.4	-17.40	9.4	0.68	1.53	20.32	21.53 to 22.52	129	82	94	7	100	3	-8
31/32	17 2.1	-17.56	17 5.1	-18.00	9.4	0.68	1.53	20.28	21.50 to 22.46	128	95	87	7	99	4	-8
August	1999															
1/ 2	17 2.9	-18.16	17 5.8	-18.20	9.4	0.68	1.53	20.25	21.48 to 22.40	128	108	79	7	99	4	-8
2/ 3	17 3.7	-18.37	17 6.6	-18.40	9.3	0.68	1.53	20.22	21.45 to 22.34	127	121	69	7	98	4	-8
3/ 4	17 4.5	-18.57	17 7.5	-19.00	9.3	0.69	1.52	20.19	21.42 to 22.27	126	135	58	7	98	4	-8
4/ 5	17 5.4	-19.16	17 8.4	-19.20	9.3	0.69	1.52	20.16	21.39 to 22.21	126	149	47	8	98	5	-8
5/ 6	17 6.4	-19.36	17 9.3	-19.40	9.3	0.69	1.52	20.13	21.36 to 22.14	125	163	36	8	97	5	-8
6/ 7	17 7.4	-19.56	17 10.3	-19.60	9.3	0.70	1.52	20.10	21.33 to 22.08	124	176	25	8	97	5	-8
7/ 8	17 8.4	-20.16	17 11.4	-20.19	9.2	0.70	1.52	20.07	21.30 to 22.01	124	169	15	8	97	6	-8
8/ 9	17 9.5	-20.36	17 12.5	-20.39	9.2	0.70	1.51	20.04	21.27 to 21.55	123	155	8	8	96	6	-8
9/10	17 10.7	-20.55	17 13.7	-20.58	9.2	0.70	1.51	20.02	21.24 to 21.48	122	141	2	8	96	6	-8
10/11	17 11.9	-21.15	17 14.9	-21.18	9.2	0.71	1.51	19.59	21.21 to 21.41	122	127	0	9	96	7	-8
11/12	17 13.2	-21.34	17 16.2	-21.37	9.2	0.71	1.51	19.56	21.19 to 21.35	121	113	0	9	95	7	-8
12/13	17 14.5	-21.53	17 17.5	-21.56	9.1	0.71	1.51	19.54	21.16 to 21.28	120	100	2	9	95	7	-7
13/14	17 15.9	-22.12	17 18.9	-22.15	9.1	0.72	1.50	19.51	21.13 to 21.21	120	87	7	9	95	7	-7
14/15	17 17.3	-22.31	17 20.4	-22.34	9.1	0.72	1.50	19.48	21.10 to 21.13	119	74	14	9	94	8	-7
15/16	17 18.8	-22.49	17 21.8	-22.52	9.1	0.73	1.50	19.46	Not Observable	118	62	22	9	94	8	-7
16/17	17 20.4	-23.08	17 23.4	-23.11	9.1	0.73	1.50	19.44	Not Observable	118	50	31	10	94	8	-7
17/18	17 21.9	-23.26	17 25.0	-23.29	9.1	0.73	1.50	19.41	Not Observable	117	39	40	10	93	9	-7
18/19	17 23.6	-23.44	17 26.6	-23.47	9.0	0.74	1.50	19.39	Not Observable	117	27	49	10	93	9	-7
19/20	17 25.3	-24.02	17 28.3	-24.04	9.0	0.74	1.49	19.37	Not Observable	116	16	59	10	93	9	-7
20/21	17 27.0	-24.20	17 30.1	-24.22	9.0	0.74	1.49	19.35	Not Observable	116	7	68	10	92	9	-7
21/22	17 28.8	-24.37	17 31.9	-24.39	9.0	0.75	1.49	19.32	Not Observable	115	9	77	11	92	10	-7
22/23	17 30.6	-24.54	17 33.7	-24.56	9.0	0.75	1.49	19.30	Not Observable	115	20	85	11	92	10	-7
23/24	17 32.5	-25.11	17 35.6	-25.13	9.0	0.76	1.49	19.28	Not Observable	114	31	91	11	92	10	-7
24/25	17 34.4	-25.28	17 37.5	-25.30	8.9	0.76	1.49	19.26	Not Observable	114	43	96	11	91	10	-6
25/26	17 36.4	-25.44	17 39.5	-25.46	8.9	0.77	1.49	19.24	Not Observable	113	56	99	11	91	11	-6
26/27	17 38.5	-26.01	17 41.6	-26.02	8.9	0.77	1.49	19.22	Not Observable	113	68	100	11	91	11	-6
27/28	17 40.5	-26.16	17 43.6	-26.18	8.9	0.78	1.49	19.21	Not Observable	112	81	99	12	90	11	-6
28/29	17 42.6	-26.32	17 45.8	-26.33	8.9	0.78	1.49	19.19	Not Observable	112	94	96	12	90	11	-6
29/30	17 44.8	-26.47	17 47.9	-26.48	8.9	0.78	1.48	19.17	Not Observable	111	107	90	12	90	12	-6
30/31	17 47.0	-27.02	17 50.1	-27.03	8.8	0.79	1.48	19.15	Not Observable	111	121	82	12	90	12	-6
31/32	17 49.2	-27.17	17 52.4	-27.17	8.8	0.79	1.48	19.13	Not Observable	110	134	72	12	89	12	-6

Ephemeris for 10P/Tempel 2 (Southern Hemisphere, 40° South)

Omega=195.0027 OMEGA=118.2156 i= 11.9762 q= 1.481761 a= 3.105629
e=0.522879 P= 5.473 T= 1999 September 8.3927 Equinox= 2000
Magnitudes calculated from m= 8.2+5.0*Log(d)+ 0.0289*Abs(Date - T - 31.5)

August 1999 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	17 2.9	-18.16	17 5.8	-18.20	9.4	0.68	1.53	20.25	18.15 to 2.18	128	108	79	7	99	0	0
2/ 3	17 3.7	-18.37	17 6.6	-18.40	9.3	0.68	1.53	20.22	18.16 to 2.17	127	121	69	7	98	4	-8
3/ 4	17 4.5	-18.57	17 7.5	-19.00	9.3	0.69	1.52	20.19	18.16 to 2.15	126	135	58	7	98	4	-8
4/ 5	17 5.4	-19.16	17 8.4	-19.20	9.3	0.69	1.52	20.16	18.17 to 2.13	126	149	47	8	98	5	-8
5/ 6	17 6.4	-19.36	17 9.3	-19.40	9.3	0.69	1.52	20.13	18.18 to 2.12	125	163	36	8	97	5	-8
6/ 7	17 7.4	-19.56	17 10.3	-19.60	9.3	0.70	1.52	20.10	18.19 to 2.10	124	176	25	8	97	5	-8
7/ 8	17 8.4	-20.16	17 11.4	-20.19	9.2	0.70	1.52	20.07	18.20 to 2.09	124	169	15	8	97	6	-8
8/ 9	17 9.5	-20.36	17 12.5	-20.39	9.2	0.70	1.51	20.04	18.20 to 2.07	123	155	8	8	96	6	-8
9/10	17 10.7	-20.55	17 13.7	-20.58	9.2	0.70	1.51	20.02	18.21 to 2.06	122	141	2	8	96	6	-8
10/11	17 11.9	-21.15	17 14.9	-21.18	9.2	0.71	1.51	19.59	18.22 to 2.05	122	127	0	9	96	7	-8
11/12	17 13.2	-21.34	17 16.2	-21.37	9.2	0.71	1.51	19.56	18.23 to 2.03	121	113	0	9	95	7	-8
12/13	17 14.5	-21.53	17 17.5	-21.56	9.1	0.71	1.51	19.54	18.24 to 2.02	120	100	2	9	95	7	-7
13/14	17 15.9	-22.12	17 18.9	-22.15	9.1	0.72	1.50	19.51	18.24 to 2.01	120	87	7	9	95	7	-7
14/15	17 17.3	-22.31	17 20.4	-22.34	9.1	0.72	1.50	19.48	18.25 to 1.60	119	74	14	9	94	8	-7
15/16	17 18.8	-22.49	17 21.8	-22.52	9.1	0.73	1.50	19.46	18.26 to 1.59	118	62	22	9	94	8	-7
16/17	17 20.4	-23.08	17 23.4	-23.11	9.1	0.73	1.50	19.44	18.27 to 1.58	118	50	31	10	94	8	-7
17/18	17 21.9	-23.26	17 25.0	-23.29	9.1	0.73	1.50	19.41	18.28 to 1.57	117	39	40	10	93	9	-7
18/19	17 23.6	-23.44	17 26.6	-23.47	9.0	0.74	1.50	19.39	18.29 to 1.56	117	27	49	10	93	9	-7
19/20	17 25.3	-24.02	17 28.3	-24.04	9.0	0.74	1.49	19.37	18.29 to 1.55	116	16	59	10	93	9	-7
20/21	17 27.0	-24.20	17 30.1	-24.22	9.0	0.74	1.49	19.35	18.30 to 1.54	116	7	68	10	92	9	-7
21/22	17 28.8	-24.37	17 31.9	-24.39	9.0	0.75	1.49	19.32	18.31 to 1.53	115	9	77	11	92	10	-7
22/23	17 30.6	-24.54	17 33.7	-24.56	9.0	0.75	1.49	19.30	18.32 to 1.52	115	20	85	11	92	10	-7
23/24	17 32.5	-25.11	17 35.6	-25.13	9.0	0.76	1.49	19.28	18.33 to 1.51	114	31	91	11	92	10	-7
24/25	17 34.4	-25.28	17 37.5	-25.30	8.9	0.76	1.49	19.26	18.34 to 1.50	114	43	96	11	91	10	-6
25/26	17 36.4	-25.44	17 39.5	-25.46	8.9	0.77	1.49	19.24	18.35 to 1.50	113	56	99	11	91	11	-6
26/27	17 38.5	-26.01	17 41.6	-26.02	8.9	0.77	1.49	19.22	18.35 to 1.49	113	68	100	11	91	11	-6
27/28	17 40.5	-26.16	17 43.6	-26.18	8.9	0.78	1.49	19.21	18.36 to 1.48	112	81	99	12	90	11	-6
28/29	17 42.6	-26.32	17 45.8	-26.33	8.9	0.78	1.49	19.19	18.37 to 1.48	112	94	96	12	90	11	-6
29/30	17 44.8	-26.47	17 47.9	-26.48	8.9	0.78	1.48	19.17	18.38 to 1.47	111	107	90	12	90	12	-6
30/31	17 47.0	-27.02	17 50.1	-27.03	8.8	0.79	1.48	19.15	18.39 to 1.47	111	121	82	12	90	12	-6
31/32	17 49.2	-27.17	17 52.4	-27.17	8.8	0.79	1.48	19.13	18.40 to 1.46	110	134	72	12	89	12	-6
September 1999																
1/ 2	17 51.5	-27.31	17 54.7	-27.32	8.8	0.80	1.48	19.12	18.41 to 1.45	110	147	61	12	89	12	-5
2/ 3	17 53.9	-27.45	17 57.0	-27.45	8.8	0.80	1.48	19.10	18.41 to 1.45	109	160	49	13	89	12	-5
3/ 4	17 56.2	-27.59	17 59.4	-27.59	8.8	0.81	1.48	19.09	18.42 to 1.44	109	171	38	13	89	13	-5
4/ 5	17 58.6	-28.12	18 1.8	-28.12	8.8	0.81	1.48	19.07	18.43 to 1.44	108	168	27	13	88	13	-5
5/ 6	18 1.1	-28.25	18 4.3	-28.25	8.7	0.82	1.48	19.06	18.44 to 1.43	108	156	17	13	88	13	-5
6/ 7	18 3.6	-28.38	18 6.7	-28.37	8.7	0.83	1.48	19.04	18.45 to 1.43	107	143	10	13	88	13	-5
7/ 8	18 6.1	-28.50	18 9.3	-28.49	8.7	0.83	1.48	19.03	18.46 to 1.43	107	130	4	13	87	13	-5
8/ 9	18 8.7	-29.02	18 11.8	-29.01	8.7	0.84	1.48	19.01	18.47 to 1.42	107	117	0	14	87	14	-4
9/10	18 11.3	-29.13	18 14.5	-29.12	8.7	0.84	1.48	19.00	18.48 to 1.42	106	105	0	14	87	14	-4
10/11	18 13.9	-29.24	18 17.1	-29.23	8.7	0.85	1.48	18.59	18.49 to 1.41	106	92	1	14	87	14	-4
11/12	18 16.6	-29.35	18 19.8	-29.34	8.7	0.85	1.48	18.57	18.50 to 1.41	105	80	4	14	86	14	-4
12/13	18 19.3	-29.46	18 22.5	-29.44	8.6	0.86	1.48	18.56	18.51 to 1.41	105	69	10	14	86	14	-4
13/14	18 22.0	-29.56	18 25.2	-29.54	8.6	0.86	1.48	18.55	18.52 to 1.40	105	57	16	15	86	14	-4
14/15	18 24.8	-30.05	18 28.0	-30.03	8.6	0.87	1.48	18.54	18.53 to 1.40	104	46	24	15	85	14	-3
15/16	18 27.6	-30.14	18 30.8	-30.12	8.6	0.88	1.48	18.53	18.53 to 1.40	104	35	33	15	85	15	-3
16/17	18 30.4	-30.23	18 33.6	-30.21	8.6	0.88	1.48	18.52	18.54 to 1.39	104	25	42	15	85	15	-3
17/18	18 33.3	-30.31	18 36.5	-30.29	8.6	0.89	1.49	18.51	18.55 to 1.39	103	15	52	15	85	15	-3
18/19	18 36.1	-30.39	18 39.3	-30.36	8.6	0.89	1.49	18.49	18.56 to 1.39	103	10	61	15	84	15	-3
19/20	18 39.0	-30.47	18 42.3	-30.44	8.5	0.90	1.49	18.48	18.57 to 1.38	102	15	70	16	84	15	-3
20/21	18 42.0	-30.54	18 45.2	-30.51	8.5	0.91	1.49	18.47	18.58 to 1.38	102	25	79	16	84	15	-2
21/22	18 44.9	-31.01	18 48.2	-30.57	8.5	0.91	1.49	18.46	18.59 to 1.38	102	36	87	16	84	15	-2
22/23	18 47.9	-31.07	18 51.1	-31.03	8.5	0.92	1.49	18.46	19.00 to 1.37	101	48	93	16	83	15	-2
23/24	18 50.9	-31.13	18 54.1	-31.09	8.5	0.93	1.49	18.45	19.01 to 1.37	101	61	98	16	83	16	-2
24/25	18 53.9	-31.18	18 57.2	-31.14	8.5	0.93	1.49	18.44	19.02 to 1.36	101	74	100	16	83	16	-2
25/26	18 57.0	-31.23	19 0.2	-31.19	8.5	0.94	1.49	18.43	19.03 to 1.36	100	87	100	17	82	16	-2
26/27	19 0.0	-31.27	19 3.3	-31.23	8.5	0.95	1.49	18.42	19.04 to 1.36	100	100	97	17	82	16	-1
27/28	19 3.1	-31.32	19 6.3	-31.27	8.4	0.95	1.50	18.41	19.06 to 1.35	100	114	92	17	82	16	-1
28/29	19 6.2	-31.35	19 9.4	-31.30	8.4	0.96	1.50	18.40	19.07 to 1.35	99	127	84	17	82	16	-1
29/30	19 9.3	-31.38	19 12.5	-31.33	8.4	0.97	1.50	18.39	19.08 to 1.34	99	140	75	17	81	16	-1
30/31	19 12.4	-31.41	19 15.6	-31.36	8.4	0.97	1.50	18.38	19.09 to 1.34	99	153	64	17	81	16	-1
October 1999																
1/ 2	19 15.6	-31.44	19 18.8	-31.38	8.4	0.98	1.50	18.38	19.10 to 1.33	98	164	52	18	81	16	0
2/ 3	19 18.7	-31.45	19 21.9	-31.40	8.4	0.99	1.50	18.37	19.11 to 1.33	98	168	41	18	81	16	0
3/ 4	19 21.9	-31.47	19 25.1	-31.41	8.4	1.00	1.50	18.36	19.12 to 1.32	98	161	30	18	80	16	0
4/ 5	19 25.0	-31.48	19 28.2	-31.42	8.3	1.00	1.51	18.35	19.13 to 1.32	97	150	20	18	80	16	0
5/ 6	19 28.2	-31.49	19 31.4	-31.42	8.3	1.01	1.51	18.35	19.14 to 1.31	97	138	12	18	80	16	0
6/ 7	19 31.4	-31.49	19 34.6	-31.42	8.3	1.02	1.51	18.34	19.15 to 1.31	97	126	6	18	79	16	0
7/ 8	19 34.6	-31.49	19 37.8	-31.42	8.3	1.03	1.51	18.33	19.17 to 1.30	97	114	2	19	79	16	0
8/ 9	19 37.8	-31.48	19 41.0	-31.41	8.3	1.03	1.51	18.32	19.18 to 1.30	96	102	0	19	79	16	0
9/10	19 41.0	-31.47	19 44.2	-31.40	8.3	1.04	1.52	18.32	19.19 to 1.29	96	90	0	19	79	17	0
10/11	19 44.2	-31.46	19 47.4	-31.38	8.3	1.05	1.52	18.31	19.20 to 1.27	96	79	2	18	78	17	0
11/12	19 47.4	-31.44	19 50.6	-31.36	8.4	1.06	1.52	18.30	19.21 to 1.26	95	68	6	18	78	17	0
12/13	19 50.6	-31.41	19 53.8	-31.33	8.4	1.07	1.52	18.29	19.23 to 1.24	95	57	11	17	78	17	0
13/14	19 53.8	-31.39	19 57.0	-31.31	8.5	1.07	1.53	18.29	19.24 to 1.23	95	46	18	17	78	17	1
14/15	19 57.0	-31.36	20 0.2	-31.27	8.5	1.08	1.53	18.28	19.25 to 1.21	94	35	26	16	77	17	1
15/16	20 0.2	-31.32	20 3.4	-31.24	8.6	1.09	1.53	18.27	19.26 to 1.19	94	25	35	16	77	17	1
16/17	20 3.5	-31.28	20 6.6	-31.19	8.6	1.10	1.53	18.26	19.28 to 1.18	94	16	44	16	77	17	1
17/18	20 6.7	-31.24	20 9.8	-31.15	8.7	1.11	1.54	18.26	19.29 to 1.16	94	12	54	15	77	17	1
18/19	20 9.9	-31.19	20 13.0	-31.10	8.7	1.12	1.54	18.25	19.30 to 1.14	93	17	64	15	77	17	1
19/20	20 13.1	-31.14	20 16.2	-31.05	8.7	1.12	1.54	18.24	19.31 to 1.12	93	26	73	14	76	17	2
20/21	20 16.3	-31.09	20 19.4	-30.59	8.8	1.13	1.54	18.23	19.33 to 1.10	93	38	82	14	76	17	2
21/22	20 19.5	-31.03	20 22.6	-30.53	8.8	1.14	1.55	18.23	19.34 to 1.09	92	50	90	14	76	17	2
22/23	20 22.6	-30.57	20 25.7	-30.47	8.9	1.15	1.55	18.22	19.35 to 1.07	92	63	96	13	76	17	2
23/24	20 25.8	-30.51	20 28.9	-30.41	8.9	1.16	1.55	18.21	19.37 to 1.05	92	76	99	13	75	17	2
24/25	20 29.0	-30.44	20 32.1	-30.34	9.0	1.17	1.56	18.20	19.38 to 1.03	92	90	100	13	75	17	2
25/26	20 32.1	-30.37	20 35.2	-30.26	9.0	1.18	1.56	18.19	19.39 to 1.01	91	104	99	12	75	17	2
26/27	20 35.3	-30.29	20 38.4	-30.19	9.1	1.19	1.56	18.19	19.41 to 0.59	91	117	94	12	75	16	3
27/28	20 38.4	-30.21	20 41.5	-30.11	9.1	1.20	1.56	18.18	19.42 to 0.57	91	131	87	12	75	16	3
28/29	20 41.6	-30.13	20 44.6	-30.02	9.2	1.21	1.57	18.17	19.44 to 0.54	90	144	78	11	74	16	3
29/30	20 44.7	-30.05	20 47.7	-29.54	9.2	1.22	1.57	18.16	19.45 to 0.52	90	157	67	11	74	16	3
30/31	20 47.8	-29.56	20 50.8	-29.45	9.3	1.22	1.57	18.15	19.46 to 0.50	90	167	56	11	74	16	3

31/32	20 50.9	-29.47	20 53.9	-29.35	9.3	1.23	1.58	18.15	19.48 to 0.48	90	167	45	10	74	16	3

Ephemeris for 29P/Schwassmann-Wachmann 1 (Southern Hemisphere, 40° South)

Note: when in outburst the comet may be visible from the UK, although it is low in the southern sky.

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Omega= 47.6175 OMEGA=312.8006 i=  9.3848 q= 5.725325 a=  6.000672
 e=0.045886  P=    14.699  T= 2004 June      22.2264    Equinox= 2000
 Magnitudes calculated from m= 2.0+5.0*Log(d)+10.0*Log(r)
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May 1999 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	15 3.1	-28.48	15 6.1	-28.59	13.5	5.19	6.17	0.24	19.48 to 5.00	165	23	95	0	334	-2	0
7/ 8	15 0.7	-28.39	15 3.7	-28.51	13.5	5.18	6.17	0.02	19.26 to 4.38	168	78	58	0	354	-2	0
12/13	14 58.2	-28.29	15 1.2	-28.41	13.5	5.17	6.17	23.40	19.04 to 4.16	169	143	9	0	21	-2	0
17/18	14 55.8	-28.19	14 58.8	-28.30	13.5	5.18	6.17	23.18	18.43 to 3.53	167	136	9	0	46	-2	0
22/23	14 53.4	-28.07	14 56.4	-28.19	13.5	5.19	6.16	22.56	18.21 to 3.30	164	70	58	0	64	-2	0
27/28	14 51.2	-27.55	14 54.2	-28.07	13.5	5.20	6.16	22.34	18.00 to 3.07	160	18	96	0	75	-2	1
June 1999																
1/ 2	14 49.1	-27.42	14 52.0	-27.54	13.5	5.23	6.16	22.12	17.52 to 2.45	155	54	94	0	82	-2	1
6/ 7	14 47.2	-27.29	14 50.1	-27.41	13.5	5.26	6.16	21.50	17.51 to 2.22	151	115	52	0	87	-2	1
11/12	14 45.4	-27.16	14 48.4	-27.28	13.5	5.29	6.16	21.29	17.51 to 1.59	146	162	4	0	91	-1	1
16/17	14 43.9	-27.03	14 46.9	-27.16	13.5	5.34	6.16	21.08	17.51 to 1.37	141	97	14	0	94	-1	1
21/22	14 42.7	-26.51	14 45.6	-27.03	13.6	5.39	6.16	20.47	17.52 to 1.14	136	35	63	0	97	-1	1
26/27	14 41.7	-26.39	14 44.6	-26.52	13.6	5.44	6.16	20.26	17.53 to 0.52	131	31	97	0	98	-1	0
July 1999																
1/ 2	14 41.0	-26.28	14 43.9	-26.41	13.6	5.50	6.15	20.05	17.55 to 0.30	126	89	91	0	100	0	0
6/ 7	14 40.5	-26.18	14 43.4	-26.30	13.6	5.56	6.15	19.45	17.57 to 0.09	122	151	44	0	101	0	0
11/12	14 40.3	-26.09	14 43.3	-26.21	13.6	5.63	6.15	19.25	18.00 to 23.47	117	130	1	0	103	0	0
16/17	14 40.5	-26.00	14 43.4	-26.13	13.7	5.70	6.15	19.06	18.03 to 23.26	112	62	18	0	104	0	0
21/22	14 40.9	-25.53	14 43.8	-26.06	13.7	5.77	6.15	18.47	18.07 to 23.06	107	15	66	0	105	0	0
26/27	14 41.5	-25.48	14 44.4	-26.00	13.7	5.84	6.15	18.27	18.10 to 22.45	103	62	98	0	105	0	0
31/32	14 42.5	-25.43	14 45.4	-25.55	13.7	5.92	6.15	18.09	18.14 to 22.25	98	123	87	0	106	1	0
August 1999																
5/ 6	14 43.7	-25.40	14 46.6	-25.52	13.8	5.99	6.15	17.50	18.18 to 22.05	94	160	36	0	107	1	0
10/11	14 45.1	-25.37	14 48.1	-25.50	13.8	6.07	6.14	17.32	18.22 to 21.46	89	95	0	0	108	1	0
15/16	14 46.8	-25.36	14 49.8	-25.49	13.8	6.15	6.14	17.14	18.26 to 21.27	85	32	22	0	108	1	0
20/21	14 48.8	-25.37	14 51.7	-25.49	13.9	6.22	6.14	16.56	18.30 to 21.08	81	34	68	0	109	2	0
25/26	14 51.0	-25.38	14 53.9	-25.50	13.9	6.30	6.14	16.39	18.35 to 20.49	76	92	99	0	109	2	0
30/31	14 53.3	-25.41	14 56.3	-25.53	13.9	6.37	6.14	16.21	18.39 to 20.31	72	156	82	0	110	2	0
September 1999																
4/ 5	14 55.9	-25.44	14 58.8	-25.56	13.9	6.44	6.14	16.04	18.43 to 20.13	68	129	27	0	110	2	0
9/10	14 58.7	-25.49	15 1.6	-26.00	13.9	6.51	6.14	15.47	18.48 to 19.55	64	63	0	0	111	3	0
14/15	15 1.6	-25.54	15 4.6	-26.05	14.0	6.58	6.13	15.31	18.53 to 19.38	60	13	24	0	111	3	0
19/20	15 4.8	-26.00	15 7.7	-26.12	14.0	6.65	6.13	15.14	18.57 to 19.20	56	60	70	0	112	3	0
24/25	15 8.1	-26.07	15 11.0	-26.18	14.0	6.71	6.13	14.58	19.02 to 19.03	51	123	100	0	112	3	0
29/30	15 11.5	-26.15	15 14.5	-26.26	14.0	6.76	6.13	14.41	Not Observable	47	160	75	0	113	3	0
October 1999																
4/ 5	15 15.1	-26.23	15 18.0	-26.34	14.0	6.82	6.13	14.25	Not Observable	43	96	20	0	114	4	0
9/10	15 18.8	-26.32	15 21.8	-26.43	14.1	6.87	6.13	14.09	Not Observable	39	34	0	0	115	4	0
14/15	15 22.6	-26.41	15 25.6	-26.52	14.1	6.91	6.13	13.53	Not Observable	35	30	26	0	116	4	0
19/20	15 26.5	-26.51	15 29.5	-27.01	14.1	6.95	6.12	13.37	Not Observable	31	87	73	0	117	4	0
24/25	15 30.5	-27.01	15 33.5	-27.11	14.1	6.99	6.12	13.22	Not Observable	28	153	100	0	119	4	0
29/30	15 34.6	-27.12	15 37.7	-27.21	14.1	7.02	6.12	13.06	Not Observable	24	130	67	0	122	4	0

Ephemeris for Hale-Bopp 1995 O1 (Southern Hemisphere, 40° South)

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Omega=130.5551 OMEGA=282.4209 i= 89.4232 q= 0.913457 a=181.674025
 e=0.994972  P= 2448.721  T= 1997 April      1.1099    Equinox= 2000
 Magnitudes calculated from m=-2.0+5.0*Log(d)+10.0*Log(r)
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May 1999 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	5 12.8	-63.52	5 13.2	-63.49	11.8	8.34	8.30	14.35	18.15 to 22.53	85	100	99	1	142	0	0
6/ 7	5 16.9	-63.38	5 17.2	-63.34	11.8	8.37	8.34	14.20	18.09 to 22.33	85	92	68	1	146	2	1
11/12	5 21.1	-63.25	5 21.4	-63.22	11.9	8.41	8.38	14.04	18.05 to 22.13	85	82	17	1	150	2	1
16/17	5 25.4	-63.15	5 25.7	-63.12	11.9	8.45	8.42	13.49	18.01 to 21.54 5.43 to 5.52	85	82	3	1	153	2	0
21/22	5 29.8	-63.06	5 30.2	-63.04	11.9	8.48	8.46	13.33	17.57 to 21.36 5.31 to 5.56	85	92	48	1	157	2	0
26/27	5 34.3	-63.01	5 34.7	-62.59	11.9	8.52	8.50	13.18	17.55 to 21.18 5.18 to 5.59	86	99	91	1	161	2	0
31/32	5 38.9	-62.57	5 39.3	-62.55	12.0	8.55	8.54	13.03	17.53 to 21.01 5.06 to 6.03	86	97	98	1	165	2	0
June 1999																
5/ 6	5 43.6	-62.55	5 44.0	-62.54	12.0	8.59	8.58	12.48	17.51 to 20.43 4.53 to 6.06	86	89	63	1	169	2	0
10/11	5 48.3	-62.56	5 48.7	-62.55	12.0	8.62	8.62	12.33	17.51 to 20.27 4.39 to 6.08	86	82	11	1	172	2	0
15/16	5 53.1	-62.59	5 53.4	-62.58	12.1	8.66	8.66	12.18	17.51 to 20.10 4.26 to 6.10	86	85	7	1	176	2	0
20/21	5 57.8	-63.04	5 58.2	-63.04	12.1	8.70	8.69	12.03	17.52 to 19.54 4.12 to 6.12	87	94	53	1	179	2	0
25/26	6 2.6	-63.11	6 2.9	-63.11	12.1	8.73	8.73	11.48	17.53 to 19.38 3.58 to 6.12	87	98	93	1	183	2	0
30/31	6 7.3	-63.21	6 7.7	-63.21	12.1	8.77	8.77	11.33	17.55 to 19.23 3.44 to 6.13	87	94	96	1	187	2	0
July 1999																
5/ 6	6 12.0	-63.32	6 12.4	-63.33	12.2	8.81	8.81	11.18	17.57 to 19.07 3.29 to 6.12	87	87	56	1	191	2	0
10/11	6 16.7	-63.46	6 17.0	-63.47	12.2	8.85	8.85	11.03	17.60 to 18.52 3.14 to 6.11	87	83	6	1	194	2	-1
15/16	6 21.3	-64.01	6 21.6	-64.03	12.2	8.88	8.89	10.48	18.03 to 18.37 2.59 to 6.09	87	88	10	1	198	2	-1
20/21	6 25.9	-64.19	6 26.1	-64.21	12.3	8.92	8.92	10.33	18.06 to 18.23 2.43 to 6.07	87	94	56	1	202	2	-1
25/26	6 30.3	-64.38	6 30.5	-64.40	12.3	8.96	8.96	10.18	2.27 to 6.03	87	95	95	1	206	2	-1
30/31	6 34.6	-64.59	6 34.8	-65.02	12.3	9.00	9.00	10.02	2.11 to 5.60	87	92	94	1	209	2	-1

August 1999																
4/ 5	6 38.9	-65.22	6 39.0	-65.25	12.3	9.04	9.04	9.47	1.54 to 5.55	87	87	47	1	213	2	-1
9/10	6 42.9	-65.47	6 43.1	-65.50	12.4	9.08	9.08	9.31	1.37 to 5.50	87	86	2	1	217	2	-2
14/15	6 46.8	-66.13	6 46.9	-66.17	12.4	9.12	9.11	9.15	1.20 to 5.44	86	90	14	1	221	1	-2
19/20	6 50.5	-66.41	6 50.6	-66.45	12.4	9.16	9.15	8.59	1.02 to 5.38	86	92	59	1	225	1	-2
24/25	6 54.0	-67.10	6 54.0	-67.14	12.5	9.20	9.19	8.43	0.43 to 5.31	86	93	96	1	229	1	-2
29/30	6 57.3	-67.40	6 57.2	-67.45	12.5	9.24	9.23	8.26	0.24 to 5.24	86	91	90	0	233	1	-2
September 1999																
3/ 4	7 0.3	-68.12	7 0.2	-68.16	12.5	9.29	9.26	8.09	0.05 to 5.16	86	89	38	0	237	1	-2
8/ 9	7 3.0	-68.44	7 2.8	-68.49	12.5	9.33	9.30	7.52	23.45 to 5.08	85	88	0	0	241	1	-2
13/14	7 5.4	-69.18	7 5.1	-69.22	12.6	9.37	9.34	7.35	23.24 to 5.00	85	89	16	0	245	1	-2
18/19	7 7.4	-69.52	7 7.1	-69.57	12.6	9.42	9.38	7.17	23.02 to 4.52	85	90	61	0	250	0	-2
23/24	7 9.0	-70.26	7 8.6	-70.31	12.6	9.46	9.41	6.59	22.40 to 4.43	84	91	98	0	254	0	-2
28/29	7 10.2	-71.01	7 9.7	-71.06	12.6	9.50	9.45	6.40	22.18 to 4.35	84	93	84	0	259	0	-2
October 1999																
3/ 4	7 10.9	-71.37	7 10.3	-71.42	12.7	9.55	9.49	6.21	21.54 to 4.26	84	91	30	0	264	0	-2
8/ 9	7 11.1	-72.12	7 10.3	-72.17	12.7	9.59	9.52	6.02	21.30 to 4.17	83	88	0	0	268	0	-2
13/14	7 10.7	-72.47	7 9.8	-72.52	12.7	9.63	9.56	5.41	21.04 to 4.09	83	86	18	0	273	0	-2
18/19	7 9.6	-73.21	7 8.6	-73.26	12.8	9.68	9.60	5.20	20.38 to 4.00	82	87	64	0	279	0	-2
23/24	7 7.9	-73.55	7 6.8	-74.00	12.8	9.72	9.63	4.59	20.11 to 3.52	82	92	99	0	284	0	-2
28/29	7 5.4	-74.28	7 4.2	-74.33	12.8	9.77	9.67	4.37	19.44 to 3.44	82	95	78	0	290	0	-2

Ephemeris for LINEAR (1998 M5) (UK)

Omega=101.2881 OMEGA=333.3762 i= 82.2279 q= 1.742203 a=434.248006
e=0.995988 P= 9049.128 T= 1999 January 24.5753 Equinox= 2000
Magnitudes calculated from m= 6.0+5.0*Log(d)+10.0*Log(r)

May 1999 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	8 30.0	47.49	8 33.5	47.38	10.4	2.10	2.14	17.56	21.11 to 2.44	79	112	99	5	100	4	-16
2/ 3	8 31.0	47.10	8 34.5	46.59	10.5	2.12	2.15	17.53	21.13 to 2.41	78	122	95	4	100	4	-16
3/ 4	8 31.9	46.32	8 35.4	46.21	10.5	2.14	2.15	17.50	21.16 to 2.38	77	132	91	4	100	4	-15
4/ 5	8 32.9	45.54	8 36.4	45.44	10.5	2.16	2.16	17.47	21.19 to 2.35	77	141	84	4	100	4	-15
5/ 6	8 33.9	45.17	8 37.3	45.07	10.5	2.18	2.17	17.44	21.21 to 2.24	76	148	76	4	99	4	-15
6/ 7	8 34.9	44.41	8 38.3	44.30	10.6	2.20	2.18	17.41	21.24 to 2.13	76	153	68	4	99	4	-15
7/ 8	8 35.8	44.05	8 39.2	43.54	10.6	2.21	2.18	17.38	21.27 to 2.03	75	153	58	4	99	4	-14
8/ 9	8 36.8	43.30	8 40.2	43.19	10.6	2.23	2.19	17.35	21.30 to 1.53	74	149	47	4	99	4	-14
9/10	8 37.8	42.55	8 41.1	42.44	10.7	2.26	2.20	17.32	21.32 to 1.44	74	141	37	4	99	4	-14
10/11	8 38.7	42.21	8 42.1	42.10	10.7	2.28	2.21	17.29	21.35 to 1.35	73	130	26	4	99	4	-14
11/12	8 39.7	41.47	8 43.0	41.36	10.7	2.30	2.21	17.26	21.38 to 1.26	73	118	17	4	99	4	-14
12/13	8 40.7	41.14	8 44.0	41.03	10.8	2.32	2.22	17.23	21.41 to 1.17	72	106	9	4	99	4	-13
13/14	8 41.6	40.41	8 44.9	40.30	10.8	2.34	2.23	17.20	21.44 to 1.09	71	92	3	4	99	4	-13
14/15	8 42.6	40.09	8 45.9	39.58	10.8	2.36	2.24	17.17	21.47 to 1.01	71	79	0	3	99	4	-13
15/16	8 43.6	39.37	8 46.8	39.26	10.8	2.38	2.24	17.14	21.50 to 0.53	70	65	0	3	99	4	-13
16/17	8 44.5	39.06	8 47.8	38.55	10.9	2.40	2.25	17.11	21.52 to 0.45	69	51	3	3	98	4	-13
17/18	8 45.5	38.35	8 48.7	38.24	10.9	2.42	2.26	17.08	21.55 to 0.37	69	39	9	3	98	4	-12
18/19	8 46.5	38.05	8 49.7	37.53	10.9	2.44	2.27	17.05	21.58 to 0.29	68	28	17	3	98	4	-12
19/20	8 47.4	37.35	8 50.6	37.23	11.0	2.46	2.27	17.02	22.01 to 0.22	67	21	27	3	98	4	-12
20/21	8 48.4	37.05	8 51.6	36.54	11.0	2.48	2.28	16.59	22.04 to 0.14	67	21	37	3	98	4	-12
21/22	8 49.4	36.36	8 52.5	36.25	11.0	2.50	2.29	16.56	22.07 to 0.07	66	28	48	3	98	4	-12
22/23	8 50.3	36.07	8 53.5	35.56	11.0	2.52	2.30	16.53	22.10 to 0.00	66	38	58	3	98	4	-11
23/24	8 51.3	35.39	8 54.4	35.28	11.1	2.55	2.31	16.50	22.13 to 23.53	65	49	68	3	98	4	-11
24/25	8 52.2	35.11	8 55.4	34.60	11.1	2.57	2.31	16.47	22.16 to 23.46	64	60	77	3	98	4	-11
25/26	8 53.2	34.44	8 56.3	34.32	11.1	2.59	2.32	16.44	22.19 to 23.39	64	71	85	3	98	4	-11
26/27	8 54.2	34.17	8 57.3	34.05	11.2	2.61	2.33	16.41	22.22 to 23.33	63	82	91	3	98	4	-11
27/28	8 55.1	33.50	8 58.2	33.38	11.2	2.63	2.34	16.38	22.25 to 23.26	62	93	96	3	98	4	-11
28/29	8 56.1	33.23	8 59.2	33.12	11.2	2.65	2.35	16.35	22.28 to 23.19	62	104	99	3	98	4	-10
29/30	8 57.0	32.57	9 0.1	32.46	11.2	2.67	2.35	16.32	22.31 to 23.13	61	115	100	2	98	4	-10
30/31	8 58.0	32.32	9 1.0	32.20	11.3	2.69	2.36	16.29	22.34 to 23.06	60	126	100	2	98	5	-10
31/32	8 58.9	32.06	9 2.0	31.54	11.3	2.71	2.37	16.26	22.37 to 22.60	60	137	98	2	98	5	-10
June 1999																
1/ 2	8 59.9	31.41	9 2.9	31.29	11.3	2.74	2.38	16.23	22.40 to 22.53	59	148	94	2	98	5	-10
2/ 3	9 0.8	31.17	9 3.9	31.05	11.4	2.76	2.39	16.20	22.42 to 22.47	58	158	88	2	98	5	-10
3/ 4	9 1.8	30.52	9 4.8	30.40	11.4	2.78	2.39	16.17	Not Observable	58	165	81	2	99	5	-10
4/ 5	9 2.7	30.28	9 5.7	30.16	11.4	2.80	2.40	16.14	Not Observable	57	165	72	2	99	5	-10
5/ 6	9 3.7	30.04	9 6.7	29.52	11.4	2.82	2.41	16.11	Not Observable	56	156	63	2	99	5	-9

Ephemeris for comet LINEAR (1998 T1) (Southern Hemisphere, 40° South)

Omega=226.3268 OMEGA=153.3495 i=170.1621 q= 1.468076 a=**********
e=0.999435 P=********* T= 1999 June 25.2401 Equinox= 2000
Magnitudes calculated from m= 8.0+5.0*Log(d)+10.0*Log(r)

May 1999 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	23 34.0	-3.50	23 36.6	-3.33	11.8	2.15	1.65	8.59	4.48 to 5.40	48	116	99	2	246	0	-2
2/ 3	23 34.0	-3.56	23 36.6	-3.39	11.8	2.12	1.65	8.55	4.42 to 5.40	49	104	95	2	246	0	-2
3/ 4	23 34.0	-4.02	23 36.6	-3.45	11.8	2.10	1.64	8.51	4.37 to 5.41	50	92	91	2	246	0	-2
4/ 5	23 34.0	-4.08	23 36.6	-3.51	11.7	2.07	1.64	8.47	4.31 to 5.42	51	81	84	2	246	0	-2
5/ 6	23 34.0	-4.14	23 36.5	-3.58	11.7	2.04	1.63	8.43	4.26 to 5.43	52	69	76	2	246	0	-2
6/ 7	23 33.9	-4.21	23 36.5	-4.05	11.6	2.02	1.62	8.39	4.20 to 5.44	53	56	68	2	246	0	-2
7/ 8	23 33.8	-4.28	23 36.4	-4.12	11.6	1.99	1.62	8.35	4.14 to 5.45	54	44	58	2	246	0	-2
8/ 9	23 33.8	-4.36	23 36.3	-4.19	11.5	1.96	1.61	8.31	4.09 to 5.45	55	31	47	3	246	0	-3
9/10	23 33.6	-4.44	23 36.2	-4.27	11.5	1.93	1.61	8.27	4.03 to 5.46	56	18	37	3	246	0	-3
10/11	23 33.5	-4.52	23 36.1	-4.35	11.4	1.90	1.60	8.23	3.57 to 5.47	57	4	26	3	246	0	-3
11/12	23 33.3	-5.00	23 35.9	-4.44	11.4	1.87	1.59	8.19	3.51 to 5.48	58	10	17	3	245	-1	-3
12/13	23 33.2	-5.09	23 35.7	-4.53	11.3	1.85	1.59	8.14	3.45 to 5.49	59	25	9	3	245	-1	-3
13/14	23 32.9	-5.19	23 35.5	-5.02	11.3	1.82	1.58	8.10	3.39 to 5.50	60	40	3	3	245	-1	-3
14/15	23 32.7	-5.29	23 35.3	-5.12	11.2	1.79	1.58	8.06	3.33 to 5.50	62	55	0	3	245	-1	-4
15/16	23 32.4	-5.39	23 35.0	-5.22	11.2	1.76	1.57	8.02	3.27 to 5.51	63	70	0	3	245	-1	-4
16/17	23 32.1	-5.50	23 34.7	-5.33	11.1	1.73	1.57	7.58	3.21 to 5.52	64	86	3	4	245	-1	-4
17/18	23 31.8	-6.01	23 34.3	-5.45	11.1	1.70	1.56	7.53	3.15 to 5.53	65	101	9	4	245	-2	-4
18/19	23 31.4	-6.13	23 34.0	-5.57	11.0	1.67	1.56	7.49	3.09 to 5.54	66	115	17	4	245	-2	-4
19/20	23 31.0	-6.26	23 33.6	-6.09	11.0	1.64	1.55	7.45	3.03 to 5.54	67	130	27	4	245	-2	-5
20/21	23 30.5	-6.39	23 33.1	-6.23	10.9	1.61	1.55	7.40	2.56 to 5.55	68	144	37	4	245	-2	-5
21/22	23 30.0	-6.53	23 32.6	-6.36	10.9	1.58	1.55	7.36	2.50 to 5.56	69	157	48	4	245	-3	-5
22/23	23 29.5	-7.08	23 32.0	-6.51	10.8	1.55	1.54	7.31	2.43 to 5.57	71	170	58	4	245	-3	-6
23/24	23 28.9	-7.23	23 31.4	-7.07	10.8	1.51	1.54	7.27	2.37 to 5.57	72	177	68	5	245	-3	-6

24/25	23 28.2	-7.39	23 30.8	-7.23	10.7	1.48	1.53	7.22	2.30 to 5.58	73	164	77	5	246	-4	-6
25/26	23 27.5	-7.57	23 30.1	-7.40	10.7	1.45	1.53	7.18	2.23 to 5.59	74	152	85	5	246	-4	-7
26/27	23 26.7	-8.15	23 29.3	-7.58	10.6	1.42	1.53	7.13	2.16 to 5.59	76	140	91	5	246	-4	-7
27/28	23 25.9	-8.34	23 28.5	-8.17	10.5	1.39	1.52	7.08	2.09 to 6.00	77	128	96	5	246	-5	-7
28/29	23 25.0	-8.54	23 27.5	-8.38	10.5	1.36	1.52	7.03	2.02 to 6.01	78	115	99	6	246	-5	-8
29/30	23 24.0	-9.15	23 26.6	-8.59	10.4	1.33	1.51	6.58	1.55 to 6.01	79	103	100	6	246	-6	-8
30/31	23 22.9	-9.38	23 25.5	-9.22	10.4	1.29	1.51	6.53	1.47 to 6.02	81	91	100	6	246	-6	-9
31/32	23 21.7	-10.02	23 24.3	-9.46	10.3	1.26	1.51	6.48	1.39 to 6.03	82	79	98	6	246	-7	-9
June	1999															
1/ 2	23 20.5	-10.28	23 23.1	-10.11	10.2	1.23	1.50	6.43	1.32 to 6.03	84	66	94	6	246	-7	-10
2/ 3	23 19.1	-10.55	23 21.7	-10.38	10.2	1.20	1.50	6.38	1.24 to 6.04	85	54	88	7	246	-8	-11
3/ 4	23 17.6	-11.23	23 20.2	-11.07	10.1	1.17	1.50	6.32	1.15 to 6.04	87	41	81	7	246	-9	-11
4/ 5	23 16.0	-11.54	23 18.6	-11.37	10.0	1.13	1.50	6.27	1.07 to 6.05	88	28	72	7	247	-9	-12
5/ 6	23 14.3	-12.26	23 16.9	-12.10	10.0	1.10	1.49	6.21	0.58 to 6.06	90	15	63	7	247	-10	-13
6/ 7	23 12.4	-13.01	23 15.0	-12.44	9.9	1.07	1.49	6.15	0.49 to 6.06	91	5	52	8	247	-11	-14
7/ 8	23 10.3	-13.38	23 12.9	-13.21	9.8	1.04	1.49	6.09	0.40 to 6.07	93	14	41	8	247	-12	-15
8/ 9	23 8.1	-14.17	23 10.7	-14.01	9.7	1.01	1.49	6.03	0.30 to 6.07	95	29	30	8	248	-13	-16
9/10	23 5.6	-14.59	23 8.3	-14.43	9.7	0.98	1.48	5.57	0.20 to 6.08	96	43	20	8	248	-14	-17
10/11	23 3.0	-15.44	23 5.6	-15.28	9.6	0.95	1.48	5.50	0.10 to 6.08	98	59	11	9	248	-16	-18
11/12	23 0.0	-16.32	23 2.7	-16.16	9.5	0.91	1.48	5.43	23.59 to 6.09	100	75	4	9	249	-17	-20
12/13	22 56.8	-17.24	22 59.5	-17.08	9.4	0.88	1.48	5.36	23.48 to 6.09	102	91	0	9	249	-19	-21
13/14	22 53.3	-18.19	22 56.0	-18.03	9.3	0.85	1.48	5.29	23.36 to 6.09	104	107	0	10	250	-20	-23
14/15	22 49.4	-19.19	22 52.1	-19.03	9.3	0.82	1.48	5.21	23.24 to 6.10	106	123	2	10	250	-22	-24
15/16	22 45.2	-20.23	22 47.9	-20.07	9.2	0.79	1.47	5.13	23.11 to 6.10	108	138	7	10	251	-24	-26
16/17	22 40.5	-21.31	22 43.2	-21.15	9.1	0.77	1.47	5.04	22.57 to 6.10	111	153	14	10	252	-27	-28
17/18	22 35.3	-22.45	22 38.0	-22.29	9.0	0.74	1.47	4.55	22.42 to 6.11	113	165	23	11	253	-30	-30
18/19	22 29.5	-24.03	22 32.2	-23.48	8.9	0.71	1.47	4.45	22.27 to 6.11	116	167	32	11	254	-33	-32
19/20	22 23.0	-25.28	22 25.8	-25.12	8.8	0.68	1.47	4.35	22.10 to 6.11	118	156	43	11	256	-36	-35
20/21	22 15.8	-26.58	22 18.6	-26.42	8.8	0.66	1.47	4.24	21.52 to 6.12	121	143	53	11	258	-40	-37
21/22	22 7.8	-28.33	22 10.6	-28.18	8.7	0.63	1.47	4.12	21.33 to 6.12	124	129	63	11	260	-44	-39
22/23	21 58.8	-30.14	22 1.7	-29.60	8.6	0.61	1.47	3.59	21.12 to 6.12	127	115	72	11	262	-48	-42
23/24	21 48.6	-32.01	21 51.6	-31.47	8.5	0.59	1.47	3.45	20.50 to 6.12	131	101	80	11	265	-53	-44
24/25	21 37.3	-33.52	21 40.2	-33.38	8.4	0.57	1.47	3.29	20.26 to 6.12	134	87	87	11	269	-59	-46
25/26	21 24.4	-35.46	21 27.5	-35.33	8.4	0.55	1.47	3.13	19.60 to 6.12	137	73	93	11	273	-65	-47
26/27	21 10.0	-37.42	21 13.2	-37.30	8.3	0.53	1.47	2.54	19.32 to 6.13	141	59	97	10	279	-71	-48
27/28	20 53.8	-39.37	20 57.1	-39.25	8.2	0.52	1.47	2.34	19.01 to 6.13	144	46	100	10	285	-77	-47
28/29	20 35.8	-41.28	20 39.1	-41.17	8.2	0.51	1.47	2.13	18.29 to 6.13	148	33	100	9	294	-84	-46
29/30	20 15.9	-43.12	20 19.3	-43.02	8.2	0.50	1.47	1.49	17.54 to 6.13	151	26	99	8	304	-90	-43
30/31	19 54.1	-44.44	19 57.6	-44.36	8.1	0.49	1.47	1.23	17.55 to 6.13	153	27	96	8	316	-96	-38
July	1999															
1/ 2	19 30.7	-46.01	19 34.3	-45.55	8.1	0.49	1.47	0.56	17.55 to 6.13	155	36	91	7	331	-101	-32
2/ 3	19 6.0	-46.60	19 9.7	-46.55	8.1	0.49	1.47	0.27	17.56 to 6.13	156	49	85	7	347	-105	-24
3/ 4	18 40.6	-47.37	18 44.4	-47.34	8.1	0.49	1.47	23.58	17.56 to 6.13	155	64	76	7	3	-106	-15
4/ 5	18 15.2	-47.52	18 19.0	-47.51	8.1	0.49	1.47	23.29	17.56 to 6.12	154	80	66	8	19	-106	-6
5/ 6	17 50.3	-47.46	17 54.1	-47.46	8.2	0.50	1.48	22.60	17.57 to 6.12	152	96	56	8	33	-104	2
6/ 7	17 26.6	-47.21	17 30.4	-47.23	8.2	0.51	1.48	22.32	17.57 to 6.12	149	112	44	8	45	-100	10
7/ 8	17 4.5	-46.39	17 8.2	-46.43	8.3	0.52	1.48	22.06	17.58 to 6.12	146	128	33	9	55	-94	17
8/ 9	16 44.2	-45.45	16 47.8	-45.50	8.4	0.54	1.48	21.42	17.59 to 5.50	143	142	22	9	63	-88	22
9/10	16 25.8	-44.42	16 29.3	-44.49	8.4	0.56	1.48	21.19	17.59 to 5.19	139	151	13	10	70	-81	26
10/11	16 9.2	-43.33	16 12.7	-43.41	8.5	0.57	1.48	20.59	17.60 to 4.50	136	152	6	10	76	-74	28
11/12	15 54.5	-42.21	15 57.9	-42.30	8.6	0.60	1.49	20.40	18.00 to 4.23	133	143	1	10	81	-68	30
12/13	15 41.4	-41.08	15 44.7	-41.17	8.7	0.62	1.49	20.23	18.01 to 3.58	130	129	0	10	85	-61	30
13/14	15 29.7	-39.55	15 33.0	-40.05	8.8	0.64	1.49	20.07	18.01 to 3.34	127	115	1	10	89	-55	30
14/15	15 19.4	-38.44	15 22.6	-38.54	8.9	0.67	1.49	19.53	18.02 to 3.13	124	100	4	10	92	-50	29
15/16	15 10.2	-37.35	15 13.3	-37.46	9.0	0.69	1.50	19.40	18.03 to 2.53	121	85	10	10	94	-45	28
16/17	15 1.9	-36.29	15 5.1	-36.40	9.0	0.72	1.50	19.28	18.03 to 2.34	118	71	18	10	96	-41	27
17/18	14 54.6	-35.26	14 57.7	-35.38	9.1	0.75	1.50	19.16	18.04 to 2.16	116	57	27	10	98	-37	26
18/19	14 48.1	-34.26	14 51.1	-34.39	9.2	0.78	1.51	19.06	18.05 to 1.60	114	45	37	9	100	-33	24
19/20	14 42.2	-33.30	14 45.2	-33.43	9.3	0.81	1.51	18.56	18.05 to 1.45	111	34	47	9	101	-30	23
20/21	14 36.9	-32.37	14 39.9	-32.50	9.4	0.84	1.51	18.47	18.06 to 1.30	109	25	56	9	103	-27	22
21/22	14 32.1	-31.47	14 35.1	-32.00	9.5	0.87	1.52	18.38	18.07 to 1.17	107	21	66	8	104	-25	20
22/23	14 27.8	-31.00	14 30.7	-31.13	9.6	0.90	1.52	18.30	18.07 to 1.04	105	25	74	8	105	-23	19
23/24	14 23.8	-30.16	14 26.8	-30.29	9.7	0.93	1.52	18.22	18.08 to 0.52	103	33	82	8	106	-21	18
24/25	14 20.3	-29.34	14 23.2	-29.48	9.7	0.96	1.53	18.14	18.09 to 0.40	101	44	89	8	106	-19	17
25/26	14 17.0	-28.55	14 20.0	-29.09	9.8	0.99	1.53	18.07	18.10 to 0.29	99	55	95	7	107	-17	16
26/27	14 14.1	-28.19	14 17.0	-28.33	9.9	1.02	1.54	18.00	18.10 to 0.18	98	67	98	7	108	-16	15
27/28	14 11.4	-27.44	14 14.3	-27.58	10.0	1.05	1.54	17.53	18.11 to 0.08	96	80	100	7	108	-14	14
28/29	14 8.9	-27.12	14 11.8	-27.26	10.1	1.09	1.54	17.47	18.12 to 23.58	94	92	100	7	109	-13	13
29/30	14 6.7	-26.42	14 9.5	-26.56	10.1	1.12	1.55	17.41	18.13 to 23.49	93	105	98	6	110	-12	12
30/31	14 4.6	-26.13	14 7.4	-26.27	10.2	1.15	1.55	17.35	18.13 to 23.40	91	118	94	6	110	-11	11
31/32	14 2.7	-25.46	14 5.5	-26.00	10.3	1.18	1.56	17.29	18.14 to 23.31	90	131	87	6	110	-10	11
August	1999															
1/ 2	14 1.0	-25.21	14 3.8	-25.35	10.4	1.22	1.56	17.23	18.15 to 23.22	88	143	79	6	111	-9	10
2/ 3	13 59.3	-24.57	14 2.2	-25.11	10.4	1.25	1.57	17.18	18.16 to 23.14	87	155	69	5	111	-9	9
3/ 4	13 57.9	-24.34	14 0.7	-24.49	10.5	1.28	1.57	17.12	18.16 to 23.06	86	163	58	5	111	-8	9
4/ 5	13 56.5	-24.13	13 59.3	-24.27	10.6	1.31	1.58	17.07	18.17 to 22.58	84	160	47	5	112	-7	8
5/ 6	13 55.3	-23.53	13 58.1	-24.07	10.6	1.35	1.58	17.02	18.18 to 22.50	83	150	36	5	112	-7	8
6/ 7	13 54.1	-23.34	13 56.9	-23.48	10.7	1.38	1.59	16.57	18.19 to 22.42	82	138	25	5	112	-6	7
7/ 8	13 53.1	-23.16	13 55.8	-23.30	10.8	1.41	1.59	16.52	18.20 to 22.35	80	124	15	4	113	-6	7
8/ 9	13 52.1	-22.59	13 54.9	-23.13	10.8	1.44	1.60	16.47	18.20 to 22.28	79	110	8	4	113	-5	7
9/10	13 51.2	-22.43	13 54.0	-22.57	10.9	1.47	1.60	16.42	18.21 to 22.20	78	96	2	4	113	-5	6
10/11	13 50.4	-22.27	13 53.1	-22.42	11.0	1.51	1.61	16.37	18.22 to 22.13	77	82	0	4	113	-4	6
11/12	13 49.6	-22.13	13 52.4	-22.28	11.0	1.54	1.61	16.32	18.23 to 22.07	75	68	0	4	114	-4	6
12/13	13 48.9	-21.59	13 51.7	-22.14	11.1	1.57	1.62	16.28	18.24 to 21.60	74	55	2	4	114	-3	5
13/14	13 48.3	-21.46	13 51.1	-22.01	11.1	1.60	1.63	16.23	18.24 to 21.53	73	42	7	4	114	-3	5
14/15	13 47.7	-21.34	13 50.5	-21.49	11.2	1.63	1.63	16.19	18.25 to 21.47	72	30	14	3	114	-3	5
15/16	13 47.2	-21.22	13 50.0	-21.37	11.2	1.66	1.64	16.14	18.26 to 21.40	71	20	22	3	114	-3	4
16/17	13 46.7	-21.11	13 49.5	-21.26	11.3	1.69	1.64	16.10	18.27 to 21.34	70	15	31	3	115	-2	4
17/18	13 46.3	-21.01	13 49.0	-21.16	11.4	1.73	1.65	16.05	18.28 to 21.27	69	18	40	3	115	-2	4
18/19	13 45.9	-20.51	13 48.7	-21.06	11.4	1.76	1.66	16.01	18.29 to 21.21	67	27	49	3	115	-2	4
19/20	13 45.6	-20.41	13 48.3	-20.56	11.5	1.79	1.66	15.57	18.29 to 21.15	66	37	59	3	115	-2	3
20/21	13 45.3	-20.32	13 48.0	-20.47	11.5	1.82	1.67	15.52	18.30 to 21.09	65	48	68	3	115	-1	3
21/22	13 45.0	-20.24	13 47.7	-20.39	11.6	1.85	1.68	15.48	18.31 to 21.03	64	60	77	3	115	-1	3
22/23	13 44.7	-20.16	13 47.5	-20.31	11.6	1.88	1.68	15.44	18.32 to 20.57	63	72	85	2	116	-1	3
23/24	13 44.5	-20.08	13 47.3	-20.23	11.7	1.91	1.69	15.40	18.33 to 20.51	62	84	91	2	116	-1	3
24/25	13 44.3	-20.01	13 47.1	-20.16	11.7	1.94	1.70	15.36	18.34 to 20.45	61	96	96	2	116	-1	3
25/26	13 44.2	-19.54	13 46.9	-20.09	11.8	1.97	1.70	15.32	18.35 to 20.39	60	109	99	2	116	0	2
26/27	13 44.1	-19.47	13 46.8	-20.02	11.8	2.00	1.71	15.28	18.35 to 20.33	59	121	100	2	116	0	2
27/28	13 44.0	-19.41	13 46.7	-19.56	11.9	2.02	1.72	15.24	18.36 to 20.28	58	134	99	2	116	0	2
28/29	13 43.9	-19.35	13 46.6	-19.50	11.9	2.05	1.72	15.20	18.37 to 20.22	57	147	96	2	116	0	2
29/30	13 43.8	-19.30	13 46.6	-19.45	12.0	2.08	1.73	15.16	18.38 to 20.16	56	159	90	2	117	0	2
30/31	13 43.8	-19.24	13 46.5	-19.39	12.0	2.11	1.74	15.12	18.39 to 20.11	55	167	82	2	117	0	2
31/32	13 43.8	-19.19	13 46.5	-19.34	12.1	2.14	1.75	15.08	18.40 to 20.05	54	162	72	2	117	0	2

September 1999

1/ 2	13 43.8	-19.15	13 46.5	-19.29	12.1	2.17	1.75	15.04	18.41 to 19.59	53	151	61	2	117	0	1
2/ 3	13 43.8	-19.10	13 46.5	-19.25	12.2	2.19	1.76	14.60	18.41 to 19.54	52	138	49	2	117	0	1
3/ 4	13 43.8	-19.06	13 46.6	-19.21	12.2	2.22	1.77	14.56	18.42 to 19.49	51	125	38	2	117	0	1
4/ 5	13 43.9	-19.02	13 46.6	-19.17	12.3	2.25	1.78	14.52	18.43 to 19.43	50	111	27	1	118	0	1
5/ 6	13 44.0	-18.58	13 46.7	-19.13	12.3	2.27	1.78	14.48	18.44 to 19.38	49	97	17	1	118	0	1
6/ 7	13 44.1	-18.54	13 46.8	-19.09	12.3	2.30	1.79	14.44	18.45 to 19.32	48	84	10	1	118	0	1
7/ 8	13 44.2	-18.51	13 46.9	-19.06	12.4	2.33	1.80	14.40	18.46 to 19.27	47	70	4	1	118	0	1
8/ 9	13 44.3	-18.48	13 47.0	-19.03	12.4	2.35	1.81	14.37	18.47 to 19.22	46	57	0	1	118	0	1
9/10	13 44.4	-18.45	13 47.1	-18.60	12.5	2.38	1.82	14.33	18.48 to 19.16	45	44	0	1	118	0	1
10/11	13 44.5	-18.42	13 47.3	-18.57	12.5	2.40	1.82	14.29	18.49 to 19.11	44	32	1	1	119	0	1
11/12	13 44.7	-18.39	13 47.4	-18.54	12.6	2.43	1.83	14.25	18.50 to 19.06	43	21	4	1	119	0	1
12/13	13 44.9	-18.37	13 47.6	-18.52	12.6	2.45	1.84	14.21	18.51 to 19.00	42	13	10	1	119	0	1
13/14	13 45.0	-18.34	13 47.8	-18.49	12.6	2.48	1.85	14.18	18.52 to 18.55	41	14	16	1	119	1	0
14/15	13 45.2	-18.32	13 48.0	-18.47	12.7	2.50	1.86	14.14	Not Observable	41	23	24	1	119	1	0
15/16	13 45.4	-18.30	13 48.1	-18.45	12.7	2.52	1.86	14.10	Not Observable	40	34	33	1	120	1	0
16/17	13 45.6	-18.28	13 48.4	-18.43	12.8	2.55	1.87	14.06	Not Observable	39	45	42	1	120	1	0
17/18	13 45.8	-18.27	13 48.6	-18.41	12.8	2.57	1.88	14.03	Not Observable	38	56	52	1	120	1	0
18/19	13 46.1	-18.25	13 48.8	-18.40	12.8	2.59	1.89	13.59	Not Observable	37	68	61	1	120	1	0
19/20	13 46.3	-18.23	13 49.0	-18.38	12.9	2.62	1.90	13.55	Not Observable	36	80	70	1	121	1	0
20/21	13 46.5	-18.22	13 49.3	-18.37	12.9	2.64	1.91	13.52	Not Observable	35	92	79	1	121	1	0
21/22	13 46.8	-18.21	13 49.5	-18.36	12.9	2.66	1.91	13.48	Not Observable	34	104	87	1	121	1	0
22/23	13 47.0	-18.20	13 49.8	-18.35	13.0	2.68	1.92	13.44	Not Observable	33	117	93	1	121	1	0

Ephemeris for Jager (1998 U3) (UK)

```
Omega=180.8900 OMEGA=303.5428 i= 19.1414 q= 2.133928 a=  6.064449
e=0.648125  P=   14.934  T= 1999 March     10.0600    Equinox= 2000
Magnitudes calculated from m= 6.5+5.0*Log(d)+10.0*Log(r)
```

Note: the comet is likely to be fainter than indicated by these predictions.

April 1999 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	7 2.1	18.46	7 5.0	18.42	11.1	1.84	2.14	18.25	19.60 to 23.54	94	99	99	3	96	8	-4
2/ 3	7 3.5	18.36	7 6.4	18.32	11.1	1.85	2.15	18.23	20.02 to 23.50	93	111	97	3	96	8	-4
3/ 4	7 5.0	18.26	7 7.9	18.21	11.2	1.86	2.15	18.20	20.04 to 23.46	92	122	92	3	97	8	-4
4/ 5	7 6.5	18.16	7 9.4	18.11	11.2	1.87	2.15	18.18	20.06 to 23.43	92	134	86	3	97	8	-4
5/ 6	7 8.0	18.06	7 10.9	18.01	11.2	1.88	2.15	18.15	20.08 to 23.39	91	145	79	3	97	8	-4
6/ 7	7 9.5	17.57	7 12.4	17.51	11.2	1.89	2.15	18.13	20.10 to 23.35	91	157	70	3	97	8	-4
7/ 8	7 11.0	17.47	7 13.9	17.41	11.2	1.91	2.15	18.11	20.12 to 23.31	90	168	61	3	97	9	-4
8/ 9	7 12.6	17.37	7 15.5	17.31	11.2	1.92	2.15	18.08	20.15 to 23.27	89	178	52	3	97	9	-4
9/10	7 14.1	17.27	7 17.0	17.21	11.3	1.93	2.15	18.06	20.17 to 23.24	89	168	41	3	98	9	-4
10/11	7 15.7	17.17	7 18.6	17.11	11.3	1.94	2.16	18.03	20.19 to 23.20	88	155	31	3	98	9	-4
11/12	7 17.2	17.07	7 20.1	17.02	11.3	1.95	2.16	18.01	20.21 to 23.16	88	142	22	3	98	9	-4
12/13	7 18.8	16.57	7 21.7	16.52	11.3	1.96	2.16	17.59	20.24 to 23.13	87	129	13	3	98	9	-4
13/14	7 20.4	16.48	7 23.3	16.42	11.3	1.98	2.16	17.56	20.26 to 23.09	86	115	6	3	98	9	-4
14/15	7 22.0	16.38	7 24.9	16.32	11.3	1.99	2.16	17.54	20.28 to 23.05	86	101	2	3	99	9	-4
15/16	7 23.6	16.28	7 26.5	16.22	11.4	2.00	2.16	17.52	20.31 to 23.01	85	87	0	3	99	9	-4
16/17	7 25.2	16.18	7 28.1	16.12	11.4	2.01	2.16	17.49	20.33 to 22.58	85	72	1	3	99	9	-4
17/18	7 26.9	16.08	7 29.7	16.02	11.4	2.02	2.17	17.47	20.35 to 22.54	84	57	5	3	99	9	-4
18/19	7 28.5	15.59	7 31.4	15.52	11.4	2.04	2.17	17.45	20.38 to 22.50	84	43	11	3	100	9	-4
19/20	7 30.1	15.49	7 33.0	15.42	11.4	2.05	2.17	17.42	20.40 to 22.47	83	29	20	2	100	9	-4
20/21	7 31.8	15.39	7 34.6	15.32	11.4	2.06	2.17	17.40	20.43 to 22.43	82	15	30	2	100	9	-4
21/22	7 33.5	15.29	7 36.3	15.22	11.5	2.07	2.17	17.38	20.45 to 22.39	82	4	41	2	100	10	-4
22/23	7 35.1	15.19	7 38.0	15.13	11.5	2.08	2.17	17.36	20.47 to 22.36	81	13	52	2	100	10	-4
23/24	7 36.8	15.10	7 39.6	15.03	11.5	2.10	2.18	17.33	20.50 to 22.32	81	25	63	2	101	10	-4
24/25	7 38.5	14.60	7 41.3	14.53	11.5	2.11	2.18	17.31	20.52 to 22.28	80	38	73	2	101	10	-4
25/26	7 40.2	14.50	7 43.0	14.43	11.5	2.12	2.18	17.29	20.55 to 22.25	80	50	81	2	101	10	-4
26/27	7 41.9	14.40	7 44.7	14.33	11.5	2.13	2.18	17.26	20.58 to 22.21	79	62	89	2	101	10	-4
27/28	7 43.6	14.30	7 46.4	14.23	11.5	2.15	2.18	17.24	21.00 to 22.18	79	74	94	2	102	10	-4
28/29	7 45.3	14.20	7 48.1	14.13	11.6	2.16	2.19	17.22	21.03 to 22.14	78	85	98	2	102	10	-4
29/30	7 47.0	14.10	7 49.8	14.03	11.6	2.17	2.19	17.20	21.05 to 22.10	78	97	100	2	102	10	-4
30/31	7 48.7	14.01	7 51.5	13.53	11.6	2.18	2.19	17.18	21.08 to 22.07	77	108	100	2	102	10	-4
May 1999																
1/ 2	7 50.4	13.51	7 53.3	13.43	11.6	2.19	2.19	17.15	21.11 to 22.03	77	120	99	2	103	10	-4
2/ 3	7 52.2	13.41	7 55.0	13.33	11.6	2.21	2.19	17.13	21.13 to 21.59	76	131	95	2	103	10	-4
3/ 4	7 53.9	13.31	7 56.7	13.22	11.6	2.22	2.20	17.11	21.16 to 21.56	76	142	91	2	103	10	-4
4/ 5	7 55.6	13.21	7 58.4	13.12	11.7	2.23	2.20	17.09	21.19 to 21.52	75	154	84	2	103	10	-4
5/ 6	7 57.4	13.11	8 0.2	13.02	11.7	2.24	2.20	17.06	21.21 to 21.48	75	165	76	2	104	10	-4
6/ 7	7 59.1	13.01	8 1.9	12.52	11.7	2.26	2.20	17.04	21.24 to 21.45	74	174	68	2	104	10	-4
7/ 8	8 0.9	12.50	8 3.7	12.42	11.7	2.27	2.21	17.02	21.27 to 21.41	74	169	58	2	104	10	-4
8/ 9	8 2.6	12.40	8 5.4	12.32	11.7	2.28	2.21	16.60	21.30 to 21.37	73	158	47	2	104	10	-4
9/10	8 4.4	12.30	8 7.2	12.21	11.7	2.29	2.21	16.58	21.32 to 21.34	73	145	37	2	105	10	-4
10/11	8 6.2	12.20	8 8.9	12.11	11.8	2.30	2.21	16.56	Not Observable	72	132	26	2	105	10	-4
11/12	8 7.9	12.10	8 10.7	12.01	11.8	2.32	2.21	16.53	Not Observable	72	119	17	2	105	10	-4
12/13	8 9.7	11.60	8 12.5	11.51	11.8	2.33	2.22	16.51	Not Observable	71	105	9	2	105	10	-4
13/14	8 11.5	11.49	8 14.2	11.40	11.8	2.34	2.22	16.49	Not Observable	71	90	3	2	106	10	-4
14/15	8 13.3	11.39	8 16.0	11.30	11.8	2.35	2.22	16.47	Not Observable	70	76	0	2	106	10	-4
15/16	8 15.0	11.29	8 17.8	11.19	11.8	2.37	2.23	16.45	Not Observable	70	61	0	2	106	10	-4

TA format (example)

```
          1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                        Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5   2               Shanklin
961214.70 S   3.8  AA   8   B        20  6     7/  0.50   40   Baroni
```

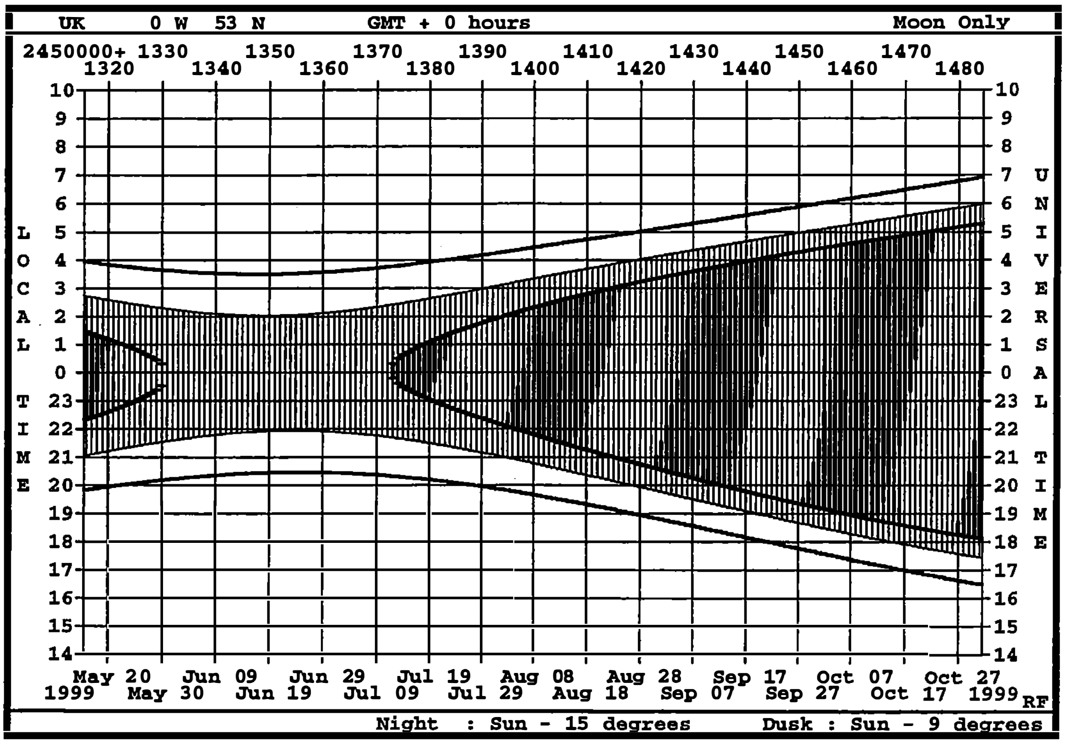
ICQ format (example)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
 991992    1992  5 18.94  S  9.3 AA  7.5R     50    6    4        135 ICQ XX BEA
  P1955A1  1955  6 18.08     5.0 BD  5  R      6    5    s5    0.75 335 ICQ XX STO01
```

Charts

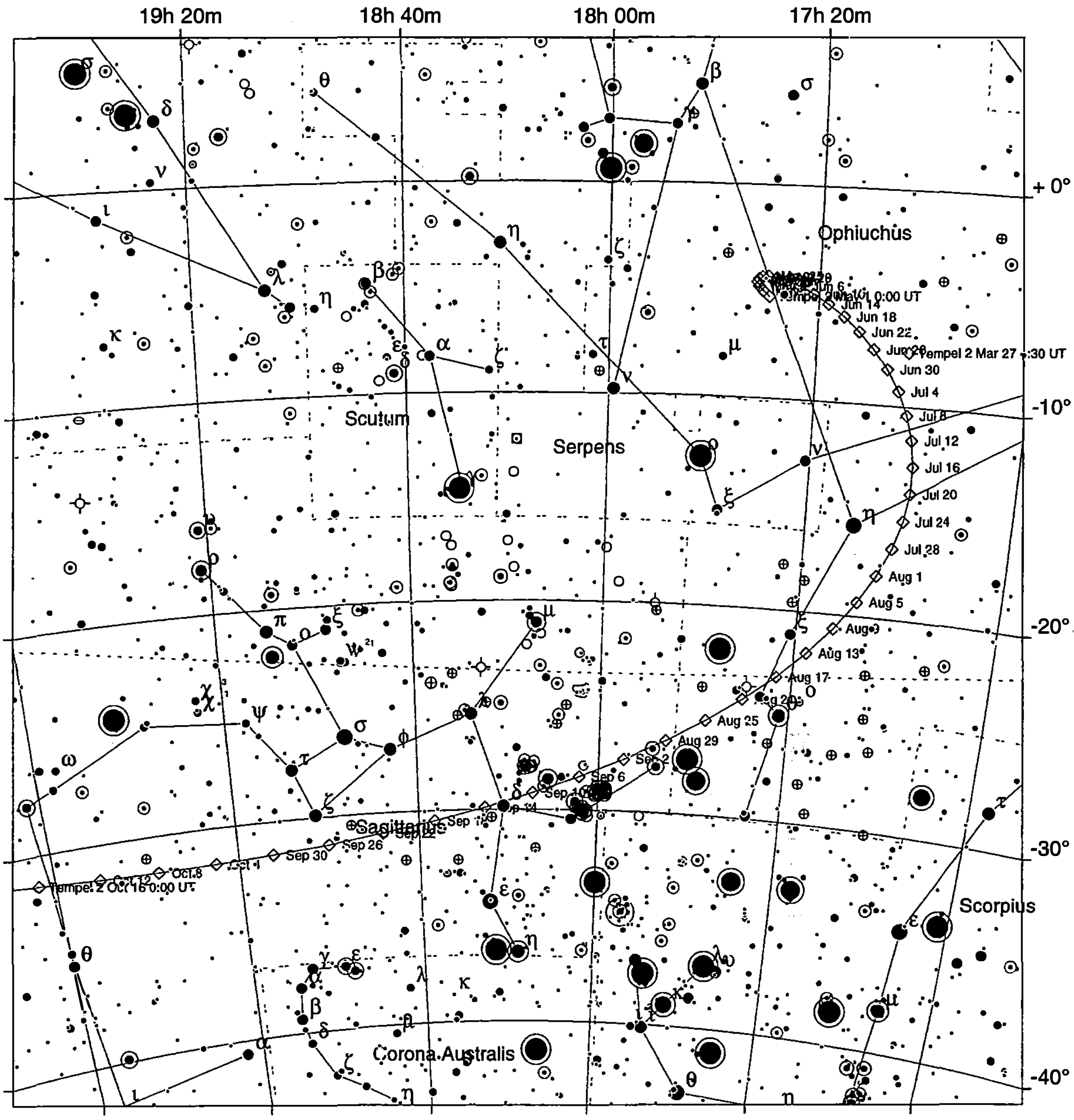
The diagram on this page shows when the moon interferes with observations and was produced using software written by Richard Fleet. There is no moon in the dark regions and the moon will only interfere a little in the grey shaded regions.

The listed comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet. Overleaf is a finder chart for comet 10P/Tempel 2, which is predicted to be the brightest comet on view from the UK for the next six months.



MegaStar

N E W	0 1 2 3 4 5 6 7	50° 28.5' x 47° 49.2'	18h 17m 25.9s -18° 37' 30"	Mar 27, 1999 4:30 LT 04:30 UT N 52° 0' 0.0" W 0° 0' 0.0" Alt: 16.6° Azim: 157.6° Trans: 06:00 Rise: 01:48 Set: 10:13
Galaxy	Glxy Cl	Globular	Open Cl	Planetary
Clust+Neb	Sgr	Uranometria 339		
Bright Neb	Dark Neb	Asterism	Unknown	Quasar
Dbl Star	Comet	Asteroid		



Finder chart for comet 10P/Tempel 2

Mar 27, 1999 4:30

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are VT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	[illegible]	[illegible]	Sky	[illegible]	Comments

Second International Workshop on Cometary Astronomy

New Hall, Cambridge

Saturday - Monday, 1999 August 14 - 16

(Please print or type)

Name--

Full Postal Address---

E-mail address--

The entire meeting will be held within the precincts of New Hall. The following rates apply, note that late booking is more expensive!

Date of booking	April	May - July	August
Daily full board, 'shared' facilities	£72.50	£75	£82.50
Daily full board, en-suite facilities	£87.50	£90	£99
Supplement for double	£17	£17	£21
Day visitor with lunch	£17.50	£18	£19.80
Discount for sharing a twin room	£10	£10	£10
Stonehenge (provisional)	£10	£10	£15

"En-suite" means shower and toilet internal to the room; "shared" means that they are external in separate rooms, but shared with other rooms. Supplement for double is the additional rate for a spouse or partner and covers bed and breakfast only. Other combinations of meals, day visits, nights etc are open to negotiation.

Please indicate your requirements with a tick or number in each box:

	Thursday	Friday	Saturday	Sunday	Monday
Full board					
Full board + ensuite					
Sharing					
Day visitor					
Lunch					
Dinner					
Stonehenge					

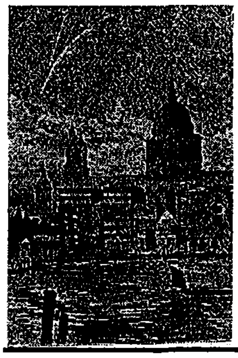
If booking meals please indicate any dietary requirements--

If sharing please indicate the name of a person you are willing to share with (or take a lottery!)---------------------------

A deposit of 25% of total cost or £25 per day per person, with a minimum deposit of £20 is required as soon as possible. Please make cheques payable to the BAA and send them to me at 11 City Road, Cambridge CB1 1DP. Alternative payment arrangements may be possible for overseas visitors.

Amount enclosed---

Date--



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 6, No 2 (Issue 12), 1999 October

THE SECOND INTERNATIONAL WORKSHOP ON COMETARY ASTRONOMY

New Hall, Cambridge, 1999 August 14 - 16

After months of planning and much hard work the participants for the second International Workshop on Cometary Astronomy began to assemble at New Hall, Cambridge on the afternoon and evening of Friday, August 13th. New Hall is one of the more recent Cambridge colleges and includes a centre built for Japanese students as well as accommodation for the graduate and undergraduate students. It is a women's college and a few participants were later disturbed by the night porter doing his rounds and making sure that all ground floor windows were closed. A hearty dinner was provided, but afterwards I had to leave to continue last minute preparations for the morning.

On Saturday morning, Dan Green and Jon Shanklin made a few opening announcements. We had nine comet discoverers present and five continents were represented. The next meeting would take place in 4 – 5 years time, possibly in America. For most of the day the British Astronomical Association had a sales desk in the entrance foyer to New Hall, with a range of eclipse memorabilia on offer, as well as copies of cometary publications.

Don Machholz gave the opening talk about comet hunting. He used to live in a light polluted site and drove out to Lomo Prieta for comet searching. In 1990 he moved 180 miles to the small town of Colfax (pop 1000) and has since discovered five comets.

He had searched 1000 hours since 1994 without a discovery. If the Edgar Wilson award had been in operation he would have netted an average of $4000 a year, though some years would be more rewarding and others less. His search technique is to scan east/west and move down in the morning sky. There are three conditions for success – you must look, the comet must be bright enough and you must find it first. His first three comets were closer to the sun than those previously discovered by amateurs in the previous 25 years. Type 1 comets are 30 – 60 deg from the Sun in the morning sky, bright, few in number and have small q. Type 2 lie in the evening sky 60 – 120 deg from the Sun, are dim, common and have large q.

Most discoveries were from Japan, USA and Australia. Southern Hemisphere observers only discover southern declination comets, however northern hemisphere observers find them in both hemispheres. There is no significant trend in discovery declination.

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way. Renewals should be sent to the Director and cheques made payable to the BAA. Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

As you will read elsewhere in this issue the IWCA was very successful and an enjoyable time was had by all participants. I was pleased to see a good representation from British amateurs and hope that the next workshop, likely to be held in the USA in five years time will see an equally large British contingent.

On September 17 I became the proud discoverer of a comet myself. As with many discoveries there was an element of luck to it, in that I just happened to be the first person to scan the real time images from the SOHO LASCO coronagraph and recognise that there was an intruder present. The discovery does however follow Don Machholz's tenets of comet discovery: you have to look, the comet must be bright enough and you have to find it first.

I have agreed to take on the Directorship of the Comet Section of the Society for Popular Astronomy. I've actually been a member of this society longer than I have been a member of the BAA. SPA members will be able to subscribe to The Comet's Tale and their observations will be included in the Section archives. I look forward to close co-operation between the two groups.

Since the last newsletter observations or contributions have been received from the following BAA members: Sally Beaumont, Denis Buczynski, John Fletcher, James Fraser, Maurice Gavin, Werner Hasubick, Guy Hurst, Nick James, Martin Mobberley, Bob Neville, Gabriel Oksa, Roy Panther, Jonathan Shanklin, David Storey, David Strange, John Vetterlein and Alex Vincent

and also from: Jose Aguiar, Alexandr Baransky, John Bortle, Reinder Bouma, Jose Carvajal, Tim Cooper, Stephen Getliffe, Guus Gilein, Bjorn Granslo, Roberto Haver, Andreas Kammerer, Heinz Kerner, Atilla Kosa-Kiss, Martin Lehky, Rolando Ligustri, Andrew Pearce and Seiichi Yoshida (apologies for any errors or omissions).

Comets under observation were: 10P/Tempel 2, 29P/Schwassmann-Wachmann 1, 37P/Forbes, 52P/Harrington-Abell, 95P/Chiron, 134P/Kowal-Vavrova, 140P/Bowell-Skiff, 1995 O1 (Hale-Bopp), 1997 BA6 (Spacewatch), 1998 M5 (LINEAR), 1998 P1 (Williams), 1998 T1 (LINEAR), 1998 U3 (P/Jager), 1998 U5 (LINEAR), 1999 F2 (Dalcanton), 1999 H1 (Lee), 1999 H3 (LINEAR), 1999 J2 (Skiff), 1999 J3 (LINEAR), 1999 K2 (Ferris), 1999 K3 (LINEAR), 1999 K5 (LINEAR), 1999 K6 (LINEAR), 1999 K8 (LINEAR), 1999 L2 (LINEAR), 1999 N2 (Lynn), 1999 S3 (LINEAR), 1999 S4 (LINEAR).

Many of the fainter comets were observed by Seiichi Yoshida who is using a CCD camera on an 18 cm reflector to very good effect. It is pleasing to have received a few CCD observations from UK observers over the summer and I hope the winter will bring many more.

The observing supplement accompanying this issue of *The Comet's Tale* is thinner than usual to compensate for the thicker main section. I have only given ephemerides for comets brighter than 10th magnitude. Ephemerides for fainter comets are available on the Section web page and observers can generate their own charts using the elements given in the supplement. In future I will only give ephemerides for fainter comets if they are particularly in need of observation.

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, BAA Journals and Sky & Telescope.

150 Years Ago: The editor noted that, given the discovery circumstances, he would prefer to call Schweizer's comet (1849 G1) that of Schweizer-Bond, however he followed the authority of Professor Schumacher. Computations by Hind showed that the 'first Comet of Brorsen, 1846' (5D/Brorsen) had passed very close to Jupiter in May 1842. He further suggested that there might be a link with the comets of 1532 & 1661, which could be investigated further.

100 Years Ago: A paper read at the June meeting discussed 'Who First suggested the Periodical Return of Comets' and suggested that Hooke had the idea that comets could return as early as 1665, following the appearance of the comet of 1664, which Hooke thought could be a return of the comet of 1618 [it wasn't]. At this time Halley was only 9 and didn't voice his famous utterance until shortly before his death in 1742. At the same meeting a paper by Mr John Grigg described a graphic method of computing a search ephemeris for a periodic comet. The annual report of the Section in the October Journal records that two conspicuous comets had been under observation and that Tempel's comet (10P) had been observed by Mr Denning with a 10" (25 cm) telescope.

50 Years Ago: The July Journal has a note about an article on comet Families by C H Schwette which appeared in Popular Astronomy in April. He thought that a group of comets with aphelia one and a half times that of Pluto implied a tenth planet. The annual report notes observations by George Alcock and Albert Jones, both still active observers.

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

Andreas Kammerer has pointed out an interesting article by Ichiro Hasegawa and Syuichi Nakano on **Periodic Comets Found in Historical Records** in the Publications of the Astronomical Society of Japan (**47**, pp 699-710, 1995). The authors have studied observations of comets reported in oriental manuscripts and have made three linkages. They suggest that comet 1110 K1 was a return of comet Pons-Gambart (see also The Comet's Tale No 8). Their linkage implies that it returned unseen in 1956 and will return again in 2022. They also link 1500 H1 with 1861 J1, which would give a return in 2265 or thereabouts. The final linkage is for 1337 M1 and 1468 S1, with a period of just over 130 years, and if this is correct the comet would have returned in 1984. The comet is always well placed, so the failure to see it suggests an error in the period and that perhaps the comet has not yet returned. It might be worth searching along a track given by the approximate elements, which are given in the observing supplement.

Jonathan Shanklin

The following abstracts (some shortened further for publication) are taken from the Cambridge Conference Network (CCNet), which is a scholarly electronic network devoted to catastrophism, but which includes much information on comets. To subscribe, contact the moderator Benny J Peiser at <b.j.peiser@livjm.ac.uk>. Information circulated on this network is for scholarly and educational use only. The abstracts, taken from daily bulletins, may not be copied or reproduced for any other purposes without prior permission of the copyright holders. The electronic archive of the CCNet can be found at http://abob.libs.uga.edu/bobk/cccmenu.html

A. Lewis Licht: **The rate of naked-eye comets from 101 BC to 1970 AD.** *Icarus*, **137** (**2**), pp 355-356 February 99

The number of comets that are bright enough and that come close enough to Earth to be seen with the unaided eye fluctuates randomly from century to century. The mean number seen per century, R, is a parameter determined by the distribution of short-period comets and by the escape of new, near parabolic comets into the inner Solar System from the Oort Cloud (J. H. Oort, 1963, The Solar System, Univ, of Chicago Press, Chicago, London) and the Kuiper Belt (H. F. Levison and M. J. Duncan, 1997, Icarus 127, 13-32). A measurement of R provides a constraint on possible escape mechanisms. In the following it is shown that R can be determined by a comparison of the number of comets reported from the east and west with those reported from both regions. An analysis of the reports compiled by I. Hasegawa (1980, Vistas in Astronomy, Pergamon, Great Britain) shows that R = 86.0 +/- 6.7 comets/century and moreover R has been remarkably constant over the past two millennia. One could conclude from this that the mean rate at which all comets, visible and invisible, enter the inner Solar System has also been constant over this period. © *1999 Academic Press*

E. Desvoivres, J. Klinger, A.C. LevasseurRegourd, J. Lecacheux, L. Jorda, A. Enzian, F. Colas, E. Frappa, P. Laques: **Comet C/1996 B2 Hyakutake: observations, interpretation and modelling of the dynamics of fragments of cometary nuclei.** MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY, 1999, Vol.303, No.4, pp.826-834

Comet C/1996 B2 Hyakutake was extensively observed at the Pic du Midi observatory during late March of 1996, Bright condensations were observed in the near-nucleus coma. We have performed a detailed data analysis in order to derive the position of these features with respect to the nucleus. We make the hypothesis that they are induced by fragments of the nucleus. Despite the frequency of fragmentation of cometary nuclei, the dynamics of the fragments is not yet well understood. We propose a general approach in order to study the motion of the fragments in the orbital plane of the comet. An estimate of the non-gravitational forces is used to describe the motion of the fragment and of the nucleus with respect to their centre of mass. Then the equations of the theory of perturbed Keplerian motion are solved in order to study the motion of the centre of mass, This approach is applied to Comet C/1996 B2 Hyakutake, The results are in good agreement with the observations, An excellent fit is obtained for a fragment size of 20 m, assuming a density of 300 kg m(-3). © *1999, Institute for Scientific Information Inc.*

S.H. Pravdo, D.L. Rabinowitz, E.F. Helin, K.J. Lawrence, R.J. Bambery, C.C. Clark, S.L. Groom, S. Levin, J. Lorre, S.B. Shaklan, P. Kervin, J.A. Africano, P. Sydney, V. Soohoo: **The Near-Earth Asteroid Tracking (NEAT) Program: An automated system for telescope control, wide-field imaging, and object detection.** ASTRONOMICAL JOURNAL, 1999, Vol.117, No.3, pp.1616-1633

The Near-Earth Asteroid Tracking (NEAT) system operates autonomously at the Maul Space Surveillance Site on the summit of the extinct Haleakala Volcano Crater, Hawaii. The program began in 1995 December and continues with an observing run every month. Its astrometric observations result in discoveries of near-Earth objects (NEOs), both asteroids (NEAs) and comets, and other unusual minor planets. Each six-night run NEAT covers about 10% of the accessible sky, detects thousands of asteroids, and detects two to five NEAs. NEAT has also contributed more than 1500 preliminary designations of minor planets and 26,000 detections of main-belt asteroids. This paper presents a description of the NEAT system and discusses its capabilities, including sky coverage, limiting magnitude, and detection efficiency. NEAT is an effective discoverer of NEAs larger than 1 km and is a major contributor to NASA's goal of identifying all NEAs of this size. An expansion of NEAT into a network of three similar systems would be capable of discovering 90% of the 1 km and larger NEAs within the next 10-40 yr, while serving the additional role of satellite detection and tracking for the US Air Force. Daily updates of NEAT results during operational periods can be found at JPL's Web site (http://huey.jpl.nasa.gov/ similar to spravdo/neat.html). The images and information about the detected objects, including times of observation, positions, and magnitudes are made available via NASA's SkyMorph program. © *1999, Institute for Scientific Information Inc.*

NASA SELECTS MISSIONS TO A COMET'S INTERIOR AS NEXT DISCOVERY FLIGHT

The Deep Impact mission will send a 1,100-pound (500-kilogram) copper projectile into comet P/Tempel 1, creating a crater as big as a football field and as deep as a seven-story building. A camera and infrared spectrometer on the spacecraft, along with ground-based observatories, will study the resulting icy debris and pristine interior material. Dr. Michael A'Hearn will lead Deep Impact from the University of Maryland in College Park.

Deep Impact will be launched in January 2004 toward an explosive July 4, 2005, encounter with P/Tempel 1. It will use a copper projectile because that material can be identified easily within the spectral observations of the material blasted off the comet by the impact, which will occur at an approximate speed of 22,300 mph (10 kilometers per second.). The total cost of Deep Impact to NASA is $240 million. Deep Impact will be managed by NASA's Jet Propulsion Laboratory in Pasadena, CA, and built by Ball Aerospace in Boulder, CO.

Other comet missions include the Stardust mission to gather samples of comet dust and return them to Earth, which was launched in February 1999. The Genesis mission to gather samples of the solar wind and return them to Earth and the Comet Nucleus Tour (CONTOUR) mission to fly closely by three comets are being prepared for launch in January 2001 and June 2002, respectively.

Y.R. Fernandez, D.D. Wellnitz, M.W. Buie, E.W. Dunham, R.L. Millis, R.A. Nye, J.A. Stansberry, L.H. Wasserman, M.F. AHearn, C.M. Lisse, M.E. Golden, M.J. Person, R.R. Howell, R.L. Marcialis, J.N. Spitale: **The inner coma and nucleus of Comet Hale-Bopp: Results from a stellar occultation.** ICARUS, 1999, Vol.140, No.1, pp.205-220

We discuss the properties of the nucleus and inner coma of Comet Hale-Bopp (C/1995 O1) as derived from observations of its occultation of Star PPM 200723 on 5 October 1996, while the comet was 2.83 AU from the Sun. Compared to previous occultations by active comets, this is possibly the closest to the nucleus one has ever observed. Three chords (lightcurves) through the comet's inner coma were measured, though only one chord has a strong indication of measuring the occultation, and that was through thin cirrus. We have constrained the radius of the nucleus and properties of the coma using a simple model; there is a large valid section of parameter space. Our data show the optical depth of the coma was greater than or equal to 1 within 20 to 70 km of the center of the (assumed spherical) nucleus, depending on the coma's structure and the nucleus' size. The dependence of the dust coma's opacity on cometocentric distance, rho, was steeper than expected for force-free, radial how being probably as steep as or steeper than 1/rho(1.4) within 100 km of the nucleus (though it is marginally possible to fit one coma hemisphere with a 1/rho law), Assuming the dust coma flowed radially from a spot at the center of the nucleus and that the coma's profile was not any steeper than rho(-2) the upper limit to the radius of the nucleus is about 30 km, though relaxing these assumptions limits the radius to 48 km, The chord through the coma does not show the same coma structure within 100 km of the nucleus as that which is apparent in larger-scale (similar to 700 km/pixel) imaging taken just before the event, suggesting that (a) the star's path sampled the acceleration region of the dust, and/or (b) azimuthal variation in the inner coma is different than that seen in the outer coma. © *1999 Academic Press*

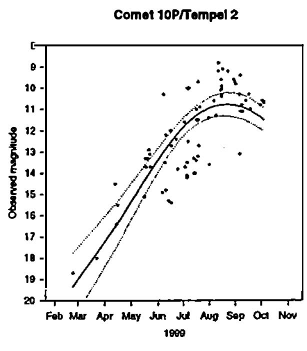
Review of comet observations for 1999 April - 1999 September

The information in this report is a synopsis of material gleaned from IAU circulars 7139 – 7280 and The Astronomer (1999 April – 1999 September). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

Comet 10P/Tempel 2, made its 20th observed return since its discovery by William Tempel (Milan, Italy) as a 9^m object in 1873.

David Strange obtained an image of the comet on July 10. It brightened rapidly. Jose Carvajal estimated it at 10.6 in his 32-cm L on August 5.9, but I was unable to see it with the 20-cm Thorrowgood refractor on the same night. On Aug 10.9 Andrew Pearce and I observed it with 14x100B from just outside Penzance, Cornwall, my estimate was 8.7 and Andrew made it a little fainter. In Cambridge it was a very difficult object in the 20-cm refractor, though it was observed during the IWCA. Back in Australia Andrew Pearce reported that the comet had faded to near 10^m at the end of August.

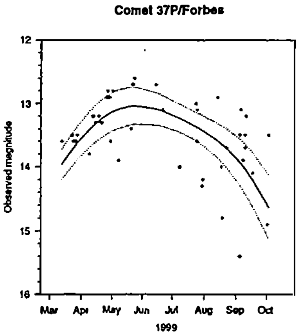
77 observations give an uncorrected preliminary light curve of 5.8 + 5 log d + 32.2 log r



A few further observations of **Comet 21P/Giacobini-Zinner** were received after the last issue appeared, though they don't change the overall shape of the light curve very much.

223 observations give an uncorrected preliminary light curve of 8.9 + 5 log d + 13.6 log r

Comet 29P/Schwassmann-Wachmann 1. Reports suggest another outburst to around 13^m in early June. Jose Aguiar reported it in outburst once again at the beginning of July.

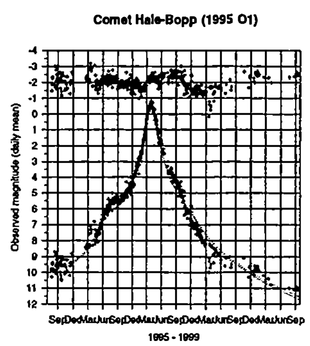


Comet 37P/Forbes is currently 14^m, but is fading rapidly. 49 observations give an uncorrected preliminary light curve of 10.6 + 5 log d + 11.8 log r

A few further observations of **Comet 52P/Harrington-Abell** were received, which give an uncorrected preliminary light curve following the second outburst of m = 10.2 + 5 log d + 0.0416abs(t-T+23.1).

Comet/Asteroid 95P/Chiron was around 16m when at opposition in late May in Libra. Maurice Gavin obtained images of the comet on July 10 and 11.

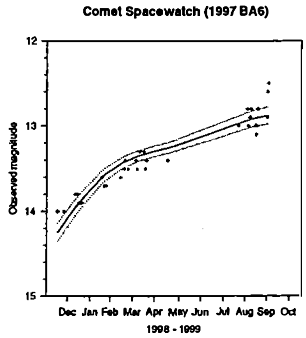
Comet 114P/Wiseman-Skiff will be brightening from 14^m in November and may be observed with large aperture telescopes or CCDs.



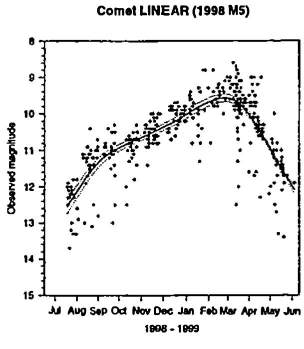
The residuals on the fitted curve are shown above.

Comet 1995 O1 Hale-Bopp , the great comet of 1997, is fading slowly but is only observable from Southern Hemisphere locations as it loops round the Large Magellanic Cloud. An observation by Andrew Pearce in late August 1999 made it 12.5.

Over the entire apparition (750 days with observations, spread over 1532 days) the comet has the corrected lightcurve of: -0.66 + 5 log d + 7.59 log r There are significant variations from this, and the comet is currently a little brighter than indicated by this equation.

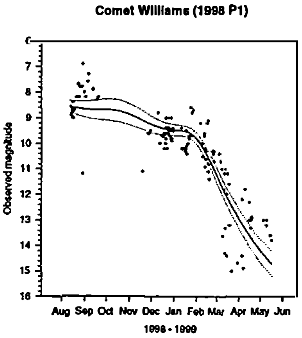


1997 BA6 Spacewatch Details of the orbit of an unusual asteroid, 1997 BA6 were given on MPEC 1997 C-13. The orbit is very eccentric, with a period near 4500 years and a semi-major axis of several hundred AU. Currently it is near 13^m and will be at high southern dec when near perihelion which is at 3.4 AU in 1999 December when it may be around 12^m. 40 observations give an uncorrected preliminary light curve of 5.5 + 5 log d + 8.2 log r

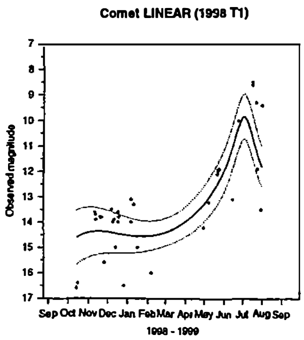


1998 M5 LINEAR was at perihelion in January and passed very close to the pole in mid March. Heading south it passed through Camelopardalus and Lynx, reaching Cancer in mid year. 397 observations give an uncorrected preliminary light curve of 6.1 + 5 log d + 10.0 log r

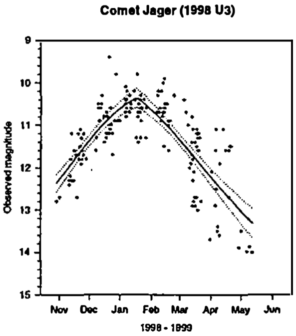
1998 P1 Williams was widely observed from the UK after perihelion. 126 observations give an uncorrected preliminary light curve of 6.7 + 5 log d + 9.9 log r



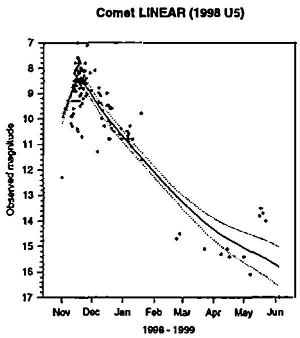
1998 T1 LINEAR. Seiichi Yoshida recovered the comet in late April after conjunction but its magnitude was fainter than expected in his CCD images. It brightened and reached 9^m in late June, but is now fading. 35 observations give an uncorrected preliminary light curve of 10.2 + 5 log d + 4.5 log r



1998 U3 P/Jager Observations with the Northumberland in March put the comet at 12^m - 13^m. Observing on April 9/10 I could barely see the comet in the Northumberland, estimating it 13.6. 157 observations give an uncorrected preliminary light curve of 9.8 + 5 log d + 0.0151 abs(t-T-46.0). This is a linear type of light curve and the comet began fading before perihelion.



Only a few further observations of **1998 U5 LINEAR** were received. The 130 observations give an uncorrected preliminary light curve of 8.4 + 5 log d + 14.7 log r



1999 G2 SOHO (IAUC 7142, 1999 April 14), **1999 H2 SOHO** (IAUC 7147, 1999 April 19), **1999 H4 SOHO** (IAUC 7157, 1999 May 3), **1999 J1 SOHO** (IAUC 7162, 1999 May 10), **1999 K1 SOHO** (IAUC 7173, 1999 May 20), **1999 K9 SOHO** (IAUC 7204, 1999 June 18), **1999 K10 SOHO** (IAUC 7204, 1999 June 18), **1999 L1 SOHO** (IAUC 7197, 1999 June 11), **1999 L4 SOHO** (IAUC 7204, 1999 June 18), **1999 L5 SOHO** (IAUC 7208, 1999 June 25), **1999 M1 SOHO** (IAUC 7208, 1999 June 25), **1999 M2 SOHO** (IAUC 7212, 1999 June 30), **1999 N1 SOHO** (IAUC 7213, 1999 July 1), **1999 N3 SOHO** (IAUC 7222, 1999 July 14), **1999 P2 SOHO** (IAUC 7234, 1999 August 9), **1999 S1 SOHO** (IAUC 7256, 1999 September 17) were sungrazing comets discovered with the SOHO LASCO coronographs and have not been observed elsewhere. Several others have yet to receive designations. SOHO has now discovered 89 comets, of which 84 are members of the Kreutz group of sungrazing comets.

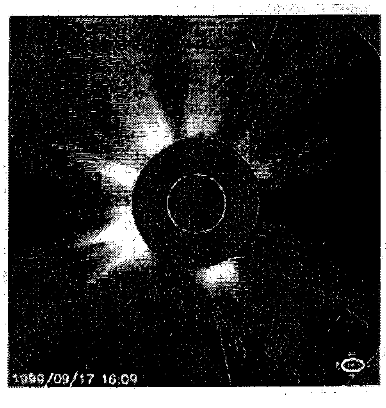
1999 K1 was one of the brighter objects. On May 20.47 UT, the comet was about 11 solar radii from the sun and showed a tail; on May 20.51 it was 6.8^m. A standard magnitude prediction suggested it could reach -4 magnitude, however as with most of the Kreutz group fragments it faded as it got closer to the sun. Some of the comets show no tail at all and it is possible that some supposed observations of Vulcan were actually tiny Kreutz group comets.

I discovered SOHO-86=1999 S1 on the morning of September 17 and the discovery has a story behind it.

A discovery frame of comet 1999 S1. The comet is shown circled.

The University of Cambridge Cavendish Laboratory hosts a 'Physics at Work' Exhibition in mid September, which is designed to get prospective GCSE students enthusiastic about following a career in physics. I usually run an exhibit about work at the British Antarctic Survey (BAS), which shows the students the physics behind measuring ozone in the atmosphere. This year we were asked to put on two exhibits and for a variety of reasons I ended up teaching the students about 'geospace'. I had been looking at the real-time movies of the LASCO C3 camera for several months on an occasional basis and was impressed by how well they show the dynamic activity of the Sun. I thought it would be educational to show the students live images of the Sun, so I downloaded the images every morning and showed the current movie loop. There were no comets during the exhibition, but the planet Mercury was visible heading out from superior conjunction. I also showed an archival image, which did show a comet, to illustrate that comet tails always point away from the sun, thus demonstrating the existence of the solar wind.

Having packed everything up on Friday morning (September 17th), I cycled back to BAS and decided to have a look at the latest sequence from the wide field C3 camera. A quick scrutiny showed a star-like object heading towards the Sun and brightening, but without a tail. The object became visible at about 15:18 UT on September 16 and was brightest on the most recent frame to be downloaded, which was taken at 05:18. I guessed that it was a probable Kreutz group fragment, though expected someone else to have picked it up already. At 09:41 UT, I e-mailed Doug Biesecker of the SOHO-LASCO consortium to inform him of the object, with a copy to Dan Green at the CBAT. Doug responded at 12:32, and confirmed that it was a probable Kreutz group fragment and that I was the first to report it. He measured the images and quickly passed the details on to the CBAT. Brian Marsden was able to compute a preliminary orbit whilst the object was still visible in the coronagraphs. The positions and orbit appeared on MPEC 1999-S04, issued at 15:26 and a note recording the discovery appeared on IAUC 7256 at 17:08. The orbit shows that it is another member of group I of the Kreutz family of sungrazing comets. The fragment grew a short tail, visible on the C2 frames, but then faded as it dived towards the sun. The last available image to show it that day was taken at 16:54, though archival images record it a little longer.



The comet is the radial streak in the bottom right corner.

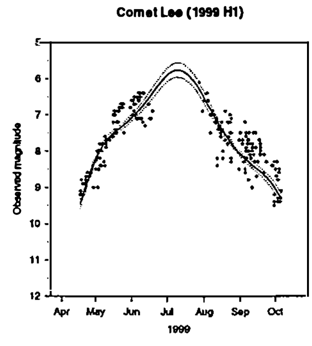
1999 DN3 P/Korlevic-Juric The 19m, apparently asteroidal object 1999 DN3, observed by K. Korlevic and M. Juric at Visnjan (0.41-m f/4.3 reflector + CCD) on February 18.97 and 24.0 UT (MPC 33833, MPS 4018), was linked by G. V. Williams, Minor Planet Center, to observations on April 6 and 14 in routine asteroidal astrometry from LINEAR. Owing to the unusual nature of the orbit, computed on May 13, the object was added to The NEO Confirmation Page. In response to this, further observations were reported on May 14.2 by D. A. Klinglesmith, III, and R. Huber (Etscorn Observatory) and by G. Hug (Farpoint Observatory). Williams also identified LONEOS observations of the object on Apr. 10. In addition, C. W. Hergenrother, Lunar and Planetary Laboratory, reported that observations made on May 14 with the 1.5-m Catalina reflector showed the object to be cometary, with a compact, well-condensed 10" coma and a strongly curved 30" tail, starting in p.a. 45 deg and curving to p.a. 335 deg. [IAUC 7167, 1999 May 14]. The comet is distant and fading.

1999 F1 CATALINA On Apr. 17, T. B. Spahr, Lunar and Planetary Laboratory, reported the automatic discovery of an 18m object of unusual motion and stellar appearance in the course of the Catalina Sky Survey (0.41-m Schmidt + CCD) on March 23.32. Spahr obtained follow-up data on Apr. 16 and 17. Computations by B. G. Marsden suggested that the object was a long-period comet in a highly-inclined orbit, yielding an identification in Mar. 13 Spacewatch data. CCD images (660 s total exposure) obtained with the Catalina 1.5-m reflector by J. Bialozynski, D. Dietrich, C. Greenberg, E. Hooper, D. McBee, D. McCarthy, J. Pici, G. Rudnick, and C. Vedeler, and co-added by C. W. Hergenrother, show a faint coma of diameter 8"-10" [IAUC 7148, 1999 April 20]. The comet is currently very distant (over 8 AU) and not due to reach perihelion until 2002, but even then it will be 5.8 AU from the Sun.

1999 F2 Dalcanton Julianne Dalcanton, University of Washington; S. Kent, Fermi National Accelerator Laboratory; and S. Okamura, University of Tokyo, on behalf of the Sloan Digital Sky Survey (SDSS), reported the discovery by Dalcanton of a comet on several SDSS images taken on March 20 through different filters. An r'-band filter shows a tail about 2' long and a sharp nucleus inside a coma of diameter about 20". Upon receipt at the Central Bureau on June 7 of the astrometry, spanning only 72 s of time, G. V. Williams found a possible link with a single-night apparently asteroidal LINEAR object in archival data for March 24; this permitted Williams to find further apparently asteroidal LINEAR observations, first on Feb. 23, then on May 12, and finally on 1998 June 18. At this point, the object was placed on the NEO Confirmation Page in expectation that additional observations would confirm the cometary nature. In response, confirming CCD observations showing cometary appearance were received from M. Tichy and Z. Moravec at Klet on June 7.9 UT (coma diameter 15", tail 50" in p.a. 230 deg) and from R. A. Koff at Thornton, CO, on June 8.2 (15" coma, 35" tail in p.a. 195 deg). Dalcanton subsequently forwarded single-night LONEOS observations obtained on March 28 and found by G. Magnier. [IAUC 7194, 1999 June 8]. The comet is distant, but intrinsically quite bright. It will fade from its current 15m.

1999 G1 LINEAR another object discovered by LINEAR has been identified as a comet [IAUC 7140, 1999 April 10]. The 17m object is in a distant parabolic orbit and will fade.

1999 H1 Lee Steven Lee (a night assistant at the Anglo-Australian Telescope in New South Wales) discovered this 9m comet on April 16.5 with a 0.41-m f/6 Newtonian reflector (about x75) at a star party near Mudgee, New South Wales [IAUC 7144, 1999 April 16].

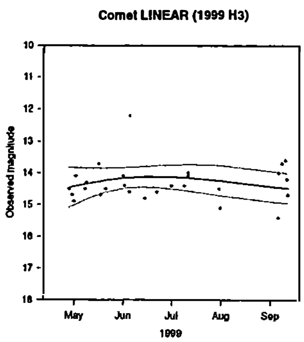


I picked it up in 14x100B on July 27.09 at mag 6.1, though it was a difficult object in a bright twilight sky. It has faded and become more diffuse. Several observers imaged an anti-tail in September.

213 observations give an uncorrected preliminary light curve of 6.6 + 5 log d + 11.5 log r

1999 H3 LINEAR An apparently asteroidal 17th mag object discovered by LINEAR on April 22.31, and noted on The NEO Confirmation Page, was reported as cometary by Klet and Ondrejov observers [IAUC 7151, 1999 April 23]. The comet is in a distant parabolic orbit and didn't become much brighter than 13^m.

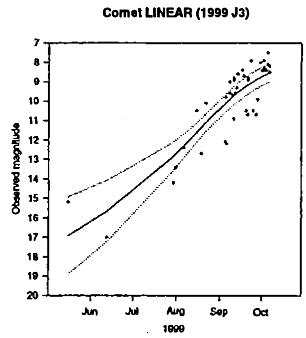
38 observations give a somewhat indeterminate uncorrected preliminary light curve of 8.7 + 5 log d + [5] log r



1999 J2 Skiff Brian Skiff of the Lowell Observatory Near-Earth Object Search (LONEOS) team discovered a 16^m comet on May 13.40 [IAUC 7165, 1999 May 13]. The comet is at high northern declination, and is very distant at over 7 AU, with perihelion in October 1999. It will remain near 15^m for some time.

1999 J3 LINEAR An apparently asteroidal 19^m object discovered by LINEAR on May 12.28, and noted on The NEO Confirmation Page, was reported as cometary by Klet observers [IAUC 7166, 1999 May 13]. Estimates in mid July put it at 12^m. By early September it had reached 10^m. It was 9.6 in 20x80B from a dark sky site on September 12.1, rather smaller than comet Lee. It peaked in brightness at around 7^m in mid October. It is currently small and well condensed.

50 observations give an uncorrected preliminary light curve of 9.3 + 5 log d + 17.4 log r



1999 J4 LINEAR Another asteroidal object reported by LINEAR on May 15.32 UT (mag 18.2-18.8) with unusual motion was noted on The NEO Confirmation Page, and it was subsequently reported to be cometary in appearance by several observers, including M. Elowitz and F. Shelly from May 17 LINEAR observations. P. Pravec, U. Babiakova, and P. Kusnirak (Ondrejov, 0.65-m f/3.6 reflector + V filter) reported a coma diameter of 0'.2 and a tail 0'.6 long in p.a. 160 deg, and J. Ticha and M. Tichy (Klet, 0.57-m f/5.2 reflector) noted the object to be slightly diffuse (coma diameter about 7"), on May 16.9 [IAUC 7170, 1999 May 17]. The comet is in a distant parabolic orbit.

1999 J5 P/LINEAR An apparently asteroidal 19^m object reported by LINEAR on May 12.36 and 17, and linked by G. V. Williams to LINEAR observations on June 8 and 10 by way of a comet-like orbit, was posted on The NEO Confirmation Page for additional observations. P. Pravec and P. Kusnirak, Ondrejov, reported that their June 12 CCD images showed a faint coma and a tail marginally visible to the southwest. Also, A. Sugie, Dynic Astronomical Observatory, reported strong condensation and a coma diameter of 12" on June 14 [IAUC 7201, 1999 June 14]. The comet will fade.

1999 K2 Ferris William D. Ferris discovered an 18th mag comet on CCD frames taken with the 0.59-m LONEOS Schmidt telescope on May 19.37. Measurer B. Koehn noted that the comet showed a well-condensed nucleus, a coma of diameter about 15", and a faint tail about 20" long in p.a. 225 deg on May 19. Additional astrometry appeared on MPEC 1999-K22. May 22 observations by J. Ticha and M. Tichy (Klet) showed the comet as diffuse with a 12" coma; observations on the same night by L. Kornos and P. Koleny (Modra) also showed a coma. C. W. Hergenrother and A. E. Gleason (Catalina 1.5-m reflector) reported a 20" coma and a 20" tail in p.a. 230 deg. [IAUC 7175, 1999 May 22]. The comet is in a distant parabolic orbit and won't brighten much from its present visual magnitude of around 16.

1999 K3 LINEAR M. Elowitz, Lincoln Laboratory, Massachusetts Institute of Technology, reported the discovery of 19^m, apparently cometary object in LINEAR data on May 20.27. Following posting of this object on The NEO Confirmation Page, numerous observers confirmed the cometary appearance, and additional astrometry and orbit were given on MPEC 1999-K23. Around May 22.0 UT, L. Sarounova (Ondrejov) reported coma diameters about 20" and 15"; Ticha and Tichy report a 10" coma and a wide tail in p.a. 245 deg; and coma was also noted by Kornos and Koleny. [IAUC 7175, 1999 May 22]. The comet is past perihelion and is fading from visual magnitude 16.

1999 K4 LINEAR Another apparently asteroidal object of 19^m found by LINEAR on May 17.33, and posted on The NEO Confirmation Page, was reported as cometary by M. Hicks (Table Mountain; faint coma of diameter about 5" on May 21) and by C. W. Hergenrother and A. E. Gleason (Catalina 1.5-m reflector; highly condensed coma with a faint 10"-15" tail in p.a. 170 deg on May 22) [IAUC 7176, 1999 May 22]. The comet is intrinsically faint and will fade.

1999 K5 LINEAR Another apparently asteroidal, 17^m object discovered by LINEAR on May 20.32 and posted on The NEO Confirmation Page, was reported as cometary by several observers. CCD frames taken by D. D. Balam (Victoria) on May 23 show a condensed coma with a 16" fan-shaped tail in p.a. 303 deg. On May 24, L. Kornos and P. Koleny (Modra) report a coma diameter of about 15" and a short tail in p.a. 330 deg, and G. Hug (Farpoint Observatory) indicated a hint of coma in p.a. about 300 deg. [IAUC 7178, 1999 May 24]. This is LINEARs 23rd discovery in around 14 months. The comet is currently around 16^m visually, and does not reach perihelion until 2000 July, by which time it may have brightened to around 13^m. It will however be at high southern declination.

1999 K6 LINEAR Yet another apparently asteroidal object, of 18^m, discovered by LINEAR on May 20.23, and posted on The NEO Confirmation Page, was reported as cometary, on May 24 by L. Sarounova (Ondrejov; faint coma with condensed nucleus) and by M. Tichy and Z. Moravec (Klet; diffuse with coma diameter /= 10") [IAUC 7180, 1999 May 25]. The comet will brighten a little, but is unlikely to do better than 15^m.

1999 K7 LINEAR A 19^m object discovered by LINEAR on May 24.34 was reported as possibly cometary by M. Elowitz, Lincoln Laboratory, with an apparent tail in p.a. about 220 deg. Confirmation of cometary activity was made by D. D. Balam (Victoria), who noted no tail but measured a 7" diffuse coma. [IAUC 7181, 1999 May 26] The comet will fade from its present magnitude.

1999 K8 LINEAR Another apparently asteroidal 19^m object discovered by LINEAR on May 26.38 and posted on The NEO Confirmation Page, was reported as cometary on May 27 by L. Sarounova (Ondrejov; coma diameter at least 30" with condensed nucleus), by M. Tichy and Z. Moravec (Klet; 10" coma), and by R. A. Koff (Thornton, CO; diffuse coma of diameter about 8") [IAUC 7182, 1999 May 27]. The comet is a distant one and will remain near 14^m until 2000.

12 observations give an uncorrected preliminary light curve of 1.8 + 5 log d + [15] log r

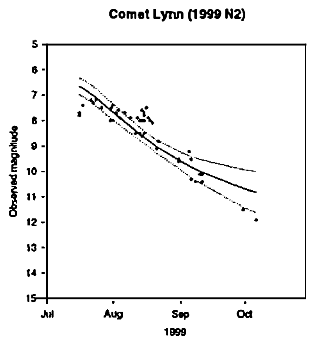
1999 L2 LINEAR M. Elowitz and F. Shelly reported the discovery of a 18^m comet with a coma but no distinct tail in LINEAR data on June 11.24. In response to posting on The NEO Confirmation Page, G. R. Viscome (Lake Placid, NY) reported that the object showed a 16" coma and moderately strong condensation, but again no discernible tail [IAUC 7199, 1999 June 12]. The comet is around 16^m visually and reached perihelion in August.

1999 L3 LINEAR An 18th mag apparently asteroidal fast-moving LINEAR object found on June 9.17 and posted on The NEO Confirmation Page, was noted by F. B. Zoltowski, Woomera, S. Australia, as having a tail about 30" long in p.a. 100 deg and a rather dense coma on June 13 and 14 CCD images. P. R. Holvorcem, Valinhos, Brazil, reports a about 10" coma on his June 12 images. [IAUC 7200, 1999 June 14]

A/1999 LD31 and **A/1999 LE31** MPEC 1999-M28 and 1999-M29 provided detailed information about two apparently asteroidal objects, 1999 LD31 and LE31, discovered by LINEAR on June 8 and 12, respectively (with prediscovery observations of the latter on May 17), and followed extensively by observers using The NEO Confirmation Page. In each case the orbit was found to be retrograde: 1999 LD31 has a = 21.9 AU, e = 0.89, i = 160 deg, P=103 years, H = 13.9; 1999 LE31 has a = 8.0 AU, e = 0.46, i = 152 deg, P=23 years, H = 12.3. All observers consistently reported 1999 LD31 to be asteroidal, and only one observer suggested that 1999 LE31 may have cometary appearance (although this is unconfirmed). In particular, A. Fitzsimmons, Queen's University, Belfast, reported that 250-s exposures in 1" seeing by S. Collander-Brown and S. Lowry with the 1-m Kapteyn telescope at La Palma on June 15 show both objects clearly to be point sources. [IAUC 7208, 1999 June 25]

1999 N2 Lynn Daniel W. Lynn, Kinglake West, Victoria, Australia, visually discovered an 8^m comet using handheld 10x50 binoculars on July 13.45 [IAUC 7222, 1999 July 14]. I glimpsed it in 20x80B on August 5.9 at 7.7, and Jose Carvahal also estimated it at 7.7. I made a further observation in company with Andrew Pearce on August 10.9 and estimated the comet at about 7.6 in 20x80B. The comet will continue to fade slowly and will become a morning object.

54 observations give an uncorrected preliminary light curve of 8.4 + 5 log d + 5.8 log r



1999 N4 LINEAR (L-30) Yet another LINEAR discovery with unusual motion, which was placed in The NEO Confirmation Page and found to have a retrograde orbit. At the request of the Central Bureau, some of the observers making astrometric observations examined their images carefully and concluded that the object was a comet. M. Tichy (Klet, 0.6-m reflector) noted comae of diameter about 6" on July 14.9 and about 7" on July 15.9 UT. L. Sarounova (Ondrejov, 0.6-m reflector) indicated a small coma, some lack of condensation but no tail on July 16.9. F. B. Zoltowski (Woomera, 0.3-m reflector) remarked on a compact, diffuse image with an asymmetrical distribution that may indicate a small, faint tail at p.a. around 90 deg on July 17.6 [IAUC 7226, 1999 July 17]. The comet has m2 around 18^m and is a distant object, reaching perihelion next year.

Robert H. McNaught recovered **Comet 1999 P1 141P/Machholz 2** on CCD images obtained with the 1.0-m f/8 reflector at Siding Spring on August 3.55. The object was of stellar appearance. The indicated correction to the prediction by B. G. Marsden on MPC 27082 (for component A) is Delta T = +0.8 day. Seeing was good on Aug. 4, and there was no sign of any other components within Delta T = +/- 1.5 days. Further orbital computations by Brian Marsden confirmed that if the observations were of the same object that was observed at Siding Spring on 1995 Mar. 29 and 30 (MPC 25097), this is indeed component A. However, attempts to link all the observations (back to 1994 Aug. 15), even using the nongravitational parameters A1 and A2, were not satisfactory. A gravitational solution gives an acceptable fit to 67 observations back to 1994 Oct. 2 (mean residual 0".9; earlier residuals increasing to 20") [IAUC 7231, 1999 August 04] Z. Sekanina (1999, A & Ap 342, 285; Table 7) tabulates the expected offsets of components B and D from component A. In terms of Delta T, these amount to +0.21 and +0.82 day, respectively. [IAUC 7232, 1999 August 04] The expected magnitude this autumn is still a little uncertain.

1999 R1 SOHO =SOHO 85 Doug A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reported observations of what was presumably a comet, not a Kreutz sungrazer, discovered by T. Lovejoy in SOHO/LASCO C3 data and later also recognized in earlier C2 data. It was observed from September 4.90 to September 6.26, reaching 6th mag at best and no tail was detected. [IAUC 7251, 1999 September 9]

1999 R2 142P/Ge-Wang Jim Scotti, Lunar and Planetary Laboratory, recovered comet P/1988 V1 (= 1988o = 1988 VIII) with the Spacewatch 0.9-m telescope at Kitt Peak on September 15.44. The nuclear magnitude m2 was 22.1. On September 15 there was a coma 12" across and a tail extending 0'.53 in p.a. 266 deg. On September 16 the coma diameter was 11", and the tail extended 0'.47 in p.a. 267 deg. The indicated correction to the prediction by S. Nakano on MPC 27081 was Delta T = -5.5 days. The comet is unlikely to become brighter than 19th mag. [IAUC 7255, 1999 September 17].

1999 RO28 P/LONEOS C. Hergenrother, Lunar and Planetary Laboratory, reported that a co-added 600-s CCD exposure with the Steward Observatory 2.3-m reflector on Sept. 13 of 1999 RO_28 (discovered by LONEOS on September 7.33, with details given on MPEC 1999-R23) showed a stellar condensation with a faint 20" tail in p.a. 310 deg. M. Tichy and J. Ticha, Klet, later reported a faint coma of diameter 8" and 7" on images taken on Sept. 8.93 and 10.02 UT, respectively. Observations by J. V. Scotti with the Spacewatch telescope at Kitt Peak on Sept. 15.4 showed a coma diameter of 9" (m_1 = 18.6-18.7, m_2 = 20.6-21.0) and a 0'.72 tail in p.a. 308 deg. [IAUC 7253, 1999 September 15]. The comet has a 6.5 year period and will fade as it recedes from the Earth.

1999 S2 McNaught-Watson Rob H. McNaught, Australian National University, reported his discovery of a comet on an R survey film taken with the U.K. Schmidt Telescope by F. G. Watson on September 19.72. The comet showed a very strong central condensation, a weak circular coma of diameter 20", and a diffuse tail 3'.5 long in p.a. 210 deg. Confirming CCD images by McNaught with the 1.0-m f/8 reflector at Siding Spring taken on September 21.6 yielded m_2 = 20.1-20.2 [IAUC 7260, 1999 September 21]. The orbit shows that the comet is intrinsically bright, but very distant and perihelion was a couple of years ago.

1999 S3 LINEAR (L-31) M. Bezpalko reported the discovery by LINEAR of a 16^m comet on September 24.34. Following posting on the NEO Confirmation Page, additional observations were reported, giving m1 near 13^m [IAUC 7264, 1999 September 24]. The comet has a period of around 80 years and reaches perihelion in early November. It will brighten a little before fading. It was surprisingly easy in the Northumberland refractor on October 2.90, although the BAA VS sequence for RX And put it at 13.6. Transparency was very good and I could see star S of the sequence, which is magnitude 15.6.

1999 S4 LINEAR (L-32) Another unusual-moving object of 17^m discovered by LINEAR on September 27.40, reported as asteroidal and subsequently posted on the NEO Confirmation Page, was noted to be cometary in appearance by D. Durig (Sewanee, TN, 0.3-m f/7 reflector + CCD; coma diameter about 10"; tail about 20"-25" long in p.a. 200-220 deg) and by J. Ticha and M. Tichy (Klet, 0.57-m f/5.2 reflector + CCD; comet diffuse with 8" coma and tail 10" long in p.a. 245 deg). The preliminary parabolic orbital elements suggest that this comet might become a naked-eye object next July [IAUC 7267, 1999 October 1]. The comet will brighten to within reach of visual observers early next year before solar conjunction. After conjunction it will brighten rapidly to become a naked eye object in the northern sky. Full details will appear in the next issue.

Stop press. 1999 T1 (McNaught-Hartley) may be a binocular object in December 2000 and **1999 T2 (LINEAR)** may reach 13^m in late summer of 2000. More details in the next issue.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds
or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Comet Hunting Notes

Don Machholz

MAY 1999: Of the 79 comets visually discovered since 1975, 36 were found in the southern sky. These southern discoveries were not evenly spaced throughout the year. Exactly half (18) of them took place in about three months- between Nov. 23 and Feb. 25. (During that same time only eight Northern Hemisphere finds occurred.) Good summer weather in the Southern Hemisphere does not account for all the finds; eight of those 18 discoveries were made by Northern Hemisphere comet hunters searching the southern skies. So when did Northern Hemisphere finds prevail? Between mid-March and mid-June, 11 of the 12 finds occurred in the northern sky.

JUNE 1999: Comet Lee is one of four comets found by amateurs at star parties during the past 25 years. In 1975 Doug Berger found Comet Kobayashi-Berger-Milon while looking for M 2 at a San Jose Astronomical Association event. In 1985 I found Comet Machholz (1985e) at the Riverside Telescope Makers' Conference. In 1995, at a star party in Arizona, Thomas Bopp found a comet near M 70. Three of these four finds were accidental finds, and those three comets reached magnitude seven or brighter.

JULY 1999: Steve Lee's comet discovery in April was the third accidental find of the past six Southern Hemisphere visual comet discoveries. That is a high percentage considering that there are only two other accidental finds among the 80 discoveries visually found since 1975. What does this mean? Are comet hunters getting lazy? If the comets were outside typical comet hunting areas, then comet hunters would tend to miss them. For two of the comets this may be true, as the discovery elongations of all three were 72, 103, and 120 degrees from the sun. And if the comets brighten rapidly before discovery, then the usual comet hunting methods may miss them. A third reason for more accidental finds is an increase of activity among non-comet hunters. With the Internet making it easier to report suspicious objects, and the Wilson award motivating the reporting of new comets, it is likely that accidental comet discoveries by amateurs will continue at a brisk rate in the Southern Hemisphere, which is not covered well by the automated search programs.

AUGUST 1999: Fifty-two of the 80 comets discovered by amateurs over the past 24 years have perihelion distances of less than 1.0 Astronomical Unit (AU). At the extremes we have a minimum distance of 0.11 AU for a comet found by me in 1985, and a maximum distance of 3.32 AU for a comet found by K. Cernis in 1983. Now contrast that to the SOHO satellite whose discoveries have perihelion distances of under .01 AU and to LINEAR, which is finding many comets with perihelion distances of greater than 3.0 AU.

SEPTEMBER 1999: Lynn's discovery is the fourth consecutive comet to be visually discovered from Australia, and all four have been found in the past 12 months. Of the last nine comets found visually, seven have been discovered by Australians.

OCTOBER 1999: Comet LINEAR (1999 J3) discovered on May 12, has left the polar region and entered our morning sky, brightening rapidly. Imagine my surprise when I recently swept it up while comet hunting, not knowing it would be so bright. The tilt of the comet's orbit is called the inclination, and it is measured in degrees. A comet going in earth's orbit has a 0 degree inclination, while one going in the opposite direction has a 180 degree inclination. An object travelling perpendicular to earth's orbit (as does Comet Hale-Bopp) has an inclination of 90 degrees. The average inclination for the last 81 visually found comets is 84 degrees. There is a slight grouping of comets in the 40-50 degree range and a dearth of comets near 100 degrees. I suspect this is a true picture of comet orbit distribution, since comet hunter sweeping patterns would not seem to favour (and unfavour) these particular inclinations.

Don's Comet Hunting Hours

Comet Hunting Hours 1975-1998: **6468.00**
Additional hours in 1999: **117.00**
Total hours at last discovery (10-8-94): **5589.00** (nearly 1,000 hours ago)
Least hours in any month since he began comet hunting on 1/1/75: **4.00** (02/98), **4.50** (01/86), **5.50** (02/80)
Most hours in any month since he began comet hunting: **69.25** (05/76), **63.00** (05/78)

These notes are taken from Comet Comments by Don Machholz, which is published on the Internet.

The Edgar Wilson award for 1999 was announced on IAUC 7223 on July 14 and was divided among the following six individuals or groups: Peter Williams, Heathcote, N.S.W., Australia, for C/1998 P1; Roy A. Tucker, Tucson, AZ, U.S.A., for P/1998 QP54; Michael Jager, Weissenkirchen i.d. Wachau, Austria, for P/1998 U3; Justin Tilbrook, Clare, S.A., Australia, for C/1999 A1; Korado Korlevic and Mario Juric, Visnjan, Croatia, for P/1999 DN3; and Steven Lee, Coonabarabran, N.S.W., Australia, for C/1999 H1.

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Continued from page 1

The average elongation is 70 deg. Most are 20 to 60 altitude and average 9.4 mag. They are slightly brighter closer to the sun, but not much. Some bright comets (6^{th} mag) have been found far from the Sun. Amateurs average 3.3 per year, with an average of 368 hours per comet and a median of 177 [NH 433/228, SH 165/113]. Average q is 0.9.

Kesao Takimizawa addressed the meeting on Japanese comet discoverers. He had become interested in astronomy in 1966 aged 14, and had observed Ikeya-Seki. He had searched for 33 years and discovered 5 comets. The first Japanese comet discovery occurred in 1928. Honda had been very successful with 12 comets, followed by Ikeya and Seki. Several Japanese discoveries were made simultaneously by three or more observers. 57 visual Japanese discoverers have found comets, with 72 in total (14 photographic and one CCD). Most used reflectors or binoculars, and 113 different instruments had been used. He has used large binoculars for 15 years. A plot of discoveries showed that they were mostly morning, followed by evening and opposition, with gaps between opposition and quadrature, particularly in the evening sky. He showed prints of Japanese discoverers and mentioned a medal for Japanese discoverers.

Alan Hale and Kesao Takamizawa.

After a break for refreshments came a panel discussion on hunting for comets, however I missed most of these whilst carrying out administrative duties. LINEAR doesn't search within 90 deg of the sun, and there is no move to set up a Southern

Hemisphere equivalent. The Edgar Wilson award was discussed, most panellists didn't think it would make much difference, but it was nice to have the money. One negative aspect is the feeling of financial loss when someone else discovers a comet.

Michael Jager had made accidental discoveries as a result of photographing other comets. He had found a fragment of Machholz 2 (what should this be called if it turned out to be the main fragment?) and P/1998 U3 whilst photographing Harrington-Abel. He uses Schmidt cameras, the smaller reaching 14m and the larger 15m and has photographed over 150 comets. He thanked the discoverers for providing him with opportunities for photographing new comets. He began photographic work in 1982 and had failed to see comet Kohoutek.

We broke for a buffet lunch, which turned out to be another filling meal, with more than just bites on offer. After lunch Charles Morris spoke to the title "Why you don't get your papers published in the ICQ and other rants". He began by defining a rant as a heated one sided discussion. His topic was on amateur research. Many amateurs observe at a professional level. The ICQ would like to publish amateur papers, but their quality is often below the acceptable standard.

To demonstrate the problem that occurs with some amateur publications, he cited a situation at the last IWCA where informal exchange about his use of averted vision was then used as the basis of a paper to (incorrectly) discredit the Morris magnitude estimation method. This paper was published in an amateur comet publication and neither the author nor editor bothered to check the validity of the reference to the informal conversation. The ICQ tries to avoid such problems by using a referee review system.

As a side note, he pointed out that the Morris method actually integrates the Sidgwick and Bobrovnikoff methods. That is, when properly used these two methods are actually subsets of the Morris method. Morris then asserted (Charles Morris personal communication!) that using the Sidgwick technique for DC3+ or Bobrovnikoff method for DC7- will give biases brighter and fainter, respectively. In discussion Nick James pointed out that this assertion about the Morris method was not proven; Charles was not allowed to forget it for the rest of the meeting, though he commented that the underestimate of the Bobrovnikoff method was well documented. Joe Marcus later commented that the extensive work by the Dutch comet section did demonstrate the delta effect.

Morris noted that several groups want additional observational information to be published in the ICQ tabulations. However, prior to adding parameters, it must be shown that the information would be useful. This is the responsibility of the person/group proposing the parameters, not the ICQ staff. Adding additional parameters to the database, particularly for past observations, is non-trivial. It will be done (for instance, the changes made in the DC parameter after the last IWCA) when the change clearly improves the database.

Most amateur research requires statistics. Statistics are very important and you can't just assert a correlation. There is a difference between precision and accuracy and you need to quote errors. The delta effect may exist, but as r and delta are correlated, any delta effect study must not blindly use multiple regression analyses. (Morris has yet to be convinced that the delta effect has been proven.) Extrapolation also presents problems when observations only cover a limited magnitude range. Adding extra parameters, eg coma diameter, doesn't necessarily improve estimates or analyses of M1, particularly if the parameter is poorly defined. Morris' advice was to listen to reviewers comments, they should help to improve the paper, though reasoned argument can convince an editor that the reviewer is incorrect.

The next item was a panel discussion between Charles Morris, Jonathan Shanklin, Guy Hurst, Dan Green and Andreas Kammerer on the World Wide Web, the Internet and the influence on comet observing. Although there had been some feeling that the new media acted to bias observers, there was little demonstrable evidence. Guy Hurst made the point that the scatter in variable star estimates was typically no more than ±0.8 whilst the scatter in comet observations was often 2 magnitudes. When the extreme observations were queried the observers sometimes admitted that they were guestimates rather than actual observations. There might be a case for always including the actual magnitude estimate in reported observations, as is done with variable stars. Magnitude estimates of comet Hyakutake were quite discordant, with experienced and inexperienced observers making systematically different estimates. It was pointed out that the telephone had existed before the Internet and that it had always been possible to exchange information. Charles Morris said that he regarded the Internet as an educational tool, and the beginner observers would eventually become experienced.

Andreas Kammerer commented that the long tails reported for comet Hyakutake were physically impossible. The waxing moon coincided with the publication of IAUC 6360, which first cast doubts on these estimates, thus preventing further observations, which might have settled the question of influence on observers. The tail had shrunk significantly by the time the moon waned after closest approach. In his poster Andreas showed results of his investigations on this matter: the contentious observations can only be explained by the somewhat dubious assumption of a tail that must have deviated in step with the changing position of the earth.

After the discussion, tea was a little delayed and we took the opportunity for the first group photograph. Following the break Herman Mikuz explained his careful procedures for CCD photometry [I missed this talk whilst finding new supplies of poster pins and mains adaptors.] Nicolas Biver spoke on his work on the outgassing of carbon monoxide from distant comets. He concluded that there was a good correlation between visual magnitude and CO outgassing. He suggested that any comet brighter than 14th magnitude should be observable if CO drives the activity, even out to 30 AU.

A panel discussion between Charles Morris, Dan Green, Herman Mikuz, Nicolas Biver and for the last few minutes Jonathan

Shanklin followed. One conclusion was that a group should be set up to discuss the issues of CCD photometry and set up standard procedures. Jon Shanklin commented that current ICQ coding didn't include a code for the type of CCD chip being used in the photometry.

As the weather looked a bit threatening (we had heard thunder rolling around and a gust front had thrown up dust outside the college), a fleet of taxis took the participants the short drive to the Cambridge University Press bookshop in the centre of Cambridge. It should have been a short drive, but at least one taxi was sufficiently unfamiliar with Cambridge that they went to the Press Building on the other side of town. Here we were treated to a generous reception from the Press, and were able to purchase books at 20% of list price. Most participants managed to walk back to New Hall for dinner. By the end of dinner the storm clouds were retreating and Jon Shanklin took all those that were interested over to the University Observatory, a 20 minute walk from New Hall. Here we were able to use 20x80 binoculars to observe comet Lynn, the Thorrowgood refractor to observe comet 10P/Tempel 2 and the Northumberland refractor for a variety of deep sky objects. The two refractors are historic instruments, with the Northumberland first being used to observe comets over 150 years ago. Skies were very transparent and most observers spotted fragments of 109P/Swift-Tuttle blazing through our atmosphere. Observing finished around midnight, though we managed to loose at least a couple of observers on the walk back to New Hall. They were eventually retrieved and I stayed up till dawn at a dark sky site observing Perseid meteors and the other two comets visible in the morning sky.

On Sunday morning the participants were free to explore Cambridge and discussions resumed after lunch. Kay Williams introduced the legendary British observer, George Alcock. By way of background she revealed that her son Gareth had wanted to be an astronomer from the age of seven and had eventually gone to Cambridge, MA to work with Brian Marsden. At a dinner party Nancy Marsden had suggested that her next work should be a biography of George Alcock. She was a bit daunted by this as all her previous subjects had been dead! George's work speaks for itself and includes history, architecture, ornithology, meteorology and astronomy as well as a lifetime in teaching. George is perhaps most famous for his comet and novae discoveries, but some of his comet drawings were also on display. George said a few words in response and sat down to a standing ovation.

George Alcock, Brian Marsden and John Alcock.

George was followed by another comet discoverer, Kesao Takamizawa, who had been observing comets, variable stars, novae, supernovae etc since the 1960s. He now uses a 10-cm f4 astrograph, with limiting magnitude 15.5 (B) on T-Max 400 and a 25-cm f2.8 Baker-Schmidt with limiting magnitude 17. He sometimes visits a 1500-m altitude site in the mountains. He searches in 720 areas and checks for variable stars and minor planets using a PC. Over 5 years he has observed on 367 occasions, taken 16530 shots and discovered two comets, two novae, one supernova and 502 new variables. He changed from visual to photographic search techniques in 1994.

Jean-Claude Merlin spoke about his work at Le Creusot, IAU station 504, which has a 40-cm f5 reflector and CCD, with more than 120 clear nights a year. He averages 6 runs per month, taking two hours per run while observing two - five comets, with up to 30 second exposures. He has measured 900 positions since 1997, with an average accuracy of about 0.5". As a guide he suggested that Exposure time = pixel size/object speed. As an example if pixel size was 2" and the object was moving 30" per hour it would require a total of 4 minutes exposure. Looking at combined observations he had found systematic trends in the position residuals, for example 104P/Kowal 2 showed about a 160 day period. 73P/Schwassmann-Wachmann 3 showed larger residuals than average and he thought there might be a 75 day period to them. Questions suggested that these might be related to poor orbital determinations, or that the non-gravitational parameters didn't quite match reality. However the possibility of a true physical phenomenon is not completely ruled out (for example precession effect on a small nucleus, such as in the case of comet 104P/Kowal 2).

Bob Neville gave a very enthusiastic talk about the need to use CCD equipment to make positional measurements. His own set-up at 967 Greens Norton was entirely homemade. He used a 30-cm guide scope to a 22-cm reflector with a Starlight Xpress SX CCD. The system allowed for offset guidance to about 1 degree. The telescope had a roller drive in RA, which was very smooth and gave symmetrical star images. For reduction he used Astrometrica and the USNO catalogue which gives dense coverage, with Guide 6 or Megastar for finder charts. ACLOCK (share/freeware) provided LST. Observers need to use short exposures to avoid saturation. Sometimes poor seeing can actually help as it fuzzes out images; it is possible to make worthwhile observations even in poor environments. Nicolas Biver commented that speedy astrometry to provide good orbits is essential to help professionals target radio telescopes.

During the break for tea we had a group photograph and managed to capture 11 discoverers on film, namely: George Alcock, Doug Biesecker (SOHO), Kazimieris Cernis, Alan Hale, Michael Jager, Bill Liller, Don Machholz, David Seargent, Patrick Stonehouse, Kesao Takamizawa and Keith Tritton who between them had discovered 28 comets and many SOHO comets. Research in Sky & Tel showed that seven discoverers who at that time had discovered 15 comets had been present at an RTM meeting in 1990 [David Levy (6), Jean Mueller (1), Don Machholz (4), Clyde Tombaugh (1?), William

Sorrels (1), Doug Berger (1) and Jeff Phinney (1)].

Before we resumed the formal sessions Charles Morris took centre stage and confessed that it was time to honour his bet with Alan Hale that his comet wouldn't become brighter than 0 mag. It did, so Alan received 10 one dollar bills. Our first speaker after tea was Doug Biesecker, a member of the SOHO LASCO team, which has discovered a large number of sungrazing comet fragments. They are all remains of a single progenitor, which had a period of around 800 years, with a highly inclined orbit (and therefore not affected much by Jupiter). The date of the original progenitor is not known and multiple fragmentation has occurred. The most famous member of the familly is Ikeya-Seki.

SOHO orbits at the L1 Lagrangian point between the earth and sun. The LASCO C2 camera has an orange filter with a bandwith of 100nm and views the region from 2.5 to 6 solar radii with a resolution of 13". The C3 camera has an orange/clear filter with a bandwith of 300nm and views from 4 to 30 solar radii with a resolution of 56". They offer 360 deg coverage round the sun, with C3 taking about 1 frame an hour and C2 2 frames an hour. The camera support pylon hides the track of typical sungrazers between March and April. Before LASCO about 10 sungrazers had been discovered from the ground between –371 and 1970. Six were discovered by Solwind between 1979 and 1984 and 10 by SMM between 1980 and 1989. SOHO has now discovered 78 comets (updated to 79 that evening); it finds about 1.9 comets a month, when corrected for the duty cycle. Of a subset of 53 Kreutz group comets, 33 were seen in C2 and 52 in C3. It has not been possible to compute an orbit for SOHO-45, though an mpeg loop shown later clearly showed the object. There was some speculation as to whether the object was a sungrazer or earth approacher. The team are getting better at visual detection, but are still running the automated search program. This will only detect potential Kreutz group members, so there could be other faint comets being missed. The comets show fairly slow motion, and 'disc' like ones are difficult to spot, and may only be seen in a few frames.

Most of the comets brighten as 10 log r, but after a certain point fade quickly. Magnitude scales are not well calibrated on SOHO, partly because solar physicists require less accuracy than comet observers do. There is a problem with vignetting and this makes reduction of the C2 and C3 magnitudes uncertain. At T-20 hours the median magnitude is around 8, with the brightest 1st magnitude and the faintest 10th. Most stop brightening 6 – 12 hours before perihelion, which implies a fairly narrow range of sizes. No comets have shown tail features, and none have been observed closer than 3 solar radii.

The SOHO spectrometer had observed two comets. Lyman alpha emissions give an upper limit to the solar wind velocity of 640 km/sec. The comets suffer a 20 kg/sec mass loss. A body 6.7-m in diameter would weigh 120,000 kg and evaporate in about 5 hours.

Brian G. Marsden, (Harvard-Smithonian Center for Astrophysics) provided a synopsis of his talk on 'Discoveries, astrometry, catalogues and awards'.

This month we are celebrating the fortieth anniversary of George Alcock's discovery of what were announced on the IAU Circulars at the time as "Comet Alcock (1959e)" and "Comet Alcock (1959f)". Following the tradition, the year/letter designations supplied in order of discovery announcement were later changed to 1959 IV and 1959 VI, showing the order of passage of the year's comets through perihelion. In terms of the new system introduced in 1994 the announcements would have involved the single appellations "Comet C/1959 Q1 (Alcock)" and "Comet C/1959 Q2 (Alcock)", the 1 and 2 indicating the order of announcement of discoveries in half-month "Q" of the year, i.e., the second half of August. Although we intended no disrespect, some astronomers have been condemning the IAU Circulars for this "new" procedure of placing the name of the discoverer, rather than the designation, in parentheses. As it happens, this procedure is not new at all--early IAU Circulars speak of "Comet 1922c (Baade)", for example--and since "Comet Alcock" is not by itself a unique form of address, it is surely more logical to state the unique designator for the comet first, backing it up with the additional information identifying the discoverer. The parenthetical use of the discoverer's name was for many decades also standard use in the Astronomische Nachrichten, the principal international source for information about discoveries, astrometry and orbits of comets prior to the first IAU Circular. The discoverer's name, and sometimes also the date of discovery, were specified in this way, even in cases when the year/letter designations were not used and the Roman numeral designations had not yet been supplied. "Comet 1889 ... (Barnard 1888 Sept. 2)", already recognizing the year in which the object would pass perihelion, uniquely defined the comet that later became 1889 I, that was from the start defined in some publications as 1888e, and that we now know as C/1888 R1 (Barnard).

Since two earlier speakers have provided admirable accounts of their astrometric activities, there is little I need add, except perhaps to point out that it was not always this way. Modern CCD astrometry has turned out to be a much more automatic, accurate, reliable, rapid and straightforward process than the older astrometric processes involving photography and micrometry.

Although I am happy to announce that the thirteenth edition of the Central Bureau for Astronomical Telegrams/Minor Planet Center "Catalogue of Cometary Orbits" has just now become available, I again want to stress that by far the best and most detailed such catalogue ever published is that by Galle of 1894, which has the sole disadvantage that it is just very much out of date! One feature of the 1894 catalogue is that it defined the 15 multiple-apparition comets as (H) = Halley, (E) = Encke, ..., (Wo) = Wolf, (Fi) = Finlay. Actually, these periodic comets are the only named objects in the catalogue. Since there are now 140 such comets, it might have been preferable if Galle had instead given them consecutive numbers. The 1994 designation system has taken care of this by calling them 1P, 2P, etc. As many as 55 comets were discovered during the twelve months preceding the end of July 1999. Although 22 and 14 of these were discovered by the very automated LINEAR and SOHO projects, respectively, even the remaining activity was prodigious in comparison with a year as recent as 1971, which yielded only a single discovery. Cataloguing new discoveries has been complicated by the fact that, more often than not, LINEAR does not recognize its discoveries as cometary. The same is also true of other CCD discovery programs, which often involve exposures sufficient only to detect moving objects. Cometary status is often established only by careful scrutiny of objects that have orbits suggesting cometary nature. Although some of these objects, like P/1999 DN3 (Korlevic-Juric), had already received designations as minor planets, the beauty of the new system is that such designations can be retained and combined with genuine cometary designations in a transparent manner. Again to complicate matters, June 1999 saw for the first time the discovery of an object (two objects, in fact) having a retrograde orbit but no trace of cometary activity!

While monetary prizes and other awards specifically for the discoveries of comets date back to the year 1831, there was no such international award between the 1950s and this past year. The Edgar Wilson Award, made possible by a bequest from a businessman in Kentucky, has recently been instituted for cometary discoveries by amateur astronomers (or individuals acting in an amateur capacity) for whom those comets are named and who are using for the discoveries amateur, privately-owned equipment. The amount available each year, roughly $20 000, is shared according to the number of comets with eligible discoveries during the year, which for this purpose is taken as beginning at 0 hours UT on June 11. The first year of operation has just ended, and there were six eligible comets, including the aforementioned P/1999 DN3 (with the two Croatian CCD discoverers having an equal share), a CCD discovery in Arizona, a photographic discovery in Austria and three visual discoveries in Australia.

My notes show a few further asides, which Brian mentioned in passing. The D/ designation for some periodic comets implies defunct or comets which JPL shouldn't send a mission to as they might not find it. He would like to see the numeric sequence disappearing from the named periodic comets (eg S-L 1 to 9). Orbital computations are now not quite good enough to fit all the available observations, even with the inclusion of non-gravitational forces, and an improved model is clearly needed. July and August is the rainy season in New Mexico, so there are not many LINEAR observations at this time of year. LINEAR doesn't follow objects from night to night, which gives the amateur the chance to do two night linkages. By definition tailed asteroids are comets (eg 133P/Elst-Pizzarro). The Edgar Wilson award begins on June 11th because his brother died on June 10th. The original bequest included recoveries, however this was thought to be unfair for recoveries with well-known orbits, though accidental recoveries might count towards future awards.

Responding to a question, Brian said that comets are not allocated a provisional designation until positions were available. Several recent SOHO comets have yet to have their positions measured and so do not yet have designations, and one has positions but no derivable orbit, despite clearly existing. Brian's talk continued into a panel discussion also including Doug Biesecker, Bill Liller and Alan Hale. Kuiper belt objects are cometary objects. There might be some bright Kreutz group comets to come, but he wasn't sure about different sub-groups. The IAU could decline to name a comet if this might cause aggravation. The first Solwind object had been named, and the team's intention had been to name each subsequent object with the next three team-member's names, however they were instead named after the instrument. New spacecraft missions planned for the future include stereo solar imaging and all sky imaging down to 12th magnitude every 90 minutes. The first named comet is 1760 A1 as this was the year the Messier first began deliberate comet hunting.

Guiseppe Canonaco commented that useful positional data had been found in the logbook of a Dutch ship, enabling an orbit to be computed for a comet for the first time. Jon Shanklin noted that he had been forwarded recent meteorological logbook entries relating to comets Hyakutake and Hale-Bopp, which showed that mariners were generally unaware of the comets despite widespread information being available and that they only spotted them when they reached 2nd or 3rd magnitude.

The skies again cleared after dinner, giving another very transparent night (for Cambridge), with the Milky Way clearly visible from the University Observatory. It was possible to observe comets Lynn and 10P/Tempel 2 and more fragments of 109P/Swift-Tuttle were seen.

Monday began with the final session, which was devoted to short presentations and posters. Philippe Morel of the Societe Astronomique de France described the history of the comet section of the SAF. L'Astronmie, the Journal of the SAF had published observations of comets since 1887 when it was founded by Camille Flammarion. Charles Bertaud formed the comet section in 1970. Annie Chantal Levasseur Regourd, who organised several training camps for the International Halley Watch, followed him. Serge Thebault took over in 1989 and he organised further camps to observe comet Austin in Provence in 1990 and Hale-Bopp in Normandy in 1997. There are about 120 members distributed through France and other countries, of which around 15 regularly submit observations, including drawings and photographs. The Internet is very important for communication between members. Two members have been successful in discovering comets: Alain Maury (1998 X1) and Michel Meunier (1997 J2). Future projects include transcribing old observations from L'Astronomie. The SAF web pages (http://www.iap.fr/saf) include a section on comets. Visitors to Paris can be assured of a welcome at 3 Rue Beethoven, across the Seine from the Tour Eiffel.

Stephane Garro went on to elaborate about the SAF comet database. They had decided to use database software and set up a form input so that those not familiar with the ICQ codes could enter observations correctly. The first observations were from 1882, but there are few in the ICQ database prior to 1980 and they were concentrating on entering these observations. There were 713 observations between 1939 and 1959. Many of the early observations are rough, lacking supporting data. Sometimes the date is imprecise, for example only quoting October 1901, others gave no instrument and often only the date and magnitude were quoted.

Gyula Szabo described his observations at Konkoly in northern Hungary. The 0.60-m Schmidt is now equipped with a CCD camera which has a 29'x18' field of view, compared to the original plates which gave a 5°x5° field, however the CCD reaches 22 magnitude compared to 19 magnitude on film. He showed images of 1998 K5, which revealed a bright tail, but little coma. Several comets showed features in the coma. A short period light curve of P/1998 U3 over 2 hours showed variation in the nuclear brightness. They had carried out surface photometry using varying apertures, calculating the magnitude in various rings. Theoretically (d ln B)/(d ln P) = -1 where P is the radius of the annulus and B its width. Some LINEAR comets, eg 1998 K5, show much greater slopes than this. Solar activity, diffusivity in the coma or activity in the comet may explain the variation. Some of the data may show a trend, with minimum values occurring some 20 days after perihelion.

Bill Liller had followed comet Hale-Bopp with his 0.20-m f1.5 Schmidt with an ST5 CCD at the Newtonian focus on 338 nights. This gave a 27'x36' field at a scale of 7" per pixel. He could get a photometric accuracy of ±0.04 magnitude using a broadband V filter (effectively minus IR). Looking at the inner coma only, there was a 20±5 day periodicity when the comet was inbound. After perihelion there were ongoing recurrent outbursts about 100 days apart, which showed an outflow of 40 - 55 ms^{-1}.

After the tea break Bill Liller presented Jonathan Shanklin with a bottle of Chilean wine and thanked him for making all the local arrangements for what had been a very successful meeting. Bernd Brinkmann gave a short talk on his CCD observations with an SX camera on a C8 and with the Askania 0.34/0.50-m Schmidt camera and ST6 camera, which also has several smaller telescopes which are under used. He processes the images, which are mostly 60-second exposures, with bias, dark and flat field frames and uses co-added frames for fainter objects. He showed high quality images of several recent comets, which had been used for astrometry. He concluded with some spectacular slides of Hale-Bopp.

Bill Liller and Michael Jager.

The final speaker was Simona Nikolova who spoke about the endurance lifetime of meter sized cometary fragments. Meter sized fragments were common in meteor streams [though the audience was a little sceptical that photographs had showed such objects prior to atmospheric entry] and fragmentation in comets was common. She had developed a sublimation model, in collaboration with Martin Beech, using the interaction of solar radiation with water ice and several variable parameters. She concluded that 2P/Encke looses 0.65-m per revolution and a 10-meter sized fragment would last around 50 years; 55P/Tempel-Tuttle looses 0.18-m and a fragment would last 1900 years.

During the meeting several posters were on display, though I'm afraid I didn't have time to make detailed notes. The BAA Comet Section and TA had light curves of recent comets on display, a selection of superb comet drawings by George Alcock and the discovery observations of comet 1980 Y2 by Roy Panther. Comets Hyakutake and Hale-Bopp featured prominently in several posters. Nicolas Biver presented work on the estimation of the rotation period of Hale-Bopp using visual drawings. Philippe Morel discussed possible irregularities in Hale-Bopp's rotation, illustrating his poster with 15 drawings made through his 0.41-m Newtonian. Bill Liller had illustrations from his talk on Hale-Bopp and the Belgian VVS showed many photographs. Andreas Kammerer displayed a comprehensive analysis of observations of the two comets and this will also be displayed at the Meteor Section meeting at the end of October. Simona Nikolova showed a synopsis of her talk on cometary fragment lifetimes.

After lunch we boarded an air-conditioned coach for the trip to Avebury and Stonehenge. It is quite a long journey to Avebury and I kept everyone entertained with descriptions of the passing scenery and was persuaded to recount some tales from my other hobbies, which include church bell-ringing, ice hockey, natural history and cricket. Although there was rain en route, it had stopped by the time we reached Avebury and there was time to look round the large complex and discover its history in the local museum. After a light tea we continued on to Stonehenge, where we waited until the public had left before being ushered into the stone circle. We had an hour to ourselves and the lighting conditions provided a spectacular backdrop to the ancient monument, which is Britain's earliest astronomical observatory. The trip back was much quicker than the outward journey and we arrived back before midnight.

Final goodbyes were said on Tuesday morning and the remaining participants departed from New Hall for further touring round the UK and their journeys home. During the three days of the Workshop 65 astronomers and friends participated in what was a very rewarding meeting. My thanks to all those that contributed to making it such a success and I look forward to the next one in a few years time.

Jonathan Shanklin

Thanks to Martin Mobberley for providing the illustrations. Colour versions can be seen on his web page at http://ourworld.compuserve.com/homepages/MartinMobberley

Observations of Comet 2P/Encke

Alex Vincent

During its 1994 apparition, I made an extensive number of observations of Comet Encke during the early evenings of January of that year. The comet went through the Water Jar asterism of Aquarius and passed very close to the star Pi Aquarii on January 15.

I observed the comet through Dave Storey's 0.30-m telescope on 1993 December 31 when it appeared as a faint ball shaped object at 9.5 magnitude and also on 1994 January 16th near Pi Aquarii shining at magnitude 8.5. It appeared slightly elongated as shown in the sketch. I took several photographs of it at prime focus.

My other observations were done through 10x50 binoculars and an 8x21 monocular on January 7th, 13th, 14th, 16th, 17th, 19th, 23rd and 28th. It appeared as a small smudge of light as it traversed Aquarius

I took a number of photographs of Comet Encke with my camera piggyback on the Worthing Astronomical Society's 0.30-m telescope and also down at the beach with a camera platform, using 50-mm, 135-mm and 270-mm lenses. As the moon was around on some of the days, the sky appears blue.

Comet Encke has the shortest known period of any comet, which is only 3.3 years, and its last return was in 1997, but it was not favourable placed. It will however be well placed for observation in the year 2000.

C/1807 R1 (Great Comet)

Gary W. Kronk

(Abridged from Cometography, to be published this winter by Cambridge University Press)

This comet was first seen on 1807 September 9 by Castro Giovanni (Sicily). It passed perihelion on September 19 and then emerged out of evening twilight, at which point it became widely observed. Independent discoveries were then reported by Jean Louis Pons (Marseille, France) on September 21 and Edward Pigott (Bath) on September 28. The comet passed closest to Earth (0.1533 AU) on September 26.

The comet was well observed as October began. William Dunbar saw the comet on the 3rd. He was then situated about 5 miles southeast of Natchez, Mississippi. He said it seemed similar in brightness to a star of magnitude 2 or 3, though "considerably larger." With a reflecting telescope (128x) he said the nucleus and coma were shown "with tolerable distinctness; the idea produced in the mind of the observer, was that of a round body in combustion, which had produced so much smoke as to obscure the nucleus; the smoke seemed to be emitted in every direction; but, as if it met on one side with a gentle current of air, the smoke seemed to be repelled and bent around the nucleus, escaping on the opposite side, in the direction of the tail." Dunbar added that the telescope showed about 63' of tail, while the nucleus was considered one-third, or possibly one-half, the brightness of Mars. William Herschel saw the comet with the naked eye on October 4. He said a reflector of 10-foot focal length showed an apparently round nucleus which was evenly illuminated across its surface. Although he initially estimated its diameter as 5" in the reflector of 7-foot focal length, later in the observing session he said it was more like 3" across. He made several comparable nuclear diameter estimates during the next few days, and also estimated the tail length as 3.75 degrees on October 18. On the 19th Herschel said the coma diameter was 6 arcmin. About mid October the Gentleman's Magazine reported, "The Comet became visible immediately after twilight, at a considerable elevation in the heavens, nearly due West, and set about one degree half past eight o'clock, within a few degrees of N.W. The nucleus, or star, when viewed through a small telescope, appeared about the size of a star of the first magnitude, but less vivid, and of a pale dusky colour. The atmosphere of the Comet, owing to the limited power of the telescope, was barely perceptible. The tail...appeared sometimes extremely brilliant, seeming to be a vibration of luminous particles, somewhat resembling the Aurora Borealis, and at other times almost to disappear." H. W. M. Olbers saw the comet on October 20 and said the comet exhibited two tails separated by about 1.5 degrees. The northern tail was very slender, faint, and straight, with a length of about 10 degrees, while the southern tail was short, wide, and brighter, with a length of about 4.5 degrees. The southern tail was also more intense on the southern side, while the concave side of the tail was very poorly defined. Olbers measured the very distinct nucleus as 8" or 9" across, which he said equalled about 900 miles. On October 24, Dunbar indicated the tail was about 2.7 degrees long. On October 26, Herschel said the tail was "considerably longer on the south-preceding, than on the north-following side." On October 28, Herschel said the tail's south-preceding side was well defined, while the north-following side is shorter and "hazy." On October 31, Herschel said, "The tail continues to be better defined on the south-preceding than on the north-following side."

Moonlight interfered for about a week before mid-November. By the 18th Dunbar said the comet had visibly diminished since earlier observations, and noted the nucleus was about one-half its observed magnitude of October 3. On November 20, Herschel said the nucleus was distinctly visible, but only "a mere point" in the 7-foot focal length reflector. On December 6, Herschel observed with the 24-inch reflector and described the coma as "a very large, brilliant, round nebula, suddenly much brighter in the middle." It was about 4.75 arcmin across, with a tail 23 arcmin long. On December 7, Dunbar said, "I directed the reflecting telescope to the comet; the nucleus is now much diminished in apparent magnitude; I compared it with a star of the sixth magnitude in the Swan, which was within the field of view at the same time, their apparent diameters were nearly equal, but the comet is become so dim, as to be seen with the naked eye only in a pure atmosphere, with favourable circumstances...the coma is yet considerable, but the tail is no longer visible...." On December 16, Herschel said the comet resembled "a very bright, large, irregular, round nebula, very gradually much brighter in the middle, with a faint nebulosity on the south preceding side."

On 1808 January 1 Herschel described the comet as "very bright, very large, very gradually much brighter in the middle." He added that the 7-foot focal length telescope showed the center consisting of very small stars, but the 24-inch reflector showed "several small stars shining through the nebulosity of the coma." On January 6, Dunbar said the comet was no longer visible to the naked eye. His reflecting telescope showed the nucleus "as small as a star of the seventh magnitude." He added, "the coma seems diminished more than half of its appearance, on the 6th of December [December 7th UT], and the nucleus is equally surrounded by it on all sides, without any trace of tail, and so faint as very much to resemble some of the nebulae." On January 14, Herschel described the comet as "bright, pretty large, irregular round, brighter in the middle." On January 16, Dunbar said, "In the great telescope, the coma is yet sufficiently conspicuous; the nucleus visible like a star of the eighth magnitude, in our purest atmosphere, and the coma little changed since the 5th instant [January 6th UT]."

On February 2, Herschel observed with the 24-inch reflector and described the comet as "very bright, large, irregular round, very gradually much brighter in the middle." He added that a faint, diffused nebulosity was seen on the north-preceding side, and he surmised this might have been "the vanishing remains of the comet's tail." On February 19, Herschel indicated the comet was about 3.4 arcmin across and "gradually brighter in the middle." He added, "The faint nebulosity in the place where the tail used to be, still projects a little farther from the center than in other directions." On February 21, Herschel noted the comet was fainter than on the 19th, but still about the same size. It was gradually brighter towards the middle, and some nebulosity still extended on the side where the tail once existed. On February 24, Bessel observed the comet with a 7-foot focal length reflector and described it as very faint. On February 26, Dunbar "searched with great diligence and some anxiety, and at length found an object which I had no doubt was the comet, situated between Chi Cassiopeiae and Omicron Cassiopeiae...." This observation was made with the 6-foot Gregorian reflector, but the comet was not detected in its finder.

The comet was last detected on March 27.87, when Vincent Wisniewski (St. Petersburg, now Leningrad, Soviet Union) estimated the position as RA=1h 43m 13.83s, DEC=+48d 54m 38.6s.

Bessel ultimately used positions reported from September 22 to March 27 and found the comet was moving in a long-period orbit of nearly 2000 years.

Comet Prospects for 2000

The year 2000 is not a particularly good one for predicted returns of periodic comets. The comet predicted to be brightest is a new discovery by LINEAR, 1999 S4. There is a good chance that it could become a naked eye object in the northern sky next summer. A couple of long period comets discovered in previous years are still faintly visible and there are some poor returns of short period comets. Recent theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. Ephemerides for new and currently observable comets are published in the *Circulars*, Comet Section Newsletters and on the Section, CBAT and Seiichi Yoshida's web pages. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook[1]; details of subscription to the ICQ are available from the comet section Director. The section booklet on comet observing[2] is available from the BAA office or the Director; a new edition is likely to be printed in 2000.

First some comets, which were at perihelion in previous years. Comet **Hale-Bopp (1995 O1)**, the great comet of 1997, is still fading slowly and could be 13^m at the beginning of the year, though this is likely to be the last year with visual observations. It is only observable from Southern Hemisphere locations as it loops round Mensa.

1999 S4 (LINEAR) offers the prospect of a naked eye comet next July. The comet should become visible to large aperture telescopes in the New Year, possibly earlier if the comet is brighter visually than with CCD. It brightens slowly, but also closes with the Sun and reaches conjunction in March. We should pick it up again as a binocular object in the northern sky in June, becoming naked eye in July. It doesn't stray far from the Sun and then begins to head south and back towards conjunction. UK observers will loose it by August, but Southern Hemisphere observers may follow it into September and will pick it up again as a telescopic object in November.

Stop Press: Another new comet **1999 T1 (McNaught-Hartley)** may reach binocular brightness in December 2000. More details in the next issue.

141P/Machholz 2 (1999 P1) was recovered by Rob McNaught in early August, not far from its predicted track. Its likely brightness is still uncertain, but it could be fading from 8^{th} magnitude at the end of 1999.

29P/Schwassmann-Wachmann 1 is an annual comet which has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. In the first half of 1999 it was in outburst on several occasions. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet. It begins the year in Scorpius and reaches opposition in the same constellation in June. It passes through Ophiuchus and into Sagittarius and is in solar conjunction in December. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. Unfortunately opportunities for UK observers may be limited, as its altitude does not exceed 11° from this country.

This year sees comet **2P/Encke's** 58th observed return to perihelion since its discovery by Mechain in 1786. The orbit is quite stable, and with a period of 3.3 years apparitions repeat on a 10 year cycle. This year the comet is not particular well seen, but there are short observing windows from the Northern Hemisphere prior to perihelion, which is in September, and in the Southern Hemisphere after the comet reaches perihelion. There is some evidence for a secular fading and any observations will help confirm this. Another suggestion is that Encke has two active regions, an old one with declining activity, which operates prior to perihelion and a recently activated one present after perihelion. The comet is the progenitor of the Taurid meteor complex and may be associated with several Apollo asteroids.

9P/Tempel 1 was first observed in 1867, but was lost between 1879 and 1967 following an encounter with Jupiter in 1881 which increased the perihelion distance from 1.8 to 2.1 AU. Further encounters in 1941 and 1953 put q back to 1.5 AU and calculations by Brian Marsden allowed Elizabeth Roemer to recover it in 1967. Alternate returns are favourable, but pertubations will once again increase the perihelion distance in the middle of the next century. This return is an unfavourable one, but Southern Hemisphere observers will be able to follow it as it fades after perihelion. It is an important comet to observe as it is a potential spacecraft target, so all observations will be welcome.

A few comets not due to return until 2001 may become visible towards the end of the year. Horace Tuttle was the first discoverer of **41P/Tuttle-Giacobini-Kresak** in 1858, when he found a faint comet in Leo Minor. Nearly 50 years later, Professor M Giacobini discovered a 13th magnitude object whilst comet hunting, which was observed for a fortnight. A C D Crommelin linked the apparitions in 1928 and made predictions for future returns, but the comet wasn't recovered and it was given up as lost. In 1951, Lubor Kresak discovered a 10th magnitude comet in 25x100 binoculars whilst participating in the Skalnate Pleso Observatory's program of routine searches for comets. After further observations the comet was identified with the lost comet and a better orbit computed. At the 1973 return, which was similar to the 1907 return, it underwent a major outburst and reached 4th magnitude, before fading and then undergoing a second outburst. Alternate returns are unfavourable and this is one of them, but the comet has been observed at a few of them and it should be possible to observe it from equatorial regions in December. If it undergoes a further outburst, more widespread observation may be possible.

47P/Ashbrook-Jackson was discovered in 1948 following an approach to Jupiter in 1945, which reduced the perihelion distance from 3.8 to 2.3 AU. Although intrinsically relatively bright, the large perihelion distance keeps it faint. Alternate returns are favourable, but this is not one of them, although the comet will be reasonably well placed for Southern Hemisphere observers at 13th magnitude.

Professor A Schwassmann and A A Wachmann of Hamburg Observatory discovered their 3rd periodic comet, on minor planet patrol plates taken on 1930 May 2. Initially of magnitude 9.5 it brightened to nearly 6^m, thanks to a very close approach to Earth (0.062 AU) on June 1. The initial orbit was a little uncertain and the comet wasn't found at this or succeeding apparitions until 1979. The comet passed within 0.9 AU of Jupiter in 1953, and 0.25 AU in 1965. In August 1979, Michael Candy reported the discovery of a comet on a plate taken by J Johnston and M Buhagiar while searching for minor planets; this had the motion expected for **73P/Schwassmann-Wachmann 3**, but with perihelion 34 days later than in a prediction by Brian Marsden. Missed again at the next return, it has been seen at the last three returns. The 1930 approach to Earth is 9th on the list of well determined cometary approaches to our planet. In May 2006 it will make another close approach (0.082 AU), when it could again reach 7^m or brighter. This small miss distance makes it a convenient spacecraft target, and the Contour mission is scheduled to intercept it, as well as comets 2P/Encke and 6P/d'Arrest and possibly a new discovery. Following its outburst in 1995, 73P/Schwassmann-Wachmann 3 is expected to show fresh cometary surfaces, whilst 2P/Encke is an old comet and 6P/d'Arrest an average one. With the orbit approaching so closely to the Earth, an associated meteor shower might be expected, and the comet has been linked to the Tau Herculid shower, though the radiant now lies in the Bootes - Serpens region. Strong activity was reported in 1930 by a lone Japanese observer, but little has been seen since then. It is likely that any future activity would be in the form of a short-lived outburst, confined to years when the comet is at perihelion.

The comet underwent several outbursts at its last return, reaching naked eye brightness and the expected magnitude at this return is uncertain. The comet will be brightening towards the end of the year on its way to perihelion in late January 2001. If it maintains the level of activity seen at the last return it might be glimpsed in the morning sky around the beginning of December and may reach 7th magnitude at the end of the year, although the solar elongation is not good.

A number of fainter comets may be of interest to CCD observers or those with large aperture telescopes. These include: Spacewatch (1997 BA6) (slowly fading from 13^{tm} in January), LINEAR (1999 H3) (fading from 13^m in January), LINEAR (1999 L3) (fading from 13^m in January), LINEAR (1999 K5) (14^{tm} between May and September), LINEAR (1999 T2) (13^m in late Summer) and 95P/Chiron (16^m at opposition in late May in Libra). Ephemerides for these can be found on the CBAT WWW pages. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically.

Several other comets return to perihelion during 2000, however they are unlikely to become bright enough to observe or are poorly placed. 71P/Clark, 76P/West-Kohoutek-Ikemura, 64P/Swift-Gehrels, 108P/Ciffreo, 112P/Urata-Niijima, 137P/Shoemaker-Levy 2 and P/Lovas 2 (1986 W1) have unfavorable returns. 14P/Wolf, 17P/Holmes, 33P/Daniel, 70P/Kojima, 87P/Bus, 114P/Wiseman-Skiff, D/Kowal-Mrkos (1984 H1), D/Shoemaker 2 (1984 W1), P/Shoemaker-Levy 5 (1991 T1), Skiff (1999 J2), LINEAR (1999 K5), LINEAR (1999 K8) and LINEAR (1999 N4) are intrinsically faint or distant comets. 5D/Brorsen has not been seen for over a century and is unlikely to be recovered, however if it still exists and resumes activity it could be a binocular object in the dawn sky between late August and early October, however it could be virtually anywhere along its orbital track.

Looking ahead, 2001 sees favourable returns of comets 19P/Borelly, which may reach 9th magnitude and 24P/Schaumasse, which may reach 10th magnitude.

References and sources

1. Nakano, S. and Green D. W. E., Eds, *International Comet Quarterly 2000 Comet Handbook*, (1999).
2. Shanklin, J. D., *Observing Guide to Comets*, (1996).
3. Marsden, B. G. *Catalogue of Cometary Orbits*, 13th edition, IAU CBAT, (1999).
4. Kronk, G. W., *Cometographia*, Cambridge University Press, (1999).

Jonathan Shanklin

Comets reaching perihelion in 2000

Comet	T	q	P	N	H1	K1
9P/Tempel 1	Jan 02.6	1.50	5.51	9	5.2	23.4
C/LINEAR (1999 L3)	Jan 04.8	1.99			10.0	10.0
114P/Wiseman-Skiff	Jan 11.7	1.57	6.66	2	11.5	15.0
137P/Shoemaker-Levy 2	Feb 05.8	1.87	9.37	1	14.5	10.0
112P/Urata-Niijima	Mar 04.4	1.46	6.65	2	14.0	15.0
P/Lovas 2 (1986 W1)	Mar 11.7	1.45	6.75	1	10.0	10.0
C/Skiff (1999 J2)	Apr 05.9	7.11			6.4	5.0
108P/Ciffreo	Apr 18.4	1.71	7.24	2	9.2	15.0
64P/Swift-Gehrels	Apr 21.9	1.34	9.18	4	9.0	20.0
C/LINEAR (1999 K8)	Apr 24.4	4.20			1.9	15.0
C/LINEAR (1999 N4)	May 25.5	5.50			6.0	10.0
17P/Holmes	May 11.8	2.17	7.07	8	10.0	15.0
76P/West-Kohoutek-Ikemura	Jun 01.3	1.60	6.45	4	11.0	15.0
D/Shoemaker 2 (1984 W1)	Jun 15.5	1.32	7.84	1	13.0	10.0
33P/Daniel	Jun 23.5	2.16	8.07	8	10.5	20.0
C/LINEAR (1999 K5)	Jul 04.6	3.25			6.0	10.0
C/LINEAR (1999 S4)	Jul 24.4	0.75			7.0	10.0
P/Shoemaker-Levy 5 (1991 T1)	Aug 18.6	1.99	8.68	1	13.0	10.0
2P/Encke	Sep 09.7	0.34	3.30	57	10.0	8.8
70P/Kojima	Sep 14.8	2.00	7.05	4	11.0	15.0
5D/Brorsen	Oct 05±	0.54	5.5±	5	9.5	10.0
D/Kowal-Mrkos (1984 H1)	Oct 26.8	2.68	9.31	1	12.0	15.0
14P/Wolf	Nov 21.1	2.41	8.21	14	5.3	30.0
C/LINEAR (1999 T2)	Nov 24.7	3.02			6.0	10.0
71P/Clark	Dec 01.9	1.56	5.51	5	8.6	15.0
C/McNaught-Hartley (1999 T1)	Dec 09.6	1.15			5.0	10.0
87P/Bus	Dec 29.8	2.18	6.51	3	10.0	15.0

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 are given for each comet. Note: $m_1 = H1 + 5.0 * \log(d) + K1 * \log(r)$

Introduction

This issue has ephemerides for comets which are likely to be brighter than 11th magnitude:

- Lee (1999 H1) (UK)
- LINEAR (1999 J3) (UK & Southern Hemisphere)
- 141P/Machholz 2 (1999 P1) (UK)
- LINEAR (1999 S4) (UK)

Current ephemerides for fainter comets are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for comet 1999 H1 (Lee) (UK)

Omega= 40.7006 OMEGA=162.6490 i=149.3533 q= 0.708101 a=**********
e=0.999740 P=********* T= 1999 July 11.1725 Equinox= 2000
Magnitudes calculated from m= 6.6+5.0*Log(d)+12.6*Log(r)

October 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	0 50.4	51.45	0 53.2	52.01	9.0	0.83	1.67	0.12	18.59 to 4.40	131	70	52	8	187	-44	-29
2/ 3	0 39.6	50.30	0 42.4	50.46	9.0	0.83	1.68	23.57	18.56 to 4.42	133	82	41	7	183	-42	-31
3/ 4	0 29.5	49.11	0 32.2	49.27	9.1	0.84	1.70	23.43	18.54 to 4.44	135	93	30	7	178	-41	-32
4/ 5	0 20.0	47.49	0 22.7	48.05	9.2	0.84	1.71	23.30	18.52 to 4.46	136	104	20	6	173	-39	-34
5/ 6	0 11.1	46.25	0 13.8	46.41	9.2	0.85	1.73	23.17	18.49 to 4.48	138	115	12	6	168	-38	-35
6/ 7	0 2.9	44.59	0 5.5	45.16	9.3	0.86	1.74	23.05	18.47 to 4.49	139	125	6	6	163	-36	-35
7/ 8	23 55.2	43.33	23 57.8	43.49	9.4	0.87	1.75	22.53	18.44 to 4.51	140	132	2	5	159	-35	-36
8/ 9	23 48.1	42.05	23 50.6	42.22	9.4	0.88	1.77	22.42	18.42 to 4.53	141	136	0	5	154	-33	-36
9/10	23 41.5	40.38	23 43.9	40.55	9.5	0.89	1.78	22.31	18.40 to 4.55	142	136	0	5	149	-31	-36
10/11	23 35.3	39.12	23 37.8	39.29	9.6	0.90	1.80	22.21	18.38 to 4.56	142	133	2	4	144	-29	-36
11/12	23 29.6	37.46	23 32.0	38.03	9.7	0.91	1.81	22.12	18.35 to 4.58	142	126	6	4	139	-28	-35
12/13	23 24.3	36.22	23 26.7	36.39	9.7	0.93	1.82	22.02	18.33 to 4.60	142	118	11	4	134	-26	-35
13/14	23 19.4	34.59	23 21.8	35.16	9.8	0.94	1.84	21.53	18.31 to 5.02	142	108	18	4	130	-25	-34
14/15	23 14.8	33.38	23 17.2	33.55	9.9	0.96	1.85	21.45	18.29 to 5.03	142	98	26	4	126	-23	-33
15/16	23 10.6	32.19	23 13.0	32.35	10.0	0.98	1.87	21.37	18.26 to 4.56	142	87	35	3	122	-22	-32
16/17	23 6.7	31.02	23 9.1	31.18	10.0	1.00	1.88	21.29	18.24 to 4.38	141	77	44	3	118	-21	-32
17/18	23 3.0	29.47	23 5.4	30.03	10.1	1.02	1.89	21.21	18.22 to 4.20	141	66	54	3	114	-19	-31
18/19	22 59.6	28.35	23 2.0	28.51	10.2	1.04	1.91	21.14	18.20 to 4.04	140	56	64	3	111	-18	-30
19/20	22 56.5	27.24	22 58.9	27.40	10.3	1.06	1.92	21.07	18.18 to 3.47	139	46	73	3	107	-17	-29
20/21	22 53.6	26.16	22 56.0	26.32	10.4	1.08	1.94	20.60	18.16 to 3.32	138	38	82	3	105	-16	-28
21/22	22 50.9	25.11	22 53.3	25.27	10.5	1.10	1.95	20.53	18.14 to 3.17	137	33	90	3	102	-15	-27
22/23	22 48.3	24.08	22 50.8	24.24	10.5	1.12	1.96	20.47	18.12 to 3.02	136	35	96	3	99	-14	-26
23/24	22 46.0	23.07	22 48.4	23.23	10.6	1.15	1.98	20.41	18.10 to 2.48	135	41	99	3	97	-13	-25
24/25	22 43.8	22.08	22 46.3	22.24	10.7	1.17	1.99	20.34	18.08 to 2.35	134	51	100	3	95	-12	-24
25/26	22 41.8	21.12	22 44.2	21.28	10.8	1.20	2.01	20.29	18.06 to 2.21	132	64	99	2	93	-11	-23
26/27	22 39.9	20.18	22 42.4	20.33	10.9	1.22	2.02	20.23	18.04 to 2.08	131	77	94	2	91	-10	-22
27/28	22 38.2	19.26	22 40.6	19.41	11.0	1.25	2.03	20.17	18.02 to 1.56	130	90	87	2	90	-10	-21
28/29	22 36.6	18.36	22 39.0	18.51	11.0	1.27	2.05	20.11	18.00 to 1.44	129	104	78	2	88	-9	-20

29/30	22 35.1	17.48	22 37.5	18.03	11.1	1.30	2.06	20.06	17.59 to 1.32	128	117	67	2	87	-8	-20
30/31	22 33.7	17.02	22 36.2	17.17	11.2	1.33	2.07	20.01	17.57 to 1.20	126	130	56	2	85	-8	-19
31/32	22 32.4	16.17	22 34.9	16.33	11.3	1.35	2.09	19.55	17.55 to 1.08	125	141	45	2	84	-7	-18

Ephemeris for comet 1999 J3 (LINEAR) (UK)

Omega=161.9509 OMEGA=229.0006 i=101.6670 q= 0.977475 a=**********
e=1.000000 P=********* T= 1999 September 20.1699 Equinox= 2000
Magnitudes calculated from m= 8.8+5.0*Log(d)+25.9*Log(r)

October 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	8 3.1	22.11	8 6.1	22.03	8.0	0.70	1.00	7.25	0.29 to 4.40	69	23	52	28	283	-8	-44
2/ 3	8 1.6	20.17	8 4.5	20.09	8.0	0.68	1.00	7.19	0.34 to 4.42	70	8	41	28	282	-9	-47
3/ 4	7 59.9	18.17	8 2.8	18.08	8.0	0.66	1.01	7.14	0.40 to 4.44	71	6	30	29	281	-9	-50
4/ 5	7 58.3	16.09	8 1.1	16.00	8.0	0.64	1.01	7.08	0.45 to 4.46	72	20	20	29	280	-10	-53
5/ 6	7 56.5	13.54	7 59.3	13.45	7.9	0.62	1.02	7.02	0.52 to 4.48	73	33	12	29	279	-10	-56
6/ 7	7 54.7	11.31	7 57.5	11.22	7.9	0.61	1.02	6.57	0.59 to 4.49	74	47	6	28	279	-11	-59
7/ 8	7 52.8	8.60	7 55.5	8.52	7.9	0.59	1.03	6.51	1.06 to 4.51	75	60	2	28	278	-11	-62
8/ 9	7 50.8	6.21	7 53.5	6.13	7.9	0.58	1.03	6.45	1.14 to 4.53	77	73	0	28	278	-12	-66
9/10	7 48.8	3.34	7 51.4	3.26	7.9	0.56	1.04	6.39	1.23 to 4.55	78	85	0	28	277	-12	-69
10/11	7 46.6	0.39	7 49.2	0.31	8.0	0.55	1.04	6.33	1.33 to 4.56	79	97	2	27	277	-13	-72
11/12	7 44.4	-2.23	7 46.9	-2.31	8.0	0.54	1.05	6.26	1.44 to 4.58	80	109	6	27	277	-14	-75
12/13	7 42.0	-5.32	7 44.5	-5.40	8.0	0.53	1.05	6.20	1.56 to 4.60	81	119	11	26	277	-14	-78
13/14	7 39.5	-8.48	7 41.9	-8.55	8.1	0.52	1.06	6.14	2.10 to 5.02	82	128	18	25	277	-15	-81
14/15	7 36.9	-12.08	7 39.2	-12.15	8.1	0.52	1.07	6.07	2.27 to 5.03	83	135	26	24	277	-16	-83
15/16	7 34.1	-15.33	7 36.4	-15.40	8.2	0.51	1.07	6.00	2.47 to 5.05	84	140	35	23	277	-16	-85
16/17	7 31.2	-19.00	7 33.4	-19.07	8.2	0.51	1.08	5.53	3.12 to 5.07	85	140	44	22	278	-17	-86
17/18	7 28.0	-22.29	7 30.2	-22.35	8.3	0.51	1.09	5.46	3.47 to 5.09	86	137	54	21	279	-18	-86
18/19	7 24.7	-25.57	7 26.8	-26.03	8.4	0.51	1.10	5.39	4.52 to 5.10	87	132	64	20	279	-18	-86
19/20	7 21.2	-29.23	7 23.2	-29.29	8.5	0.51	1.10	5.31	Not Observable	88	124	73	19	280	-19	-85
20/21	7 17.4	-32.46	7 19.3	-32.51	8.6	0.52	1.11	5.23	Not Observable	89	115	82	18	282	-19	-84
21/22	7 13.4	-36.03	7 15.2	-36.09	8.7	0.52	1.12	5.15	Not Observable	89	107	90	17	283	-20	-82
22/23	7 9.1	-39.15	7 10.8	-39.20	8.8	0.53	1.13	5.07	Not Observable	90	98	96	15	285	-20	-79
23/24	7 4.5	-42.20	7 6.1	-42.25	8.9	0.54	1.14	4.58	Not Observable	91	90	99	14	286	-21	-76
24/25	6 59.6	-45.17	7 1.1	-45.21	9.0	0.55	1.15	4.49	Not Observable	91	84	100	13	288	-21	-73
25/26	6 54.4	-48.05	6 55.7	-48.09	9.2	0.56	1.15	4.40	Not Observable	91	79	99	12	290	-21	-70
26/27	6 48.7	-50.45	6 50.0	-50.48	9.3	0.58	1.16	4.30	Not Observable	92	76	94	11	292	-22	-66
27/28	6 42.7	-53.15	6 43.8	-53.18	9.5	0.59	1.17	4.20	Not Observable	92	75	87	10	294	-22	-62
28/29	6 36.2	-55.36	6 37.1	-55.39	9.6	0.61	1.18	4.10	Not Observable	92	76	78	9	297	-22	-58
29/30	6 29.2	-57.48	6 30.0	-57.50	9.8	0.63	1.19	3.58	Not Observable	92	79	67	9	299	-23	-54
30/31	6 21.6	-59.51	6 22.3	-59.53	9.9	0.65	1.20	3.47	Not Observable	92	82	56	8	302	-23	-51
31/32	6 13.6	-61.45	6 14.1	-61.46	10.1	0.66	1.21	3.35	Not Observable	92	86	45	7	305	-23	-47

Ephemeris for comet 1999 J3 (LINEAR) (Southern Hemisphere, 40° South)

Omega=161.9509 OMEGA=229.0006 i=101.6670 q= 0.977475 a=**********
e=1.000000 P=********* T= 1999 September 20.1699 Equinox= 2000
Magnitudes calculated from m= 8.8+5.0*Log(d)+25.9*Log(r)

October 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
20/21	7 17.4	-32.46	7 19.3	-32.51	8.6	0.52	1.11	5.23	22.25 to 3.57	89	115	82	18	282	-19	-84
21/22	7 13.4	-36.03	7 15.2	-36.09	8.7	0.52	1.12	5.15	22.05 to 3.55	89	107	90	17	283	-20	-82
22/23	7 9.1	-39.15	7 10.8	-39.20	8.8	0.53	1.13	5.07	21.44 to 3.54	90	98	96	15	285	-20	-79
23/24	7 4.5	-42.20	7 6.1	-42.25	8.9	0.54	1.14	4.58	21.22 to 3.52	91	90	99	14	286	-21	-76
24/25	6 59.6	-45.17	7 1.1	-45.21	9.0	0.55	1.15	4.49	20.59 to 3.50	91	84	100	13	288	-21	-73
25/26	6 54.4	-48.05	6 55.7	-48.09	9.2	0.56	1.15	4.40	20.36 to 3.49	91	79	99	12	290	-21	-70
26/27	6 48.7	-50.45	6 50.0	-50.48	9.3	0.58	1.16	4.30	20.11 to 3.47	92	76	94	11	292	-22	-66
27/28	6 42.7	-53.15	6 43.8	-53.18	9.5	0.59	1.17	4.20	19.45 to 3.46	92	75	87	10	294	-22	-62
28/29	6 36.2	-55.36	6 37.1	-55.39	9.6	0.61	1.18	4.10	19.44 to 3.44	92	76	78	9	297	-22	-58
29/30	6 29.2	-57.48	6 30.0	-57.50	9.8	0.63	1.19	3.58	19.45 to 3.43	92	79	67	9	299	-23	-54
30/31	6 21.6	-59.51	6 22.3	-59.53	9.9	0.65	1.20	3.47	19.46 to 3.41	92	82	56	8	302	-23	-51
31/32	6 13.6	-61.45	6 14.1	-61.46	10.1	0.66	1.21	3.35	19.48 to 3.40	92	86	45	7	305	-23	-47

November 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 4.9	-63.30	6 5.3	-63.31	10.2	0.68	1.22	3.22	19.49 to 3.38	91	90	34	7	308	-24	-43
2/ 3	5 55.7	-65.07	5 55.8	-65.07	10.4	0.70	1.23	3.09	19.51 to 3.37	91	93	24	6	311	-24	-40
3/ 4	5 45.8	-66.36	5 45.8	-66.35	10.5	0.73	1.24	2.55	19.52 to 3.35	91	95	16	5	314	-24	-36
4/ 5	5 35.2	-67.56	5 35.1	-67.54	10.7	0.75	1.25	2.40	19.54 to 3.34	91	96	9	5	318	-24	-33
5/ 6	5 24.1	-69.09	5 23.7	-69.06	10.8	0.77	1.26	2.25	19.55 to 3.32	90	97	4	5	322	-24	-30
6/ 7	5 12.3	-70.15	5 11.8	-70.11	11.0	0.79	1.27	2.09	19.56 to 3.31	90	96	1	4	325	-24	-27
7/ 8	4 59.9	-71.13	4 59.3	-71.09	11.1	0.82	1.28	1.52	19.58 to 3.30	90	95	0	4	329	-24	-24
8/ 9	4 46.9	-72.04	4 46.2	-71.59	11.3	0.84	1.29	1.35	19.59 to 3.28	89	93	0	3	333	-24	-21
9/10	4 33.5	-72.49	4 32.7	-72.43	11.4	0.86	1.30	1.18	20.01 to 3.27	89	90	3	3	338	-24	-18
10/11	4 19.8	-73.27	4 18.9	-73.20	11.6	0.89	1.31	1.00	20.02 to 3.26	89	87	7	3	342	-24	-16
11/12	4 5.7	-73.60	4 4.9	-73.52	11.7	0.91	1.32	0.42	20.04 to 3.24	88	84	12	3	346	-24	-13
12/13	3 51.6	-74.27	3 50.7	-74.18	11.9	0.94	1.33	0.24	20.05 to 3.23	88	80	19	2	350	-23	-11
13/14	3 37.4	-74.48	3 36.7	-74.38	12.0	0.96	1.35	0.06	20.07 to 3.22	87	77	28	2	355	-23	-8
14/15	3 23.4	-75.05	3 22.7	-74.54	12.2	0.98	1.36	23.48	20.08 to 3.21	87	75	37	2	359	-22	-6
15/16	3 9.7	-75.17	3 9.1	-75.05	12.3	1.01	1.37	23.31	20.10 to 3.20	86	73	46	2	3	-21	-5
16/17	2 56.3	-75.25	2 55.9	-75.13	12.5	1.03	1.38	23.13	20.11 to 3.18	86	72	57	2	7	-21	-3
17/18	2 43.4	-75.29	2 43.2	-75.16	12.6	1.06	1.39	22.57	20.13 to 3.17	85	73	67	2	11	-20	-1
18/19	2 31.1	-75.30	2 31.0	-75.17	12.8	1.08	1.40	22.41	20.14 to 3.16	85	74	77	1	15	-19	0
19/20	2 19.4	-75.28	2 19.5	-75.14	12.9	1.11	1.41	22.25	20.16 to 3.15	84	77	85	1	19	-18	0
20/21	2 8.3	-75.24	2 8.6	-75.09	13.0	1.14	1.42	22.10	20.17 to 3.14	84	81	93	1	22	-17	1
21/22	1 57.9	-75.17	1 58.4	-75.02	13.2	1.16	1.43	21.56	20.18 to 3.13	83	86	98	1	26	-16	2
22/23	1 48.2	-75.09	1 48.8	-74.54	13.3	1.19	1.45	21.43	20.20 to 3.12	83	91	100	1	29	-15	3
23/24	1 39.1	-74.59	1 39.9	-74.44	13.5	1.21	1.46	21.30	20.21 to 3.12	82	97	100	1	32	-14	4

24/25	1 30.7	-74.47	1 31.7	-74.32	13.6	1.24	1.47	21.18	20.23 to 3.11	82	103	96	1	35	-13	4
25/26	1 22.9	-74.35	1 24.0	-74.19	13.7	1.26	1.48	21.06	20.24 to 3.10	81	108	90	1	38	-12	5
26/27	1 15.7	-74.22	1 17.0	-74.06	13.9	1.29	1.49	20.55	20.26 to 3.09	81	112	81	1	40	-12	5
27/28	1 9.0	-74.08	1 10.4	-73.52	14.0	1.31	1.50	20.45	20.27 to 2.53	80	114	71	1	43	-11	5
28/29	1 2.9	-73.53	1 4.4	-73.37	14.1	1.34	1.52	20.35	20.28 to 2.25	80	115	61	1	45	-10	6
29/30	0 57.3	-73.38	0 58.9	-73.22	14.2	1.36	1.53	20.25	20.30 to 1.59	79	115	50	1	47	-9	6
30/31	0 52.1	-73.23	0 53.8	-73.07	14.4	1.39	1.54	20.16	20.31 to 1.33	79	113	39	1	49	-9	6

Ephemeris for comet 1999 P1 (141P/Machholz 2) (UK)

Omega=149.3019 OMEGA=246.1350 i= 12.8112 q= 0.748971 a= 3.008761
e=0.751070 P= 5.219 T= 1999 December 9.2811 Equinox= 2000
Magnitudes calculated from m=12.0+5.0*Log(d)+30.0*Log(r)

November 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	18 13.5	-11.54	18 16.3	-11.53	11.8	1.08	0.97	15.33	Not Observable	56	124	34	3	80	16	0
2/ 3	18 16.2	-11.54	18 19.0	-11.53	11.7	1.07	0.96	15.32	Not Observable	55	112	24	3	80	16	0
3/ 4	18 18.9	-11.54	18 21.7	-11.53	11.5	1.06	0.95	15.30	Not Observable	55	100	16	4	80	16	0
4/ 5	18 21.6	-11.54	18 24.4	-11.52	11.4	1.05	0.94	15.29	Not Observable	55	88	9	4	79	16	0
5/ 6	18 24.4	-11.53	18 27.2	-11.51	11.2	1.05	0.93	15.28	Not Observable	54	77	4	4	79	17	0
6/ 7	18 27.2	-11.53	18 30.0	-11.51	11.0	1.04	0.92	15.27	Not Observable	54	65	1	5	79	17	0
7/ 8	18 30.1	-11.52	18 32.9	-11.50	10.9	1.03	0.91	15.26	17.44 to 17.47	54	54	0	5	78	17	0
8/ 9	18 33.0	-11.52	18 35.8	-11.49	10.7	1.02	0.91	15.25	17.42 to 17.53	54	43	0	6	78	17	0
9/10	18 36.0	-11.51	18 38.7	-11.48	10.6	1.01	0.90	15.24	17.41 to 17.59	53	32	3	6	78	18	0
10/11	18 38.9	-11.50	18 41.7	-11.47	10.4	1.00	0.89	15.23	17.39 to 18.04	53	22	7	7	77	18	0
11/12	18 42.0	-11.50	18 44.8	-11.46	10.3	0.99	0.88	15.22	17.38 to 18.09	53	12	12	8	77	18	0
12/13	18 45.0	-11.49	18 47.8	-11.45	10.1	0.97	0.87	15.21	17.37 to 18.13	53	9	19	8	76	18	0
13/14	18 48.1	-11.48	18 50.9	-11.44	10.0	0.96	0.86	15.20	17.35 to 18.18	52	16	28	9	76	19	0
14/15	18 51.3	-11.47	18 54.1	-11.43	9.8	0.95	0.85	15.20	17.34 to 18.22	52	26	37	10	76	19	0
15/16	18 54.5	-11.46	18 57.3	-11.42	9.7	0.94	0.85	15.19	17.33 to 18.25	52	37	46	11	75	19	0
16/17	18 57.7	-11.45	19 0.5	-11.40	9.6	0.93	0.84	15.18	17.32 to 18.29	52	49	57	12	75	19	0
17/18	19 1.0	-11.44	19 3.8	-11.39	9.4	0.92	0.83	15.17	17.31 to 18.32	52	60	67	13	75	20	0
18/19	19 4.3	-11.43	19 7.1	-11.38	9.3	0.91	0.82	15.17	17.29 to 18.36	51	73	77	14	74	20	0
19/20	19 7.7	-11.41	19 10.5	-11.36	9.1	0.90	0.82	15.16	17.28 to 18.39	51	86	85	16	74	20	0
20/21	19 11.1	-11.40	19 13.9	-11.35	9.0	0.88	0.81	15.16	17.27 to 18.41	51	99	93	17	74	20	0
21/22	19 14.6	-11.39	19 17.3	-11.34	8.9	0.87	0.81	15.15	17.26 to 18.44	51	113	98	18	74	21	0
22/23	19 18.0	-11.38	19 20.8	-11.32	8.7	0.86	0.80	15.15	17.26 to 18.47	51	127	100	20	73	21	0
23/24	19 21.6	-11.37	19 24.4	-11.31	8.6	0.85	0.79	15.14	17.25 to 18.49	51	141	100	21	73	21	0
24/25	19 25.2	-11.36	19 28.0	-11.30	8.5	0.83	0.79	15.14	17.24 to 18.51	50	154	96	23	73	21	0
25/26	19 28.8	-11.35	19 31.6	-11.29	8.4	0.82	0.78	15.14	17.23 to 18.53	50	167	90	25	72	22	0
26/27	19 32.5	-11.35	19 35.3	-11.28	8.3	0.81	0.78	15.13	17.22 to 18.55	50	170	81	26	72	22	0
27/28	19 36.2	-11.34	19 39.0	-11.27	8.2	0.80	0.77	15.13	17.22 to 18.57	50	161	71	28	72	22	0
28/29	19 40.0	-11.34	19 42.8	-11.26	8.1	0.78	0.77	15.13	17.21 to 18.59	50	149	61	30	72	23	0
29/30	19 43.9	-11.33	19 46.6	-11.26	8.0	0.77	0.77	15.13	17.20 to 19.01	50	136	50	32	71	23	0
30/31	19 47.8	-11.33	19 50.5	-11.25	7.9	0.76	0.76	15.13	17.20 to 19.03	50	125	39	33	71	23	0

December 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	19 51.7	-11.33	19 54.5	-11.25	7.8	0.74	0.76	15.13	17.19 to 19.04	50	113	29	35	71	24	0
2/ 3	19 55.7	-11.33	19 58.5	-11.25	7.7	0.73	0.76	15.13	17.19 to 19.05	50	102	21	37	71	24	0
3/ 4	19 59.8	-11.34	20 2.6	-11.25	7.6	0.72	0.75	15.13	17.18 to 19.07	50	91	13	39	71	24	0
4/ 5	20 3.9	-11.34	20 6.7	-11.26	7.5	0.70	0.75	15.13	17.18 to 19.08	50	80	7	40	70	25	0
5/ 6	20 8.1	-11.35	20 10.9	-11.26	7.5	0.69	0.75	15.14	17.18 to 19.09	50	69	3	42	70	25	0
6/ 7	20 12.4	-11.37	20 15.2	-11.27	7.4	0.68	0.75	15.14	17.18 to 19.10	49	58	0	43	70	26	0
7/ 8	20 16.8	-11.38	20 19.5	-11.29	7.4	0.66	0.75	15.14	17.17 to 19.12	49	48	0	44	70	26	0
8/ 9	20 21.2	-11.40	20 23.9	-11.30	7.3	0.65	0.75	15.15	17.17 to 19.13	49	37	1	45	70	27	0
9/10	20 25.7	-11.42	20 28.5	-11.32	7.3	0.64	0.75	15.15	17.17 to 19.14	50	27	3	46	70	27	0
10/11	20 30.3	-11.45	20 33.1	-11.35	7.2	0.62	0.75	15.16	17.17 to 19.14	50	16	8	47	70	28	-1
11/12	20 35.0	-11.48	20 37.8	-11.37	7.2	0.61	0.75	15.17	17.17 to 19.15	50	8	14	47	70	28	-1
12/13	20 39.8	-11.52	20 42.6	-11.41	7.2	0.60	0.75	15.18	17.17 to 19.16	50	10	21	48	70	29	-1
13/14	20 44.7	-11.55	20 47.5	-11.44	7.1	0.59	0.75	15.19	17.17 to 19.17	50	19	30	48	69	29	-1
14/15	20 49.7	-11.60	20 52.5	-11.48	7.1	0.57	0.76	15.20	17.17 to 19.18	50	30	40	48	69	30	-1
15/16	20 54.9	-12.05	20 57.6	-11.53	7.1	0.56	0.76	15.21	17.17 to 19.19	50	41	50	48	69	31	-1
16/17	21 0.1	-12.10	21 2.9	-11.58	7.1	0.55	0.76	15.22	17.18 to 19.19	50	53	61	48	69	32	-2
17/18	21 5.5	-12.16	21 8.3	-12.03	7.1	0.53	0.76	15.24	17.18 to 19.20	50	66	71	47	70	33	-2
18/19	21 11.1	-12.22	21 13.8	-12.09	7.1	0.52	0.77	15.25	17.18 to 19.21	51	78	81	46	70	33	-2
19/20	21 16.8	-12.28	21 19.5	-12.16	7.2	0.51	0.77	15.27	17.19 to 19.22	51	92	90	46	70	34	-2
20/21	21 22.7	-12.35	21 25.4	-12.22	7.2	0.50	0.78	15.29	17.19 to 19.23	51	105	96	45	70	35	-2
21/22	21 28.8	-12.43	21 31.5	-12.30	7.2	0.49	0.78	15.31	17.20 to 19.24	52	119	100	44	70	36	-3
22/23	21 35.0	-12.51	21 37.7	-12.37	7.2	0.48	0.78	15.33	17.20 to 19.25	52	133	100	42	70	38	-3
23/24	21 41.5	-12.59	21 44.2	-12.45	7.3	0.46	0.79	15.36	17.21 to 19.26	52	146	98	41	70	39	-3
24/25	21 48.1	-13.08	21 50.8	-12.54	7.3	0.45	0.80	15.39	17.21 to 19.27	53	160	93	40	70	40	-3
25/26	21 55.0	-13.17	21 57.7	-13.03	7.3	0.44	0.80	15.42	17.22 to 19.28	53	173	86	39	70	41	-3
26/27	22 2.2	-13.26	22 4.9	-13.12	7.4	0.43	0.81	15.45	17.22 to 19.30	54	175	77	37	71	43	-3
27/28	22 9.6	-13.36	22 12.3	-13.21	7.4	0.42	0.81	15.48	17.23 to 19.31	54	163	67	36	71	44	-3
28/29	22 17.2	-13.45	22 19.9	-13.30	7.5	0.41	0.82	15.52	17.24 to 19.33	55	151	56	34	71	46	-3
29/30	22 25.2	-13.55	22 27.8	-13.40	7.6	0.40	0.83	15.56	17.25 to 19.35	56	140	46	33	71	48	-3
30/31	22 33.4	-14.04	22 36.1	-13.49	7.6	0.39	0.84	16.00	17.26 to 19.37	57	130	36	32	71	49	-3
31/32	22 41.9	-14.14	22 44.6	-13.58	7.7	0.38	0.84	16.05	17.26 to 19.39	58	120	27	30	71	51	-3

January 2000

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	22 50.8	-14.23	22 53.4	-14.07	7.8	0.38	0.85	16.10	17.27 to 19.42	59	110	19	29	71	53	-3
2/ 3	22 59.9	-14.31	23 2.5	-14.15	7.8	0.37	0.86	16.15	17.28 to 19.45	60	100	12	27	72	55	-3
3/ 4	23 9.3	-14.39	23 12.0	-14.23	7.9	0.36	0.87	16.20	17.29 to 19.48	61	90	6	26	72	57	-3
4/ 5	23 19.1	-14.46	23 21.7	-14.29	8.0	0.35	0.87	16.26	17.30 to 19.51	62	81	2	25	72	58	-2
5/ 6	23 29.2	-14.52	23 31.8	-14.35	8.1	0.35	0.88	16.32	17.31 to 19.55	63	71	0	23	72	60	-2
6/ 7	23 39.5	-14.57	23 42.1	-14.40	8.2	0.34	0.89	16.39	17.33 to 19.59	65	62	0	22	72	62	-1
7/ 8	23 50.1	-15.00	23 52.7	-14.43	8.3	0.34	0.90	16.45	17.34 to 20.03	66	52	1	21	72	64	-1
8/ 9	0 1.0	-15.02	0 3.6	-14.45	8.4	0.33	0.91	16.52	17.35 to 20.08	68	43	4	19	72	65	0
9/10	0 12.2	-15.02	0 14.7	-14.45	8.5	0.33	0.92	16.59	17.36 to 20.13	69	34	9	18	72	67	0
10/11	0 23.5	-15.00	0 26.0	-14.44	8.6	0.33	0.93	17.07	17.37 to 20.18	71	25	16	17	72	68	0
11/12	0 35.0	-14.57	0 37.5	-14.40	8.7	0.32	0.94	17.14	17.39 to 20.23	72	18	24	16	71	69	1
12/13	0 46.6	-14.51	0 49.1	-14.35	8.8	0.32	0.95	17.22	17.40 to 20.29	74	14	34	15	71	70	2

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
13/14	0 58.3	-14.43	1 0.8	-14.27	9.0	0.32	0.96	17.30	17.41 to 20.34	76	16	44	14	71	70	3
14/15	1 10.1	-14.33	1 12.6	-14.17	9.1	0.32	0.97	17.37	17.42 to 20.40	78	24	55	13	71	71	4
15/16	1 21.8	-14.21	1 24.3	-14.05	9.2	0.32	0.98	17.45	17.44 to 20.46	79	34	66	11	71	71	5
16/17	1 33.5	-14.06	1 35.9	-13.51	9.4	0.32	0.99	17.53	17.45 to 20.52	81	44	77	11	70	70	5
17/18	1 45.1	-13.50	1 47.5	-13.35	9.5	0.32	1.00	18.01	17.47 to 20.58	83	55	86	10	70	70	6
18/19	1 56.5	-13.32	1 58.9	-13.17	9.6	0.32	1.01	18.08	17.48 to 21.03	85	66	94	9	70	69	7
19/20	2 7.7	-13.12	2 10.2	-12.58	9.8	0.33	1.02	18.15	17.49 to 21.09	87	78	98	8	70	68	8
20/21	2 18.8	-12.50	2 21.2	-12.37	10.0	0.33	1.03	18.22	17.51 to 21.14	88	90	100	7	70	67	8
21/22	2 29.5	-12.27	2 31.9	-12.14	10.1	0.33	1.04	18.29	17.52 to 21.18	90	101	100	7	70	65	9
22/23	2 40.0	-12.04	2 42.4	-11.51	10.3	0.34	1.05	18.36	17.54 to 21.23	92	112	96	6	70	64	9
23/24	2 50.2	-11.39	2 52.6	-11.27	10.4	0.34	1.06	18.42	17.55 to 21.27	93	122	90	5	69	62	10
24/25	3 0.1	-11.13	3 2.5	-11.02	10.6	0.35	1.07	18.48	17.57 to 21.30	95	132	82	5	69	60	10
25/26	3 9.6	-10.47	3 12.0	-10.36	10.8	0.36	1.08	18.54	17.59 to 21.32	96	141	73	4	69	58	10
26/27	3 18.8	-10.21	3 21.2	-10.10	10.9	0.36	1.09	18.59	18.00 to 21.34	98	149	63	4	69	56	10
27/28	3 27.7	-9.54	3 30.1	-9.44	11.1	0.37	1.10	19.04	18.02 to 21.35	99	154	53	3	69	54	11
28/29	3 36.3	-9.28	3 38.7	-9.18	11.3	0.38	1.11	19.08	18.03 to 21.36	100	157	44	3	70	52	11
29/30	3 44.5	-9.01	3 46.9	-8.52	11.5	0.39	1.13	19.13	18.05 to 21.36	101	156	34	3	70	50	11
30/31	3 52.4	-8.35	3 54.8	-8.26	11.6	0.39	1.14	19.17	18.07 to 21.35	102	152	25	2	70	48	10
31/32	4 0.0	-8.09	4 2.4	-8.01	11.8	0.40	1.15	19.20	18.08 to 21.32	103	145	18	2	70	46	10

February 2000

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	4 7.3	-7.43	4 9.7	-7.36	12.0	0.41	1.16	19.24	18.10 to 21.29	104	138	11	2	70	45	10
2/ 3	4 14.3	-7.18	4 16.7	-7.11	12.2	0.42	1.17	19.27	18.11 to 21.25	105	129	6	2	70	43	10
3/ 4	4 21.0	-6.53	4 23.5	-6.47	12.3	0.43	1.18	19.30	18.13 to 21.20	106	121	2	2	71	41	10
4/ 5	4 27.5	-6.29	4 29.9	-6.23	12.5	0.44	1.19	19.32	18.15 to 21.13	107	111	0	1	71	40	10
5/ 6	4 33.7	-6.05	4 36.2	-5.59	12.7	0.45	1.20	19.34	18.17 to 21.05	107	102	0	1	71	38	9
6/ 7	4 39.7	-5.42	4 42.1	-5.37	12.9	0.47	1.21	19.36	18.18 to 20.55	108	92	2	1	72	37	9
7/ 8	4 45.4	-5.20	4 47.9	-5.14	13.0	0.48	1.23	19.38	18.36 to 20.41	109	81	6	1	72	35	9
8/ 9	4 50.9	-4.58	4 53.4	-4.53	13.2	0.49	1.24	19.40	18.60 to 20.20	109	71	12	1	72	34	9
9/10	4 56.2	-4.36	4 58.7	-4.32	13.4	0.50	1.25	19.41	Not Observable	110	60	19	1	73	33	8
10/11	5 1.4	-4.15	5 3.8	-4.11	13.6	0.51	1.26	19.42	Not Observable	110	50	29	1	73	31	8
11/12	5 6.3	-3.55	5 8.8	-3.51	13.7	0.53	1.27	19.43	Not Observable	111	40	39	1	74	30	8
12/13	5 11.1	-3.35	5 13.6	-3.32	13.9	0.54	1.28	19.44	Not Observable	111	30	50	1	74	29	8

Ephemeris for comet 1999 S4 (LINEAR) (UK)

Omega=151.4192 OMEGA= 83.1934 i=149.4778 q= 0.753678 a=**********
e=1.000000 P=********** T= 2000 July 24.2439 Equinox= 2000
Magnitudes calculated from m= 5.0+5.0*Log(d)+10.0*Log(r)

November 1999

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	4 21.6	36.41	4 24.9	36.47	13.4	3.07	3.93	1.42	20.11 to 5.34	146	78	34	0	237	0	0
6/ 7	4 12.3	36.52	4 15.6	36.59	13.2	2.97	3.87	1.13	19.34 to 5.42	151	138	1	0	229	-9	0
11/12	4 2.2	36.58	4 5.5	37.06	13.1	2.89	3.82	0.43	18.57 to 5.50	157	149	12	0	217	-10	0
16/17	3 51.4	36.58	3 54.6	37.07	13.0	2.81	3.76	0.12	18.20 to 5.58	161	93	57	0	200	-10	0
21/22	3 39.9	36.52	3 43.1	37.01	12.9	2.75	3.70	23.41	17.44 to 5.38	163	30	98	0	176	-11	0
26/27	3 27.9	36.37	3 31.2	36.48	12.8	2.69	3.65	23.09	17.22 to 5.10	162	59	81	0	150	-11	-1
December 1999																
1/ 2	3 15.8	36.16	3 19.0	36.26	12.7	2.65	3.59	22.37	17.19 to 4.41	159	123	29	0	128	-12	-1
6/ 7	3 3.7	35.46	3 6.9	35.58	12.6	2.62	3.53	22.06	17.18 to 4.11	153	155	0	0	113	-12	-2
11/12	2 51.9	35.10	2 55.0	35.22	12.5	2.60	3.48	21.34	17.17 to 3.41	147	107	14	0	103	-12	-3
16/17	2 40.6	34.29	2 43.6	34.41	12.4	2.60	3.42	21.03	17.18 to 3.09	141	47	61	1	95	-11	-3
21/22	2 29.9	33.43	2 32.9	33.56	12.3	2.60	3.36	20.32	17.20 to 2.38	134	39	100	1	89	-11	-3
26/27	2 20.0	32.54	2 23.0	33.07	12.3	2.61	3.30	20.03	17.22 to 2.07	127	108	77	1	84	-10	-4
31/32	2 11.1	32.03	2 14.0	32.17	12.2	2.63	3.24	19.34	17.26 to 1.36	121	157	27	1	81	-9	-4
January 2000																
5/ 6	2 3.0	31.13	2 6.0	31.28	12.1	2.65	3.18	19.06	17.31 to 1.07	114	120	0	1	77	-8	-4
10/11	1 56.0	30.25	1 58.9	30.39	12.1	2.68	3.12	18.40	17.37 to 0.38	108	63	16	1	74	-7	-4
15/16	1 49.8	29.38	1 52.7	29.53	12.0	2.71	3.06	18.14	17.44 to 0.10	101	23	66	1	72	-6	-3
20/21	1 44.6	28.55	1 47.4	29.10	12.0	2.75	3.00	17.49	17.51 to 23.44	95	83	100	1	70	-5	-3
25/26	1 40.2	28.15	1 43.0	28.30	11.9	2.79	2.94	17.25	17.59 to 23.18	89	147	73	1	68	-4	-3
30/31	1 36.6	27.39	1 39.4	27.54	11.8	2.82	2.88	17.01	18.07 to 22.54	83	138	25	2	66	-3	-2
February 2000																
4/ 5	1 33.7	27.08	1 36.5	27.23	11.8	2.86	2.82	16.39	18.15 to 22.31	78	83	0	2	64	-3	-2
9/10	1 31.5	26.40	1 34.3	26.56	11.7	2.89	2.76	16.17	18.23 to 22.09	72	27	19	2	62	-2	-2
14/15	1 29.9	26.17	1 32.7	26.33	11.6	2.93	2.69	15.55	18.32 to 21.49	67	55	73	2	61	-1	-1
19/20	1 28.8	25.59	1 31.6	26.14	11.5	2.95	2.63	15.35	18.41 to 21.29	61	122	100	2	59	-1	-1
24/25	1 28.2	25.44	1 31.0	25.59	11.5	2.98	2.57	15.14	18.50 to 21.11	56	157	71	2	57	0	-1
29/30	1 28.0	25.33	1 30.8	25.49	11.4	2.99	2.50	14.54	18.59 to 20.53	52	107	24	2	55	0	0
March 2000																
5/ 6	1 28.3	25.26	1 31.0	25.41	11.3	3.01	2.44	14.35	19.08 to 20.36	47	50	0	2	53	0	0
10/11	1 28.8	25.22	1 31.6	25.38	11.1	3.01	2.37	14.16	19.17 to 20.20	42	29	25	2	51	0	0
15/16	1 29.7	25.22	1 32.4	25.38	11.0	3.01	2.31	13.57	19.27 to 20.05	38	91	80	2	48	0	0
20/21	1 30.8	25.25	1 33.6	25.41	10.9	3.00	2.24	13.38	19.37 to 19.51	34	152	100	2	44	1	0
25/26	1 32.2	25.31	1 34.9	25.47	10.7	2.99	2.17	13.20	Not Observable	30	134	69	2	40	1	0
30/31	1 33.7	25.41	1 36.5	25.56	10.6	2.96	2.11	13.02	Not Observable	26	79	23	2	35	1	0

Name	Number	T	q	e	w	W	i	H1	K1	Epoch	Source
Encke	2P	2000 09 09.5774	0.338494	0.847319	186.4575	334.6644	11.7821	11.5	15.0	2000	MPC 29882
Faye	4P	1999 05 06.1057	1.656988	0.568176	204.9711	199.3387	9.0488	8.0	15.0	2000	MPC 27081
Tempel 2	10P	1999 09 08.4166	1.481682	0.522813	195.0202	118.2115	11.9766	5.0	25.0	2000	MPC 27082
Wolf	14P	2000 11 20.8442	2.413520	0.407166	162.2852	204.1226	27.5232	5.5	30.0	2000	MPC 29882
Holmes	17P	2000 05 11.7402	2.165760	0.412016	23.3132	328.0136	19.1871	10.0	15.0	2000	MPC 29881
Giacobini-Zinner	21P	1998 11 21.3102	1.033853	0.706413	172.5470	195.3981	31.8591	9.0	15.0	2000	MPC 25184
Schaumasse	24P	2001 05 02.7098	1.201191	0.705179	57.9695	79.8978	11.7485	6.5	35.0	2000	MPC 31663
Neujmin 1	28P	2002 12 26.5953	1.546777	0.776283	346.9495	347.0966	14.2111	8.5	15.0	2000	MPC 34424
Schwassmann-Wachmann 1	29P	2004 06 28.7540	5.722922	0.045958	48.1163	312.7827	9.3851	4.0	10.0	2000	MPC 23105
Schwassmann-Wachmann 2	31P	2002 02 01.5812	3.317290	0.210865	20.2774	116.6708	4.5026	5.0	20.0	2000	MPC 34422
Forbes	37P	1999 05 04.1994	1.446056	0.568187	310.7108	334.3676	7.1625	10.5	12.0	2000	MPC 34736
Ashbrook-Jackson	47P	2001 01 06.2265	2.306052	0.396414	348.7915	2.6156	12.5135	1.0	28.0	2000	MPC 31662
Arend-Rigaux	49P	1998 07 12.6344	1.368327	0.611749	330.5729	121.7166	18.2897	11.3	11.0	2000	unp
Arend	50P	1999 08 03.7727	1.916694	0.530353	48.9945	355.3828	19.1790	9.5	15.0	2000	MPC 27082
Kearns-Kwee	59P	1999 09 16.3118	2.339121	0.476616	127.4407	313.0374	9.3518	7.0	15.0	2000	unp
Shajn-Schaldach	61P	2001 05 08.6892	2.331759	0.389496	216.4913	166.8935	6.0837	6.0	25.0	2000	MPC 31664
Wild 1	63P	1999 12 27.4425	1.960852	0.649584	167.9993	358.5244	19.9345	10.5	15.0	2000	MPC 27082
Gunn	65P	1996 07 22.5910	2.455484	0.316527	196.3870	68.4234	10.3831	5.0	15.0	2000	MPC 29285
Kojima	70P	2000 09 14.5717	2.000570	0.456054	1.8348	119.4699	6.5992	11.0	15.0	2000	MPC 29882
Smirnova-Chernykh	74P	2001 01 15.2842	3.546660	0.147747	86.5770	77.1581	6.6524	5.0	15.0	2000	MPC 31662
West-Kohoutek-Ikemura	76P	2000 06 01.3353	1.595464	0.539773	0.0998	84.1394	30.4965	8.0	30.0	2000	MPC 29881
Longmore	77P	2002 09 08.4649	2.347062	0.352260	195.2669	15.4191	24.5370	7.0	20.0	2000	unp
Gehrels 3	82P	2001 10 08.1574	3.577178	0.133007	233.0125	240.5705	1.0910	5.0	20.0	2000	MPC 31664
Giclas	84P	1999 08 25.1320	1.845841	0.493638	276.4167	112.4905	7.2816	9.5	20.0	2000	MPC 27082
Bus	87P	2000 12 29.9216	2.181246	0.374570	24.1704	182.2068	2.5743	7.2	25.0	2000	MPC 29882
Howell	88P	1998 09 27.1974	1.404878	0.553112	234.8593	57.6574	4.3996	11.0	15.0	2000	MPC 31205
Kowal 1	99P	2007 01 29.5203	4.682179	0.228387	173.7062	28.7577	4.3920	4.5	15.0	2000	MPC 20775
Shoemaker 1	102P	1999 03 16.9129	1.979250	0.471443	18.6521	339.9646	26.2569	6.5	20.0	2000	MPC 27081
Schuster	106P	1999 12 16.2501	1.549644	0.587831	355.8708	50.5913	20.1381	14.0	12.0	2000	MPC 35815
Ciffreo	108P	2000 04 18.4830	1.713208	0.542378	358.0725	53.7239	13.0925	8.0	30.0	2000	MPC 29881
Hartley 3	110P	2001 03 22.7259	2.474659	0.314597	168.2260	287.8601	11.6835	1.0	30.0	2000	MPC 31663
Wiseman-Skiff	114P	2000 01 11.7424	1.569327	0.556643	172.8175	271.0819	18.2888	11.5	15.0	2000	MPC 35815
Wild 4	116P	1996 08 25.3348	2.091325	0.391650	173.6966	21.7035	3.7166	2.5	25.0	2000	MPC 30064
Helin-Roman-Alu 1	117P	1997 02 23.5198	3.649571	0.182802	211.8952	71.1679	9.8283	2.5	20.0	2000	MPC 27080
Mrkos	124P	1996 11 03.4790	1.456204	0.544941	181.3646	1.5067	31.4947	13.5	7.0	2000	MPC 34422
Shoemaker-Holt 1	128P	1997 11 20.8999	3.047821	0.321950	210.3539	214.5041	4.3617	8.5	10.0	2000	MPC 30632
Shoemaker-Levy 3	129P	1998 03 04.7160	2.816463	0.248257	181.3421	303.6882	5.0074	11.0	10.0	2000	MPC 30739
Kowal-Vavrova	134P	1998 11 18.7837	2.575233	0.586845	18.6919	202.2889	4.3455	11.5	10.0	2000	MPC 31205
Mueller 3	136P	1999 03 19.5151	3.009889	0.288880	225.3167	137.8842	9.4058	11.0	10.0	2000	MPC 31894
Shoemaker-Levy 2	137P	2000 02 05.8361	1.868613	0.579523	142.0203	234.7563	4.6569	11.0	10.0	2000	MPC 35208
Vaisala-Oterma	139P	1998 09 29.0523	3.382497	0.247905	165.6016	242.4648	2.3339	9.5	10.0	2000	MPC 33190
Machholz 2	141P	1999 12 09.2754	0.748955	0.751069	149.2984	246.1390	12.8119	12.0	30.0	2000	MPC 35815
Ge-Wang	142P	1999 06 21.4553	2.496374	0.500522	177.3784	177.1395	12.1724	8.5	15.0	2000	MPC 35815
Lovas 2	P/1986 W1	2000 03 11.6587	1.453989	0.592874	71.5222	283.5788	1.5289	8.5	25.0	2000	MPC 29881
Shoemaker-Levy 6	P/1991 V1	1999 05 02.3713	1.134488	0.705216	333.3565	37.8362	16.8921	13.0	15.0	2000	MPC 27081
Helin-Lawrence	P/1993 K2	2002 12 23.9267	3.106638	0.307052	163.9532	92.0218	9.8743	10.0	8.0	2000	MPC 34423
Kushida-Muramatsu	P/1993 X1	2001 05 01.6060	2.750059	0.276236	348.0177	93.7108	2.3670	5.5	20.0	2000	MPC 31663
Hale-Bopp	C/1995 O1	1997 04 01.0681	0.913511	0.994938	130.5540	282.3808	89.4248	-2.0	10.0	2000	MPC 35204
Jedicke	P/1996 A1	1995 08 14.7973	4.044195	0.436429	223.8664	249.1571	6.6290	7.0	10.0	2000	MPC 31893
Spacewatch	C/1997 BA6	1999 11 27.5730	3.436298	0.998951	285.9365	317.6682	72.7145	10.0	5.0	2000	MPC 35204
Mueller	C/1997 D1	1997 10 11.3744	2.248752	1.000210	185.0166	279.2356	141.8830	7.5	10.0	2000	MPC 30957
Montani	C/1997 G2	1998 04 16.4173	3.086254	0.993913	239.9035	55.7944	69.8471	8.5	10.0	2000	MPC 31347
Meunier-Dupouy	C/1997 J2	1998 03 10.4694	3.051925	1.001065	122.7019	148.8472	91.2282	3.5	10.0	2000	MPC 35204
Zhu-Balam	C/1997 L1	1996 11 22.3539	4.897335	0.996794	346.3019	233.3301	73.0162	6.5	10.0	2000	MPC 35205

Lagerkvist-Carsenty	P/1997 T3	1998 03	11.9670	4.241433	0.365277	334.3078	63.1974	4.8350	13.0	5.0	2000 MPC 35205
Larsen	P/1997 V1	1997 09	15.4668	3.295261	0.331746	132.9699	234.8323	12.0896	9.0	10.0	2000 MPC 31205
LINEAR	C/1998 G1	1998 11	16.6668	2.133627	0.823420	236.3467	341.3885	109.7090	13.0	5.0	2000 MPC 32168
SOHO	C/1998 J1	1998 05	08.6168	0.153214	1.000000	110.5409	351.6687	62.9296	8.0	10.0	2000 MPC 32168
Mueller	C/1998 K1	1998 08	31.8836	3.416155	0.944928	165.2163	18.2557	35.6380	7.5	10.0	2000 MPC 33451
LINEAR	C/1998 K2	1998 09	01.2407	2.324044	0.999165	221.4385	68.7733	64.4592	8.5	10.0	2000 MPC 35206
LINEAR	C/1998 M1	1998 10	28.2062	3.118612	0.992712	19.4342	256.0635	20.3844	8.0	10.0	2000 MPC 35553
LINEAR	C/1998 M2	1998 08	13.1981	2.725873	0.997526	37.2657	260.8742	60.1830	9.0	10.0	2000 MPC 35553
Larsen	C/1998 M3	1998 07	16.9763	5.767912	1.002391	20.8287	255.5389	113.4355	6.5	10.0	2000 MPC 34733
LINEAR	C/1998 M5	1999 01	24.5789	1.742282	0.996136	101.2870	333.3780	82.2264	6.0	10.0	2000 MPC 34733
Montani	C/1998 M6	1998 10	06.9775	5.979108	0.998977	9.1864	306.6071	91.5469	7.0	10.0	2000 MPC 33188
Williams	C/1998 P1	1998 10	17.8365	1.145590	0.999521	294.4218	156.3689	145.7238	7.5	10.0	2000 MPC 34420
LONEOS-Tucker	P/1998 QP54	1998 10	06.3551	1.881959	0.551579	30.0912	341.9253	17.7428	15.0	5.0	2000 MPC 33650
LINEAR-Mueller	P/1998 S1	1998 11	02.6555	2.548426	0.416134	26.3493	359.1788	10.5593	11.5	10.0	2000 MPC 33650
LINEAR	C/1998 T1	1999 06	25.2541	1.467727	0.999120	226.3556	153.3580	170.1599	8.0	10.0	2000 MPC 35206
LINEAR	C/1998 U1	1998 05	04.6925	3.995588	1.002001	125.2004	210.4832	156.5491	9.5	10.0	2000 MPC 33650
Jager	P/1998 U3	1999 03	10.0772	2.133877	0.648337	180.8984	303.5406	19.1403	6.5	10.0	2000 MPC 34421
Spahr	P/1998 U4	1999 02	26.8567	3.843253	0.310060	251.8049	181.7144	31.5183	8.0	10.0	2000 MPC 33857
LINEAR	C/1998 U5	1998 12	21.7592	1.236576	0.987943	51.1395	66.6505	131.7670	8.0	10.0	2000 MPC 35206
LINEAR	P/1998 VS24	1998 11	02.7833	3.405611	0.243381	244.5128	159.2034	5.0313	13.0	5.0	2000 MPC 33651
LINEAR	C/1998 W3	1998 10	06.6674	4.914775	1.000959	6.8811	123.9149	129.1854	6.0	10.0	2000 MPC 35207
Li	P/1998 Y2	1998 12	17.8376	2.518958	0.588367	318.9944	91.8304	24.3244	9.5	10.0	2000 MPC 34421
Tilbrook	C/1999 A1	1999 01	29.6554	0.730772	0.995937	232.6699	259.1205	89.4869	12.0	10.0	2000 MPC 33858
Li	C/1999 E1	1999 01	31.6503	3.919898	0.759963	329.7474	127.8337	46.8838	6.5	10.0	2000 MPC 34734
Catalina	C/1999 F1	2002 02	13.2059	5.779280	1.000427	255.2233	20.0347	92.0148	9.5	5.0	2000 MPC 34734
Dalcanton	C/1999 F2	1998 08	23.7502	4.718297	0.998254	352.3609	210.2976	56.4273	5.0	10.0	2000 MPC 35553
LINEAR	C/1999 G1	1998 07	31.8975	4.040296	0.845258	136.0063	23.4841	76.3160	7.5	10.0	2000 MPC 34734
Lee	C/1999 H1	1999 07	11.1720	0.708109	0.999754	40.6996	162.6490	149.3534	7.0	10.0	2000 MPC 35814
LINEAR	C/1999 H3	1999 08	18.2492	3.500825	1.002711	101.9143	332.7238	115.8403	5.0	10.0	2000 MPC 35814
Skiff	C/1999 J2	2000 04	06.1143	7.109991	1.000370	127.1462	50.0455	86.4110	2.0	10.0	2000 MPC 35814
LINEAR	C/1999 J3	1999 09	20.1671	0.976798	0.999366	161.9813	228.9777	101.6555	12.0	10.0	2000 MPC 35814
LINEAR	C/1999 J4	1999 11	17.6088	3.780400	1.000000	95.1591	264.4841	118.9108	11.5	5.0	2000 MPC 34734
LINEAR	P/1999 J5	1999 05	12.7811	3.712678	0.169506	132.2813	112.0141	13.7175	9.0	10.0	2000 MPC 35553
Ferris	C/1999 K2	1999 04	10.5708	5.290358	0.965850	4.5744	300.3189	82.1935	6.0	10.0	2000 MPC 35553
LINEAR	C/1999 K3	1999 02	27.5318	1.928788	0.991723	341.1496	266.9142	92.2749	12.0	10.0	2000 MPC 35207
LINEAR	C/1999 K5	2000 07	04.5754	3.254135	1.000000	241.5250	106.3811	89.4241	6.0	10.0	2000 MPC 35554
LINEAR	C/1999 K6	1999 07	24.6659	2.247014	0.993567	56.7598	245.3728	46.3447	11.0	10.0	2000 MPC 35814
LINEAR	C/1999 K8	2000 04	24.2737	4.200525	1.000278	164.6174	195.3917	52.7369	5.0	10.0	2000 MPC 35814
LINEAR	C/1999 L2	1999 08	04.8904	1.904759	0.995149	178.7186	94.2896	43.9424	13.0	10.0	2000 MPC 35208
LINEAR	C/1999 L3	2000 01	04.8415	1.990931	0.974707	353.2145	140.1537	166.0998	10.0	10.0	2000 MPC 35208
Lynn	C/1999 N2	1999 07	23.0505	0.761284	0.997459	357.8340	254.6757	111.6561	9.5	10.0	2000 MPC 35814
LINEAR	C/1999 N4	2000 05	25.5263	5.499088	1.000000	90.5786	345.8616	156.9162	6.0	10.0	2000 MPC 35814
LONEOS	P/1999 RO28	1999 10	02.3486	1.231198	0.648934	219.8711	148.4432	8.1736	20.0	5.0	2000 MPC 35814
McNaught-Watson	C/1999 S2	1997 11	25.4762	6.491126	1.000000	223.9176	74.4305	65.8207	2.0	10.0	2000 MPEC99T24
LINEAR	C/1999 S3	1999 11	09.0446	1.894413	0.898114	44.1394	11.8650	70.5358	10.0	10.0	2000 MPEC99T25
LINEAR	C/1999 S4	2000 7	24.4239	0.753678	1.0	151.4192	83.1934	149.4778	7.0	10.0	2000 MPEC99T26
McNaught-Hartley	C/1999 T1	2000 12	09.634	1.15380	1.0	345.173	181.735	79.094	5.0	10.0	2000 MPEC99T42
LINEAR	C/1999 T2	2000 11	24.6865	3.022536	1.0	104.9646	14.8207	110.9028	6.0	10.0	2000 MPEC99T64
1337 M1 = 1468 S1	P/	Unknown		0.8274	0.9684	94.7	105.6	138.0	3.5	10.0	2000 PASP

Source: CBAT web pages and Hasegawa & Nakano. H1 and K1 are also from the CBAT.

TA format (example)

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                        Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5   2               Shanklin
961214.70 S   3.8  AA   8   B       20  6      7/  0.50   40   Baroni
```

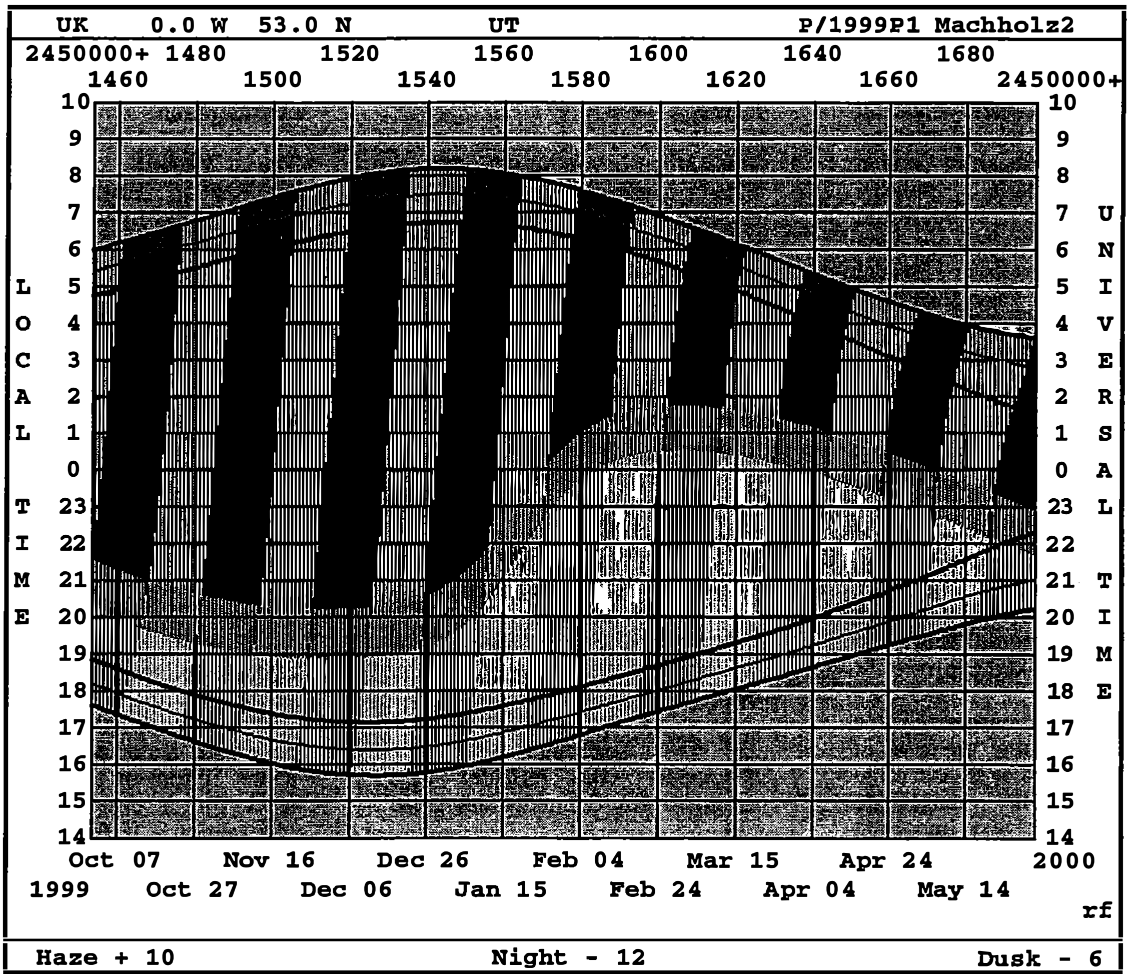
ICQ format (example)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC      m
 991992    1992  5 18.94  S  9.3 AA  7.5R     50   6    4        135 ICQ XX BEA
  P1955A1  1955  6 18.08     5.0 BD  5  R      6   5    s5    0.75 335 ICQ XX STO01
```

Charts

The diagram on this page shows when the moon interferes with observations of P/Machholz 2 and was produced using software written by Richard Fleet. There is no moon in the dark regions and the moon will interfere in the light regions. The comet is an evening object throughout the period.

The other comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet.



How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	[illegible]	[illegible]	[illegible]	[illegible]	Comments

THE COMET'S TALE

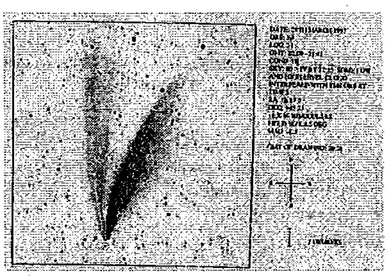
Newsletter of the Comet Section of the British Astronomical Association

Volume 7, No 1 (Issue 13), 2000 April

A Brief History of Comets II (1950-1993)

The following text is adapted from a major review on Comets, prepared by Michel C. Festou (Observatoire Midi-Pyrenees, Toulouse, France), Hans Rickman (Astronomiska Observatoriet, Uppsala, Sweden) and Richard M. West (European Southern Observatory, Garching, Germany) and published in the review journal Astronomy & Astrophysics Reviews (A&AR) (Part I, Vol. 4 pp. 363-447, 1993)

This is the second part of a brief historical review, covering the period from 1950 to 1993, i.e. until just before the crucial years 1994-1997 that saw the impact of Comet Shoemaker-Levy 9 on Jupiter (1994), the apparition of Comet Hyakutake that passed only 15 million km from the Earth (1996), as well as the bright Comet Hale-Bopp that was discovered in 1995 and put on a marvellous display when it passed perihelion in early 1997. It includes some references to major papers in this period (by author of year of publication), but the original version of this review in Astronomy & Astrophysics Reviews must be consulted for the full details about these.



Hale-Bopp 1997 March 28 Robert Bullen

Introduction The history of cometary astronomy is naturally divided into five major periods, the transitions being marked by important new insights. Before 1600, comets were essentially considered to be heavenly omens and were not yet clearly established as celestial (astronomical), rather than meteorological phenomena in the terrestrial atmosphere. Then followed two centuries of mostly positional measurements with emphasis on the motions and the orbits, lasting until the early 19th century, when the era of cometary physics was inaugurated, in particular by the passage of P/Halley in 1835. The next major step forward occurred in 1950 with the sudden emergence of the modern picture of comets as being essentially very old solar system objects made of primordial ice and dust, generally in unstable orbits and intensively interacting with the solar electromagnetic and corpuscular radiation. Finally, the space missions to P/Giacobini-Zinner in 1985 and especially to P/Halley in 1986 provided the first in situ observations of comets and dramatically widened our scientific horizon, but also posed many new questions which are yet to be answered.

1952 - 1984: The modern era Following the break-throughs in 1950-51, the entire concept about comets had to be revised. This process was a gradual one, as new observational facts were collected, and also because these observations were becoming increasingly quantitative, allowing a progressively more detailed verification of the new ideas. Although number density estimates for cometary comae had been derived since the time of Wurm's investigations in the 1930's, the figures obtained were rather uncertain and their reliability was limited by the lack of quantitative studies about the excitation mechanisms of the light. Thus it is not too surprising that, continuing the earlier investigations by Swings and McKellar, most spectroscopic studies between 1950 and 1970 were devoted to a never-ending attempt at discovering and identifying new emission lines and bands, as well as at unraveling the structure of the rotational and vibrational bands of the comet radicals and ions. A special reference must here be made to the numerous and important contributions from the Liege school, reviews of which are given by Swings (1956) and Arpigny (1965). During this epoch rather complete models were made of the fluorescence of the CN, CH, OH, and C2 radicals. The advent of high resolution spectroscopy in the late 1950's allowed the identification of many unknown lines, most of which were due to C2 and NH2. It is worth mentioning here that this effort has never been carried through to completion and many observed cometary spectral lines have still not been assigned an emitter; the most likely are CO+, CO2+ and C3 in the near-UV, C2 and NH2 in the optical and NH2 and H2O+ in the IR.

The following Sections, divided according to the main areas of investigative thrust during this period, illustrate how cometary research over the most recent decades has vindicated the ideas put forward in 1950-51.

Continued on page 4

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way. Renewals should be sent to the Director and cheques made payable to the BAA. Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

I write this introduction on my way home from Antarctica at the end of March. My visit this year was a relatively short one, and my work went very smoothly. With it approaching autumn in Antarctica the nights became darker and longer throughout my stay. Although a generally cloudy summer, we did have a few clear nights in which to experience the grandeur of the southern skies. Surprisingly light pollution is a problem about the station, as there are a number of badly designed floodlights which create considerable glare. However once you are over a bluff overlooking the station the skies are truly dark, the milky way is bright enough to cast shadows and on most moonless nights the faint glow of the diffuse aurora is visible to the south. Unfortunately there were no comets to observe, but I was able to spend time on the voyage north typing in the some more archival observations from TA for 1980 to 1989. This was over 2200 observations, bringing the total number up to over 28,000.

My success in discovering one SOHO comet was followed by two more before my departure for the Antarctic. The first of these was a faint non Kreutz group object, whilst the second was a moderately bright Kretuz group member. This discovery prompted Michael Oates to have a go and he soon spotted one, though it turned out to have already been discovered. Nothing daunted he has continued searching and has found several more, including a couple in archived SOHO observations. On my return from Antarctica I found another whilst in the process of compiling material for this issue of The Comet's Tale.

Comet LINEAR 1999 S4 offers the hope of a naked eye comet over the summer. Do make every effort to observe it, but when you send the observations up please try to submit them by email in either the ICQ format to me or the TA format to Guy. Try to get it exactly right as we both have more than enough to do without having to edit observations. There is a template for both formats on the section web page, so copy this if you are uncertain. Don't worry if you don't have email – paper copy is still acceptable, but send your observations to me as the program that I use to enter the archival data allows me to quickly enter more recent observations.

I hope to have the Section guide on comet observing reprinted during the autumn. If anyone has suggestions for additions or other improvements do let me know. The Tycho catalogue is the best source of magnitude information and this has recently been upgraded and now has fainter stars than in the first edition. I have added a section on reporting discoveries, as it is important to follow the correct steps if you think you have made one. I plan to drop the CCD and photographic reporting forms because no-one has ever used them.

I would like to develop a standard for submitting CCD images in order to make it easier to archive images from many observers. The standard needs to allow for the name of the comet, the name of the observer, the date and time of the image, the telescope and camera details, the scale of the image and different image types (gif, jpeg etc). It is good practice to include much of this information on the image, but if this is not possible an auxiliary file may be needed.

A possible suggestion would be to name image files as comet_yyyymmddl_obs.img and auxiliary files as comet_yyyymmddl_obs.txt, where comet is the comet identifier, yyyymmdd is the date, l the image number taken by the observer on that date, obs the first three letters of the observers surname, and img the image format. As an example 1999s4_19991128a_mob.jpg would be the first jpeg image that Martin Mobberley took of 1999 S4 on that date and if he felt that further information was needed there would be a supporting file 1999s4_19991128a_mob.txt. The second gif image of 141P/Machholz 2 by David Strange on the same date would be 141p_19991128b_str.gif. The advantage of the sequence comet_date_observer is that it allows sequential sorting. I have canvassed opinion from regular imagers, but other comments are welcome.

Since the last newsletter observations or contributions have been received from the following BAA members: Len Entwisle, Werner Hasubick, Guy Hurst, Nick James, Martin Mobberley, Michael Oates, Gabriel Oksa, Roy Panther, Jonathan Shanklin, David Storey, David Strange, Cliff Turk and Alex Vincent and also from: Jose Aguiar, Alexandr Baransky, Nicolas Biver, John Bortle, Jean-Gabriel Bosch, Reinder Bouma, Nicholas Brown, Paul Camilleri, Jose Carvajal, R Ferrando, Stephen Getliffe, Bjorn Granslo, Andreas Kammerer, Heinz Kerner, Atilla Kosa-Kiss, Martin Lehky, Rolando Ligustri, Maik Meyer, Antonio Milani, Andrew Pearce, Stuart Rae, San, Seg, Oddleiv Skilbrei and the Ageo Survey Team (KenIchi Kadota and Seiichi Yoshida) (apologies for any errors or omissions). Without these contributions it would be impossible to produce the comprehensive light curves that appear in each issue of *The Comet's Tale.*

Comets under observation were: 4P/Faye, 10P/Tempel 2, 37P/Forbes, 50P/Arend, 59P/Kearns-Kwee, 74P/Smirnova-Chernykh, 63P/Wild 1, 84P/Giclas, 106P/Schuster, 114P/Wiseman-Skiff, 141P/Machhol 2, 1995 O1 (Hale-Bopp), 1997 BA6 (Spacewatch), 1999 E1 (Li), 1999 H1 (Lee), 1999 H3 (LINEAR), 1999 J2 (Skiff), 1999 J3 (LINEAR), 1999 K8 (LINEAR), 1999 L3 (LINEAR), 1999 N2 (Lynn), 1999 S3 (LINEAR), 1999 S4 (LINEAR), 1999 T2 (LINEAR), 1999 T3 (LINEAR), 1999 U1 (Ferris), 1999 U3 (P/LINEAR), 1999 U4 (Catalina-Skiff), 1999 XS87 (P/LINEAR), 1999 Y1 (LINEAR).

Many of the fainter comets were observed by the AGEO team of KenIchi Kadota and Seiichi Yoshida who are using a CCD camera on an 18 cm reflector to very good effect. I hope to begin using the Cambridge Observatories 3-mirror telescope designed by Roderick Wilstrop for some astrometric and photometric observations over the coming months and so may be able to contribute some observations. Perhaps the Supernova searchers would like to add the odd comet to their list - they might discover one in outburst!

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, and BAA Journals Sky.

150 Years Ago: A large number of astrometric observations of Gambart's (Biela's) comet from the Cape of Good Hope were published in November. [Biela actually discovered it ten days before Gambart] T Maclear comments in his notes "This comet is perhaps the most interesting on record, on account of the appendage, which was probably a portion of the original mass." [The comet had split just before its 1845 return, and its next return was its final one, though remains were seen in the form of meteors for another 50 years or more.] In January a paper by J R Hind on the past history of Halley's comet was published. Here he traced past apparitions of the comet and made new links for several apparitions, including that of 1066. In March Mr Hind informed the Society about computations on the comet of 1264 and 1556 which was thought due to return. He had computed search ephemerides, but on hearing from Mr Hind that recent calculations suggested a delay in the return of several years, the Editor did not publish them. In April Norman Pogson gave a note about the comet observed by Pons in Marseilles in 1818. He noted that the elements computed from three positions were almost identical to those of a comet seen in 1772, which was supposed to have been that of Biela. [The comet of 1772 was Biela's, but that of 1818 was Crommelin's].

100 Years Ago: The November Journal has a note: Biela's Comet - The discovery of this comet was reported from Santiago, Chile at the end of October, but no confirmation has been obtained of the report, and no credence should be attached to it. In December John Tebbutt wrote to say that he had made astrometric measurements of 10P/Tempel 2 on 43 nights, which he hoped would be useful in determining the mass of the giant planet Jupiter. No 5 has a list of comets seen since 1889 compiled by A C D Crommelin. Interestingly only the periodic comets were "named". He did not include the comet seen at the total eclipse of 1893 April 16 as it was not seen again.

50 Years Ago: The December Journal includes a review of "Comets in Old Cape Records" by Donald McIntyre. At the January meeting Dr Merton spoke about comets. 1949 had been a quiet year, particularly the second half when only two observations were received. The March Journal has a paper on "The Statistics of Comet Orbits" by Harley W Wood. He concluded: 1) 77% of comets have parabolic orbits. 2) No comets have certainly hyperbolic orbits on approach to the Sun. 3) None have hit the Sun. [No longer true, I discovered another one that did shortly before I compiled these notes!] 4) The elements, particularly a and e are affected by planetary perturbations. 5) Comets are subject to wastage. 6) Their origin and history must account for the presence of volatiles.

A Brief History of Comets II (1950-1993)

Continued from Page 1

The ultraviolet, infrared and radio windows were explored in the early 1970's, the emissions of H I, O I and OH were observed and the dissociation products of the main volatile constituent of the nucleus were finally detected observationally. The first radar detection of a comet in 1980 (P/Encke, Kamoun et al. 1982), and the first recording of an image of a comet nucleus in 1986 convinced the last sceptics that Whipple was correct. From refined studies of the orbital motion of comets it was demonstrated that Oort's distant reservoir was fully justified, even though some shortcomings of the theory are only now being overcome and have led to new and exciting developments. Above all, however, a wealth of quantitative data became available, making truly comparative studies of comets possible. In a not too distant future this should enable us to learn whether the differences we observe between individual comets are the results of evolutionary processes or rather reflect intrinsic diversity.

Water as the main constituent of comets In 1958, high resolution spectroscopy allowed the separation of the terrestrial oxygen lines from the cometary ones and also led to the definitive confirmation of the presence of the isotopic lines of 13C, long suspected to be present in comets. The detection of the [O I] red lines in comet Mrkos (1957 V) (Swings and Greenstein 1958) created a completely new problem: it was soon shown by Wurm (1963) that if fluorescence is at the origin of the emission, then very large amounts of oxygen are implied, much larger than those of for instance C2. It seemed preferable to assume another emission mechanism and Wurm proposed corpuscular excitation. The idea that some coma species may be produced directly into an excited state can be traced back to McKellar (1943), but this suggestion was not explored in detail until 1964 (Biermann and Trefftz 1964). Their work led to the prediction that photodissociation of parent molecules is the main production mechanism and that not only oxygen but also hydrogen atoms must exist in large amounts in comets, with resulting production rates of e.g. log Q (mol s-1) ~ 30 for a bright comet, or much larger than those of the parents of CO+, CN or C2. In some sense, the discovery in 1970 by the Orbiting Astronomical Observatory (OAO-2) and the Orbiting Geophysical Observatory (OGO-5) of huge Lyman-alpha haloes of neutral hydrogen (1.5 x 107 km) around comets Tago-Sato-Kosaka (1969 IX) and Bennett (1970 II) did not come as a complete surprise. However, the origin of these hydrogen atoms was not yet known with certainty.

While the OH emission band at 3090 AA was first identified in comet Cunningham (1941 I) by Swings, the first quantitative OH abundance measurements only date from the early 1970's (Code et al. 1972; Blamont and Festou 1974; Keller and Lillie 1974). The analysis of the Lyman-alpha isophotes of comet Bennett (1970 II) revealed that the velocity of the H-atoms was about 8 km s-1 (Bertaux et al. 1973). Following an investigation of the photolysis of water molecules by sunlight, this led these authors to speculate about the possibility that the majority of the observed H-atoms were coming from the dissociation of OH radicals. To prove this assertion, Blamont and Festou (1974) measured both the then unknown scalelength of OH and the production rate of that radical in comet Kohoutek (1973 XII). They proposed for the first time, on a quantitative basis, that water was the parent of most of the hydrogen atoms and the OH radicals. Horst Uwe Keller and co-workers reached similar conclusions in a series of independent papers: Keller (1971) discussed the possibility that the observed H-atoms in comet Bennett might arise from the direct dissociation of water and later (Keller 1973a, 1973b) developed these ideas further. His investigation though, as well as that of Bertaux et al. (1973), was limited by the fact that the parameters governing the water photolysis were not well known at that time. Keller and Lillie (1974) also measured the scalelength of OH (in comet Bennett) and found a value in complete agreement with that found for comet Kohoutek. The definitive clue that H2O was the main source of both the H-atoms and the OH radicals came when the velocity of the H-atoms was measured directly from COPERNICUS observations (Drake et al. 1976) and, indirectly, from the analysis of H I Lyman-alpha observations (cf. the review by Keller 1976), and was found to be compatible with the water photolysis scheme. This was confirmed by the direct observation of water in P/Halley in 1986.

After the discovery of the 18 cm maser emission of OH (Biraud et al. 1974; Turner 1974), OH radio observations became routine and the evidence for the ubiquitous presence of water in comets was overwhelming. The emission of an unknown ion was observed in comet Kohoutek (1973 XII) by Herbig (1973) and Benvenuti and Wurm (1974). Herzberg and Lew (1974) had just obtained the first laboratory spectra of the H2O+ ion and tentatively identified this ion as the source of the new cometary emission. The same emission was later found in cometary spectra recorded as early as 1942 (Swings et al. 1943). Although the water ion might be an abundant species in comet tails, its presence there is not conspicuous: this is a clear indication that the ion is lost rapidly, unlike the other tail ions. Aikin (1974) showed that the main loss mechanism is a charge exchange reaction with water molecules leading to the formation of the H3O+ ion, and this latter is likely to be destroyed in electron recombination reactions. H3O+ was indeed found to be one of the main ions in the comae of P/Giacobini-Zinner and P/Halley.

Quantitative studies and comparative cometology Many parameters for the OH radical were derived from radio observations at 18 cm. The detailed mechanism by which comets emit photons at that wavelength was investigated by Despois et al. (1981). The methodology for determining OH velocity profiles was worked out by Bockeee-Morvan and Gerard (1984). An overview of the production rate and velocity determinations is given by

Bockelee-Morvan et al. (1990). Beginning with comet Bradfield (1979 X), a long series of high quality observations of the UV spectrum of comets was obtained by the International Ultraviolet Explorer (IUE), from which a self-consistent set of water production rates was derived (e.g. Festou and Feldman 1987). The radio and UV determinations of these rates do not agree perfectly, because the models used in the interpretation of the data differ markedly. Schloerb (1988) and Gerard (1990) have discussed this problem.

The 1970's saw the development of quantitative observations of comet emissions, mainly by means of narrow-band photoelectric filter photometry through diaphragms encompassing a more or less large part of the coma. A review of the early observations and the observing techniques is given by A'Hearn (1983). One of the shortcomings of standard photoelectric photometry is the contamination by an underlying continuum and by gaseous emissions in the wings of the spectral transmission curve defined by the filter. It was therefore not surprising that spectrophotometry developed rapidly in the early 1980's when linear detectors and image intensifier tubes became available; see the review by A'Hearn (1982). This method provided both a good separation of the band or line emissions and also spatially well-resolved information about the distribution of coma species. In parallel, numerous theoretical studies, aimed at calculating the fluorescence efficiencies of the coma radicals and ions, resulted in the establishment of reliable conversions of observed surface brightness into column densities of the different species. The last step in the data analysis process is then the derivation of gas production rates.

The data accumulated during the last 20 years or so by many dedicated observers, using both ground- and space-based instruments, have made possible the comparison of the relative abundances in comae of different comets. As direct sources of detailed information and for additional references on this subject as well as the radio OH measurements quoted above, we refer the reader in particular to the papers by A'Hearn and Millis (1980), Cochran (1987), Newburn and Spinrad (1989) and Osip et al. (1992). A list of all individual observations made with the IUE until late 1989 and a discussion of the resulting comparative cometology have been published by Festou (1990). The most striking observational fact is that, at first sight, all comets look alike (Cochran 1989). There are just a few well-known objects for which the chemical composition of the coma departs notably from that of an average comet, e.g. a few CO+ rich comets or those that seem to contain only one or a few of the actual compounds of comet comae. For instance, P/Giacobini-Zinner is C2 and C3 depleted (Cochran 1989), while comet Yanaka (1988 XXIV) seems to be made almost exclusively of NH2 and water (Fink 1992). As suggested by the direct inspection of optical (Swings 1948) and UV spectra (Festou 1990b), the main difference between individual comets is the continuum to gas emission ratio. Observations of P/Halley in 1986 added an interesting piece to the puzzle: CO and some other observed gases require an extended source in the coma. A key issue is now to determine the relationship between this source and the dust particles. The general picture beginning to emerge is that all comets basically have similar molecular abundances and that the observed differences might only reflect a variable dust to gas production ratio. It remains to be determined whether this ratio is an intrinsic property or the result of an evolutionary (i.e. ageing) process.

Dynamical evolution From the point of view of cometary dynamics, the modern era is first of all distinguished by the advent and development of efficient and powerful computers. This allowed, for the first time, extensive numerical simulations of the orbital evolution resulting from repeated close encounters with Jupiter and other planets. It also revolutionized the work on orbit determination and linkage of past apparitions for observed comets as well as the preparation of ephemerides for upcoming apparitions, even for long-lost comets.

Whereas Oort had been working on a small sample of comets to build his theory, Marsden et al. (1978) improved the earlier statistics by using 200 well-determined long-period orbits. They found a concentration of inverse semimajor axes corresponding to an average aphelion distance of about 45,000 AU, only about half as remote as Oort's original distance. A major problem remained the apparent overabundance of Jupiter family comets. Edgar Everhart (1972) found a possible route of direct transfer from the Oort cloud via Jovian perturbations at repeated encounters with the planet, beginning with a special type of initial orbits with perihelia near Jupiter's orbit and low inclinations. However, some authors questioned the efficiency of this transfer or the fit of the orbital distribution of the captured comets. An alternative scenario came from orbital integrations of the observed comets by Elena I. Kazimirchak-Polonskaya (1972): the comets might not be captured by Jupiter alone, but rather by a stepwise process involving all the giant planets.

The ideas about the long-term dynamics of the Oort cloud evolved considerably. While passages of individual stars were mostly considered in earlier investigations, the tidal effects of the Galaxy as a whole, preliminarily modelled by Chebotarev (1965), have become recognized in recent years as the prime mechanism to provide new comets from the outer cloud. The dramatic effects that might follow upon close encounters with massive perturbers, such as giant molecular clouds (Biermann and Luest 1978), also received a great deal of attention. In particular, the question of the stability of the outer, classical regions of the Oort cloud over the age of the solar system has been debated.

A major step forward taken during this period dealt with the modelling of nongravitational effects in cometary motions. Based on Whipple's concepts, Brian Marsden (1969) introduced a nongravitational force into the Newtonian equations of motion with simple expressions for the radial and transverse components in the orbital plane. These involved a function of the heliocentric distance r expressing a standard 'force law', multiplied by a coefficient whose value was determined along with the osculating orbital elements by minimizing the residuals of the fit to positional observations. The radial coefficient was called A1 and the transverse A2. It was realized that the model might not be physically realistic and that more meaningful parameters might be derived from a generalized formalism, but attempts in this direction were not successful (Marsden 1970). The final update of the model was made in 1973 (Marsden et al. 1973), stimulated by calculations of the H2O sublimation rate as a function of r (Delsemme and Miller 1971). This was taken as the model force law, expressed as an algebraic function g(r) whose parameters were chosen to fit Delsemme and Miller's results. Eventually more realistic models were constructed for the jet force as resulting from asymmetric H2O outgassing, including the heat flow in the surface layers of the nucleus (Rickman and Froeschle 1983). As a result it was found that the true force law might be very different from the g(r) formula, and hence there should be room for an improved model.

The long-term variations of the nongravitational forces were found to involve a wide range of behaviour. Thus the well-determined A2-values found over different periods of time for the same comet usually vary in a more or less regular fashion, often including changes of sign. This was generally interpreted in terms of spin axis precession, which in turn may be caused by the torque associated with the jet force of outgassing. An early suggestion of such a scenario was made for P/Kopff (Yeomans 1974). Quantitative models were first derived by Whipple and Zdenek Sekanina (1979) to fit the secular decrease of the nongravitational perihelion shift of P/Encke. These models, and similar ones developed later on for a number of other comets (Sekanina 1984-85; Sekanina and Yeomans 1985), led to predictions of some physical parameters of the nuclei - in particular, the orientations of the spin axes. They treated the jet force in a physically more realistic way than the g(r) formula. However, the results were still dependent on model assumptions and thus questionable (cf. Sekanina 1988).

Cometary origin The introduction of the basic concepts of the Oort cloud and the icy conglomerate nucleus have naturally influenced modern ideas about the origin of comets. Oort (1950) already paid attention to the problem of formation of the cloud and hypothesized that it could have originated as a result of Jovian perturbations after the explosion of a planet-sized body in the asteroid belt. Thereby the asteroids and comets would have a common origin, the former being devolatilized variants of the latter. However, this revival of Olbers' old idea did not gain wide acceptance, partly due to the growing evidence that meteorites, obviously part of the same complex of minor bodies, have nearly solar elemental abundances and can not originate from a planet-sized parent body.

Around 1950, the Kant-Laplace nebular hypothesis for the origin of the solar system was also reconsidered in the light of the chemical compositions of the planets and their variation with heliocentric distance. Edgeworth (1949) and Gerald P. Kuiper (1949, 1951) argued that it is unlikely for the solar nebula to have ended abruptly at the position of Neptune's orbit, and thus a large population of planet precursors with a generally icy composition would have existed outside the giant planets. Kuiper (1951) claimed that such bodies could be identified with Whipple's cometary nuclei and suggested that Pluto's gravitational action (its mass was then thought to be in the 0.1 - 1 Earth-mass range) might have scattered the objects into Neptune's zone of influence, whereupon ejection into the Oort cloud would ensue. In particular, outside Pluto's orbit, the population might still remain intact.

During the following decades, Lyttleton (1952, 1974) challenged both basic concepts (the solid nucleus and the Oort cloud), arguing instead for cometary formation by aggregation of dust during the Sun's passages through interstellar clouds. Cometary origin thus would not be coupled to the origin of the solar system but to capture events throughout its lifetime. This scenario never received as much support as the one due to Kuiper, since it faced obvious difficulties, e.g. in explaining the cometary 1/aorig distribution and nongravitational effects. As both Oort's and Whipple's concepts have been consolidated in recent years, the basis for Lyttleton's picture has now virtually disappeared.

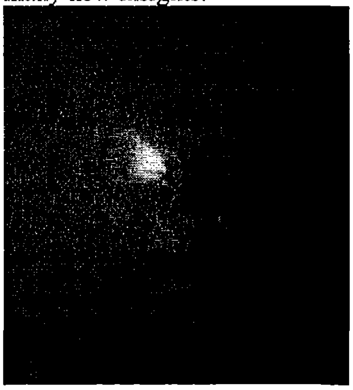
However, the idea of interstellar comets embraces many different scenarios that are subject to continued investigations. Aspects that have attracted particular attention are the distribution of aphelion directions of long-period comets and the possible signature of the solar apex, the mechanisms for formation of cometary nuclei under interstellar cloud conditions, the role of comets in galactic chemical evolution, and the significance of the fact that no hyperbolic comets have as yet been observed.

The standard concept of the solar nebula was criticized by Alfven and Arrhenius (1970, 1976), who argued for the importance of electromagnetic forces in the collapsing cloud, leading to a different picture of the radial arrangement of orbiting material and a different scenario for the accretion of larger bodies. In particular, the formation of comets was considered to occur by longitudinal focussing produced by self-gravitation and inelastic collisions in narrow streams of particles, so-called jet streams. This idea has not gained general acceptance, however. An eruptive origin of comets continued to attract attention as well. Van Flandern (1977, 1978) proposed, based on the distribution of orbits of long-period comets, that comets and asteroids originate from the break-up of a 90 Earth-mass planet in the asteroid belt only 5.5 x 10^6 years ago. This suggestion did not gain support, mainly on physical grounds (see the discussion following Van Flandern 1977). It was in stark disagreement with the picture building up during the 1970's and 80's, according to which minor bodies in general, and comets in particular, represent undifferentiated, pristine solar system material (Delsemme 1977). Sergej K. Vsekhsvyatskij (1972, 1977) continued to favour a variant of the Lagrange ejection hypothesis, involving the satellites of the giant planets, but he remained quite isolated in a community dominated by the view of comets as primordial bodies probing the solar nebula. The idea is fraught with many problems of different nature - let us mention here only that of explaining the abundance of long-period comets.

1985 - 1986: Encounters with P/Giacobini-Zinner and P/Halley Following the enormous increase of interest for comets in the late 1970's, another giant leap in our understanding of comet phenomena occurred in March 1986 when six spacecraft (henceforth `S/C') observed P/Halley in situ, and future cometary scientists will undoubtedly speak about the pre- and post-Halley eras, much as historians describe the transition from the dark ages to the renaissance period. However, the first cometary encounter took place already six months earlier on September 11, 1985, when the ISEE-3 spacecraft, released from its earlier task of monitoring the Earth's radiation belts and, renamed as the International Cometary Explorer (ICE), passed through the tail of P/Giacobini-Zinner, about 8000 km from the nucleus. The main results were the confirmation of the plasma tail model, indications about the ion composition and the detection of a neutral current sheet at the center of the tail. ICE flew on to register the effects of P/Halley on the interplanetary medium from a distance of 28 x 10^6 km sunward.

The detailed results from the extraordinary P/Halley campaign during the 1985-86 apparition fill many volumes - it will here suffice to give a very condensed overview of the main results.

Five spacecraft encountered P/Halley in early 1986: Vega 1 (closest approach on March 6 at 8890 km distance), Suisei (March 8; 150,000 km); Vega 2 (March 9; 8030 km), Sakigake (March 11; 7 x 10^6 km) and Giotto (March 14; 600 km). At the same time, an unequalled long-term Earth-based observational effort was coordinated by the International Halley Watch (IHW) (Newburn and Rahe 1990); the IHW Archive with more than 25 Gbytes of data was released in December 1992 (IHW 1992) and the associated Summary Volume (Sekanina and Fry 1991) contains detailed information about the data obtained within the various IHW Networks. The observations were carried out in all wavebands from the UV at 120 nm to the radioband at 18 cm, by professionals and amateurs. It has proven particularly fruitful to combine space- and Earth-based observations for calibration and long-term monitoring purposes. In general, the earlier developed cometary models were confirmed and could now be quantified by in situ measurements, leading to many new insights.



Comet Halley's Nucleus. Credit: Halley Multicolour Camera Team, Giotto, ESA ©: MPAE

The nucleus was observed at close distance for the first time; it was found to be larger (equivalent radius about 5.5 km) and darker (albedo about 4 percent) than expected. Surface features (craters, ridges, mountains etc.) and the emitting vents were observed. The coma was found to be highly structured on all scales (jets, shells, ion streamers, etc.) and the gaseous component (parent molecules, radicals, ions and atomic species) was analyzed in situ; H2O was confirmed to be by far (about 85 percent by weight) the most abundant constituent in the gas phase. A cavity devoid of magnetic field was detected within about 5,000 km of the nucleus. The dust was analyzed by size and composition; there was an unexpectedly high fraction of very small grains, down to the sensitivity limit (about 10^{-19} kg). In addition to those of possibly chondritic composition, carbonaceous `CHON' particles were seen for the first time; they may be a new source of gas. Atomic masses from 1 to 100 amu. were detected by mass spectroscopy, and the likely presence of large organic polymeric molecules was indicated. The maximum measured production rates were larger than 10^4 and about 3 x 10^4 kg/sec for dust and gas, respectively, i.e. a dust/gas ratio larger than 0.3. The integrated mass loss experienced by the nucleus at this passage, of the order of about 4 x 10^{11} kg (but very uncertain) was about 0.5 percent of the total mass of the nucleus, estimated at 1 - 3 x 10^{14} kg. The brightness of the central condensation appears to be varying with pseudo-periods of about 2 and 7 days, but it was not possible to determine unambiguously the rotational state of the nucleus. The various predicted plasma effects were confirmed, including the existence of a bow shock and the adjacent interplanetary medium was found to be kinematically and magnetically extremely turbulent. Several disconnection events in the ion tail were observed, also at the time of the encounters, and the suspected connection with magnetic field reversals was partly confirmed.

1986 - 1993: P/Halley follow-up Much of the period after the Halley encounters has been spent reducing the enormous amount of data on this comet. Ground-based observations of a number of other bright comets, including Wilson (1987 VII), Austin (1990 V), P/Brorsen-Metcalf (1989 X) and Levy (1990 XX), have served for comparison and have also resulted in several important discoveries, for instance of some new parent molecules, e.g. H2CO, H2S and CH3OH. Thanks to improved instrumentation and reduction techniques, it has become possible to observe fainter and more distant comets than ever before. To some surprise it has been found that several comets continue to be active many years after perihelion passage, in some cases at heliocentric distances well beyond 10 AU; this has implications for the models of the nuclei.

Another space encounter with a comet took place on July 10, 1992, when the Giotto spacecraft flew through P/Grigg-Skjellerup during the Giotto Extended Mission (GEM), cf. Schwehm and Grensemann (1992). A preliminary overview of some of the early results was published by Boehnhardt et al. (1992). The foremost virtue of GEM has been to provide direct comparison between a very active and a supposedly less active comet and to search for the underlying causes. However, P/Grigg-Skjellerup was found to be at least as active as expected, and the first presence of cometary ions was detected at a distance of about 6 x 10^5 km, while a magnetic disturbance resembling a bow shock or wave was passed at about 1.5 x 10^4 km distance. A few dust impacts occurred just after the closest approach which took place at about 200 km from the nucleus.

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

The following abstracts (some shortened further for publication) are taken from the Cambridge Conference Network (CCNet), which is a scholarly electronic network devoted to catastrophism, but which includes much information on comets. To subscribe, contact the moderator Benny J Peiser at <b.j.peiser@livjm.ac.uk>. Information circulated on this network is for scholarly and educational use only. The abstracts, taken from daily bulletins, may not be copied or reproduced for any other purposes without prior permission of the copyright holders. The electronic archive of the CCNet can be found at http://abob.libs.uga.edu/bobk/ cccmenu.html

Companion to comet Grigg-Skjellerup discovered using Giotto data? (ESA Press Release)

On 13/14 March 1986, the European Space Agency's Giotto spacecraft obtained the first close-up pictures of a comet nucleus during its close flyby of Halley's Comet. An historic second comet encounter followed on 10 July 1992 when Giotto flew within 200 km of Comet Grigg-Skjellerup.

Seven years later, continuing analysis of data from Giotto's Energetic Particle Detector (EPONA) has led to the conclusion that a second comet, possibly a fragment of the main nucleus, may have been accompanying Grigg-Skjellerup. The new results have been obtained by Professor Susan McKenna-Lawlor, the Irish Principal Scientific Investigator for the EPONA instrument, and Russian scientist Dr. Valeri Afonin. Their discovery is based on fluctuations in the energetic particle data recorded by EPONA.

One of the most important aspects of the Grigg-Skjellerup encounter was that it enabled scientists to use the same instruments to compare the fairly inactive Grigg-Skjellerup with Comet Halley, its much larger, more active cousin. A number of experiments on board Giotto were functioning during both encounters.

One of these was EPONA, which has the capability to record charged particles -- protons and heavier ions -- with energies ranging from several tens of keV to several tens of MeV. Characteristic fluctuations in the energetic particle records allowed EPONA to detect the same cometary boundaries at Halley and Grigg-Skjellerup as Giotto's other particles and fields experiments.

Recent, detailed analysis of EPONA data by McKenna-Lawlor and Afonin, (described in the journal Planetary and Space Science Vol. 47, p. 557-576 and Circular No. 7243 Central Bureau for Astronomical Telegrams IAU, 1999 August 25), has revealed a complex particle enhancement in the energy range 60-100 keV. This increase was recorded by EPONA some 90,000 km beyond Grigg-Skjellerup. Several possible explanations for this flux enhancement were considered, but the overall conclusion was that it constituted the signature of a 'companion' comet, three to four times smaller than Grigg-Skjellerup and with a correspondingly lower gas production rate. It is unlikely that these two objects have existed side by side from the beginning of their existence. A more probable explanation is that the smaller object broke away from Grigg-Skjellerup shortly before the Giotto encounter. Splitting of cometary nuclei is a well known phenomenon that can occur even at large distances from the Sun.

200 TRANSNEPTUNIAN OBJECTS Brian G. Marsden Harvard-Smithsonian Center for Astrophysics (CfA), Cambridge, Massachusetts, U.S.A.

Hard on the heels of the announcement last week of the discovery of the 200th potentially hazardous asteroid, the announcement was made today of the discovery of the 200th member of the Transneptunian Belt. Also known as the Kuiper Belt or the Edgeworth-Kuiper Belt, the Transneptunian Belt is a collection of bodies orbiting the sun generally at distances somewhat larger than that of Neptune.

As with the PHA discoveries, the rate of TNO discoveries has increased very dramatically recently. Fully half of the TNOs have been found during just the last 12 months, with the first discovery having been in 1992 or 1930, according as to whether one does not or does choose to consider Pluto to be a member. Whether one does or does not include Pluto does not affect today's milestone, because the seven new objects being announced take the count well over 200.

While the rate of new TNO discoveries is gratifying, this greatly increases the problem of obtaining enough follow-up observations to ensure a reliable prediction for the next opposition--and then ensuring that recovery observations are then made. Some 61 percent of the TNOs with an opportunity so far for recovery have in fact been observed at a second opposition. Such success is actually quite encouraging, given that the observations at the discovery opposition have often been extremely meagre, and that the orbit solutions are almost invariably complete guesswork. Although a second opposition is necessary for a reliable orbit determination, it is hardly sufficient, and continued occasional monitoring is very much in order. The recent recovery announcement of 1998 UU43 consisted of data on two consecutive nights last week of an object observed last year on one night in October and another in December. At least one of the presumed multiple-opposition TNOs, 1995 YY3, now appears to be lost.

It has been usual to separate the TNOs into two principal groups, namely, what are called the "classical Kuiper Belt objects", or "cubewanos" (this name arising from the designation 1992 QB1 of their prototype), with orbits of rather low eccentricity (though with inclinations up to 30 degrees or so) and mean distances between 42 and 47 AU from the sun (Neptune being at a distance of 30

AU); and the "plutinos" (Pluto itself being the prototype), their mean distances of 39 AU giving them orbits having revolution periods that are three-halves that of Neptune, this resonance in fact preventing close approaches to Neptune, even though orbital eccentricities up to more than 0.3 mean that these objects can cross Neptune's orbit. Almost 50 percent of the objects with good orbit determinations are cubewanos, and almost 40 percent are plutinos. It also seems that 5 percent or so have revolution periods that are twice that of Neptune, so they have mean distances of 48 AU, the rather large orbital eccentricities again allowing these objects to approach Neptune's orbit--but not Neptune itself. There are also a couple of resonant objects with revolution periods that are four-thirds and five-thirds that of Neptune.

The remaining well-observed TNO, 1996 TL66, ranges in distance between 35 AU and 135 AU from the sun. There are certainly other objects of this type, sometimes called "scattered-disk objects", although only four of the single-opposition objects, all of them discoveries in February 1999, have officially been assigned scattered-disk orbits. It is highly probable that several of the lost TNOs are actually in this category--which would help explain why they are lost, because scattered-disk status would very considerably augment the amount of sky needed to be searched to guarantee their recovery.

One can argue that the count of PHAs is arbitrary because the rules defining a PHA are also arbitrary. But we can at least be sure that the accepted PHAs meet those rules. Given that only 34 percent of the currently known TNOs have been observed at more than one opposition, we cannot really provide a satisfactory definition for a TNO that we can guarantee will be met by the majority of the objects that have been classed as TNOs. Certainly, we seem to be on reasonably firm ground when it comes to the established cubewanos and plutinos (and also perhaps the other resonant objects), but beyond that there is a problem.

Part of the problem is that there is at some level really no dynamical distinction between a scattered-disk object and a centaur. A centaur is an object that in some way moves in the general range of the giant planets. Although Chiron, which in 1977 was the first such discovery, currently moves rather neatly between the orbits of Saturn and Uranus, close approaches to these planets can change this. But half of the 16 objects classified as centaurs actually have their farthest points from the sun beyond the orbit of Neptune--i.e., into the domain of the TNOs. One of these objects, 1995 SN55, is currently well beyond Neptune, at 39 AU from the sun. Its classification as a centaur is quite arbitrary, and it could equally well be classified as a TNO: it is probably not a plutino or other "regular" TNO, but it could easily have been classified as a scattered-disk TNO. So if we are going to consider scattered-disk objects as part of the TNO population, we really should also include at least part of the centaur population.

The combined population therefore has well over 200 members--more than 220 if all the centaurs are included. Then there is the recent 1999 TD10, which we know to be currently just beyond the orbit of Saturn, well inside the "centaur region", but that at its farthest from the sun is quite akin to 1996 TL66 and the other scattered-disk objects. It is "both" a centaur and a TNO, but it is currently being classified as neither.

Finally, there is the matter of the comets. We know that Chiron shows cometary attributes, and it is classified both as a centaur, with the asteroid number (2060), and a comet, with the designation 95P/Chiron. It is widely believed that the centaurs and TNOs generally are protocomets. There are other comets, such as 29P/Schwassmann-Wachmann 1 and 39P/Oterma, with current orbital characteristics that could also allow them clearly to be classified as centaurs. Furthermore, less than half a century ago, the orbit of 39P/Oterma, then inside the orbit of Jupiter, was much like those of many of the other short-period comets, notably, D/1993 F2 (Shoemaker-Levy 9), the string of objects that crashed into Jupiter in 1994.

So we can indeed celebrate and claim that today we acquired our 200th known TNO. But we don't know what that means.

A Progress Report on the Lincoln Near Earth Asteroid Research Project R. M. Elowitz, G. H. Stokes, M. Bezpalko, M. S. Blythe, J. B.. Evans, E. C. Pearce, R. W. Sayer, F. C. Shelly, H. E. M. Viggh (MIT Lincoln Laboratory)

The Lincoln Near-Earth Asteroid Research (LINEAR) project is a MIT Lincoln Laboratory effort cooperatively sponsored by the United States Air Force Office of Scientific Research (AFOSR) and the National Aeronautics and Space Administration (NASA). The objective of the LINEAR project is to substantially contribute to the NASA goal of cataloguing 90 percent of the Near Earth Asteroids (NEAs) with sizes larger than 1 km, within the next 10 years.

Since March 1998, the LINEAR project has been hosted on a 1-meter telescope located at the Lincoln Laboratory Experimental Test Site (ETS) on the White Sands Missile Range near Socorro, New Mexico. Beginning in October 1999, the LINEAR system added a second 1-meter telescope to routine operations, thus doubling the search capacity. Each telescope is equipped with a large format 2560x1960 back-illuminated frame-transfer CCD along with associated camera/processing elements developed by MIT Lincoln Laboratory for United States Air Force space surveillance applications. Since March of 1998, LINEAR has contributed 70% of the world wide discoveries of NEAs. As of January 1, 2000 the LINEAR project has discovered 74 Potentially Hazardous Asteroids (also referred to as PHAs), 22 Atens, 150 Apollos and 140 Amors. In addition, LINEAR has discovered 33 comets since the project began [I made it 35], and the first two asteroids with retrograde orbits that show no indication of cometary activity. Future plans for the LINEAR project include further automation of operations and processing enhancements that will increase the already impressive discovery rate of the LINEAR program.

NASA BEGINS BUILDING NEXT MISSION TO STUDY COMETS (NASA Press Release)

NASA's Comet Nucleus Tour, or CONTOUR, mission took a giant step closer to its launch when the project received approval to begin building the spacecraft. Planned for a July 2002 launch, CONTOUR is expected to encounter Comet Encke in November 2003 and Comet Schwassmann-Wachmann-3 in June 2006. The mission has the flexibility to include a flyby of Comet d'Arrest in 2008 or an as-yet undiscovered comet, perhaps originating from beyond the orbit of Pluto. Such an unforeseen cometary visitor to the inner solar system, like Comet Hale-Bopp discovered in 1995, would present a rare opportunity to conduct a close-up examination of these mysterious, ancient objects which normally reside in the cold depths of interstellar space.

RADAR OBSERVATIONS OF COMETS J. K. Harmon, D. B. Campbell, S. J. Ostro, M. C. Nolan: PLANETARY AND SPACE SCIENCE, 1999, Vol.47, No.12, pp.1409-1422

Seven comets have been detected by Earth-based radars during the period 1980-1995. All but one of these gave a detectable echo from the nucleus, while three of the comets also showed a broad-band echo from large (similar to cm-size) grains in the inner coma. Although all observations have been of the CW (continuous-wave) type, which precludes direct size measurement, the radar cross sections are consistent with nucleus diameters averaging a few kilometers and varying over a range of ten. Comparisons with independent size estimates indicate relatively low radar albedos, implying nucleus surface densities of 0.5 to 1 g/cm(3). The surfaces of comet nuclei appear to be as rough as typical asteroid surfaces, but are considerably less dense. Analysis of coma echoes indicates that some comets emit large grains at rates (similar to ton/s) which are comparable with their gas and dust production rates. There is also some indirect evidence for grain evaporation or fragmentation within a few hundred to a few thousand kilometers of the nucleus. The highest priority of future radar observations will be to obtain delay-Doppler images of a nucleus, which would give direct size and shape estimates as well as a more reliable albedo. Delay-Doppler or interferometric imaging of the coma echo would also help to better characterize the grain halo. Ten short-period comets are potentially detectable during the next two decades, although the best radar opportunities may well come from comets yet to be discovered.

R.R. Weissman: **Diversity of comets: Formation zones and dynamical paths.** SPACE SCIENCE REVIEWS, 1999, Vol.90, No.1-2, pp.301-311

The past dozen years have produced a new paradigm with regard to the source regions of comets in the early solar system. It is now widely recognized that the likely source of the Jupiter-family short-period comets (those with Tisserand parameters, $T > 2$ and periods: P, generally < 20 years) is the Kuiper belt in the ecliptic plane beyond Neptune. In contrast, the source of the Halley-type and long-period comets (those with $T < 2$ and $P > 20$ years) appears to be the Oort cloud. However, the corners in the Oort cloud almost certainly originated elsewhere, since accretion is very inefficient at such large heliocentric distances. New dynamical studies now suggest that the source of the Oort cloud comets is the entire giant planets region from Jupiter to Neptune, rather than primarily the Uranus-Neptune region, as previously thought. Some fraction of the Oort cloud population may even be asteroidal bodies formed inside the orbit of Jupiter. These comets and asteroids underwent a complex dynamical random walk among the giant planets before they were ejected to distant orbits in the Oort cloud, with possible interesting consequences for their thermal and collisional histories. Observational evidence for diversity in cometary compositions is limited, at best.

NEW ORBIT VISUALISATION TOOL ONLINE

A new Orbits section has been added to JPL's Near-Earth Object home page. The highlight is a cool visualization tool. It is an interactive 3D orbit viewer written in Java, and you can view the orbit of any asteroid or comet. You can rotate the orbits around and zoom in, move around the solar system and "play" the orbits backwards and forwards like a movie. It resides at:

http://neo.jpl.nasa.gov/orbits

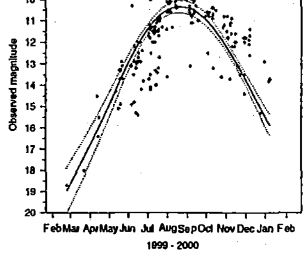
You'll have to select an object of interest first, by either entering the asteroid/comet's name (wildcards are allowed), or making a selection from the table of Potentially Hazardous Asteroids provided.

Review of comet observations for 1999 October - 2000 March

The information in this report is a synopsis of material gleaned from IAU circulars 7281 – 7399 and The Astronomer (1999 October – 2000 March). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

4P/Faye was observed by the AGEO team of Seiichi Yoshida and KenIchi Kadota by CCD in November when it was 16th magnitude.

10P/Tempel 2 continued to fade, and was generally too far south for observation from the UK. It was last seen in early January at 14th magnitude. Overall the comet was well observed, however there is considerable scatter in the observations.



The preliminary uncorrected light curve m = 5.4 + 5 log d + 32.3 log r is only a fair fit to the 200 observations.

A couple of further observations of **50P/Arend** were received, but the comet was never brighter than 14th magnitude. At its best ever return the comet reached a similar magnitude and this apparition was not a good one.

59P/Kearns-Kwee had a rather unfavourable return and was another comet which didn't become brighter than 14th magnitude. It was around this brightness during the autumn.

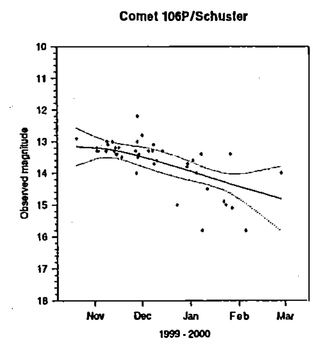
63P/Wild 1 Nakano reported observations made by T. Kojima, Chiyoda, on October 24.83 of this 13-year-period comet, missed at its 1986 return. These observations confirm a single-night detection at mag 22.4 by Hergenrother (1.5-m Catalina reflector) on February 14. The prediction on MPC 27082 requires correction by Delta T = -0.35 day. Further details were given on MPEC 1999-V18. Kojima (0.25-m f/6.3 reflector) reported the comet at m1 = 16.5 and as diffuse without a tail on October 24, at ml = 15.9 and diffuse with condensation and a coma diameter of 30" on November 4. [IAUC 7302, 1999 November 6]. The comet brightened and reached 12th magnitude in January. Moving south, it was lost to view from the UK, but Southern Hemisphere observations continued. The 25 observations received so far give a preliminary light curve of m = 10.6 + 5 log d + 7.5 log r, however the fit to the observations is not good.

Close encounters with Jupiter in 1955 and 1963 changed the orbit of **74P/Smirnova-Chernykh** drastically and it was discovered in 1975, though it had been earlier given the minor planet designation 1967 EU. For a few years around 2025 it will be captured by Jupiter and then a further encounter with the planet at the end of the century will move the perihelion distance outside that of Jupiter. Due to the low eccentricity of its orbit the comet is visible even at aphelion but it is faint at about magnitude 16. At this return it doesn't reach perihelion until January 2001, however the AGEO team are imaging it and it has reached 15th magnitude.

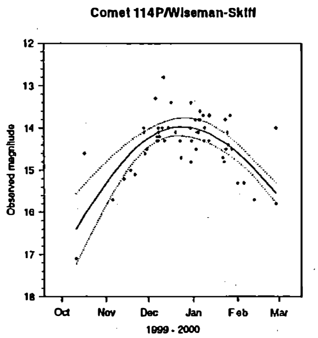
76P/West-Kohoutek-Ikemura makes a close approach to Mars on June 5, passing only 0.043 AU from the red planet. The apparition is not a good one for earth based observers, but if we were on Mars the comet would be around mag 7.5 in a dark sky, although very close to Jupiter and Saturn. From Earth it is nine magnitudes fainter and not surprisingly is close to Mars, which is at an elongation of only 7° from the Sun.

84P/Giclas made its fourth observed return since its discovery in 1978 by Henry Giclas of the Lowell Observatory. The perihelion distance is fairly constant at present and Jupiter encounters only make significant changes to the angular elements. However around 2300, a low velocity close encounter with Jupiter will transfer the comet to an orbit outside that of the planet. It was yet another faint comet, which perhaps reached 14th magnitude in the autumn.

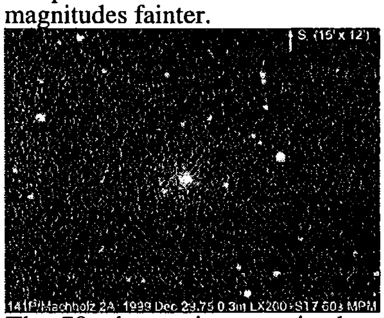
106P/Schuster was discovered in 1977 October at La Silla, though a month earlier it had been recorded as an asteroid. It was not seen at its second return, which was unfavourable. The orbit is relatively stable. This was its third observed return and it remained at 13th - 14th magnitude from late October into January. The light curve is indeterminate from the observations received so far.



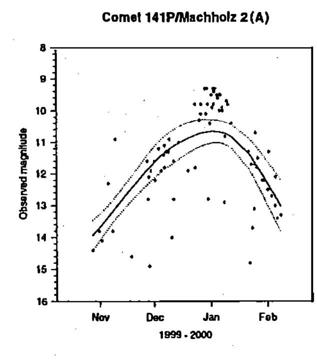
114P/Wiseman-Skiff had a favourable apparition and also reached 14th magnitude in December and was still this bright in January. The 55 observations give an uncorrected preliminary light curve of m = 8.9 + 5 log d + 28.9 log r.



141P/Machholz 2 (1999 P1) put on a disappointing performance and never reached the brightness achieved at the last return. This was not entirely unexpected as the comet had fragmented last time round and this undoubtedly boosted its performance. It was never well placed from the UK and was difficult to observe. Two components were recovered. Component A peaked at 9th magnitude in early January and component D was at least two magnitudes fainter.

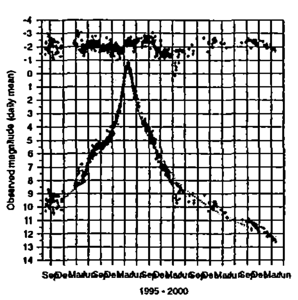


The 79 observations received so far give a preliminary, uncorrected light curve of m = 13.6 + 5 log d + 11.8 log r.



Hale-Bopp (1995 O1) is still being observed from the Southern Hemisphere, but it will soon be too faint for further visual observation. The observed arc now covers 1712 days with observations made on 796 days. The equation -0.64 + 5 log d + 7.53 log r fits the aperture corrected daily means very well, but there are long period variations about this mean light curve of around a magnitude, which are shown plotted with an offset of -2. It is currently close to the value indicated by the equation.

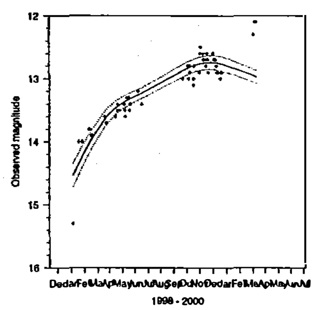
Comet Hale-Bopp (1995 O1)



The residuals on the fitted curve are shown above.

Spacewatch (1997 BA6) reached perihelion at 3.4 AU in late November and as expected was around 12th magnitude. First observed visually in 1998 December it will be around for most of this year, but only for Southern observers. The comet is currently a little brighter than expected from the uncorrected preliminary light curve, which was a good fit to m = 4.5 + 5 log d + 10.0 log r from 68 observations.

Comet Spacewatch (1997 BA6)



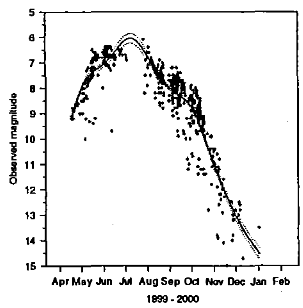
Only a few further observations of **LINEAR (1998 M5)** were received as the comet faded past 15th magnitude. The observations give an uncorrected preliminary light curve of 6.0 + 5 log d + 10.2 log r

The AGEO team made a couple of further observations of **1999 E1 (Li)** as it faded.

1999 H1 Lee reached peak brightness in early October, but became markedly harder to observe later in the month. The comet continued to fade and was last seen in early January by Andrew Pearce.

546 observations give an uncorrected preliminary light curve of 6.7 + 5 log d + 11.5 log r

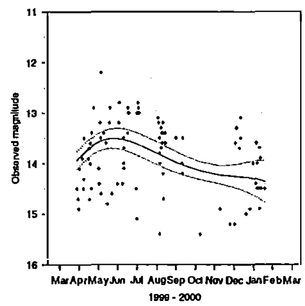
Comet Lee(1999 H1)



1999 H3 LINEAR is in a distant parabolic orbit and hasn't become much brighter than 13m. It was in conjunction with the sun during November and December, albeit at an elongation of 40° and therefore fairly difficult to observe. It faded rapidly during the early spring as its distance from Earth increased.

100 observations give a somewhat indeterminate uncorrected preliminary light curve of -1.1 + 5 log d + 21.9 log r

Comet LINEAR (1999 H3)

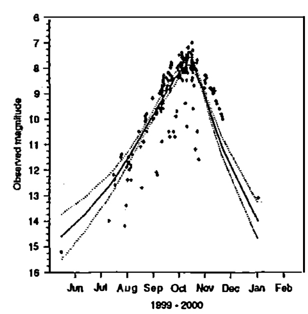


1999 J2 Skiff is slowly fading and has now reached 16th magnitude.

1999 J3 LINEAR peaked in brightness at around 7m in mid October. Thereafter it faded and was last seen in late November by Andrew Pearce at 10th magnitude in 20x80B.

197 observations give an uncorrected preliminary light curve of 9.0 + 5 log d + 11.8 log r

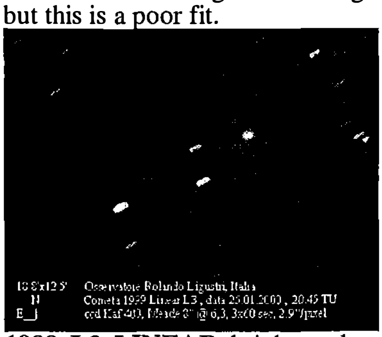
Comet LINEAR (1999 J3)



1999 J6 was a SOHO comet (SOHO-109), though not a member of the Kreutz group and was discovered by Michael Oates on 2000 March 20 using archival images on the SOHO website.

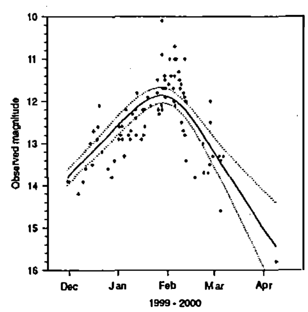
Scattered observations of **1999 K8 LINEAR** have continued, with observers estimating it at around 14th magnitude. Reaching perihelion in April, it will continue to be observable for some time.

49 observations give an uncorrected preliminary light curve of -1.4 + 5 log d + 18.7 log r but this is a poor fit.



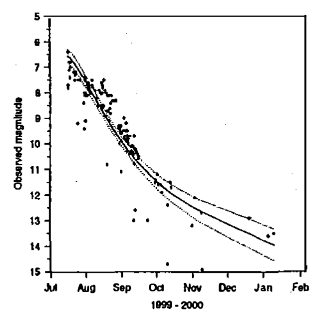
1999 L3 LINEAR brightened to within visual range at the end of November. It peaked at around 11th magnitude in early February, with several observers following it.

Comet 1999 L3 (LINEAR)



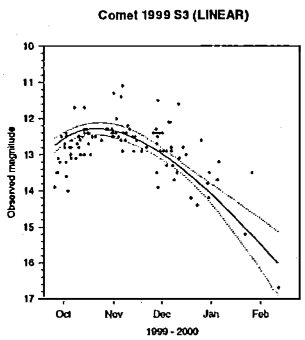
1999 N2 Lynn became difficult to observe after late Autumn, but became better placed as its elongation increased in the new year. Observations by Jonathan Shanklin suggested a magnitude around 13 in early January, but no other observers reported seeing it.

Comet Lynn (1999 N2)

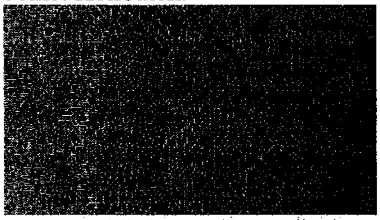


150 observations give an uncorrected preliminary light curve of 8.6 + 5 log d + 7.7 log r

1999 S3 LINEAR reached around 12th magnitude in November and early December and was quite well followed. The preliminary light curve from 106 observations is m = 0.7 + 5 log d + 39.8 log r

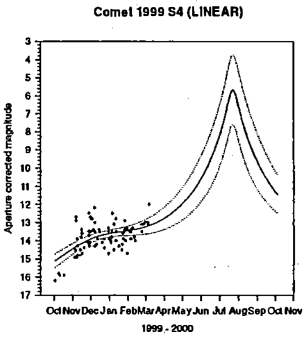


1999 S4 LINEAR has brightened quite slowly, which seems to be a feature of 'new' comets. Astrometric observations show that it is making its first visit to the inner solar system and may well behave in a similar fashion to comet Kohoutek.



Comet 1999 S4 Linear in field of UGC 1233 (mag 14.6) 2000 Jan 23 1932h U.T. 8x40 sec 50 cm f/4 + SXF CCD D. Strange Worth Hill Observatory Dorset U.K.

It is currently in conjunction, but after conjunction it should brighten rapidly and will become visible in the northern sky. The best fit light curve prior to conjunction, using observations corrected for aperture is m = 8.5 + 5 log d + 5.9 log r. This suggests that it could reach at least 5^m, and the first observations after conjunction will be important in making the final predictions. The light curve shows the observations and the range of possible extrapolation. At its best the comet could have a tail a few degrees long.



1999 T1 McNaught-Hartley Robert H. McNaught, Research School of Astronomy and Astrophysics, Siding Spring Observatory, reported his discovery of a 15th magnitude comet on a plate taken by Malcolm Hartley with the 1.2-m U.K. Schmidt Telescope on October 7.64. The strongly condensed comet showed a 8" coma and a very faint 1' tail in p.a. 320°. Additional astrometry was published on MPEC 1999-T42. I. P. Griffin, Auckland Observatory, reported a condensed coma of diameter 7" on CCD exposures taken on October 11.4 UT (0.5-m telescope). A. Becker and C. Stubbs, University of Washington; and J. Perez, Cerro Tololo Interamerican Observatory (CTIO) noted a tail in p.a. 328° on a CCD exposure taken with the CTIO 0.9-m telescope on Oct. 11.19. [IAUC 7273, 1999 October 11].

This comet may reach binocular brightness, though there are insufficient observations to make an accurate prediction. Initially at far southern declinations it will come within range of large apertures in July and binoculars in October. It moves far enough north for observation by UK observers in December when it reaches perihelion and moves through Hydra, Virgo and Libra.

1999 T2 LINEAR F. Shelly reported the discovery by LINEAR of an 18th magnitude comet on October 14.16. Additional observations were reported following posting on the NEO Confirmation Page [IAUC 7280, 1999 October 14]. The 7 observations suggest that the absolute magnitude is around 5.5, but don't place any constraint on the slope parameter. The comet will reach perihelion in November 2000 and may reach 13th magnitude or a little brighter, in the late summer.

1999 T3 LINEAR Linkage at the Minor Planet Center of observations by LINEAR on several nights during October 3.34 - 21 revealed an 18th magnitude object with a nearly-parabolic retrograde orbit. This orbit also represented a single-night detection of an object by E. W. Elst and S. Ipatov at Uccle on October 18. Following placement of an ephemeris on The NEO Confirmation Page further observations were made on October 24 and 25. In response to enquiries, Elst remarked that the object was diffuse and had a possible tail to the north; J. Ticha and M. Tichy, Klet, reported the object as slightly more diffuse than stars of comparable brightness and deduced a coma size of 9"; and D. Durig, Sewanee, TN, in poor conditions (strong wind, full moon), also noted the object's diffuse appearance. [IAUC 7289, 1999 October 25]. The comet is a distant one and will not get any brighter.

A/1999 TD10 Details of a distant asteroid discovered by Spacewatch on October 3.19 were announced on MPEC 1999-T46 [1999 October 11], with further observations and a new orbit given on MPEC 1999-V07 [1999 November 2]. The 19th magnitude asteroid is in an unusual high eccentricity orbit, which has perihelion at 11.6 AU, and a nominal semi-major axis of 155 AU giving a period of 1900 years.

1999 U1 Ferris LONEOS (0.59-m Schmidt + CCD) reported the discovery of a 17th magnitude comet on October 18.38. Additional observations were reported following posting on the NEO Confirmation Page [IAUC 7283, 1999 October 18]. The comet was at perihelion last year and will fade.

1999 U2 SOHO Doug A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reported observations of a comet (not a Kreutz sungrazer) discovered independently by S. Gregory (Stanford University) and by J. D. Shanklin (Comet Section, British Astronomical Association) in SOHO/LASCO C3 data. The comet is very faint, and not visible in very many frames. It was first visible on October 25.21 and remained visible until October

25.74. [IAUC 7292 and MPEC 1999-U29, 1999 October 28] I made the co-discovery on October 26.35.

1999 U3 P/LINEAR R. Huber reported the discovery by LINEAR of an 18th magnitude comet on October 30.32. Additional observations were reported following posting on the NEO Confirmation Page [IAUC 7295, 1999 October 31]. It is past perihelion and will fade from 16th magnitude.

1999 U4 Catalina-Skiff On October 31 T. B. Spahr, Lunar and Planetary Laboratory, reported the discovery by the Catalina Sky Survey on October 31.25 of a slow-moving 17th magnitude object that was independently discovered on November 1.28 by B. A. Skiff (measurer B. W. Koehn) of the LONEOS survey. In response to Skiff's alert, R. L. Millis and L. H. Wasserman, on a 5-min R-band exposure with the Perkins 1.8-m reflector, detected a coma extending 8" southeastward from the nucleus. After a posting in The NEO Confirmation Page, M. Tichy and Z. Moravec, Klet, also reported that the object had an 8" coma [IAUC 7298, 1999 November 1]. The object is very distant, but could brighten to 14th magnitude when at perihelion in 2001.
4 observations received so far give an uncorrected preliminary light curve of 4.6 + 5 log d + [10] log r

A/1999 UG5 Details of another unusual asteroid, discovered by the Catalina sky survey on October 29.25, were given on MPEC 1999-V09 [1999 November 3]. This 18th magnitude object has a perihelion distance of 6.6 AU and a period of 65 years.

1999 V1 Catalina C. W. Hergenrother, Lunar and Planetary Laboratory, reported the discovery of another comet of 18th magnitude by the Catalina Sky Survey on November 5.44. [IAUC 7302, 1999 November 7] The comet is close to perihelion and in a distant orbit. It will remain at a similar brightness until early next year, then fade.

1999 WJ7 P/Korlevic An apparently asteroidal 18th magnitude object discovered on November 28.94 by Korado Korlevic at Visnjan with a 0.41-m f/4.3 reflector + CCD was indicated on some of his December images to be possibly "fuzzy", and the cometary nature has been confirmed by C. Hergenrother and S. Larson, Lunar and Planetary Laboratory, who found a 13" coma elongated in p.a. 80 deg on a 600-s co-added R-band exposure taken on 2000 Feb. 7.25 UT with the 1.54-m Catalina reflector. The comet has a perihelion distance of 3.2 AU and a period of ten years. [IAUC 7368, 2000 February 18]

P/1999 X1 Hug-Bell Amateurs Gary Hug and Graham E. Bell, Eskridge, KS, reported their discovery of a 19th magnitude comet on December 10.33, showing a faint tail in p.a. 285° on CCD images taken with a 0.3-m Schmidt-Cassegrain reflector during the course of their minor planet search and follow up program. Following posting on the NEO Confirmation Page, L. Sarounova (Ondrejov, 0.65-m reflector) obtained observations on December 11.2 UT showing a tail 20" long in p.a. about 300°. C. Hergenrother, Lunar and Planetary Laboratory, reports that a co-added 1200-s R-band image obtained with the 1.54-m Kuiper telescope on December 11 shows a 15" coma and a slightly curved tail 1' long in p.a. 280°. All of the available astrometry (including prediscovery observations on October 10 and December 7 by LINEAR) gives elliptical orbital elements, with perihelion in 1999 June and a perihelion distance of 1.9 AU. [IAUC 7331, 1999 December 11]. The comet will fade.

A/1999 XS35 Details of another unusual asteroid, discovered by the LONEOS program on December 2.42, were given on MPEC 1999-X19 [1999 December 9]. This 17th magnitude object has a perihelion distance of 0.95 AU and a period of 79 years. The orbit approaches very close to the Earth at the ascending node, so the object is classed as a PHA. The orbital miss distance is only 0.008 AU from the Earth and the asteroid passed this point only 2.9 days ahead of the Earth. If it produced a meteor shower, slow meteors would have been seen by Southern Hemisphere observers on or around November 11.1, with a radiant point of RA 17h 55m, Dec -70. Next year the shower would be expected around November 10.3.

1999 XB69 P/LINEAR An apparently asteroidal, 18th magnitude object discovered by LINEAR on December 7.29, with a cometlike orbit has been observed by C. Hergenrother, Lunar and Planetary Laboratory, on February 27 with the Catalina 1.54-m reflector to show a 5" coma and a 10" tail in p.a. 80°. The comet is intrinsically faint, with a perihelion distance of 1.6 AU and a period of 9.4 years. [IAUC 7370, 2000 February 29]

1999 XS87 P/LINEAR An object that was assumed to be asteroidal was found by LINEAR on 1999 December 7.38 and 8, and it was later linked to observations by LINEAR on 2000 January 6 and 7 by G. V. Williams, Minor Planet Center. Following a request from the Minor Planet Center after seeing that the orbit appeared comet-like, M. Tichy and Z. Moravec obtained observations at Klet on January 11 and 12 that showed this object to be diffuse with a coma diameter of 15". [IAUC 7344, 2000 January 12] The comet is in a long period orbit (73 years) and was at perihelion in 1999 August at 2.8 AU.

1999 XN120 P/Catalina An apparently asteroidal, 17th magnitude object discovered on December 5.19 by the Catalina Sky Survey, with a cometlike orbit was also observed by Hergenrother on February 27 with the 1.54-m reflector to show a 12" coma but no tail. The comet has a perihelion distance of 3.29 AU and a period of 8.5 years. [IAUC 7370, 2000 February 29]

1999 Y1 LINEAR A 17th magnitude object with unusual motion and reported as asteroidal by LINEAR on December 20.22 was found to be cometary in appearance following posting on the NEO Confirmation Page. Z. Moravec, Klet, reported that the object appeared slightly diffuse with a possible coma of diameter about 10" on images taken in poor seeing on December 21 and 22. G. Billings, Calgary, AB, reported an apparent nebulosity of diameter about 12" on December 23 CCD images taken with a 0.36-m reflector, and he noted a faint tail about 20" long in p.a. 70° on December 27. S. Nakano, Sumoto, Japan, reported that H. Abe (Yatsuka, 0.26-m reflector) found the comet to be evidently diffuse, T. Kojima (Chiyoda, 0.25-m reflector) found a 10" coma and a short tail toward the northeast, and T. Oribe (Saji Observatory, 1.03-m reflector) found a 20" coma and a 30" tail in p.a. 60°, all on December 27. A. Nakamura, Kuma, Japan, found coma diameter 0'.35 and a faint tail in p.a. 60° on December 27 (0.60-m reflector). The initial orbit is parabolic with perihelion in March 2001. [IAUC 7338, 1999 December 27] The comet could reach 13th mag at the end of the year.

1999 Y2 SOHO Kazimieras Cernis, Vilnius, Lithuania, discovered an apparent comet at magnitude about 5 on SOHO images taken on 1999 December 28.28 that were posted on the SOHO website. D. A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reported that the comet was visible on both LASCO C2 and C3 images and that no tail was detected. Astrometric measurments by Biesecker and D. Hammer (University of Maryland), reduced by Marsden, appeared on MPEC 2000-A36, together with parabolic orbital elements (q = 0.048 AU, i = 111.4 deg), showing that the comet is not a Kreutz sungrazer. Magnitude reductions by Biesecker and Hammer show that the comet faded from magnitude 6.1 to 6.8 during December 28.58-28.79, and thence from view while still in the C3 field. [IAUC 7343, 2000 January 10]. The comet should have still been brightening at this point, implying that its volatiles had probably been exhausted.

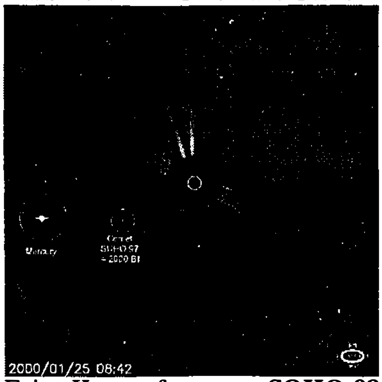
Kazimieras provided the following information about the discovery: I discovered this comet due to your two discoveries and information which helped me for looking at CCD images. The object at C2 was difficult for detecting at 1024x1024 too. I say that because I detected independently SOHO-94 with a bright tail after A. Vourlidas without problem on December 21. C/1999 Y2 was without tail and its brightness was similar to Sgr24 in orange filter (about 5 mag). Then I discovered SOHO-95 at C3 images (from December 27 23 hours) and sent more than 20 positions to B. Marsden. D. Biesecker did not reply me for 6 days. It was a holidays. If the comet has absolute magnitude about 18, it could be detectable with CCD in the evening sky as 15.5 mag with elongation about 40 deg these days before bright moonlight coming.

1999 E2 SOHO (IAUC 7377, 2000 March 09)
1999 O1 SOHO (IAUC 7367, 2000 February 15)
1999 O2 SOHO (IAUC 7376, 2000 March 07)
1999 O3 SOHO (IAUC 7376, 2000 March 07)
1999 P3 SOHO (IAUC 7367, 2000 February 15)
1999 P4 SOHO (IAUC 7376, 2000 March 07)
1999 P5 SOHO (IAUC 7376, 2000 March 07)
1999 Q1 SOHO (IAUC 7376, 2000 March 07)
1999 Q2 SOHO (IAUC 7376, 2000 March 07)
1999 Q3 SOHO (IAUC 7376, 2000 March 07)
1999 R3 SOHO (IAUC 7376, 2000 March 07)
1999 R4 SOHO (IAUC 7383, 2000 March 17)
1999 S5 SOHO (IAUC 7383, 2000 March 17)
1999 S6 SOHO (IAUC 7383, 2000 March 17)
1999 S7 SOHO (IAUC 7383, 2000 March 17)
1999 U5 SOHO (IAUC 7386, 2000 March 24)
1999 W1 SOHO (IAUC 7386, 2000 March 24)
1999 Y3 SOHO (IAUC 7386, 2000 March 24)
2000 B1 SOHO (IAUC 7349, 2000 January 24)
2000 B5 SOHO (IAUC 7386, 2000 March 24)
2000 B6 SOHO (IAUC 7386, 2000 March 24)
2000 B7 SOHO (IAUC 7386, 2000 March 24)
2000 C6 SOHO (IAUC 7364, 2000 February 12)
2000 D1 SOHO (IAUC 7370, 2000 February 29)
2000 D3 SOHO (IAUC 7386, 2000 March 24)
2000 E1 SOHO (IAUC 7376, 2000 March 07)
2000 F1 SOHO (IAUC 7393, 2000 April 04)

were discovered with the SOHO LASCO coronographs and have not been observed elsewhere. They were sungrazing comets of the kreutz familly and were not expected to survive perihelion. Some of these comets show no tail at all and it is possible that some supposed observations of Vulcan were actually tiny Kreutz group comets.

SOHO 74 (1999 O1) and SOHO-76 (1999 P3). D. A. Biesecker, SM&A Corporation and Goddard Space Flight Center, repored measurements of two apparent Kreutz sungrazing comets (both tailless) discovered with the LASCO C3 coronagraph aboard SOHO on 1999 July 31.51 and August 3.24 [IAUC 7367, 2000 February 15]. 1999 O1 was found by T. Lovejoy in movies posted at the SOHO website. 1999 P3 was found by D. Lewis.

I discovered **SOHO-97 (2000 B1)** on January 24. I had to leave work early on January 24 in order to pick up my car which had been in for servicing (an expensive business as several repairs were needed) and went straight home afterwards as it was clear and I wanted to grab a bite to eat before it got dark. I then cycled out to the Cambridge Observatories and got out the great Northumberland refractor at around 17:50. I observed 141P/Machholz 2 (a bit iffy at 13^m), 114P/Wiseman-Skiff (glimpsed with averted vision at 14^m) and 1999 S4 (LINEAR) (not seen and [13.8). I could see clearly several galaxies catalogued at 13^m. I also observed a few binocular variables and then thought about going bell-ringing (one of my other hobbies) at 19:30, though as the practice started at 19:00 I would be late. However, I decided to have a quick look at the SOHO images first on the IOA Starlink system. As soon as the java loop had downloaded it was obvious that a Kreutz fragment was heading in towards the sun. I immediately emailed Doug and Brian Marsden, though this one was so obvious that I was sure there would have been prior claims. It turned out that there weren't and Doug posted the discovery on his web page and quickly got the positions for Brian to compute the orbit, which appeared on IAUC 7349 at 23:10. The comet peaked in brightness at around 5th magnitude on the morning of January 25, and began to grow a tail, but also to fade. It disappeared from the C3 frames but a ghostly image was visible for a couple of hours on the C2 frames between 16:06 and 18:30.



Faint Kreutz fragment **SOHO-98 (2000 B6)** was discovered by Maik Meyer on January 29, however an independent discovery was made by Michael Oates of the SPA on January 30. He had heard a talk that I gave on January 29 about my discovery of SOHO-97 and decided to try it himself. He wasn't aware of the real time movie loops and so downloaded individual high resolution frames and made a movie himself. Looking at the sequence he spotted the moving image of the Kreutz fragment, however he was beaten to it by Maik Meyer. Terry Lovejoy also spotted the object. I was quite surprised therefore to get some credit on IAUC 7386 as I thought that I had only confirmed the discovery.

SOHO-99 (2000 B7) was also discovered by Maik Meyer, and almost simulataneously by Terry Lovejoy.

Three more comets, including SOHO-100 were discovered between February 3 and 5, moving in similar trajectories diagonally across the upper left quadrant. There seems to be a swarm of these objects, with a fourth discovered by Michael Oates and visible on the C2 images from 18:54 - 20:44 on February 7.

SOHO-104 (2000 C6) was a Kreutz fragment discovered by Terry Lovejoy on February 9. **SOHO-105 (2000 D3)** was another Kreutz fragment.

SOHO-106 (2000 D1) D. A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reports observations of an evident Kreutz sungrazing comet with a tail discovered by D. Lewis in SOHO/LASCO C3 data on February 28.57. Biesecker provides apparent magnitudes brightening from V = 7.4 +/- 0.2 on Feb. 28.971 to 5.8 +/- 0.1 on Feb. 29.404 UT. [IAUC 7370, 2000 February 29]

SOHO-107 (2000 E1) D. A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reports that several people browsing the SOHO Web site (including M. Meyer, M. Boschat, T. Harincar, and M. Oates) noted another Kreutz sungrazing comet in SOHO LASCO data on March 4.40. Observed in both the C2 and C3 telescope data, this object showed a tail of length about 10'. [IAUC 7376, 2000 March 7]
On the same IAUC Biesecker also reported observations (measures by D. Hammer and himself, reductions by B. G. Marsden) of some older Kreutz sungrazing comets seen in SOHO C3 data; full astrometry and parabolic orbital elements appear on the MPECs indicated below. Comet C/1999 O2 developed a short tail, C/1999 O3 had a short tail evident, C/1999 Q3 showed a tail, and C/1999 R3 showed evidence for a tail; the other four comets showed no evident tail. Comets C/1999 O2 and C/1999 P4 were discovered by D. Lewis, C/1999 P5 by A. Vourlidas, C/1999 Q2 and C/1999 R3 by K. Schenk, and C/1999 Q3 by Biesecker, while comets C/1999 O3 and C/1999 Q1 were first noted by T. Lovejoy via the SOHO Web page.

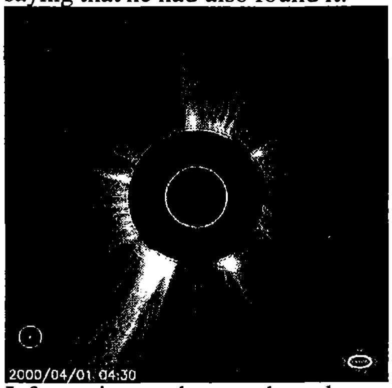
SOHO-108 (1999 E2) D. A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reported that M. Oates, Manchester, England, found another Kreutz sungrazing comet in archival SOHO LASCO C3 Web data from **1999** March 2.51. [IAUC 7377, 2000 March 9]

On IAUC 7383 [2000 March 17], D. A. Biesecker reported observations (measures by D. Hammer and himself, reductions by B. G. Marsden) of four more tailless, Kreutz sungrazing comets seen in SOHO C3 data, during 1999 September, which were discovered by K. Schenk, except for C/1999 R4, which was first noted by T. Lovejoy via the SOHO Web page.

On IAUC 7386 [2000 March 24] D. A. Biesecker reported observations (measures by D. Hammer and himself, reductions by B. G. Marsden) of four more comets seen in 1999 SOHO data, all but C/1999 J6 being presumed Kreutz sungrazers. Comets C/1999 J6 (visible in both C2 and C3 data) and C/1999 U5 (visible in only the C3 telescope) show no tail. However, C/1999 W1 and C/1999 Y3, which were both visible with only the C2 telescope, did show tails. Selected V magnitudes from Biesecker for C/1999 J6: May 10.750 UT, 8.1; 10.833, 7.3; 10.935, 6.5; 11.088, 5.9; 11.269, 5.5, 11.338, 4.9; 11.462, 5.1. Comet C/1999 J6 (SOHO-109) was first noted by M. Oates in archival data via the SOHO Web page on ? 2000 March 20; C/1999 U5 and C/1999 W1 were discovered by Biesecker, and C/1999 Y3 was discovered by A. Vourlidas of the SOHO team.

On the same IAUC Doug Biesecker also reported observations of four additional Kreutz sungrazing comets detected by SOHO in the first few months of 2000. Comet C/2000 B5 was discovered by Biesecker; the other three comets were found by several people browsing the SOHO web site, as follows: C/2000 B6, M. Meyer, T. Lovejoy, J. Shanklin, and M. Oates; C/2000 B7, Meyer and Lovejoy; C/2000 D3, Meyer and K. Cernis. C/2000 D3 was visible with both the C2 and C3 telescopes and showed a short tail; the other three comets showed no apparent tail and were visible only in the C3 data.

I discovered **SOHO-110** (1999 F1) on April 1 at 09:09 UT whilst compiling material for this issue of Comet's Tale at the Institute of Astronomy. I'd looked at the C3 frames and seen nothing and whilst waiting for the C2 frames to download I was updating the web pages and collating notes from the Journals. I thought that I glimpsed a moving object on the bit of the movie that I could see and on checking it was an obvious Kreutz fragment, visible from 04:30 to 07:31. I immediately emailed the search team and almost instantly got a message from Maik Meyer saying that he had also found it.



Information about the latest discoveries is available from Doug Biesecker who is a member of the SOHO team. To mark SOHO-100 ESA issued a Press release and more information and images are on NASA hotshots.

SOHO was launched on 1995 December 2. It experienced a malfunction on 1998 June 25 and contact with it was lost. It was located by radar on July 29, communication was established in early August and it resumed pointing at the Sun in mid September. The LASCO cameras were reactivated in October but further problems were encountered and the spacecraft did not return to action until February 1999. Further control problems were encountered from time to time during the winter of 1999/2000.

There are three LASCO (Large Angle Spectroscopic Coronographs) on the SOHO spacecraft, which orbits the sun at the earth's L1 Lagrangian point, 1.5 million km ahead of the earth. C1 has a field from 1.1 to 3 solar radii, C2 from 1.5 to 6 and C3 from 3.5 to 30. Brighter objects are often discovered in the real time data, but the fainter ones have to wait for the archival data to be searched which runs three or four months behind. SOHO has now discovered 110 comets (109 with LASCO), of which the majority are all members of the Kreutz group of sungrazing comets. So far, only 13 are not Kreutz group sungrazers. Further background information on the SOHO comets can be found on Doug Biesecker's web pages. The LASCO images are downloaded every half an hour and you can view them individually or as movies on the web.

2000 A1 Montani J. Montani, Lunar and Planetary Laboratory, reported his discovery of a faint 19th magnitude comet on CCD images taken with the 0.90-m Spacewatch telescope at Kitt Peak on January 12.33. The comet shows a coma with diameter 5"-6", slightly elongated in p.a. 245-250°. An R CCD image taken by S. Kern with the 2.3-m Steward telescope on January 13 shows the comet to be clearly extended toward the southwest, and she derived mag 18.1. W. Shook found the object to be nonstellar with a 2".6 tail toward the southwest on an image taken with the 3.5-m WIYN telescope on January 13. [IAUC 7346, 2000 January 14] The comet is very distant (9.8 AU) and close to perihelion. The perihelion distance is the largest on record for a confirmed comet, though Trans-Neptunian-Objects (for example 1999 DP8) have greater perihelion distances.

A/2000 AB229 Details of an unusual asteroid with a 400 year period, a high inclination orbit and a perihelion distance of 2.3 AU were given on MPEC 2000-B20. The 18th magnitude object was discovered by LINEAR on January 5.38 and was just past perihelion. The next MPEC gave details of another unusual object 2000 AC229, which has a period of 8.8 years, an inclination of 53 degrees and a perihelion distance of 1.8 AU. This was discovered by LINEAR on January 8.24.

2000 B2 LINEAR A 19th magnitude object with unusual motion and reported as asteroidal by LINEAR on January 29.24 was found to be cometary in appearance following posting on the NEO Confirmation Page. CCD observations by P. Kusnirak (Ondrejov, 0.65-m f/3.6 reflector) and by M. Tichy and Z. Moravec (Klet, 0.57-m f/5.2 reflector) indicate that the object appears slightly diffuse. [IAUC 7354, 2000 February 1] The comet is a distant one, past perihelion and will fade.

2000 B3 P/LINEAR A 19th magnitude object with unusual motion that was reported as asteroidal by LINEAR on January 27.24 was found to be cometary in appearance following posting on the NEO Confirmation Page. CCD observations by P. Kusnirak (Ondrejov, 0.65-m f/3.6 reflector) on Feb. 1 show a coma diameter of 6" and a faint tail in p.a. 120 deg, and F. Zoltowski (Edgewood, NM, 0.3-m f/3.3 reflector) reports a small faint tail about 30" long in p.a. 100 deg and a dense coma about 10" across. The comet is near perihelion. [IAUC 7356, 2000 February 2]

2000 B4 D/LINEAR Another apparently asteroidal object, of 19th magnitude, was reported by LINEAR on January 29.25 and posted on the NEO Confirmation Page. This object has the orbit of a centaur and was noted as appearing perhaps slightly diffuse (P. Kusnirak, Ondrejov, 0.65-m reflector, February 10) and 'soft' and slightly larger than star images (D. Balam, Victoria, 1.82-m reflector, Feb. 11). The perihelion distance is 6.8 AU and the period 77 years [IAUC 7368, 2000 February 18]

A/2000 BD19 MPEC 2000-C09 reports the discovery by LINEAR of a sun-approaching asteroid on January 26.26. The 18th magnitude object has a period of 0.8 years, and a perihelion distance of 0.09 AU. If entirely asteroidal it would be 12th magnitude at perihelion, but if it shows cometary activity it could reach 6^{m} and be visible on SOHO LASCO images. It was last at perihelion on 1999 Oct 17.3 and will next be at perihelion in 2000 August.

2000 C1 P/Hergenrother Carl Hergenrother, Lunar and Planetary Laboratory, reported a 17th magnitude object on 2000 February 4.46 that showed an 11" tail in p.a. 300 deg on one of four CCD images taken with the 0.41-m Schmidt telescope at Catalina. Following posting on The NEO Confirmation Page, numerous CCD observers reported cometary appearance: February 5.3 UT, coma diameter about 12", brighter 60" tail in p.a. 290 deg, extending more faintly to 180" (J. E. McGaha, Tucson, AZ, 0.62-m reflector); February 5.5, tail about 12" long toward the northwest (G. Billings, Calgary, AB, 0.36-m reflector); February 5.7, slightly diffuse with very faint tail about 10" long to the northwest (G. J. Garradd, Loomberah, N.S.W., 0.45-m reflector); February 6.1, coma diameter 0'.1, tail 0'.3 long in p.a. 290 deg (P. Pravec and P. Kusnirak, Ondrejov, 0.65-m reflector); February 6.4, faint tail < 10" long in p.a. about 290 deg (D. T. Durig, Sewanne, TN). Prediscovery observations by LINEAR on January 4 and 8 have also been identified. [IAUC 7357, 2000 February 6] The comet is intrinsically quite faint and has perihelion at 2 AU. It will brighten a little.

2000 C2 SOHO 2000 C3 SOHO 2000 C4 SOHO 2000 C5 SOHO 2000 C6 SOHO D. A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reported measurements of five comets observed with the coronagraphs aboard SOHO. Only C/2000 C6 appears to be a Kreutz sungrazer; it was first noticed by Terry Lovejoy on SOHO web images on February 9.22, and Biesecker notes that its brightness ranged from V = 8.7 on February 9.43 to 7.7 on February 9.68 UT, and the comet showed a tail at 13 solar radii on C3 images. The other comets showed no tail. C/2000 C2 (SOHO's 100th comet) first noted by Kazimieras Cernis on February 3.70, remained relatively stable in brightness (V = 6.5-6.9) during February 3.70-3.84. C/2000 C3, found by Biesecker on February 4.56, brightened from V = 6.7 on February 4.59 to 5.9 on February 4.79, before fading to V = 7.0 on February 5.09. C/2000 C4, found by Maik Meyer on February 5.16, was on a trajectory closely following that of C/2000 C3, and it was assumed that the orbits are identical with a difference Delta(T) = 0.60 day. C/2000 C4 brightened from V = 5.9 on February 5.17 to 4.9 on February 5.30, before fading to V = 6.7 on February 5.67. C/2000 C5, found by Michael Oates on February 7.79, was at V = 7.5-8.0 on February 7. Comets C/2000 C2 and C/2000 C5 may also be related to each other. [IAUC 7364, 2000 February 12]

2000 CT54 LINEAR Yet another apparently asteroidal LINEAR object, of 19th magnitude, discovered on February 2.44, that was posted on the NEO Confirmation Page was noted to have a 15"-16" tail toward the north-northwest on February 12 by J. G. Ries, McDonald Observatory (0.76-m reflector). The comet reaches perihelion at 3.1 AU in 2001 June [IAUC 7368, 2000 February 18]

2000 D2 LINEAR An apparently asteroidal object of 18th magnitude, discovered by LINEAR on February 25.20 and posted on the NEO Confirmation Page was observed to be cometary by F. B. Zoltowski (Edgewood, NM; very diffuse image on February 28.1 UT; 12" tail in p.a. 270 deg on March 1.1) and by C. Hergenrother (Catalina 1.54-m reflector; 8" coma and very faint 15" tail in p.a. 105 deg on March 1.3). The comet was near perihelion at 2.3 AU. [IAUC 7372, 2000 March 1]

A/2000 DG8 The third asteroid with retrograde motion was announced on MPEC 2000-E07. It has a perihelion distance of 2.19 AU and a period of 32.5 years.

A/2000 DQ110 and **A/2000 EB107** are another two asteroids with orbits similar to those of short period comets. Details of the orbits of these and other unusual asteroids are on the iau web page at http://cfa-www.harvard.edu/iau/lists/Others.html

2000 ET90 P/Kowal-Mrkos MPS 11479 contained observations on March 9.30 and 13 by LINEAR of an apparently asteroidal, 19th magnitude object presumed to have a moderately eccentric orbit in the inner part of the main belt. Linkage by G. V. Williams to LINEAR observations on April 4 and 8 demonstrated the cometary nature of the orbit, and the object was placed in The NEO Confirmation Page. Isolated observations from LINEAR on February 7, from the Catalina Sky Survey on March 1 (when observer T. B. Spahr had in fact drawn attention to the object's "slowish" motion) and from LONEOS on April 2 were then also linked. Neither these observers nor those responding to the Confirmation Page made a definite remark about the object's cometary appearance, even in response to specific enquiries from the Central Bureau (although strong moonlight has recently been a factor). Following a suspicion by Brian Marsden and an independent suggestion by C. W. Hergenrother, 2000 ET90 has been definitively identified with comet D/1984 H1 = 1984 JD (Kowal-Mrkos) = 1984n (IAUC 3988, 4001) = 1984 X, for which current predictions (ICQ Comet Handbook for 2000, p. H87; OAA Comet Handbook for 2000, p. 37) require correction by Delta T about -125 days. The comet passed only 0.16 AU from Jupiter in March 1989. There was an unobserved return with T = 1991 Aug. 2. [IAUC 7403, 2000 April 15] The original orbit was based on only eight observations, so it is perhaps not surprising that the prediction was somewhat in error.

2000 G1 LINEAR F. Shelly, for the Lincoln Near-Earth Asteroid Research project, reported, in connection with the discovery on April 7.45 of a fast-moving 18th mag object, that Lisa Brown-Manguso noticed that the object showed clear cometary activity. It is very likely that the comet is short period (with current geocentric distance 0.24 AU), though the initial elements are parabolic, with q 1.01 AU and T 2000 March 9.02. [IAUC 7396, 2000 April 8] The parabolic orbit suggests that the comet would have passed 0.15 AU from the Earth in early March, reaching 15th magnitude, but was at high southern declination.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Comet Hunting Notes

Don Machholz

NOVEMBER 1999 : Until three years ago, the search for Near-Earth Objects (NEO's) was carried out in both the Northern and Southern Hemispheres. Then, in 1996 the Australian government stopped the funding so the Southern Hemisphere search was shut down. In the meantime the Northern Hemisphere increased its search capabilities, especially with the addition of LINEAR, in New Mexico, about a year ago. Now the Southern Hemisphere search has been re-funded and should begin soon. Robert McNaught will manage it and all the equipment is being updated.

These notes are taken from Comet Comments by Don Machholz, which is published on the Internet.

ICWA II : METHOD-RELATED BRIGHTNESS ESTIMATE DIFFERENCES, AND THE DELTA EFFECT

Joseph N. Marcus

The Comet's Tale editor is to be commended for his extraordinary efforts which made the Second International Workshop on Cometary Astronomy such a success. Not only was Jonathan Shanklin key in organizing and administrating the program and its finances, but he turned out a great synopsis of the goings-on in issue 12 of *The Comet's Tale* (1) that arrived in the U.S. mail only six weeks after the event! At such a pace it was perhaps inevitable that an error or two may have crept into the summary. I should like to correct one that occurred in the discussion of Charles Morris' presentation ("Why you don't get your papers published in the ICQ and other rants") and offer some clarifying remarks.

Contrary to what was reported on p. 12, I did not comment "...that the extensive work by the Dutch Comet Section did demonstrate the delta effect." Instead I noted that the Dutch Comet Section had studied differences in brightness estimates between the the Sidgwick and Bobrovnikoff methods. My remarks addressed the misimpression that arose during the discussion period that these differences were not documented – a point over which Morris took some ribbing, as Shanklin noted.

In fact, the Dutch Comet Section had long ago published in the English language literature an analysis of methods-related brightness estimate differences in their observations of two comets in 1981-2 (2). For 64P/Swift-Gehrels, a faint, large, diffuse comet, the "...Morris and Sidgwick estimates were essentially the same, but the Bobrovnikoff estimates were considerably fainter," by 0.9 magnitude. For C/1982 M1 (Austin), which was condensed, the difference was considerably smaller, about 0.2-0.25 magnitude. The author, the venerable comet observer Reinder Bouma, further wrote: "From these two examples it is clear that there is a real difference between Bobrovnikoff and Sidgwick estimates. The size of the difference appears to be a function of the coma's brightness, size, and degree of condensation." He warned that absolute magnitude m_o and slope n value of a cometary light curve can be systematically affected by the type of method used in the analysis. Don Machholz, a participant in the Cambridge IWCA, was actually the first to present hard data on methods differences in *Comet News Service* (3), only two years after the Morris method was published in the Western literature (4,5). Machholz had found the same thing for 1980 apparitions of comets 38P/Stephan-Oterma, 8P/Tuttle, and 2P/Encke – the Sidgwick method yields brighter estimates than the Bobrovnikoff, with the Morris method in-between (3). In summary, Morris' assertion about methods-related brightness estimate differences is supported by published literature. There is no need to attribute the claim solely as a "personal communication."

The "delta effect" is an artifact in which the outer part of the coma, magnified by near-earth distance, is lost to human vision as its contrast gradient falls below threshold, leading to an underestimate in coma diameter and brightness. Named after the Greek letter Δ, which is used to connote the earth-object distance, it can be studied through the formula

1) $m_1 = m_o + 2.5\ k \log \Delta + 2.5\ n \log r$

where m_1 is the observed magnitude of the comet, r is comet-sun distance, Δ is the absolute magnitude (reduced to $\Delta = 1$ AU $= r$), and k and n are the indices of variation of m_1 with log Δ and log r, respectively. Normally k is taken to be 2, i.e., it is assumed that comet brightness varies as Δ^{-2}, the familiar inverse square law of distance, but in a delta effect, $k < 2$. Eq. (1) is in the general form

2) $a_0 + a_1 x_1 + a_2 x_2 = 0$

where x_1 (= 2.5 log Δ) and x_2 (= 2.5 log r) are independent variables and a_0 (= m_o), a_1 (= k) and a_2 (= n) are unknown coefficients that can be solved for through multiple linear regression (6) on a data set of m_1, r, and Δ values.

In his talk at IWCA II, Morris implied that doing multiple linear regression on comet light curves in the above manner is not legitimate because r and Δ are always "statistically correlated." This implication is not correct. Certainly r and Δ are always *mathematically related* by the cosine law

3) $r^2 = \Delta^2 + R^2 - 2R\Delta\cos\theta$

where R is the sun-earth distance and θ is the elongation. Morris confuses the concept of "mathematical relationship" with that of "statistical correlation." r and Δ *may* or *may not* have a significant statistical correlation depending on the geometry of the apparition and the distribution of the m_1 observations. If, say, the comet is a periodic reaching a close perigee at the time of its perihelion, then r and Δ have a high degree of covariance, and it would be difficult or impossible to do useful regression. However, if a comet reaches close perigee at a time when it is solely on the heliocentric inbound or outbound legs of its orbit, then the covariance may be minimal and legitimate regression would be possible. Such was the case for near earth-approaching comets 1P/1909 R1 (Halley), C/1975 T2 (Suzuki-Saigusa-Mori) and C/1979 Y1 (Bradfield), for which delta effect k values were found by multiple regression to be 1.41 ± 0.07, 1.61 ± 0.12, and 1.37 ± 0.09, respectively (7-9). The covariance between r and Δ can be assessed in two related ways. One is to compute the correlation coefficient between them directly using the variance-covariance matrix in the regression formula (6). For the Bobrovnikoff data set (10) for P/Halley in 1910, the correlation coefficient between log Δ and log r can be computed as -0.047 – almost no correlation at all! A second way, less direct but more utilitarian, also employing the variance-covariance matrix, is to look at the sizes of the standard deviations on k. The greater the co-correlation between log Δ and log r, the larger the standard deviation, and the less determinate the solution for k. For the m_1 data sets analyzed for these three comets, the SDs on k are small enough so that when assessed by Student t-test, all 3 k values are significantly different from $k = 2$, with the level of probabilities that the differences can be due to chance being much less than $p = 0.05$ in all three cases.

It should therefore be accepted that multiple linear regression to obtain m_0, n, and k values for comet light curves is possible and that it is a legitimate method when judiciously applied. It would be unfortunate if Morris' "rant," in his word, at the Cambridge IWCA should deter analysts from employing it for fear of having a paper rejected by the *International Comet Quarterly*, of which he is Associate Editor, or any professional astronomical journal. Charles' choice of the word "rant" in the title of his talk was amusing and appreciated for its self-deprecating good humor. However, he should realize that one of the definitions entered for it in the Oxford English Dictionary (apologies, Cambridge!) is "empty declamation." I think that it can be fairly concluded that it is this entry which most accurately characterizes his specific rant against regression on log Δ and log r in comet light curves because they are "correlated."

This being said, Charles and I would probably agree that the best way to look for a delta effect in a comet light curve is not, paradoxically, through the light curve itself. After all, comets can and quite often do behave irregularly in brightness, in such a manner as to violate the assumption of linear behavior of heliocentric magnitude with log *r*. It is this criticism of *any* log *r* regression analysis which is most cogent in my view. Ideal analyses of delta effect in light curves should take into account such potential irregularities by comparing m_1 observations with independent data sets, such as dust and gas production rate photometry, which may be less prone to a delta effect. Such analyses have never been done, to my knowledge. And analyses for delta effect (and of comet light curves in general) are further complicated by the need to adjust for systematic errors arising from the type of magnitude estimation method employed – discussed above – as well as for other error sources, such as instrument magnification – noted below.

In my view, the best evidence for delta effect is the well-documented artifact of underestimated coma diameter and brightness with increasing instrument magnification, also referred to as "aperture effect" (10, 11). Charles Morris helped to define it (11), and the effect is beautifully seen in his observations of C/Bradfield 1979 Y1 (12). In the paradigm that each is an artifact of human vision, "aperture effect" and "delta effect" are identical in that the underestimation artifact introduced by observing a comet at, say, twice the magnification in an instrument twice the aperture is physically equivalent to observing the comet in the original instrument if the comet-earth distance were to be halved. This symmetry is so direct that it should be no leap at all to accept that "delta effect" exists if "aperture effect" exists.

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Observations of Comet 109P/Swift-Tuttle

Alex Vincent

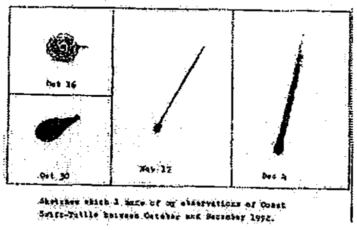
Comet Swift-Tuttle was discovered by Lewis Swift and Horace Tuttle in 1862 and came to perihelion in the same year. It was calculated to have a period of 120 years and was due to return in 1982, but it never came. Some astronomers thought that it came and went unseen while others thought that it had a longer period.

Its period is between 130 and 135 years and it last reached perihelion on 1992 December 12. T Kiuchi recovered it on 1992 September 27. Comet Swift-Tuttle is the parent comet of the Perseid meteor shower, which is seen in August each year.

The comet will return again in 2126 and will make a very close approach to the Earth to just over 1 million kilometres and its tails will stretch half way across the sky. The comet may be seen in daylight. I'd sure like to see that rascal!

I made a number of observations of comet Swift-Tuttle, the first was on 1992 October 16 through a 20cm Celestron telescope and it appeared as a large fuzzy smudge with a short tail. My next observation was on October 30 where its tail was longer and the comet more elongated. I took several photographs of it on a camera platform.

I made observations of it on November 6 through a Celestron 20cm and it looked great with its tail. My next observation of it on November 17 was down on the beach. The comet's tail was thin as viewed through a x2 teleconverter attached to a camera lens through which I took some photographs.



Sketches of Comet Swift-Tuttle made between 1992 October and December.

My best observation of the comet was on 1992 December 4, again through the 20cm Celestron, and again it looked impressive with its tail. The comet was of 5th magnitude and I took several photographs with the camera piggybacked on the telescope. My last look at it was on December 5 down at the beach with the naked eye also taking a number of photographs with my camera on a tripod.

Introduction

This issue has ephemerides for comets which are likely to be brighter than 11[th] magnitude:

- 2P/Encke (UK)
- LINEAR (1999 S4) (UK & Southern Hemisphere)
- LINEAR (1999 T1) (Southern Hemisphere)
- LINEAR (1999 Y1) (UK)

Comet 1999 T2 (LINEAR) may reach 13^m from July until the end of the year. Current ephemerides for fainter comets are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for comet 2P/Encke (UK)

Omega=186.4735 OMEGA=334.6214 i= 11.7605 q= 0.339334 a= 2.217695
e=0.846988 P= 3.303 T= 2000 September 9.6480 Equinox= 2000
Magnitudes calculated from m=10.5+5.0*Log(d)+15.0*Log(r)

Note: The comet may be fainter than indicated by this equation. It should be visible in SOHO LASCO C3 images from about September 3 to September 17.

August 2000

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	6 2.8	30.36	6 6.0	30.35	10.9	1.47	0.94	9.22	Not Observable	39	66	5	5	279	34	-1
2/ 3	6 9.2	30.33	6 12.4	30.32	10.8	1.46	0.92	9.25	Not Observable	39	78	11	5	280	34	-1
3/ 4	6 15.8	30.29	6 19.0	30.27	10.6	1.44	0.90	9.28	Not Observable	38	91	20	5	281	35	-1
4/ 5	6 22.4	30.23	6 25.7	30.21	10.5	1.43	0.89	9.30	Not Observable	38	103	29	6	282	35	-2
5/ 6	6 29.2	30.16	6 32.4	30.13	10.4	1.42	0.87	9.33	Not Observable	37	114	40	7	282	36	-2
6/ 7	6 36.1	30.07	6 39.3	30.04	10.2	1.41	0.85	9.36	2.39 to 2.41	37	125	50	7	283	37	-3
7/ 8	6 43.1	29.57	6 46.3	29.54	10.0	1.40	0.83	9.39	2.39 to 2.43	36	136	60	8	284	37	-4
8/ 9	6 50.2	29.45	6 53.4	29.41	9.9	1.39	0.82	9.42	2.39 to 2.46	36	146	69	9	285	38	-4
9/10	6 57.4	29.32	7 0.6	29.27	9.7	1.38	0.80	9.45	2.40 to 2.49	35	156	78	10	286	39	-5
10/11	7 4.7	29.16	7 7.9	29.11	9.6	1.37	0.78	9.49	2.41 to 2.51	34	166	85	11	287	39	-6
11/12	7 12.1	28.59	7 15.3	28.54	9.4	1.36	0.76	9.52	2.42 to 2.54	34	172	91	12	287	40	-7
12/13	7 19.6	28.40	7 22.7	28.34	9.2	1.35	0.75	9.56	2.44 to 2.56	33	169	96	13	288	41	-7
13/14	7 27.1	28.19	7 30.3	28.13	9.1	1.34	0.73	9.59	2.46 to 2.59	32	161	99	14	289	41	-8
14/15	7 34.8	27.56	7 37.9	27.49	8.9	1.34	0.71	10.03	2.48 to 3.01	31	151	100	16	290	42	-9
15/16	7 42.5	27.31	7 45.6	27.23	8.7	1.33	0.69	10.07	2.51 to 3.04	31	141	100	18	291	42	-10
16/17	7 50.3	27.03	7 53.3	26.55	8.5	1.33	0.67	10.11	2.54 to 3.06	30	130	97	20	291	43	-11
17/18	7 58.1	26.34	8 1.2	26.25	8.3	1.32	0.65	10.15	2.58 to 3.09	29	120	93	22	292	43	-12
18/19	8 6.0	26.02	8 9.0	25.53	8.1	1.32	0.64	10.18	3.01 to 3.11	28	109	87	25	293	44	-13
19/20	8 14.0	25.28	8 17.0	25.19	7.9	1.31	0.62	10.22	3.06 to 3.14	27	98	79	28	294	44	-14
20/21	8 22.0	24.52	8 24.9	24.42	7.7	1.31	0.60	10.26	3.10 to 3.16	26	87	69	32	295	45	-15
21/22	8 30.0	24.13	8 33.0	24.03	7.5	1.31	0.58	10.31	3.15 to 3.18	25	75	59	35	295	45	-16
22/23	8 38.1	23.32	8 41.0	23.22	7.3	1.30	0.56	10.35	3.21 to 3.21	24	64	48	40	296	46	-17

Spacewatch	C/1997 BA6	1999	11	27.5927	3.436294	0.998829	285.9424	317.6619	72.7158	10.0	5.0	2000 MPC 35204
Montani	P/1997 G1	1997	04	06.5190	4.210607	0.417483	213.4648	267.7937	3.9908	9.0	10.0	2000 MPC 31347
Meunier-Dupouy	C/1997 J2	1998	03	10.3806	3.052525	1.000825	122.7062	148.8534	91.2368	3.5	10.0	2000 MPC 35204
Lagerkvist-Carsenty	P/1997 T3	1998	03	12.2862	4.242857	0.365202	334.3656	63.1959	4.8349	13.0	5.0	2000 MPC 35205
Larsen	P/1997 V1	1997	09	15.5076	3.297062	0.331542	133.0251	234.8282	12.0891	9.0	10.0	2000 MPC 31205
Jager	P/1998 U3	1999	03	10.1142	2.133817	0.648530	180.9135	303.5299	19.1395	6.5	10.0	2000 MPC 34421
Spahr	P/1998 U4	1999	02	26.9741	3.843882	0.310111	251.8183	181.7197	31.5182	8.0	10.0	2000 MPC 36653
LINEAR	C/1998 U5	1998	12	21.7852	1.236890	0.988086	51.1541	66.6481	131.7740	8.0	10.0	2000 MPC 35206
LINEAR	P/1998 VS24	1998	11	02.9633	3.406264	0.243246	244.5532	159.2049	5.0312	13.0	5.0	2000 MPC 33651
LINEAR	C/1998 W3	1998	10	06.7514	4.915433	1.000182	6.8996	123.9111	129.1812	6.0	10.0	2000 MPC 36212
Li	P/1998 Y2	1998	12	17.9041	2.519588	0.588405	319.0269	91.8266	24.3224	9.5	10.0	2000 MPC 34421
Korlevic-Juric	P/1999 DN3	1998	09	29.4887	3.907418	0.135350	161.1161	5.9502	18.7196	12.0	5.0	2000 MPC 34734
Li	C/1999 E1	1999	01	31.8949	3.920369	0.760352	329.7875	127.8320	46.8753	6.5	10.0	2000 MPC 39021
Catalina	C/1999 F1	2002	02	13.4167	5.787047	1.000048	255.1474	20.0340	92.0523	9.5	5.0	2000 MPC 39021
Dalcanton	C/1999 F2	1998	08	23.5493	4.717287	0.998013	352.3324	210.2966	56.4267	5.0	10.0	2000 MPC 39021
LINEAR	C/1999 G1	1998	07	31.8380	4.039444	0.845367	135.9867	23.4828	76.3132	7.5	10.0	2000 MPC 34734
Lee	C/1999 H1	1999	07	11.1764	0.707853	0.999734	40.6973	162.6611	149.3409	7.0	10.0	2000 MPC 36212
LINEAR	C/1999 H3	1999	08	18.2299	3.500804	1.002894	101.9127	332.7301	115.8369	5.0	10.0	2000 MPC 37478
Skiff	C/1999 J2	2000	04	05.9195	7.109985	1.000977	127.1337	50.0433	86.4123	2.0	10.0	2000 MPC 37478
LINEAR	C/1999 J3	1999	09	20.1624	0.976810	0.999404	161.9778	228.9807	101.6576	12.0	10.0	2000 MPC 36212
LINEAR	C/1999 J4	1999	11	17.6088	3.780400	1.000000	95.1591	264.4841	118.9108	11.5	5.0	2000 MPC 34734
LINEAR	P/1999 J5	1999	05	12.2933	3.712459	0.169199	132.2150	112.0105	13.7197	9.0	10.0	2000 MPC 35553
Ferris	C/1999 K2	1999	04	10.6155	5.290482	0.965690	4.5802	300.3237	82.2023	6.0	10.0	2000 MPC 35553
LINEAR	C/1999 K5	2000	07	04.3696	3.255437	1.001818	241.4829	106.3794	89.4710	6.0	10.0	2000 MPC 36653
LINEAR	C/1999 K6	1999	07	24.7114	2.247239	0.993602	56.7823	245.3686	46.3453	11.0	10.0	2000 MPC 36653
LINEAR	C/1999 K8	2000	04	24.3160	4.200371	1.000710	164.6255	195.3939	52.7348	5.0	10.0	2000 MPC 36653
LINEAR	C/1999 L3	2000	01	04.9101	1.988921	0.974292	353.2987	140.1609	166.0993	10.0	10.0	2000 MPC 37478
Lynn	C/1999 N2	1999	07	23.0430	0.761238	0.997381	357.8286	254.6773	111.6561	9.5	10.0	2000 MPC 35814
LINEAR	C/1999 N4	2000	05	23.6636	5.505213	1.004038	90.4166	345.8982	156.9228	6.0	10.0	2000 MPC 39021
McNaught-Watson	C/1999 S2	1997	11	22.6260	6.468248	1.004850	223.5037	74.4645	65.8199	2.0	10.0	2000 MPC 39022
LINEAR	C/1999 S3	1999	11	09.0109	1.895000	0.899903	44.1269	11.8785	70.5619	10.0	10.0	2000 MPC 39022
LINEAR	C/1999 S4	2000	07	26.1600	0.765052	1.000096	151.0535	83.1828	149.3863	7.0	10.0	2000 MPC 38308
McNaught-Hartley	C/1999 T1	2000	12	13.4824	1.171753	0.999892	344.7553	182.4875	79.9795	5.0	10.0	2000 MPC 37479
LINEAR	C/1999 T2	2000	11	24.4832	3.037273	1.001624	104.6697	14.8758	110.9992	6.0	10.0	2000 MPC 36653
LINEAR	C/1999 T3	2000	08	31.0750	5.366899	1.002048	211.1743	223.5166	104.7635	6.0	10.0	2000 MPC 37479
Ferris	C/1999 U1	1998	09	03.3215	4.140285	1.002903	291.1397	58.2557	105.7666	6.5	10.0	2000 MPC 37479
LINEAR	P/1999 U3	1999	11	18.4602	1.846329	0.619019	111.3158	306.9761	20.3955	13.5	10.0	2000 MPC 39022
Catalina-Skiff	C/1999 U4	2001	10	26.9494	4.921896	1.008676	77.2711	32.3407	51.9866	4.5	10.0	2000 MPC 39022
Catalina	P/1999 V1	1999	10	25.0942	2.944315	0.550647	186.7035	294.3100	15.5861	10.0	10.0	2000 MPC 39022
Korlevic	P/1999 WJ7	2000	02	15.2582	3.167792	0.316312	154.4221	290.5303	2.9794	14.5	5.0	2000 MPC 38308
Hug-Bell	P/1999 X1	1999	06	20.8017	1.936848	0.472467	296.9127	103.6475	10.9696	13.5	10.0	2000 MPC 37479
LINEAR	P/1999 XB69	2000	02	17.0403	1.639255	0.631984	220.1818	256.1667	11.3364	17.5	5.0	2000 MPC 39023
LINEAR	C/1999 XS87	1999	08	06.5970	2.771870	0.840509	151.3537	266.7296	14.8467	10.0	10.0	2000 MPC 39023
Catalina	P/1999 XN120	2000	05	01.4646	3.286274	0.213581	161.8041	285.4622	5.0294	13.5	5.0	2000 MPC 39023
LINEAR	C/1999 Y1	2001	03	24.2090	3.090940	1.000000	184.2740	188.8527	134.8090	5.5	10.0	2000 MPC 39023
Montani	C/2000 A1	2000	07	02.5482	9.755490	1.000000	13.7543	111.8461	24.5823	3.5	10.0	2000 MPC 39023
LINEAR	C/2000 B2	1999	11	09.9344	3.776036	1.000000	154.5683	284.9897	93.6545	13.0	5.0	2000 MPC 39023
LINEAR	P/2000 B3	2000	02	14.1682	1.700252	0.575248	130.5117	352.1470	11.1263	16.0	10.0	2000 MPC 39023
LINEAR	C/2000 B4	2000	06	17.1520	6.828392	0.620816	126.3345	0.6081	15.9122	11.5	5.0	2000 MPC 39023
Hergenrother	P/2000 C1	2000	03	19.8738	2.095573	0.406398	51.1680	127.0455	6.1055	14.0	10.0	2000 MPC 39023
LINEAR	C/2000 CT54	2001	06	19.2703	3.152707	1.000000	272.6893	18.9755	49.2184	11.0	5.0	2000 MPC 39023
LINEAR	C/2000 D2	2000	03	02.6729	2.323051	1.000000	115.5323	235.7915	156.8565	15.0	5.0	2000 MPC 39023

Source: CBAT web pages. H1 and K1 are also from the CBAT; alternative values are given in the main section and on the Section web pages.

TA format (example)

```
               1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c    DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                         Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5    2               Shanklin
961214.70 S   3.8  AA   8   B        20  6      7/  0.50   40   Baroni
```

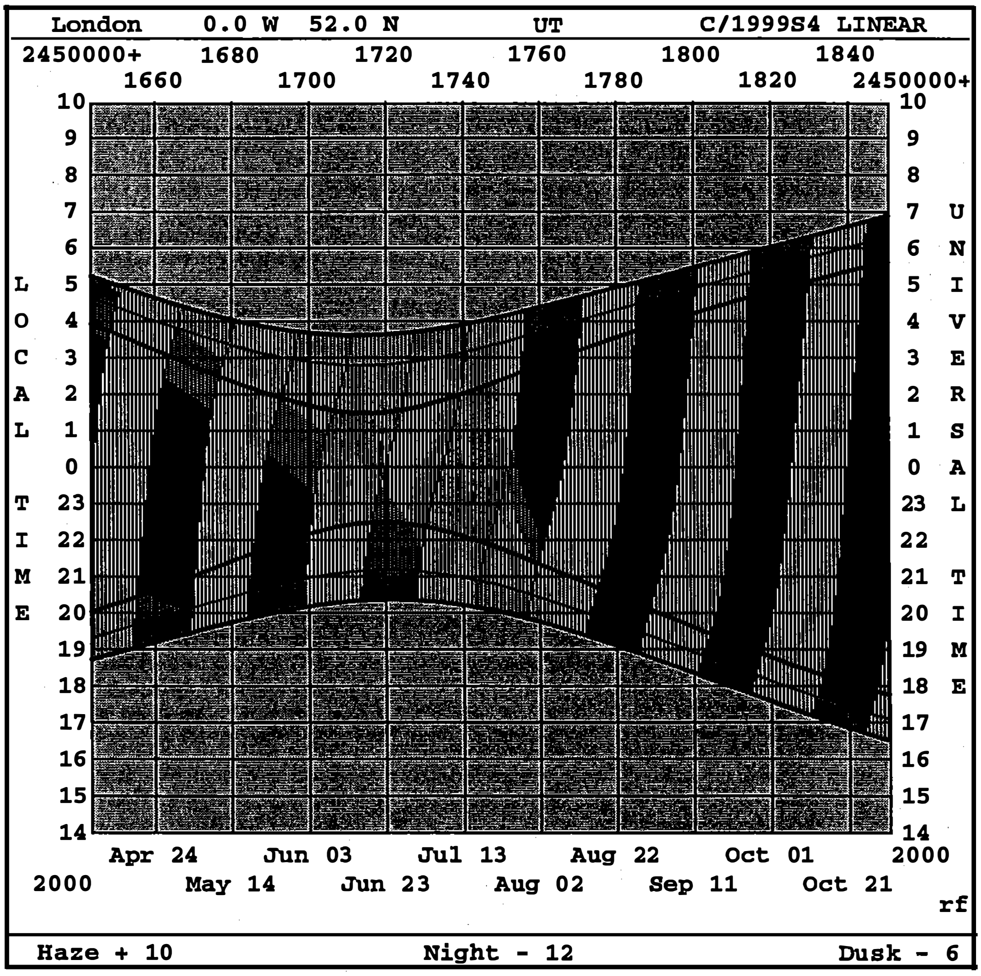
ICQ format (example)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
 991992      1992  5 18.94  S  9.3 AA  7.5R     50   6    4        135 ICQ XX BEA
  P1955A1    1955  6 18.08      5.0 BD  5  R     6   5    s5   0.75 335 ICQ XX STO01
```

Charts

The diagram on this page shows when the moon interferes with observations of 1999 S4 and was produced using software written by Richard Fleet. There is no moon in the dark regions and the moon will interfere in the light regions. The comet is a morning object in early June, becoming visible all night by early July. It ends the apparition as an evening object late in the month.

The other comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet.



How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

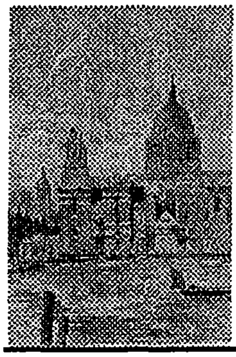
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail Len	Tail PA	[illegible]	Ref	Comments



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 7, No 2 (Issue 14), 2000 October

WHAT IS THE DIFFERENCE BETWEEN ASTEROIDS & COMETS?

From Science-Week via CCNet

Other than the moons of the various planets, the chief small bodies of the solar system are comets and asteroids.

In general, a comet is a kilometre-size chunk of ice and associated dust and debris. The Oort cloud is an apparent spherical shell of comets 10,000 to 100,000 AU from the Sun and the proposed source of comets that orbit the Sun. The cloud is at the extreme edge of the Sun's influence, halfway to the nearest star, and it is believed that when the cloud is perturbed by passing stars, comets may be sent into a solar orbit. The size and structure of the Oort cloud have been deduced from statistical studies of the orbits of comets; there is no direct evidence for the cloud's existence. Approximately 900 comets are known.

Asteroids (also called "minor planets") are small rocky objects, most of which orbit the Sun in a belt between the orbits of Mars and Jupiter. A few asteroids follow orbits that bring them into the inner Solar System, and several asteroids occasionally pass within a few tens of millions of miles of Earth. Some asteroids are located in the orbit of Jupiter, and some asteroids have been detected as far away as the orbit of Saturn. There are approximately 7200 known asteroids, and a million asteroids are believed resident in the Solar System. The consensus view is that asteroids are composed of material that failed to build a planet at a distance of 2.8 astronomical units from the Sun, perhaps due to the influence of massive Jupiter just outside the asteroid belt. Until recently, the shapes and surface features of asteroids were a matter of conjecture; during the past decade, however, significant direct observations of asteroids have been relayed back to Earth from spacecraft.

Classical astronomers have categorised comets and asteroids as distinctly different entities with different histories and compositions, but recent evidence is blurring the conceptual boundary between these two groups of small Solar System bodies, and there are several newly discovered objects that are considered to be both comets and asteroids on the basis of their characteristics.

Don Yeomans (California Institute of Technology, USA) presents a review of recent research on comets and asteroids (Small bodies of the Solar System. Nature 20 Apr 2000 404:829), the author making the following points:

1) Recent observations have revealed comets in asteroid-like orbits and asteroids in comet-like orbits. Both comets and asteroids can evolve from the Oort cloud into highly inclined, even *retrograde, orbits about the Sun, so orbital behaviour is no better than physical behaviour for distinguishing comets from asteroids. The author suggests that attempts to categorise comets and asteroids as distinctly separate entities have failed, and that astronomers should now consider these objects as members of highly diverse family: the small bodies of the Solar System.

2) If all comets were solid dirty balls of water ice, then their bulk densities would be approximately 1 gram per cubic centimetre. But some comets have apparent low-density structures that are made from several bits held together by little more than their own self-gravity. This conclusion arose after some comets were observed to break up as a result of tidal forces from either the Sun or Jupiter, and more than two dozen other comets have split apart for no obvious reason at all. In addition, comets that have apparently transformed from active to quiescent objects suggest that some cometary bodies do become defunct and join the ranks of the asteroids. Low-density extinct comets can probably explain a significant fraction of the near-Earth asteroid population, "so we cannot assume that all objects that threaten Earth will have the same composition or structure."

Continued on page 4

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way. Renewals should be sent to the Director and cheques made payable to the BAA. Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

The spring was a fairly quiet time for comet observing, with nothing within reach of moderate apertures. The summer brought comet LINEAR 1999 S4, although observing conditions from the UK were often poor in the east and then the comet disintegrated. More details of the event are described in the review of observations. The end of the year brings another possible binocular comet in the shape of 1999 T1 (McNaught-Hartley) and at least this one is intrinsically brighter than 1999 S4 so there is less chance of it disappearing.

Michael Oates has continued scouring the SOHO archives and has now discovered nearly 70 comets out of the SOHO total of 204. I've found a couple more, including one which could have been observed by large telescopes in the Southern Hemisphere. Rather surprisingly no SOHO comets were discovered during September.

A partially revised edition of the Section Guide to Observing Comets is now available as a PDF file on the Internet. It is quite a large file, and I intend to produce a printed version as well. This should be ready early next year.

Only a few imagers have adopted the format suggested in the last issue and I would encourage the remainder to use it. Just to remind you, the procedure is to name image files as comet_yyyymmddl_obs.img and auxiliary files as comet_yyyymmddl_obs.txt, where yyyy is the year, comet is the comet identifier, obs the first three letters of the observers surname, l a serial number assigned by the observer (which can be omitted) and img the image format. As an example 1999s4_19991128a_mob.jpg would be the first jpeg image that Martin Mobberley took of 1999 S4 on that date and if he felt that further information was needed there would be a supporting file 1999s4_19991128a_mob.txt. The second gif image of 141P/Machholz 2 by David Strange on the same date would be 141p_19991128b_str.gif.

Since the last newsletter observations or contributions have been received from the following BAA members: Sally Beaumont, Denis Buczynski, Len Entwisle, John Fletcher, Maurice Gavin, Massimo Giuntoli, Werner Hasubick, Guy Hurst, Nick James, Geoffrey Johnstone, Alastair McBeath, Cliff Meredith, Martin Mobberley, Terance Moseley, Michael Oates, Gabriel Oksa, Roy Panther, Jonathan Shanklin, David Storey, David Strange, Melvyn Taylor, Cliff Turk and Alex Vincent

and also from: Jose Aguiar, Mark Allison, Alexandr Baransky, Jeffrey Barham, Nicolas Biver, John Bortle, Jean-Gabriel Bosch, Reinder Bouma, Nicholas Brown, Christian Buil, Paul Camilleri, Eddie Carpenter, Jose Carvajal, Clive Curtis, Sauro Donati, R Ferrando, Stephen Getliffe, Bjorn Granslo, Bernhard Haeusler, Andreas Kammerer, Heinz Kerner, Atilla Kosa-Kiss, Martin Lehky, Rolando Ligustri, Pepe Manteca, Michael Mattiazzo, Maik Meyer, Antonio Milani, Andrew Pearce, Stuart Rae, Juan San Juan, Richard Schmude, Carlos Segarra, Oddleiv Skilbrei, Vince Tuboly Jean-Francois Viens and the Ageo Survey Team

(KenIchi Kadota and Seiichi Yoshida) (apologies for any errors or omissions).

Without these contributions it would be impossible to produce the comprehensive light curves that appear in each issue of *The Comet's Tale*. At the moment I'm finding it quite difficult to get the time to reply immediately to letters and emails due to a large number of commitments. Please be patient and I will try and reply when time permits. My commitments have also meant that this issue of *The Comet's Tale* is later and less comprehensive than I would like. Any contributions to the next issue will be very welcome.

Comets under observation were: 2P/Encke, 29P/Schwassmann-Wachmann 1, 47P/Ashbrook-Jackson, 1995 O1 (Hale-Bopp), 1997 BA6 (Spacewatch), 1999 H3 (LINEAR), 1999 J2 (Skiff), 1999 K5 (LINEAR), 1999 K8 (LINEAR), 1999 S4 (LINEAR), 1999 T1 (McNaught-Hartley), 1999 T2 (LINEAR), 1999 U4 (Catalina-Skiff) and 1999 Y1 (LINEAR).

I will again be visiting the Antarctic this winter, departing in mid November and returning in mid January. During my absence I can still be contacted by email (see contact details) or you can write to me in the Falkland Islands. I should have more time for writing whilst I'm on board ship!

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, and BAA Journals Sky.

150 Years Ago: In the May MN an extract of a letter from Professor Schumacher to the President on Petersen's comet includes "It is very desirable that this comet should be observed after its perihelion passage. M Gauss is even of opinion that it is not *proved* that a *comet* must, after having passed the perihelion, move in the same orbit as before." In June a note discussed a comet seen by the Rev. T M Jenkins ("for whose liberality Georgetown College, Washington, was indebted for its observatory") on his voyage to Rio Janeiro. On November 28, 1849 when 10°S, 30°W "We saw a comet to the westward nearly in the track of the sun, about 14° above the horizon, as measured with the quadrant. The nucleus very distinct, about as large in appearance as Mars, the tail curved and pointing towards the south (SW.), quite bright and nearly a degree in length as seen by the naked eye, but much longer when viewed with the glass. It was seen by all the crew for about twenty minutes, when a cloud obscured it and it was seen no more." Mr Jenkins unfortunately died at Rio but the master of the *Maryland* established that the comet had also been seen on November 15 at 7:30 pm at an altitude of 48°. This was irreconcilable with the expected return of a long period comet (the great comet of 1556, 1556 D1) predicted to return in 1848 by Mr Hind. [The positions were not sufficient to calculate an orbit and the comet is not listed by Kronk (1984) or Vsekhsvyatskii]

100 Years Ago: Nothing much of note occurred and the annual report in the October Journal notes "Very few comets have been observable during the year, and only one has been conveniently placed for the possessors of telescopes of moderate size in this country." Interestingly the Journal in those days was bilingual, with a paper on Jupiter appearing in French.

50 Years Ago: A review of a paper by O Struve which was in the February S&T appears in the May Journal. In it the new hypothesis by J H Oort of a distant aggregation of comets was reviewed. This is now known as the Oort Cloud. A report on the comets of 1948 appears in the July Journal. This was a forerunner to the present series, but unfortunately only 1946 - 1949 were published. A comment on the Eclipse comet of 1948 is still true today: "The magnificence of the brilliant comet, with its 25°-long tail, seems to have paralysed the abilities of most observers to make observations of scientific value." The 1949 report appeared in the October Journal and followed the pattern of the others with descriptions of observations and light curves of well-observed objects.

WHAT IS THE DIFFERENCE BETWEEN ASTEROIDS & COMETS?

Continued from Page 1

3) Asteroids have been classified according to the light reflected from their surfaces -- their optical spectra. Although no two spectra are exactly alike, most asteroids fall into one of two groups, the C-type (carbonaceous) and S-type (silicaceous). C-type asteroids have low reflectance (albedo) and may contain mixtures of hydrated silicates, carbon, and organic compounds. S-type asteroids have higher albedos and can contain pyroxene (silicates containing magnesium, iron, and calcium), olivine (magnesium and iron silicates), and nickel-iron metal. The C-type asteroids are most common in the outer part of the main asteroid belt, and the S-type asteroids are mostly found in the inner asteroid belt.

4) Meteorites are asteroid collision fragments that have fallen to Earth, and as such are thought to hold clues regarding the early history of asteroids. Because most asteroid fragments are rocky, they can survive the passage through the atmosphere of the Earth. In contrast, debris from comet streams nearly always burns up in the atmosphere, sometimes producing spectacular meteor showers in the sky, but leaving little evidence on the surface of the Earth. The most common meteorite is the ordinary chondrite, which is composed mostly of rocky silicates, and so has not experienced the chemical differentiation associated with melting. Such chondrites are thought to be some of the most primitive rocks in the Solar System, although their parent asteroid type is not clear. On 22 March 1998, and ordinary chondrite was observed to fall to Earth by 7 boys in Monahans, Texas (US), and within 48 hours

the meteorite was under examination at the Johnson Space Center in Houston, Texas. Laboratory analysis of the Monahans meteorite detected salt crystals embedded with water in the form of brine, and the salt crystals were dated to the very beginning of the Solar System, approximately 4.6 billion years ago. This suggests the presence of liquid water on the parent asteroid of this meteorite, and unless this water derived from a collision with a salt-bearing icy comet, the parent asteroid itself must have had flowing water within its interior structure. Far from being the dry rocky bodies they were once believed to be, it would seem that some asteroids, along with comets, might be significant sources of water.

Comment's on "IWCA II Method-Related Brightness Estimate Differences and the Delta Effect by Joseph N. Marcus"

Charles S. Morris, Associate Editor, ICQ

Joe Marcus and I have been at each other's throats for most of the last couple of decades, mostly in a friendly way. The long standing disagreement on the delta effect (or lack of it) has been the primary thorn in our scientific relationship. That being said, this little rant by Joe concerning my talk at the IWCA II should win a prize for being grossly off-topic.

My talk at IWCA II had almost nothing to do with the delta-effect theory. In the amateur community, there are many observers who produce very professional observations. However, when amateurs attempt to do research with the data collected (and publish papers), they often do very poorly. In large measure, this is because they have never been through the experience of publishing a real research paper. At the ICQ, we treat submitted papers in the same manner as other professional research journals. The papers are sent to anonymous referees who review the paper and offer comments and suggestions to the author. Often amateurs get easily frustrated when their paper is reviewed and it is suggested that additional work is required before it can be considered for publication. The point of my talk at the IWCA II was to point out common mistakes made by amateurs doing research and writing papers. One of the goals of the ICQ is to publish useful research articles produced by amateurs without sacrificing professional standards. I had hopped to encourage this with my talk.

In my talk, I discussed the use of statistics because statistical analysis is the basis for most papers submitted to the ICQ. One example (out of many presented in the talk) involved the dangers of performing multiple regression on correlated variables. If two variables are strongly correlated, as r and delta often are for comets, it is impossible to unambiguously and correctly separate the computed parameters. I used solving the light curve equation with a delta effect term included as an example of this problem. It is a valid example. Joe correctly pointed out that you can check the correlation coefficients to determine whether or not r and delta are significantly correlated. The bottom line is that you can not *routinely* solve for the "delta effect" coefficient without confirming that that r and delta are not significantly correlated. If you do, your results are, at best, suspect and, at worst, simply wrong. This is a valid example because on some occasions I have seen *general* light curve analyses that included the delta effect (not by Joe) that have ignored this potential problem. [All of Joe's extensive wordage proving that this concern doesn't apply in specific cases misses the point completely.]

For using this example, I received a lengthy rant by Joe in *The Comet's Tale* concerning one of his favourite topics, the delta effect.

Comments on the Delta Effect.

1) If you listen to Joe, you would think that the delta effect is a fully accepted theory, it is not. The delta effect in comet light curve research is applied to visual observations by a limited number of researchers, mostly amateur. The references in their papers are to Joe's work, mostly to his *Comet News Service* articles. That is the problem. To my knowledge, Joe's complete version of the delta effect/magnification effect theory has never been published and certainly not in a refereed journal. (If I am wrong, Joe, send me a reprint.) It is difficult to review or comment on a theory that is put forth in bits and pieces in unrefereed publications, much of it in *Comet News Service* of which Joe was author, reviewer, and editor. I have suggested many times, by the way, that Joe publish his theory in the ICQ or other refereed publications to no avail.

2) For every case of the delta effect being observed in light curves, the observed effect was just as likely to have been caused by other observing circumstances (poor location in the sky, etc.). Even the case that everyone points to, C/1979 Y1 (Bradfield), as the best example, has an alternative explanation. I had a long string of observations that suggested that this comet had the characteristics of a flare in brightness near closest approach to the Earth. The value of n can change after a brightness flare. This would explain the observed light curve. What about comets that should have had a significant delta effect, C/1983 H1 and C/1996 B2, for instance. My analyses show no sign of such an effect. I'm sure that Joe has explanations for this, as well.

3) I do not agree with Joe (as he suggests in his rant) that "the best way to look for a delta effect, is not through the light curve itself." If it doesn't show up in the light curve, why should we care about it? This is one of those ignore the data arguments, if theory is correct (and of course, it must be), who cares if the data actually shows the effect?

Before leaving this subject, I want to state that I do not rule out the possible existence of a delta effect. Joe does make some compelling arguments for his theory, particularly when applied to the instrument effects problem. Accepting that his theory might be valid for the instrument effects, does not necessarily mean that the delta effect is real, however. I do not know for a fact that applying magnification is exactly the same thing as bringing an object closer when one observes a comet, for instance.

Finally and most importantly, I was greatly offended at the implication by Joe that the International Comet Quarterly would reject a paper simply because it dealt with a subject such as the delta effect. Daniel Green, ICQ editor, and I go to great pains to be fair to all submissions made to the ICQ. This is particularly true where we may disagree with the author(s). Papers are reviewed by a number of different referees, not just us. We would welcome a well-done paper on the delta effect, even from you Joe. I have tried to get Joe to submit such an article to the ICQ for many years. Joe, perhaps you will submit something now?

[Interestingly the latest issue of A&G has a letter relevant to this subject (Astronomy & Geophysics, 41, 5.8, October 2000). The author, John McFarland, claims that C/1999 S4 (LINEAR) shows an 'Opik Law' (delta effect) and refers to papers published by E J Opik in the Irish Astronomical Journal between 1963 and 1977. I will attempt to review these in the next issue. Jonathan Shanklin.]

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

I've received two reprints from Zdenek Sekanina about the SOHO sungrazing comets. The first looks at the distribution of the comet fragments and deduces from the fact that several comet pairs have been observed that low velocity fragmentation has probably occurred after perihelion and perhaps all the way to aphelion. The second looks at their tails and finds no evidence for electrostatic repulsion, so that only gravity and solar radiation pressure control the form of the tail. He finds evidence for microscopic silicate dust particles, which stopped being produced some 20 - 30 solar radii pre-perihelion.

The following abstracts (some shortened further for publication) are taken from the Cambridge Conference Network (CCNet), which is a scholarly electronic network devoted to catastrophism, but which includes much information on comets. To subscribe, contact the moderator Benny J Peiser at <b.j.peiser@livjm.ac.uk>. Information circulated on this network is for scholarly and educational use only. The abstracts, taken from daily bulletins, may not be copied or reproduced for any other purposes without prior permission of the copyright holders. The electronic archive of the CCNet can be found at http://abob.libs.uga.edu/bobk/cccmenu.html

ULYSSES'S SURPRISE TRIP THROUGH COMET'S TAIL PUTS HYAKUTAKE IN RECORD BOOKS RAS Press Notice from Jacqueline Mitton,

Comet Hyakutake, a bright comet seen by many people in 1996, developed the longest comet tail ever recorded. At 570 million km (360 million miles) it beat the previous claimed record of 330 million km (206 million miles) held by the Great March Comet of 1843. [Not really, one is a visual observation, the other by spacecraft] The discovery was made recently, when Dr Geraint Jones and Professor Andre Balogh of Imperial College, London, together with Dr Tim Horbury of Queen Mary and Westfield College, London analysed 1996 data from the Ulysses spacecraft. Their analysis of the magnetic field data returned from Ulysses on 1 May 1996 led them to conclude that Ulysses had passed through a comet's tail on that date. They then found that the tail belonged to Comet Hyakutake. The discovery is reported in the journal 'Nature' on 6 April 2000.

The joint European Space Agency-NASA spacecraft Ulysses was launched in 1990, and is in an orbit taking it over the poles of the Sun. It makes continuous measurements of the stream of charged particles called the solar wind which flows outwards from the Sun past the spacecraft. On 1 May 1996, Ulysses was 560 million km (347 million miles) from the Sun, when decidedly unusual things happened to the solar wind. The first odd feature to be noticed was a dramatic drop in the number of protons at Ulysses, which was reported in 1998 by another team of scientists led by Dr Pete Riley, then of the Los Alamos National Laboratory. They mentioned that a comet could explain some aspects of the odd results.

Comet nuclei are small bodies that were formed when our solar system Was young. They are typically a few kilometres across, and are composed of a mixture of ice and dust. When their orbits bring them close to the Sun, the rise in temperature makes them release gas and dust. The tiny dust particles are pushed away from the Sun by the pressure of sunlight, forming a dust tail. The gas particles eventually become electrically charged, forming ions. These ions join the solar wind flowing away from the Sun, forming an ion (or plasma) tail. When Jones and colleagues looked closely at the data returned from Ulysses's magnetometer instrument at the time, they realised that the solar wind's magnetic field lines displayed a herringbone pattern - a sign that the centre of whatever Ulysses had crossed had been moving slower than its edges. This is expected at comets, because the comet's ions slow down the solar wind when near the nucleus. This convinced them that the event was indeed due to a comet; so they began to search for the comet to which the tail belonged.

Finding the comet in question was not simply a case of looking for known comets between the spacecraft and the Sun on May 1 -

as Ulysses was so distant, the solar wind flowing at 750 kilometres per second could take days to reach the spacecraft. This gave time for the comet to move away from the Sun-Ulysses line, making it trickier to find. Comet Hyakutake (official designation C/1996 B2) had given Earth-bound observers a spectacular display during late March and early April, 1996, when it approached close to the Earth. Discovered by Japanese amateur astronomer Yuji Hyakutake in January 1996, the comet was at perihelion (its closest point to the Sun) on May 1 - the day of Ulysses's tail crossing. When Jones looked at where Hyakutake had been 8 days earlier, on April 23, it turned out that it had indeed been on the Sun-Ulysses line, and that from that point, it would take 8 days for the ion tail to be carried to Ulysses. Using the magnetometer data, the team found that the tail was the right size to belong to Hyakutake, and that it was parallel to the comet's orbital plane, as expected. The comet had been identified.

Apart from the great scientific value of an encounter with a fourth comet (comets Giacobini-Zinner, Halley and Grigg-Skjellerup have been visited by other spacecraft), several aspects of the tail crossing are particularly intriguing. The tail's length is most surprising - Hyakutake's tail was over 570 million km (350 million miles) long. This breaks the record for the longest measured tail, which is generally regarded to have been previously held by the Great March Comet of 1843, which had a visible tail around 330 million km (205 million miles) long. Had Hyakutake's tail been visible at the time from the Earth, it would have stretched over 80 degrees across the sky - a very impressive length for a comet so far away. However, at this time, it was invisible from Earth because its head was very close to the Sun in the sky.

Comets' ion tails are generally thought of as pointing almost straight away from the Sun. The magnetometer data from Ulysses reveal that at the spacecraft, the tail was definitely not doing this - it was travelling almost sideways. Jones and colleagues explain this by the comet's rapid motion around perihelion. Like the jet of water from a lawn sprinkler, Hyakutake's tail started out pointing away from the Sun. The further it got from the Sun however, the more it twisted away from the anti-sunward direction, as a lawn sprinkler spray twists. Ion tails are therefore curved, especially when comets are around perihelion. This has implications for some Earth-based comet observations. "A few weeks before Ulysses's tail crossing, some observers reported tail lengths for Hyakutake that were much longer than possible if comet tails are assumed to be straight, and pointing away from the Sun", says Jones. "The Ulysses magnetic field measurements show that these assumptions aren't true.", he continued, "Although it can't quite fully account for some of the longest tail lengths reported in late March and early April 1996, Hyakutake's tail would have been curved in the correct way around the Earth for observers to see a tail longer than previously thought possible."

When Ulysses crossed the tail, the comet's head was being observed by the LASCO coronagraph aboard the SOHO spacecraft, even though it could not be seen from Earth. "At this time," says Jones, "what was happening at the head of the comet didn't have any relevance to the tail at Ulysses. If you want to study the part of the tail crossed by Ulysses, you need to look at images of Hyakutake obtained around April 23. Unfortunately, few images were obtained then, as Hyakutake was sinking into twilight as seen from Earth." Nevertheless, the Ulysses results are providing unique information on the magnetic structures of ion tails.

The discovery, and identification of the parent comet by Jones and colleagues are only the beginning of the event's analysis. The study of the data returned from other Ulysses instruments will undoubtedly lead to a fuller picture of what happened when a distant spacecraft crossed an incredibly long tail. In the same issue of 'Nature', colleagues of Jones and co-workers, led by Professor George Gloeckler of the University of Maryland, report their independent discovery of cometary ions during the same event using another instrument aboard the spacecraft.

Several items appeared about comet 1997 K2. This is one.

Astronomers Find Fleeting Comet by Maia Weinstock, Space.com

In the spring and early summer of 1997, stargazers were treated to a beautiful sky show with the passing of wispy-tailed Comet Hale-Bopp. But scientists now say that while all eyes were on this dazzling sight, another near-Earth comet slipped quietly through the sky unnoticed.

Astronomers analyzing archived data from the European Space Agency/NASA Solar and Heliospheric Observatory (SOHO) spacecraft have recently reported the presence of a never-before-detected comet, which flew close to Earth in 1997. The comet, C/1997 K2, was apparently brighter than every comet discovered by astronomers in the six months preceding its appearance, adding to the mystery of how such a prominent comet may have zoomed past Earth unseen.

"To say we were surprised would be a bit of an understatement," said Finnish astronomer Teemu Makinen, lead author of a paper in Nature, which describes the new comet discovery. "It sounded quite unlikely [to us] that a comet of such magnitude could elude both professionals and amateurs alike."

Despite its brightness, Comet K2 would not have been visible to the naked eye. Yet even "inexpensive amateur equipment would have sufficed" for stargazers to see the comet, said Makinen. "I believe that many amateurs were lured by the spectacular display of the concurrent Comet Hale-Bopp," he explained.

Professional astronomers could have easily spotted the comet, since the equipment they use is much more powerful than the average telescope. So here's the question: how did they miss it? The combination of vast expanses of space and limited resources with which to scan them are the most likely reasons, experts say. "Our records are patchy, especially at high latitudes," said Makinen. "It was probably missed by dedicated surveys because of its trajectory, which went through the southern ecliptic pole."

Though it slipped by unnoticed by human eyes, evidence for the K2 comet was captured by SOHO's Solar Wind Anisotropies (SWAN) instrument from May to July of 1997.

The SWAN instrument is not dedicated to comet discovery. Rather, it was designed to observe emissions of hydrogen around the sun at ultraviolet wavelengths. But these emissions, known as Lyman-α emissions, are also given off in high quantities by comets. As a result, though its resolution is relatively poor, the instrument is also sensitive to comets.

The discovery of Comet 1999 K2 raises an interesting question: How prepared are we to track near-Earth objects, including comets and asteroids. If we missed this comet, some experts ask, what are the chances that we'll miss a comet that's heading straight for Earth?

A great deal of work has taken place to locate and categorize near-Earth objects like comets and asteroids. Although it may sound like science fiction, scientists say that the threat of comet impacts on Earth is very real.

So what are the chances of a comet hitting Earth, or of astronomers missing a potentially dangerous on-coming object. No one really knows. What astronomers do know, however, is that better funding for continual sky scans would help them map all comets that streak through the solar system.

"It is just a matter of prioritization. Do we want to use limited resources on preventing something that is likely to happen every day and cause moderate casualties -- like traffic accidents – or something that will happen once in 30 million years but has potential for wiping out all of humankind?" asked Makinen. "In such situations, unfortunately, myopia is usually bliss."

I commented that a few points seem to have been missed in the information released about the comet:

1. It is not a near earth comet. The closest it approached was 1.17 AU.
2. The comet was not observable from most of the Northern Hemisphere. The discovery clearly shows that there are some objects that would always be missed by a Northern Hemisphere search program.
3. Looking at a comet catalogue doesn't tell you if the comet was observable. Of the six LASCO comets mentioned in the Nature review only one was actually observable, even by the search programs.
4. Some of the amateur discoveries are close to the sun rather than out of the ecliptic. This area is not searched by most programs.
5. The comet is very unlikely to have been visible in binoculars when its brightness is estimated to have not exceeded 11th magnitude.
6. The comet passed around 5 degrees north of the Large Magellanic Cloud around 1997 July 7 when it could have been near 11th magnitude. It might show on some amateur pictures as the moon was then near new.
7. Assuming that the comet followed a fairly normal light curve it is reasonable to suppose that to the search programs it would be 4 magnitudes fainter than indicated by visual observations and would follow an inverse square law for brightness. It is fairly easy to calculate where the comet would be and how bright it might be, although the orbit is not highly accurate. The comet would probably have been visible from the LINEAR site from January to May 1998 when it was probably brighter than 19th magnitude. The search plots on the LINEAR web site suggest that the likely area through which the comet passed was searched. It was therefore presumably fainter than the detection limit at the time.

In a commentary accompanying another article, astronomer Michael A'Hearn of the University of Maryland said that the failed detection of the comet three years ago may be a sign that current search efforts are skewed towards asteroids 1 km or larger in diameter, despite the fact there are likely many more smaller bodies that could wreak major damage if they struck the Earth.

Jeff Larsen added this comment: This was a failure in detection from three years ago, and not from the "current search efforts". Three years ago, out of the relatively major (all sky coverage surveys), none were in full operation yet (Spacewatch was, but it doesn't cover the sky each lunation). In other words, most likely a 1-km object would have escaped detection as well. I think the question more appropriately should be would such an object, if it were in the sky this year, escape the current system?

Working for a search group, I am the last person who would argue against additional resources. Obviously, we need to start pushing faintward to complete the inventory to smaller and smaller objects. There is a balance, however, in what can be accomplished and what can be accomplished with reasonable (or available) resources. Three years ago I started working for Spacewatch. Since then, I have seen nothing but a steady increase in capability of the search programs. I have not the growth in search capability mentioned as a variable in any comments regarding the theory of surveying.

Comet P/Gehrels 3: spectroscopic observations and nucleus models. M.C. DeSanctis*), M. Lazzarin, M.A. Barucci, M.T. Capria, A. Coradini: ASTRONOMY AND ASTROPHYSICS, 2000, Vol.354, No.3, pp.1086-1090

In the framework of an observational campaign for increasing the knowledge on the relationship between cometary nuclei and asteroids, we performed spectroscopic observations of P/Gehrels 3. The Jupiter family comet P/Gehrels 3 moves on a particular orbit, with a very high Tisserand invariant with respect to Jupiter, that makes the encounters with the planet very effective. This implies that the comet spends part of its life as a temporary satellite of Jupiter, on an orbit that shows similarity with those of Trojans. This comet has been observed when it was far from the Sun, with the aim to acquire data on the nucleus status. In order to study from a theoretical point of view the possible status and evolution of a body on this orbit we have developed different nucleus models using a numerical code for the thermal evolution of the nucleus. Copyright 2000, Institute for Scientific Information Inc.

NOBLE GAS DETECTED IN COMET HALE-BOPP Southwest Research Institute (SwRI) Press Release

San Antonio, June 5, 2000 -- Astronomers announced today at the American Astronomical Society meeting in Rochester, New York, that they have detected argon, a scientifically valuable noble gas, in comet Hale-Bopp. This discovery constitutes the first-ever detection of a noble gas in a comet. Noble gases provide valuable tracers of the thermal history and, therefore, clues to the origins of comets. The discovery was made by a team of four astronomers from Southwest Research Institute, based in San Antonio, Texas, collaborating with three colleagues from the University of Colorado, the University of Maryland, and the Observatoire de Midi-Pyrenees in France. The study was supported by NASA. The data on comet Hale-Bopp were obtained in the form of ultraviolet spectra during a NASA high-altitude suborbital research rocket flight on the evening of March 29, 1997, just as comet Hale-Bopp made its closest approach to the sun. According to team leader and Principal Investigator Dr. Alan Stern, director of the SwRI Space Studies Department, "The argon signals are weak, but unmistakable. We had previously suspected their presence, but were able to recently confirm the result when we cross-compared two independent spectra obtained by our rocket instrument back in 1997."

Adds co-investigator Dr. David Slater, a senior research scientist at SwRI, "Hale-Bopp was among the brightest comets ever witnessed, and surely the brightest comet in modern times. The detection of argon would not have been possible except for Hale-Bopp's unusually high brightness."

Because noble gases do not interact chemically with other elements and because noble gases are easily lost from icy bodies like comets at very low temperatures through processes much like evaporation, their presence or absence provides a way of measuring the thermal history of comets. University of Maryland astronomer and team member Dr. Michael A'Hearn explains, "That's the reason cometary astronomers have wanted to detect noble gases for so long. The advance of technology combined with the brightness of Hale-Bopp made this goal a reality." Interestingly, the team's spectra showed that the argon abundance in Hale-Bopp was so high that it indicates the comet has always been quite cold and likely formed in the deep outer reaches of the solar system, far beyond its once-suspected birthplace in the somewhat warmer Jupiter zone. "Our results indicate that Hale-Bopp was likely formed in the Uranus-Neptune zone," says Stern. The high argon abundance of Hale-Bopp may also help explain the unexpected findings by the Galileo Jupiter entry probe, which found that Jupiter has an argon abundance similar to comet Hale-Bopp. "Perhaps Jupiter was seeded with extra argon by the impact of many comets like Hale-Bopp early in the history of the solar system," remarks Stern.

The detection of argon in Hale-Bopp has whet the scientists' appetite for more noble gas data on comets. The team is preparing an instrument called the ALICE Ultraviolet Spectrometer for NASA to fly to comet Wirtanen aboard the European-U.S. Rosetta comet orbiter mission to be launched in 2003. The team has proposed a series of additional NASA rocket launches in 2002 and 2003 to search for argon and other noble gases, even before the Wirtanen orbiter mission is launched. Stern says, "Using this even more sensitive generation of instruments, we look forward to comparing different comets to one another to learn about the diversity of cometary birthplaces."

COMET LINEAR BREAKUP IS BOON TO SCIENTISTS By Ray Villard, from Space.com

The swift and untimely breakup of the doomed Comet Linear is much more than simply a curious celestial fireworks show.

For the first time in history, astronomers have gotten a detailed look at how the amalgam of dust and ice in a comet nucleus is actually packaged. This comes from spectacular close-up pictures taken several days ago by the Hubble Space Telescope and follow-up observations by the Very Large Telescope in Chile. Hubble first showed that the icy nucleus - the fountainhead of the comet's gossamer tail -- fell apart into a cluster of "mini-comets." Each fragment is probably smaller than a football field.

Seeing the "subassembly" of a comet nucleus provides a clear blueprint of the internal structure of comets and helps settle the debate over whether they are flying "gravel piles," or are built up from consecutively smaller pieces, like the Russian Matrushka toy of nested dolls.

The comet's solid nucleus was assembled from these mini-comets -- or cometesimals -- at about the time of the birth of the planets in our solar system 4.5 billion years ago. Seeing the comet come apart in such fine detail is like opening a time capsule containing the long-sought relics of the early solar system.

In estimating the number of planets in our galaxy, astronomers need to know how they formed around stars. Astronomers have seen both ends of the planet construction process. They've cataloged over 50 extrasolar planetsand Hubble has surveyed over 100 embryonic disks of fine dust around stars out of which the planets will presumably condense. But the process itself cannot be seen, so astronomers must look for fossil evidence within our own solar system.

Like the planets, comets were built up from micron-sized grains of dust no larger than the thickness of a human hair. Over tens of millions of years, the dust clumped together with ice to form snowball-like frozen bodies measuring dozens of feet (meters) wide.

These "cometesimals" gently merged, sticking together to build up comet nuclei, which then grew to a few miles (kilometers) across. Some of these nuclei continued to coalesce to form the icy solid cores of the gas-giant planets. Once the giant planets formed, they gravitationally captured or tossed the remaining comet nuclei out of the solar system to create the Oort cloud.

Knowing how comets are put together offers clues on how to deflect or destroy a wayward comet that might collide with Earth. © 2000, Space.com

NEA SURVEY STATUS FROM DON YEOMANS
Minutes taken during the Near-Earth Object Observers meeting held August 15, 2000 during the IAU General Assembly in Manchester England

This gathering was the second meeting of the Near-Earth Object (NEO) observers to discuss efforts to maximize the NEO discovery rate among the entire international observing community. The first meeting, which included only the NASA supported search efforts, took place September 20-21, 1999 at MIT's Lincoln Laboratory in Cambridge, Massachusetts.

Don Yeomans opened the meeting at 11:00 and welcomed the community of NEO observers and several interested IAU attendees. Yeomans noted that the goal of this meeting was to discuss plans to maximize the discovery rate of NEOs among the international community of NEO observers and to investigate the extent to which coordination among the various teams would help reach the Spaceguard goal. The Spaceguard goal is to discover 90% of the near-Earth asteroids (NEAs) larger than one kilometer within 10 years. The assumption is made that a NEA with an absolute magnitude (H) less than 18.0 has a diameter larger than one kilometer. Recent work by Rabinowitz et al. (2000), Bottke et al. (2000), and Harris (2000) suggest that the total population of near-Earth asteroids (NEAs) larger that one kilometer (H < 18.0) is about 700, 900, and 1000 respectively. In an earlier session of the IAU Working Group on NEOs (D. Morrison, Chair), Yeomans presented charts that showed a dramatic increase in the NEA discovery rate in recent years (over 400 NEAs larger than one km through July 2000). During the same WGNEO meeting, Al Harris presented his analysis suggesting that at the current rate of discovery, the Spaceguard goal of discovering 90% of the NEAs larger than one kilometer in ten years, would be reached not in 2009 but rather in about 2015. Harris noted that to achieve the Spaceguard Goal would require large NEA discoveries at roughly twice the current rate. Hence we may be 40 - 50 % of the way toward meeting the Spaceguard goal in terms of raw numbers, but certainly not in terms of the time interval required.

Appendix: Short summaries of the status of the survey efforts.

Catalina Sky Survey (S. Larson):
The Catalina program consists of both a northern and southern hemisphere search and follow up capability. In the north, the Catalina Schmidt 0.7m (f/1.6) telescope is used for search while the Mt. Lemmon 1.5 m (f/2.0) is used for follow up observations. In the south, the Siding Spring Uppsala Schmidt 0.6 m (f/3) is currently being used for search while the co-located 1.0 m (f/8) telescope is used for follow up. Upgrades are in progress for the Catalina Schmidt (corrector plate, new computers, dome control), the Uppsala Schmidt (declination drive and control room), and Mt. Lemmon (declination drive, computer controls, coma corrector). Proposed upgrades include a thinned 4K x 4K chip for the Catalina Schmidt, a 0.9 m (f/1.7) optical system redesign for the Uppsala Schmidt and a larger 4K x 4K chip for the Mt. Lemmon telescope.

LINEAR (G. Stokes):
While efforts to utilize the U.S. Air Force one meter aperture Ground-based Electro-Optical Deep Space Surveillance (GEODSS) telescopes for discovering NEAs go back several years, it was in March 1998 that the LINEAR program began routine operations using a special 1960 x 2560 CCD camera. This CCD is a thinned, back side illuminated, frame transfer device that allows very fast readouts. In October 1999, a second co-located GEODSS telescope was added to the LINEAR survey and the combination of these two telescopes now accounts for roughly 70% of all NEA discoveries.

LONEOS (E. Bowell):
The LONEOS 0.6 m Schmidt telescope (f/1.9) is currently making about 15,000 asteroid detections per lunation. With the recent improvements in computer software (Sextractor) and the new camera (two 2K x 4K thinned backside illuminated CCDs), the current detection rate is about twice what it once was. Ted Bowell noted that while an improvement to the current thermal environment might increase the system efficiency somewhat, the current system has gone about as far as it can so that plans are underway to investigate the use of the USNO 1.5 m telescope in Flagstaff for future NEA searches.

NEAT (E. Helin):
NEAT began operations with the 1.0 m GEODSS telescope at Haleakala, Maui, Hi in 1995. In 1999, NEAT was moved to the use of the MSSS 1.2 m telescope at the same location and began operations there in February 2000. The current telescope not only has a larger aperture but is available 18 nights per month whereas the GEODSS telescope was only available about 6 nights/month. In addition, upgrades are already in progress to convert the Palomar 1.2 m Schmidt telescope into a NEA search instrument with operations expected to begin in October 2000. The Maui MSSS 1.2 m telescope uses a 4Kx4K CCD with a field of view of 2.6 sq. degrees whereas the Palomar Schmidt will utilize an array of three 4Kx4K CCDs for a field of view of 3.9 sq. degrees.

Spacewatch (R. McMillan)
The Spacewatch telescopes include the 0.9 m and the 1.8 m. When used with the 4 x (4.6K x 2K) mosaic CCD, the 0.9 m has a field of view of 2.9 sq. degrees. When brought on line at the end of 2000 *[it found its first asteroid on September 14]*, the 1.8 m telescope will have a field of view of 0.32 sq. degrees and utilize a 2K x 2K CCD. The average rate of discovery of NEAs with H < 18.0 has been about 7 per year since 1995. The Spacewatch telescopes are used primarily for deep searches in limited areas for NEAs and Kuiper-belt objects (KBOs) rather than the wide area NEA searches provided by the other search programs. As a result, Spacewatch finds many of the smaller NEAs, some KBOs and recently, the 17th satellite of Jupiter.

PHYSICAL PROPERTIES OF THE NUCLEUS OF COMET 2P/ENCKE Y.R. Fernandez, C.M. Lisse, H.U. Kaufl, S.B. Peschke, H.A. Weaver, M.F. A'Hearn, P.P. Lamy, T.A. Livengood, T. Kostiuk: ICARUS 147: (1) 145-160 SEP 2000

We report a new study of the nucleus of Comet 2P/Encke, which the CONTOUR spacecraft is scheduled to encounter in November 2003. During the comet's close approach to Earth in July 1997, we measured the mid-infrared thermal and optical scattered continua with data from the TIMMI instrument (imaging) at the ESO 3.6-m telescope (wavelength lambda from 8 to 12 mu m), the ISOPHOT instrument (photometry) aboard ISO (3.6 mu m less than or equal to lambda less than or equal to 100 mu m), and the STIS instrument (imaging) aboard HST (5500 Angstrom less than or equal to lambda less than or equal to 11000 Angstrom). The optical images show the nucleus with very little coma contamination, and the ISO photometry allowed us to separate the comatic and nuclear contributions to the ESO images. We used the Standard Thermal Model for slow rotators to calculate an effective nuclear radius of 2.4 km +/- 0.3 km. The comet's mid-IR light curve implies a nuclear rotation period of 15.2 h +/- 0.3 h, although some subharmonics of this also satisfy the data. If we assume that the nucleus is a triaxial ellipsoid in principal short axis rotation with the axis direction in 1985 as derived by Sekanina (1988, Astron. J. 95, 911), then by combining our data with light curves from the 1980s we find that the nucleus' angular momentum vector migrates, making a would-be circle in less than 81 years, and that one axial ratio is at least 2.6. The nucleus' optical linear phase coefficient is 0.06 mag/degree, making it one of the most phase-darkened objects known. The surface is also rougher than that of most asteroids, The visual geometric albedo is 0.05 +/- 0.02, within the range found for other cometary nuclei. (C) 2000 Academic Press.

COMETS MAY BE A WORRY BUT ARE STILL RATHER PREDICTABLE From Brian G. Marsden

Certainly, Bob Kobres is right to point out the close approach of Lexell's Comet to the earth in 1770, despite the fact that this comet had a perihelion distance of 3 AU prior to its Jovian encounter three years earlier. I used a somewhat fictionalized version of the Lexell story in my presentation of some spoof "eighteenth-century IAU Circulars" at an NEO conference in Sicily seven years ago. We must indeed be aware that comets can surprise us in unusual ways.

But Bob speaks of PHOs. Appropriately homonymous though this term may be, I have not advocated its use for comets. At the U.N. NEO conference in 1995 I introduced the term PHA for an asteroid with an orbit coming within 0.05 AU of that of the earth (and of absolute magnitude 22.0 and brighter, although maybe we need now to extend this to intrinsically fainter objects) but remarked that the corresponding PHC was not a useful concept. This was precisely because almost all asteroids would not switch from PHA to non-PHA status (or vice versa) over the course of a century or so (and it is quite sufficient to take the earth's orbit to be a fixed circle for this purpose), whereas Jupiter can frequently and dramatically change the paths of the rather smaller number of known short-period comets, and we need to--and usually can--specifically study such changes.

As Bob indicates, the study of the motions of comets is also complicated by the effects of the loss of material associated with the sublimation of ices. One can indeed be suitably wary of active comets. But, as he says, it is also clear that there are *inactive* comets, therefore indistinguishable from asteroids in appearance. Of course, if they are truly inactive, either having lost all their ices or having the ices completely smothered by nonvolatile material, their motions are quite gravitational. We in fact know of some comets that are only mildly active, and we have seen that their motions are affected little, if any, by outgassing. Much cometary outgassing is in fact rather predictable.

Might we be missing such activity on what we think of as asteroids when they are near perihelion? That is something I have wondered about from time to time, particularly when the perihelion distance is small enough that the object can not then be observed in a dark sky. What one *can* say is that the orbits of well-observed, small-perihelion objects like Icarus and Phaethon are completely compatible with point-mass dynamics (including relativistic terms, of course), even though the former is just coming up its 46th passage some 28 million km from the sun since discovery.

This is not to say that an "asteroid" could not surprise us in this way, to the extent of making the difference between an impact and a miss a Century hence for an object whose orbit we think we know very well. But the predicted miss would surely be enough of a "near-miss" to interest us, and we still get to monitor the object, including its physical appearance, between now and then, thus steadily improving the prediction until the outcome is clear.

Review of comet observations for 2000 April - 2000 October

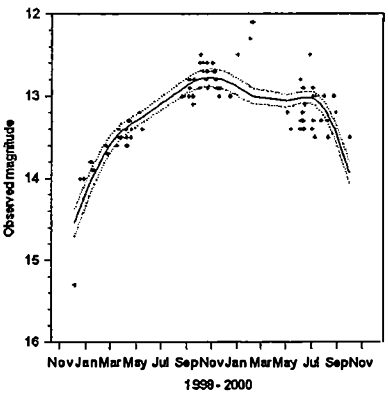
The information in this report is a synopsis of material gleaned from IAU circulars 7398 – 7505 and The Astronomer (2000 April – 2000 September). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

Hale-Bopp (1995 O1) is still being observed from the Southern Hemisphere, but only just. Andrew Pearce managed to spot it at around 14th magnitude in early July, but there have been no recent positive observations.

Spacewatch (1997 BA6) is another 'old' comet still under observation, but it is now beginning to fade. Southern

Hemisphere observers will be able to follow it for the remainder of the year. The uncorrected preliminary light curve is m = 4.6 + 5 log d + 9.8 log r from 97 observations.

Comet Spacewatch (1997 BA6)

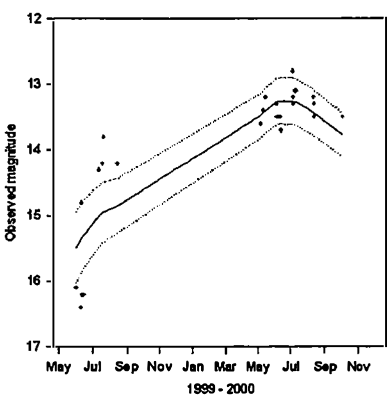


Werner Hasubick made a final couple of observations of **1999 H3 LINEAR** in May and June, when it was 14th magnitude.

A few further visual observations of **1999 J2 Skiff** were made, although the comet was 15th magnitude.

T. Fukushima, T. Nakajima, and J. Watanabe, National Astronomical Observatory of Japan (NAOJ), reported that I-band CCD images of comet 1999 J2 taken with the NAOJ 0.50-m telescope showed a dust anti-tail at the large heliocentric distance of 7 AU (the comet having passed perihelion on April 5). The earth crossed the comet's orbital plane on May 10.4 [IAUC 7415, 2000 May 5]

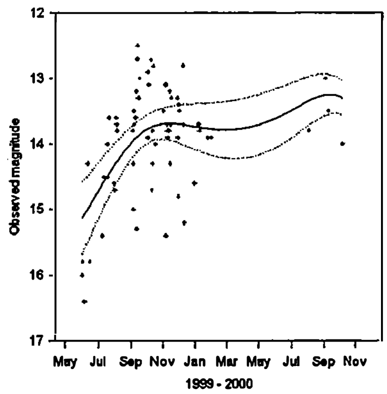
Comet LINEAR (1999 K5)



1999 K5 LINEAR is currently around 13th magnitude visually, and has now passed perihelion, at high southern declination. Michael Mattiazzo reported it at 13.2 on July 4. 27 observations received so far give an uncorrected preliminary light curve of 6.7 + 5 log d + 8.2 log r

Scattered observations of **1999 K8 LINEAR** have continued, with observers estimating it at around 14th magnitude. Now past perihelion, it is at its brightest because the distance from earth is at its smallest. 72 observations give an uncorrected preliminary light curve of -2.1 + 5 log d + 19.7 log r

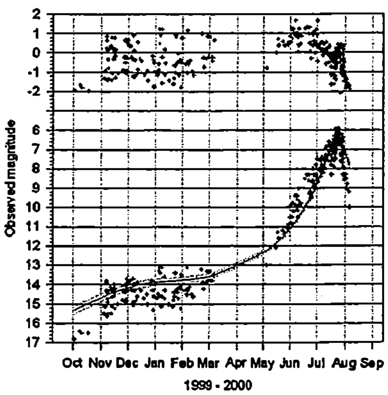
Comet LINEAR (1999 K8)



1999 S4 LINEAR brightened quite slowly, which seems to be a feature of 'new' comets. Astrometric observations show that it is making its first visit to the inner solar system and therefore behaviour in a similar fashion to comet Kohoutek was expected.

D. Schleicher, Lowell Observatory; and C. Eberhardy, University of Washington, used the Hall 1.1-m telescope at Lowell Observatory to obtain narrowband photometry of comet C/1999 S4, with the following averaged results: June 10-12, log Q(OH) = 28.41, log Q(CN) = 25.54, log Af(rho) = 2.83 (cf. IAUC 7342); July 13 (seven sets), log Q(OH) = 28.24, log Q(CN) = 25.45; log Af(rho) = 2.55. The equivalent log Q(water; vectorial) is 28.42 for July 13, and no significant temporal or aperture variations were observed. Significant variability was observed during the June observations, with the gas-production rates on June 11 being 30--50 percent larger than on June 10, and then on June 12 dropping to 10 percent less than on June 10. [IAUC 7455, 2000 July 16]

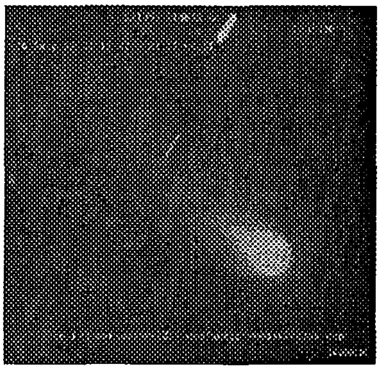
Comet 1999 S4 (LINEAR)



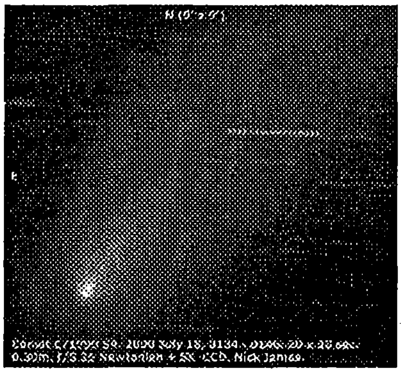
Brian Marsden issued several orbital updates. Although earlier orbital elements predicted the comet's position to at worst 0'.1, many users were unable to reproduce the ephemeris correctly for themselves because of the need to incorporate the nongravitational parameters. These parameters are quite large for this comet, and their effect on the ephemeris computed back from the standard 2000 Aug. 4 epoch was augmented by the rather small value of Delta. Some users also commented on the fact that the eccentricity in the nongravitational solution is significantly smaller than that in a gravitational solution, such as that on MPEC 2000-N15. This is a normal phenomenon and does not alter the likelihood that this is a "new" comet in the Oort sense. [MPEC 2000-O07, 2000 July 19]

H. Weaver, Johns Hopkins University, on behalf of the Hubble Space Telescope (HST) ToO comet team, reports the following results: "HST images of the comet show a dramatic increase in activity on July 5, with the flux in a 0".15 square aperture increasing by a factor of about 1.5 in just under 4 hr (from July 5.776 to 5.940 UT). During HST observations one day later (July 6.717-6.889), the activity levels were decreasing and were about 3 times lower for the final observation, compared to the peak value from the previous day. The flux in the last HST image (on July 7.961) was about 7 times lower than the peak value measured on July 5. On July 7, at least one 'fragment' is seen 0".85 (460 km, projected) from the nucleus in the tailward direction, and a sharp tailward spike of emission is observed, reminiscent of the morphology observed during the outburst in C/1996 B2

(Hyakutake) in late-March 1996. HST spectroscopic data taken on July 5 with STIS show evidence for emissions from CO, C, H, O, and possibly S. S_2, CS, and OH were detected during STIS observations on July 6, and OH, CS, NH, and possibly S_2 were detected on July 7. Preliminary production rates are 5 x 10**26 (July 5), 1.4 x 10**24 (July 6), and 1.2 x 10**29 (July 6) for CO, S_2, and H_2O, respectively, but the CO and S_2 values could change by a factor of about 2 or so, pending final analysis. Nevertheless, one firm conclusion is that CO is strongly depleted in C/1999 S4, relative to the observed abundances in C/1996 B2 and C/1995 O1." [IAUC 7461, 2100 July 20 (sic)]

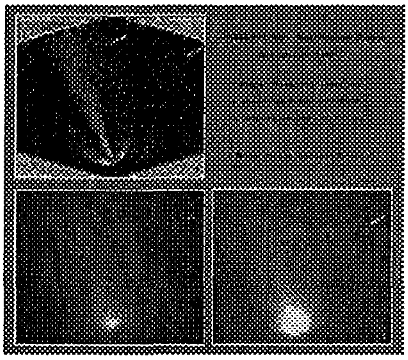


C. Lisse and D. Christian, Space Telescope Science Institute; K. Dennerl, Max-Planck-Institut fur Extraterrestrische Physik; F. Marshall, R. Mushotzky, R. Petre, and S. Snowden, NASA/Goddard Space Flight Center; H. Weaver, Johns Hopkins University; B. Stroozas, University of California; and S. Wolk, Harvard-Smithsonian Center for Astrophysics, report the first detection of x-ray line emission due to charge exchange between cometary neutrals and solar-wind minor ions using Chandra and EUVE: "Using a 960-s ACIS-S observation of comet C/1999 S4 on July 14.20 UT, the comet was detected with a rate in the S3 chip of 0.3 count/s, with a total integral flux of 8 x 10**-13 erg s**-1 cm**-2 over 0.2-0.7 keV and a total x-ray luminosity of 6 x 10**14 erg/s. The ACIS-S spectrum showed a strong line at 570 eV detected at greater than 10 sigma, due to charge exchange to O VII. Other lines due to charge exchange are also present (e.g., N VI, N VII at 300-500 eV, O VIII at 650 eV) at lower S/N. The best fit to the preliminary spectrum is the MEKAL multiple-line emission model (Mewe et al. 1986, A.Ap. Suppl. 65, 511) using solar elemental abundances with enhanced oxygen and nitrogen abundances, and a plasma temperature of 0.17 keV. The EUVE Lexan B count rate at July 14.21 was 0.06 count/s in 5400 s, for an equivalent luminosity of 1 x 10**15 erg/s at 0.16 keV. The observed emission was found to be highly time variable on the order of hours, enhanced by a strong solar flare propagating radially from the sun." [IAUC 7464, 2000 July 25]



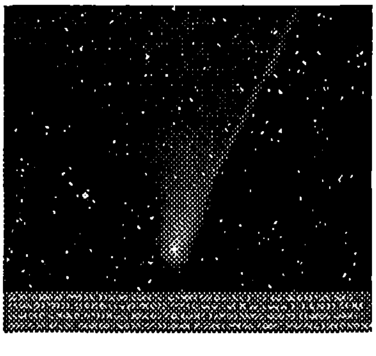
I. de Pater, University of California, Berkeley, with M. R. Hogerheijde, M. C. H. Wright, R. Forster, W. Hoffman, L. E. Snyder, A. Remijan, L. M. Woodney, M. F. A'Hearn, P. Palmer, Y.-J. Kuan, H.-C. Huang, G. A. Blake, C. Qi, J. Kessler, and S.-Y. Liu, report the detection of HCN from comet C/1999 S4 at the Berkeley-Illinois- Maryland-Association (BIMA) Array in autocorrelation mode: "The peak antenna temperature in a 130" beam, averaged over July 21-24 (about 10 hr total on source), was 3.5 +/- 1 mK (a signal suggesting an outgassing rate a few percent that of C/1995 O1). No signal was detected in cross-correlation mode with the combined Owens Valley Radio Observatory and BIMA data (the virtual Combined Array for Research in Millimeter-wave Astronomy). This suggests a source size slightly larger than expected for a Haser model." M. Kidger, Instituto de Astrofisica de Canarias, writes that nightly observations made since July 23 in U, B, V, R, and Z broadband filters with the 1-m Jacobus Kapteyn Telescope show what appears to be the complete disruption of the comet's nucleus: "The central condensation was highly condensed and showed the typical 'teardrop' form on July 23.9 and 24.9 UT, although its brightness decreased by a factor of about 3 between the two nights. On July 25.9 the central condensation was seen to be strongly elongated (length about 15") in p.a. 80 deg, with a very flat brightness distribution. The condensation's brightness faded further and its length increased to about 30" and 45"-50" (p.a. 80 deg) on July 26.9 and 27.9, respectively. On July 27.9, there was no evidence of any local brightness peak that would indicate the presence of subnuclei. The expansion velocity of the condensation is about 40 m/s, indicating that it is particulate material and not gas. The gas tail, which virtually disappeared between July 23.9 and 24.9, has reformed as an extension of the major axis of the central condensation." [IAUC 7467, 2000 July 27]

J. Licandro, G. Tessicini, and I. Perez, Centro Galileo Galilei; and S. Hidalgo, Instituto de Astrofisica de Canarias, report that the inner coma of C/1999 S4 appears extremely elongated in the tailward direction on J, H, and K_s images obtained with the 3.6-m Telescopio Nazionale Galileo (+ ARNICA camera) at La Palma on July 26.9 and 27.9 UT. There is no clear central condensation, but the photometric peak appears to move from the anti-tailward border of the coma toward p.a. 81 deg on July 26.9 and 84 deg on July 27.9, with a velocity of 7".4/day (26 m/s). The brightness of the central coma decreased from J = 8.83 +/- 0.04 on July 26.9 to 9.46 +/- 0.07 on July 27.9, as measured in a 30"-diameter aperture around the peak. Color maps do not show any major structure, the mean colors being J-K = +0.61 +/- 0.05, and H-K = +0.12 +/- 0.06 on July 26.9. These data suggest that a major event has occurred in the nucleus of the comet. A. V. Filippenko and R. Chornock, University of California at Berkeley, report that inspection of a CCD spectrum (range 320-1000 nm) of this comet obtained on July 28 UT with the Shane 3-m reflector at Lick Observatory reveals no clear emission lines superposed on the solar reflection spectrum, unlike the case in spectra they obtained with the same instrument on July 6 and June 27. There is no evidence for the normally strong CN emission near 380 nm. The comet's morphology is peculiar, lacking an obvious head that is brighter than the adjacent tail, although the leading edge of the head/tail combination is very sharply defined. S. Nakano, Sumoto, Japan, writes that A. Asami (Bisei Spaceguard Center) was unable to find a peak in the comet's central-condensation brightness to determine an astrometric position from a CCD image taken in fair conditions on July 28.490 UT with a 0.25-m f/5 reflector. [IAUC 7468, 2000 July 28]



Further to their item on IAUC 7468, Filippenko and Chornock report that full reduction of their CCD spectrum obtained on July 28 shows that CN emission near 380 nm is actually present; the CN was not initially noticed in the two-dimensional spectrum because it spans the entire slit, making it resemble a night-sky emission line. In contrast, the continuum (reflected sunlight) is visible only on part of the slit, ending abruptly (as mentioned on IAUC 7468). [IAUC 7470, 2000 July 30]

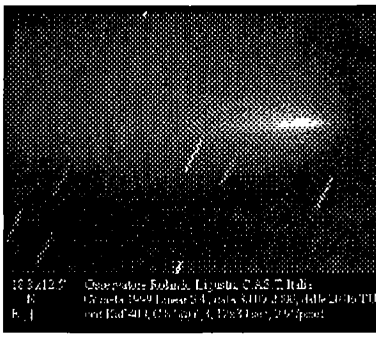
Z. Sekanina, Jet Propulsion Laboratory, reports: "The unusually large nongravitational forces found by B. G. Marsden (MPEC 2000-O07) suggest that comet C/1999 S4 was a trailing fragment of a more massive comet that has been moving in the same orbit, arrived at perihelion long (centuries?) ago but (not surprisingly) was missed. Trailing fragments of known comet pairs have a tendency to sudden disintegration (e.g., Sekanina 1997, A.Ap. 318, L5). If much of the comet's mass did indeed dissipate into a cloud of dust in the recent event, as suggested by M. R. Kidger (IAUC 7467) and others, the total mass involved could be estimated by further monitoring the tail. Experience with the past initially bright comets that later became headless and disappeared shows that a narrow, bandlike tail--a developing synchronic formation--should survive the head by several weeks or even longer (Sekanina 1984, Icarus 58, 81). A very preliminary analysis suggests that the event may have begun as early as July 23.6 UT and involved submillimeter-sized and larger dust (repulsive accelerations up to 0.024 of the solar attraction). The position angle and approximate length of this tail feature are then predicted to reach: July 30.0 UT, 90 deg, 2'; Aug. 4.0, 98 deg, 4'; 9.0, 102 deg, 7'; 14.0, 104 deg, 10'; 19.0, 105 deg, 12'; 24.0, 106 deg, 15'; 29.0, 106 deg, 17'. Especially toward the end of this period, the predicted length probably is a crude upper bound. If no such tail persists, the comet's upper mass limit should be tightly constrained, or the amount of dust lost in the event did not represent a substantial fraction of the total mass." [IAUC 7471, 2000 July 30]



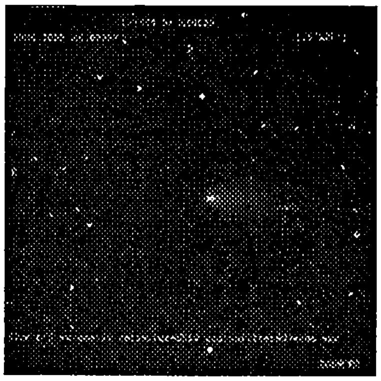
M. Kidger, Instituto de Astrofisica de Canarias, reports analysis of continued observations of C/1999 S4 at La Palma: "A 100-s exposure in R, taken by R. Corradi and N. O'Mahoney (Isaac Newton Group of Telescopes) on Aug. 1.9 UT with the Wide Field Camera on the 2.5-m Isaac Newton Telescope, shows no evidence of a nuclear condensation or subnuclei within the coma. The seeing (measured from a short exposure at the same airmass) was 1".5. It is thus highly improbable that any fragments of the nucleus of significant size exist within the coma. The coma shows a similar structure to that reported previously, with a well-defined sunward boundary to the coma similar to the point of a lance, although the brightest part of the coma is now displaced 1' tailwards. The tail can be traced at least 20'." [IAUC 7472, 2000 August 3]

Further to IAUC 7472, M. Kidger reports that the limiting magnitude for a 5-sigma point source detection in the Isaac Newton Telescope images taken on Aug. 1.9 UT is R = 22.0. He adds that the continued presence of a well-defined leading edge or point to the coma suggests that an unresolved fragment of the nucleus in this position continues to release dust. However, this structure has faded considerably since the disruption occurred. Measurements of the coma brightness distribution indicate that the maximum of light is about 75" from the leading border of the coma. [IAUC 7474, 2000 August 5]

D. Schleicher and L. Woodney, Lowell Observatory, write: "We used the Hall 1.1-m telescope (+ 95"-diameter aperture) at Lowell Observatory to obtain narrowband photometry of comet C/1999 S4 (centered at the nominal ephemeris position; cf. MPEC 2000-O02), yielding the following production rates: log Q(OH) = 27.4; log Q(CN) = 24.4; log Af(rho) = 1.5 (cf. IAUC 7342). The equivalent log Q (water; vectorial) is 27.6. The values are 8-10 times less than those measured on July 13 (cf. IAUC 7455)." [IAUC 7475, 2000 August 7]

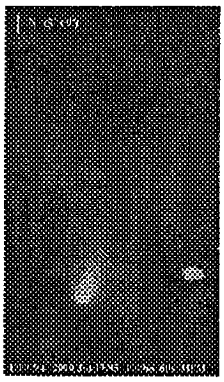


H. Weaver, Johns Hopkins University, and R. West, European Southern Observatory, on behalf of a large group of collaborators, report the following results: "Hubble Space Telescope (HST) images taken during Aug. 5.167-5.396 UT and Very Large Telescope (VLT) images (image quality about 0".6) taken during Aug. 6.978-6.999 revealed about a dozen active fragments, most of them located within about 20" of the western tip of the dust tail (cf. IAUC 7474). The correspondence between fragments in the HST and VLT images is generally very good, but the brightest fragment in the HST image is not seen in the VLT image, indicating rapid variability in the activity levels. The dynamic nature of the fragments was further highlighted by a dramatic change in the appearance of the fragments in VLT images taken during Aug. 9.976-9.996, when they were barely detectable. Although the latter images were taken under mediocre observational conditions (image quality about 1"-1".3, thin cirrus, and nearly full moon), that alone seems unlikely to account for the observed changes. A very preliminary estimate for the R magnitude, within a circular aperture of radius 0".23, of one well-isolated fragment is about 24. A completely inactive fragment with a diameter of 100 meters observed under these conditions (r = 0.79 AU, Delta = 0.69 AU, Phase = 86o) would have R about 25.9 (assuming a 4-percent albedo and 0.04 mag/deg phase law). We urge ground-based observers to continue monitoring the comet and to report any unusual changes near the 'tip', both in brightness and morphology." [IAUC 7476, 2000 August 10]

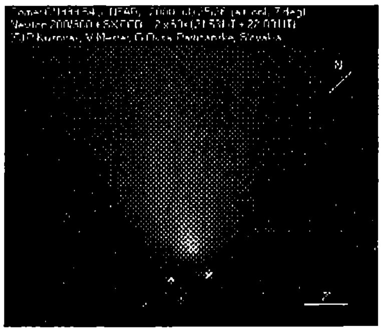


Professional observations show highly variable emissions. The orbit requires large non gravitional parameters and this combined with the faint absolute magnitude suggests that it is a small variably active object. As described above recent observations suggest that it may have fragmented, though there is some 'hype' on the topic, for example from Space Science. Note the amateur observations suggest that a burst of activity between July 20 and 21, caused a brief brightening of the comet, followed by a more rapid fade, although the professionals persist in giving a later date. Indeed there is evidence from the light curve that fading may have started as early as late June. Hubble images taken on August 5 show the the comet fragmented into a number of cometisimals, confirming the concept that comets are a loose aggregation of smaller bodies, cemented together by ice and dust. Further images taken the next day by the ESO VLT show significant changes to the distribution of the cometisimals.

KenIchi Kadota succeeded in recovering the comet on May 4, when he estimated it at 13.0, though at very low altitude. Several observers recovered it at the beginning of June with C Segarra reporting it at 10.5 visually. Rolando Ligustri imaged it with CCD on June 1 when it was 9.9 and on June 4, June 23, July 1, July 2, July 6, July 18 July 20, July 21, July 26, July 30. Pepe Manteca imaged the comet on June 9, June 22, June 28, July 2, July 12, July 14, July 22. Martin Mobberley imaged the comet on June 22 when it was about 9th mag and on July 17. Denis Buczynski imaged it on June 26, June 27, July 03, July 04, July 11, July 15/16, July 16/17, July 19, July 23. David Strange imaged it on June 26, July 21 and on July 25 as it fragmented. Nick James imaged it on July 2, July 18 July 19 July 20. R Ferrando imaged it on July 9, July 28. John Fletcher imaged it on July 20. Maurice Gavin imaged the comet on July 16 and also obtained a spectrum. Christian Buil imaged the comet and obtained spectra on July 17. Gabriel Oksa imaged the comet on July 25.



I picked up the comet in my 20cm LX200 x75 on June 7.05, it was mag 9.9, DC3, coma diameter 1.1'. I did not seen again for 34 days due to a lengthy spell of cloudy weather over eastern England. I saw it again on July 11.94 it was 7.4 in 20x80B, coma diameter 3.1', DC5. Unusually it cleared as it became dark on July 14 and I made another observation on July 14.9, the comet was 7.1 in 20x80B, DC5, coma diameter 3', tail 20' in pa 310. On July 16.9 the comet had brightened to 6.8 in 20x80B despite the nearly full moon. It was a similar magnitude on July 18.9 and 19.9. It was markedly brighter on July 21.9 than it was on July 20.9 with a prominent stellar condensation. Observations with 8x30B on July 21.9 gave a mag of 6.0 suggesting it could be seen with the naked eye from a really dark site. No positive observations were made after August 6.

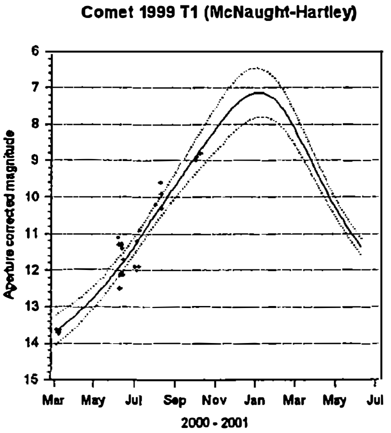


292 observations give an uncorrected preliminary light curve of 9.1 + 5 log d + 5.6 log r

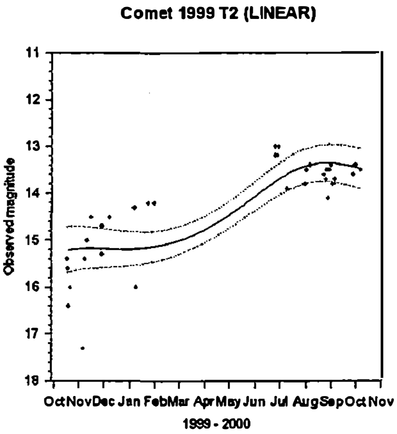
1999 T1 McNaught-Hartley According to the preliminary light curve the comet should reach binocular brightness. Initially at far southern declinations it will come within range of binoculars in October. It moves far enough north for observation by UK observers in December when it reaches perihelion and moves through Hydra, Virgo and Libra.

Andrew Pearce and Stuart Rae picked up the comet at around 13th magnitude in early June. It was 12.7 when Stuart Rae observed it on July 7.7. Recent observations from Andrew and Michael Mattiazzo make it a little brighter than 10th mag.

26 observations give an aperture corrected preliminary light curve of 5.8 + 5 log d + 7.5 log r

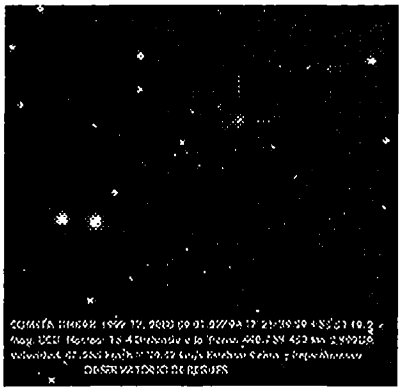


1999 T2 LINEAR will reach perihelion in November, but is already at its brightest. Denis Buczynski imaged it on 2000 May 31.04 I estimated it as fainter than 13.1 around the same time and Denis' image shows that it was significantly fainter than this.



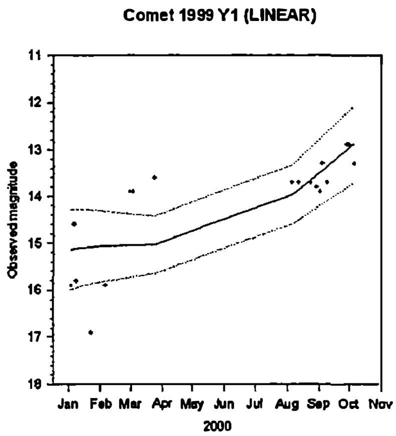
Rolando Ligustri imaged the comet on August 26. Pepe Manteca imaged the comet on August 9, August 16, August 17, August 25, August 28, September 4, September 5 September 7, September 9 September 10. I observed the comet on September 26.8 and estimated it at 13.6, with a small, moderately condensed coma.

39 observations give an uncorrected preliminary, very uncertain light curve of 7.7 + 5 log d + 6.4 log r



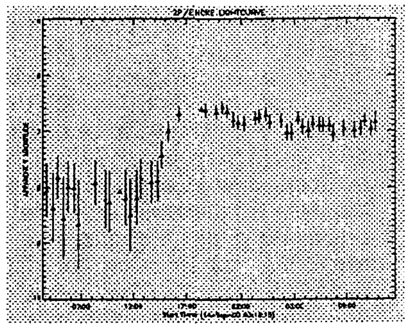
1999 U4 Catalina-Skiff is very distant, but could brighten to 14th magnitude when at perihelion in 2001. Pepe Manteca imaged the comet on August 25.

1999 Y1 LINEAR could reach 12th mag at the end of the year. Pepe Manteca imaged the comet on August 10, August 18, August 25. 19 observations give an uncorrected preliminary light curve of 7.1 + 5 log d + 6.6 log r



Comet 2P/Encke made its 58th observed return to perihelion since its discovery by Mechain in 1786. The orbit is quite stable, and with a period of 3.3 years apparitions repeat on a 10 year cycle. This year the comet is not particular well seen, but there was a short observing window from the Northern Hemisphere prior to perihelion in September. There is currently another short window from the Southern Hemisphere. There is some evidence for a secular fading and any observations will help confirm this. Another suggestion is that Encke has two active regions, an old one with declining activity, which operates prior to perihelion and a recently activated one present after perihelion. The comet is the progenitor of the Taurid meteor complex and may be associated with several Apollo asteroids.

A few observers spotted the comet in early August, estimating it at around 11th mag. Pepe Manteca imaged the comet on August 10 and August 14. The comet was visible in the SOHO C3 coronagraph, but was fainter than expected and was only 8.8 on September 7.1. It suddenly brightened on September 14 at around 15:00 to 6.5.



Comet 9P/Tempel 1 was first observed in 1867, but was lost between 1879 and 1967 following an encounter with Jupiter in 1881 which increased the perihelion distance from 1.8 to 2.1 AU. Further encounters in 1941 and 1953 put q back to 1.5 AU and calculations by Brian Marsden allowed Elizabeth Roemer to recover it in 1967. Alternate returns are favourable, but perturbations will once again increase the perihelion distance in the middle of the next century. This return is an unfavourable one and no observations were made. It is an important comet to observe as it is a potential target for the Deep Impact mission and a special request for observations has been made.

It is a difficult target for amateur observation and may be around 17th magnitude. There were special observing efforts over the weekends of July 8/9 and August 5/6 and there was a further one the LINEAR "asteroidal" objects 1998 XA_70 and 1999 UJ_10, together with improved orbital elements: T = 2000 Jan. 27.35 TT, Peri. = 55.11 deg, Node = 88.86 deg, i = 148.10 deg (equinox 2000.0), q = 5.9219 AU, e = 1.0009. [IAUC 7465, 2000 July 25]

2000 O2 P/Kushida C. E. Delahodde, European Southern Observatory, reports the recovery by O. R. Hainaut and herself of comet P/1994 A1 (= 1994a = 1993 XX) with the 3.6-m reflector on July 25.33. The indicated correction to the prediction by S. Nakano on MPC 31664 is Delta(T) = -0.10 day. Further observations and improved orbital elements are given on MPEC 2000-O32. [IAUC 7467, 2000 July 27]

2000 O3 SOHO I discovered another comet at 10:45 (UT) on July 31. I had given a lecture in the centre of Cambridge and didn't get into the office until after 10:00 (11:00 BST). First I checked the emails, including several Antarctic ones which had data that needed processing. Then I had a look at various web pages, including the latest MPECs, finally I had a look at the SOHO real time movies. I first looked at C2; there were no obvious Kreutz objects but I noted something that appeared to be moving opposite to the stars. I quickly found that it was moving consistently and emailed Doug and the group with details of the possible object. I then checked C3 in case it was visible and downloaded the real-time gif images to measure the positions. I found that it came into view at 21:30 on July 30 and was visible until 03:30 on July 31, moving horizontally from right to left just above the level of the occulting disc and below the beehive cluster. At its brightest (00:06) it was around 7th mag. I think the biggest surprise is that no-one else had picked up this object! Subsequently the comet came into view again, on images from 05:54 till after 12:00. The apparent fading around 03:30 may be due to phase effects playing a part. If it was then between us and the sun it would have zero phase and be difficult to see. The phase effect partly explains why many Kreutz comets are seen during May as this is when they are on the far side of the Sun and fully illuminated.
The orbit was finally published on MPEC 2000-Q09 [2000 August 19], after Brian Marsden returned to the USA following the IAU meeting in Manchester. It seems that the IAU had commanded all three senior members of the CBAT to attend the meeting. The comet had been at perihelion on July 30.94 at a perihelion distance of 0.054 AU. Potentially it was observable from the ground at an elongation of 50 degrees in late August, though at a magnitude of near 20. The orbit shows that it passed on the far side of the sun, so phase effects do not explain the fading.

Further to IAUC 7472, D. Hammer has provided measurements of a comet detected by the SOHO C2 and C3 instruments and found by J. D. Shanklin via the SOHO website. The reduced measurements and orbits by B. G. Marsden, together with a search ephemeris, are given on MPEC 2000-Q09. G. J. Garradd, Loomberah, N.S.W., reports that his search for this object around Aug. 21.4 UT, out to about 0.5 deg ahead of its predicted position, yielding nothing to mag about 18. [IAUC 7479, 2000 August 21]

2000 OF$_8$ Spacewatch Details of an unusual asteroid with a 190 year period, a high inclination orbit and a perihelion distance of 2.0 AU were given on MPEC 2000-P03. The 20th magnitude object was discovered by Spacewatch on July 24.32 and won't reach perihelion until next year. It is currently 4.4 AU from the Sun and it is possible that it will develop cometary activity as it gets closer. Further observations did indeed show cometary activity and a parabolic orbit was published on MPEC 2000-Q43. The comet reaches perihelion in August 2001 at 2.2 AU. The comet could reach 14th mag next summer.

2000 Q1 SOHO James Danaher discovered a faint non Kreutz object on C3 images from August 28. It tracked diagonaly across the upper left quadrant. The orbit published on MPEC 2000-Q42 suggests that it could be visible from the ground, but will be a very faint southern hemisphere object.

2000 R1 P/Shoemaker-Levy 5 The LINEAR team reported that one of their objects observed on Sept. 6 was cometary, and T. Spahr and Dan Green noted that this was about 0.6 deg northwest of the prediction for P/1991 T1 = 1991z = 1991 XXII (MPC 29882, 39661), corresponding to Delta(T) = -1.4 day. Following a request from the Central Bureau, D. Balam reported that images taken with the 1.82-m Plaskett telescope of the National Research Council of Canada show this object to have a well-condensed coma and a fan-shaped tail extending 30" in p.a. 250 deg; his R magnitude of 18? was obtained in a 10" aperture. [IAUC 7488, 2000 September 7] The 18th mag object will brighten a little.

2000 R2 P/LINEAR A 19th mag object reported as asteroidal by the LINEAR team on September 3.15, and subsequently posted on the NEO Confirmation Page, has been reported as cometary in appearance on various CCD exposures: Sept. 7.2 UT, condensed 9" coma (D. Balam, Victoria, 1.82-m reflector); Sept. 7.9, object seemed diffuse with a faint east-west tail about 10" long (M. Tichy, Klet, 0.57-m reflector); Sept. 18.51, near-stellar condensation with a fairly narrow 40" tail in p.a. 90 deg (R. H. McNaught, Siding Spring, 1.0-m reflector + 100-s R frames). The available astrometric observations are given on MPEC 2000-S04, where orbital elements show this to be a short-period comet with perihelion distance of 1.39 AU and period of 6.26 years. It has a very faint absolute magnitude of 18.0 [IAUC 7492, 2000 September 18]

2000 S1 P/Skiff B. W. Koehn, Lowell Observatory, reports the discovery by Brian A. Skiff of a comet on images from September 24.30 taken in the course of the LONEOS program. [IAUC 7496, 2000 September 25] Prediscovery observations made by LINEAR on August 26, together with additional astrometry on September 26, are given on MPEC 2000-S60 and show that the comet is periodic with a period of 17.1 years. [IAUC 7497, 2000 September 27] The comet is reported as around 15th mag, but may be brighter visually. It is near opposition in Cetus and will fade.

2000 S2 P/Shoemaker-LINEAR F. Shelly and R. Huber, MIT Lincoln Laboratory, reported the discovery by LINEAR of a 19th mag comet with a tail in p.a. about 280 deg, on September 27.44. Confirmation of cometary appearance on September 29.1 was received from P. Pravec and P. Kusnirak at Ondrejov (coma diameter 0'.2 with a 0'.2 tail in p.a. 260 deg) and from J. Ticha and M. Tichy at Klet (object diffuse with 14" tail in p.a. 265 deg). Available astrometry and preliminary parabolic orbital elements (T = 2000 July 27.6 TT, q = 1.305 AU, i = 20.2 deg) were published on MPEC 2000-S67. [IAUC 7498, 2000 September 29] S. Nakano, Sumoto, Japan, then identified comet C/2000 S2 with comet D/1984 W1 (Shoemaker 2), the comet now being off from his prediction (cf. ICQ 2000 Comet Handbook) by Delta(T) = +23.2 days or about 7.5 deg in sky position. [IAUC 7499, 2000 September 29]

2000 S3 On October 1, B. W. Koehn communicated his measurements of a comet, later reported as discovered by B. A. Skiff on images taken on September 29.27 by M. E. Van Ness in the course of the LONEOS program at Lowell Observatory. Skiff described a nearly circular coma of diameter 15" with moderate condensation. Following tentative linkage by B. G. Marsden, Center for Astrophysics, to one (mag about 19) of about 2000 asteroidal objects recorded on September 20 by LINEAR, a tentative ephemeris was provided on the NEO Confirmation Page. This linkage was confirmed by observations obtained on Oct. 2 by J. G. Ries with the 0.76-m reflector at McDonald Observatory. Skiff adds that observations by L. H. Wasserman with the 1.1-m telescope at Lowell Observatory on Oct. 2 showed a 14" x 11" coma, elongated east-west. [IAUC 7501, 2000 October 2] The comet is periodic, with a period of 40 years and was at perihelion in mid July at a distance of 2.66 AU. It will fade.

2000 S4 Tom Gehrels reported his discovery of a faint (20th mag) comet on October 2.15 images taken with the Spacewatch telescope at Kitt Peak, noting it to have a 4" tail in p.a. 170 deg. T. B. Spahr, Minor Planet Center, linked it to an asteroidal object observed on September 23 and 26 reported earlier by LINEAR and then found LINEAR observations made on September 1. At the request of Gehrels, P. Massey obtained images of the object in subarcsecond seeing with the 4-m Mayall Telescope at Kitt Peak on October 3.25 UT, showing the comet to have a fan-shaped structure 4" long spanning p.a. 0-80 deg. [IAUC 7502, 2000 October 3] The comet is close to perihelion at 2.3 AU and has a period of around 19 years.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Comet Prospects for 2001

2001 sees a couple of good returns of periodic comets. 19P/Borrelly, which was well observed at the last return, is predicted to be the brightest, and may reach 9^m in the northern autumn. 24P/Schaumasse also has a good return and reaches 10^m. Several long period comets discovered in previous years are still visible and there are some poor returns of short period comets. Theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. This would make a useful project for CCD observers. Ephemerides for new and currently observable comets are published in the *Circulars*, Comet Section Newsletters and on the Section, CBAT and Seiichi Yoshida's web pages. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook; details of subscription to the ICQ are available from the comet section Director. The section booklet on comet observing is available from the BAA office or the Director; a new edition is in preparation.

Alphonse Borrelly discovered comet **19P/Borrelly** in 1904 from Marseilles, France, during a routine comet search with a 160mm refractor. It was put into its discovery orbit by an encounter with Jupiter in 1889, which only made minor changes, and subsequent returns slowly became more favourable. Despite having had several further moderately close approaches to Jupiter the orbit has only changed a little and the comet will next approach Jupiter in 2019. This will be its 13th observed return, with two poor ones having been missed. At its best return in 1987 it reached 7.5^m. This return is only a little worse and the brightness should peak at around 9.5^m towards the end of September, shortly after perihelion. UK observers are likely to first pick up the comet as it passes through Orion in mid August when 10^m, though more southerly observers will already have had it under observation for a couple of months. The solar elongation only slowly increases, but the comet moves north, although remaining a morning object. Slowly fading as it passes through Gemini (September), the Leos (October) and into Ursa Major (November), the comet begins to move north more rapidly and ends the year at 11^m in Canes Venatici.

Alexandre Schaumasse discovered comet **24P/Schaumasse** during a visual search with the 400mm coude equatorial at Nice, France in 1911 December as a 12^m diffuse object and it reaches a similar magnitude at average returns. The 1952 return was very favourable and the comet reached 5^m, though there may have been an outburst. The orbit is relatively stable and this will be its 10th observed return. UK observers may pick up the 13^m comet in the evening sky in February as it brightens on its way to perihelion. Moving northwards in Aries, it passes into Taurus in mid March when it should be a magnitude brighter. It is at its brightest tracking through Auriga at the end of April and early May when it should be at nearly 10^m. Passing into Gemini we will loose it low in the summer twilight by the end of the month.

29P/Schwassmann-Wachmann 1 is an annual comet which has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. It spends the year in Sagittarius reaching opposition in early July and solar conjunction in January 2002. The comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. Unfortunately opportunities for UK observers are limited, as its altitude does not exceed 13° from this country.

Horace Tuttle was the first discoverer of **41P/Tuttle-Giacobini-Kresak** in 1858, when he found a faint comet in Leo Minor. Nearly 50 years later, Professor Michael Giacobini discovered a 13^m object whilst comet hunting, which was observed for a fortnight. Andrew C D Crommelin linked the apparitions in 1928 and made predictions for future returns, but the comet wasn't recovered and it was given up as lost. In 1951, Lubor Kresak discovered a 10^m comet in 25x100 binoculars whilst participating in the Skalnate Pleso Observatory's program of routine searches for comets. After further observations the comet was identified with the lost comet and a better orbit computed. At the 1973 return, which was similar to the 1907 return, it underwent a major outburst and reached 4^m, before fading and then undergoing a second outburst. Alternate returns are unfavourable and this is one of them, but the comet has been observed at a few of them and it should be possible to observe it near perihelion in January from equatorial regions, though it will be little brighter than 12^m. If it undergoes a further outburst, more widespread observation may be possible.

45P/Honda-Mrkos-Pajdusakova makes its 10th observed return since discovery in 1948 (it was missed in 1959). It has had several close encounters with Jupiter, the most recent in 1983 which made dramatic changes to ω and Ω. The perihelion distance has steadily decreased and is now the smallest it has been for the last 200 years. It can approach quite closely to the Earth and will do so in 2011 (0.06 AU) and 2017 (0.08 AU). At present the MPC only lists eight approaches closer than 0.06 AU, and five of these are by periodic comets. It was well observed at its last return in 1995/96. The comet will be in the field of the SOHO LASCO coronagraphs in March, though it may be too faint to be seen. Observers at low northern latitudes should be able to observe it as it recedes from the sun during April and early May.

47P/Ashbrook-Jackson was discovered in 1948 following an approach to Jupiter in 1945, which reduced the perihelion distance from 3.8 to 2.3 AU. Although intrinsically relatively bright, the large perihelion distance keeps it faint. Alternate returns are favourable, but this is not one of them and the comet will be in solar conjunction after perihelion in January. The comet may be seen in early January by Southern Hemisphere observers at 13^m.

Professor Arnold Schwassmann and Artur A Wachmann of Hamburg Observatory discovered their third periodic comet on minor planet patrol plates taken on 1930 May 2. Initially of magnitude 9.5 it brightened to nearly 6^m, thanks to a very close approach to Earth (0.062 AU) on June 1. The initial orbit was a little uncertain and the comet wasn't found at the next or succeeding apparitions until 1979. The comet passed within 0.9 AU of Jupiter in 1953, and 0.25 AU in 1965. In August 1979, Michael Candy reported the discovery of a comet on a plate taken by J Johnston and M Buhagiar while searching for minor planets; this had the motion expected for **73P/Schwassmann-Wachmann 3**, but with perihelion 34 days later than in a prediction by Brian Marsden. Missed again at the next return, it has been seen at the last three returns. At the last return, in 1995, the comet underwent a major outburst near perihelion, reaching 5^m when it was only expected to be 12^m. Subsequently four components were observed, though calculations by Sekanina suggested that the fragmentation occurred after the outburst. The comet will be brightening towards the end of 2000 on its way to perihelion in late January 2001. If it maintains the level of activity seen at the last return it might be glimpsed in the morning sky around the beginning of December, although the solar elongation is not good. More likely the comet will have returned to a quiescent state and will not be observed. If an outburst does occur near perihelion, it is still unlikely to be observed as the elongation does not become favourable until May, but then the comet could be observed for the rest of the year as it slowly fades.

The comet's 1930 approach to Earth is ninth on the list of well determined cometary approaches to our planet. In May 2006 it will make another close approach (0.082 AU), when it could again reach 7^m or brighter. This small miss distance makes it a convenient spacecraft target, and the Contour mission is scheduled to intercept it, as well as comets 2P/Encke and 6P/d'Arrest and possibly a new discovery. Following its outburst in 1995, 73P/Schwassmann-Wachmann 3 is expected to show fresh cometary surfaces, whilst 2P/Encke is an old comet and 6P/d'Arrest an average one. With the orbit approaching so closely to the Earth, an associated meteor shower might be expected, and the come`t has been linked to the Tau Herculid shower, though the radiant now lies in the Bootes - Serpens region. Strong activity was reported in 1930 by a lone Japanese observer, but little has been seen since then. It is likely that any future activity would be in the form of a short-lived outburst, confined to years when the comet is at perihelion.

97P/Metcalf-Brewington. Howard J Brewington of Cloudcroft, New Mexico discovered a comet with his 0.41-m reflector on 1990 January 7. This was subsequently found to be the first observed return of P/Metcalf (1906 V2), which had been lost since 1907, though a good prediction for its return in 1975 had appeared in the Journal. A prediscovery image on January 5 showed the comet at about 15^m suggesting that it was found during an outburst. The failure to find it during its first few returns and also in 1975 and 1983 indicate that it is normally inactive. A close approach to

Jupiter in 1993 has drastically altered the orbit and q has increased to 2.6 AU, so that it is unlikely to be observable visually unless it undergoes another outburst. Perihelion occurs in April, and a substantial pre perihelion outburst could bring it within visual range, though the elongation is poor and gets worse as it closes in on perihelion. It was recovered by LINEAR in 2000 September, several degrees from its nominal position.

Several recently discovered parabolic comets will be visible during 2001. **1999 T1 (McNaught-Hartley)** is the brightest of these comets and should be fading from binocular brightness. It tracks northwards through Serpens and Hercules and then loops through Draco where it will remain visible until the autumn. **1999 T2 (LINEAR)** is unlikely to be better than 13^m at the beginning of the year and will fade. **1999 Y1 (LINEAR)** spends much of the year at around 13^m and crosses into the Southern Hemisphere in April. **2000 OF_8 (Spacewatch)** may reach 14^m around the time of its perihelion, but is a Southern Hemisphere object.

95P/Chiron is 17^m when at opposition in June on the border of Ophiuchus and Sagitarrius. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically.

Comets reaching perihelion in 2001

Comet	T	q	P	N	H1	K1
47P/Ashbrook-Jackson	Jan 06.5	2.31	7.46	7	5.0	15.0
41P/Tuttle-Giacobini-Kresak	Jan 07.0	1.05	5.43	8	7.0	15.0
74P/Smirnova-Chernykh	Jan 15.6	3.55	8.49	4	5.0	15.0
73P/Schwassmann-Wachmann 3	Jan 27.8	0.94	5.36	4	5.5	7.0
1992 G3 (P/Mueller 4)	Feb 07.9	2.65	9.01	1	11.5	10.0
44P/Reinmuth 2	Feb 20.0	1.89	6.63	8	10.5	15.0
113P/Spitaler	Feb 25.9	2.13	7.09	2	12.5	5.0
75P/Kohoutek	Feb 27.3	1.79	6.68	3	10.5	10.0
110P/Hartley 3	Mar 21.4	2.48	6.88	2	8.0	15.0
1999 Y1 (LINEAR)	Mar 24.1	3.09			5.5	10.0
107P/Wilson-Harrington	Mar 26.6	1.00	4.30	5	15.0	5.0
45P/Honda-Mrkos-Pajdusakova	Mar 29.9	0.53	5.25	9	10.7	11.1
97P/Metcalf-Brewington	Apr 13.7	2.61	10.5	2	4.6	15.0
1993 X1 (P/Kushida-Muramatsu)	May 01.2	2.75	7.44	1	8.0	10.0
24P/Schaumasse	May 02.7	1.20	8.25	9	7.6	24.2
61P/Shajn-Schaldach	May 08.8	2.33	7.46	5	10.0	10.0
51P/Harrington	Jun 05.9	1.57	6.77	5	12.0	10.0
86P/Wild 3	Jun 18.6	2.31	6.93	3	8.5	15.0
2000 CT_{54} (LINEAR)	Jun 19.5	3.16			8.5	10.0
1994 A1 (P/Kushida)	Jun 27.8	1.43	7.58	1	11.5	2.1
16P/Brooks 2	Jul 19.8	1.83	6.86	14	8.8	15.0
2000 OF_8 (Spacewatch)	Aug 05.0	2.17			9.5	10.0
82P/Gehrels 3	Sep 03.1	3.63	8.45	3	6.0	15.0
19P/Borrelly	Sep 14.7	1.36	6.86	12	7.0	12.7
1987 Q3 (P/Helin)	Sep 26.3	2.53	14.1	1	5.0	20.0
1999 U4 (Catalina-Skiff)	Oct 28.4	4.92			4.5	10.0
133P/Elst-Pizzaro	Nov 23.7	2.64	5.61	3	12.0	10.0
11D/Tempel-Swift	Dec 12.1	1.59	6.37	4	13.0	10.0

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 are given for each comet.

Note: $m_1 = H1 + 5.0 * \log(d) + K1 * \log(r)$

Several other comets return to perihelion during 2001, however they are unlikely to become bright enough to observe visually or are poorly placed. 16P/Brooks 2, 44P/Reinmuth 2, 82P/Gehrels 3, 107P/Wilson-Harrington, 1993 X1 (Kushida-Muramatsu) and 1994 A1 (Kushida) have unfavourable returns. 51P/Harrington, 61P/Shajn-Schaldach, 74P/Smirnova-Chernykh, 75P/Kohoutek, 86P/Wild 3, 110P/Hartley 3, 133P/Elst-Pizarro, 1987 Q3 (Helin), 1992 G3 (Mueller 4), 1999 U4 (LINEAR) and 2000 CT_{54} (LINEAR) are intrinsically faint or distant comets. Ephemerides for these can be found on the CBAT WWW pages. 11D/Tempel-Swift has not been seen since 1908 and the time of its return to perihelion is uncertain by many months.

Looking ahead, 2002 doesn't see any particularly good returns of periodic comets. Perhaps the most interesting is that of **96P/Machholz 1**. The orbit is very unusual, with the smallest perihelion distance of any short period comet (0.13 AU), which is decreasing further with time, a high eccentricity (0.96) and a high inclination (60°). Studies by Sekanina suggest it has only one active area, which is situated close to the rotation pole and becomes active close to perihelion. The comet may be the parent of the Quadrantid meteor shower. It is rarely sufficiently well placed to see visually and this return is no exception. Although it may be as bright as 6th magnitude at the end of 2001, the elongation is only 18°. At perihelion on 2002 January 8 it is only a few degrees from the Sun and may be seen in the SOHO LASCO coronagraphs from January 5 to 11. **6P/d'Arrest** is another of 2002's comets, but we should be able to recover it at the very end of 2001 as it brightens past 14th magnitude.

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Why Study Comets?

Don Yeomans, Jet Propulsion Lab

Life on Earth began at the end of a period called the late heavy bombardment, some 3.8 billion years ago. Before this time, the influx of interplanetary debris that formed the Earth was so strong that the proto-Earth was far too hot for life to have formed. Under this heavy bombardment of asteroids and comets, the early Earth's oceans vapourised and the fragile carbon-based molecules, upon which life is based, could not have survived. The earliest known fossils on Earth date from 3.5 billion years ago and there is evidence that biological activity took place even earlier - just at the end of the period of late heavy bombardment. So the window when life began was very short. As soon as life could have formed on our planet, it did. But if life formed so quickly on Earth and there was little in the way of water and carbon-based molecules on the Earth's surface, then how were these building blocks of life delivered to the Earth's surface so quickly? The answer may involve the collision of comets with the Earth, since comets contain abundant supplies of both water and carbon-based molecules.

As the primitive, leftover building blocks of the outer solar system formation process, comets offer clues to the chemical mixture from which the giant planets formed some 4.6 billion years ago. If we wish to know the composition of the primordial mixture from which the major planets formed, then we must determine the chemical constituents of the leftover debris from this formation process - the comets. Comets are composed of significant fractions of water ice, dust, and carbon-based compounds. Since their orbital paths often cross that of the Earth, cometary collisions with the Earth have occurred in the past and additional collisions are forthcoming. It is not a question of whether a comet will strike the Earth, it is a question of when the next one will hit. It now seems likely that a comet struck near the Yucatan peninsula in Mexico some 65 million years ago and caused a massive extinction of more than 75% of the Earth's living organisms, including the dinosaurs.

Comets have this strange duality whereby they first brought the building blocks of life to Earth some 3.8 billion years ago and subsequent cometary collisions may have wiped out many of the developing life forms, allowing only the most adaptable species to evolve further. Indeed, we may owe our pre-eminence at the top of Earth's food chain to cometary collisions. A catastrophic cometary collision with the Earth is only likely to happen at several million year intervals on average, so we need not be overly concerned with a threat of this type. However, it is prudent to mount efforts to discover and study these objects, to characterise their sizes, compositions and structures and to keep an eye upon their future trajectories.

As with asteroids, comets are both a potential threat and a potential resource for the colonisation of the solar system in the twenty first century. Whereas asteroids are rich in the mineral raw materials required to build structures in space, the comets are rich resources for the water and carbon-based molecules necessary to sustain life. In addition, an abundant supply of cometary water ice can provide copious quantities of liquid hydrogen and oxygen, the two primary ingredients in rocket fuel. One day soon, comets may serve as fueling stations for interplanetary spacecraft.

Introduction

This issue has ephemerides for the comets that are likely to be brighter than 11th magnitude:

- 24P/Schaumasse (UK)
- 1999 T1 (McNaught-Hartley) (Southern Hemisphere & UK)

Several other comets, including 47P/Ashbrook-Jackson, 73P/Schwassmann-Wachmann 3, 75P/Kohoutek, 97P/Metcalf-Brewington, 1999 T2 (LINEAR) and 1999 Y1 (LINEAR) may be brighter than 14^{m}. 41P/Tuttle-Giacobini-Kresak may be visible from equatorial latitudes during December and January in the dawn sky at 12th magnitude. 45P/Honda-Mrkos-Pajdusakova may be visible in the dusk sky from equatorial latitudes in April and May as it fades from 8th magnitude. 73P/Schwassmann-Wachmann 3 may be visible from the UK from mid November to early December in the dawn sky if it maintains its brightness following the outburst at the last return. Current ephemerides for these fainter comets are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for comet 1999 T1 (McNaught-Hartley) (Southern Hemisphere, 40° South)

Omega=344.7576 OMEGA=182.4823 i= 79.9752 q= 1.171683 a=**********
e=0.999954 P=********* T= 2000 December 13.4682 Equinox= 2000
Magnitudes calculated from m= 6.6+5.0*Log(d)+ 8.1*Log(r)

November 2000 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	11 56.6	-38.21	11 59.1	-38.38	9.1	1.92	1.34	9.13	1.58 to 3.37	41	89	29	11	245	16	5
2/ 3	11 59.9	-38.08	12 2.5	-38.25	9.0	1.92	1.33	9.12	1.58 to 3.35	41	97	38	11	245	16	5
3/ 4	12 3.2	-37.54	12 5.8	-38.11	9.0	1.91	1.33	9.12	1.58 to 3.34	40	106	47	11	246	16	5
4/ 5	12 6.5	-37.41	12 9.1	-37.57	9.0	1.91	1.32	9.11	1.58 to 3.33	40	114	57	11	247	16	5
5/ 6	12 9.7	-37.26	12 12.3	-37.43	9.0	1.90	1.31	9.10	1.58 to 3.31	40	123	66	11	248	16	5
6/ 7	12 13.0	-37.12	12 15.6	-37.28	8.9	1.90	1.30	9.10	1.58 to 3.30	40	131	75	11	249	16	6
7/ 8	12 16.2	-36.57	12 18.8	-37.13	8.9	1.89	1.30	9.09	1.58 to 3.29	40	137	83	12	249	16	6
8/ 9	12 19.4	-36.41	12 22.0	-36.58	8.9	1.89	1.29	9.08	1.58 to 3.27	40	142	91	12	250	16	6
9/10	12 22.6	-36.26	12 25.2	-36.42	8.9	1.88	1.28	9.07	1.58 to 3.26	40	144	96	12	251	16	6
10/11	12 25.8	-36.10	12 28.4	-36.26	8.8	1.88	1.28	9.07	1.58 to 3.25	39	142	99	12	252	15	6
11/12	12 28.9	-35.53	12 31.6	-36.10	8.8	1.87	1.27	9.06	1.58 to 3.23	39	136	100	12	253	15	6
12/13	12 32.1	-35.37	12 34.7	-35.53	8.8	1.87	1.27	9.05	1.58 to 3.22	39	127	99	13	254	15	6
13/14	12 35.2	-35.19	12 37.9	-35.36	8.8	1.86	1.26	9.04	1.58 to 3.21	39	117	95	13	255	15	7
14/15	12 38.3	-35.02	12 41.0	-35.18	8.7	1.85	1.26	9.03	1.58 to 3.20	39	106	88	13	255	15	7
15/16	12 41.4	-34.44	12 44.1	-35.01	8.7	1.85	1.25	9.03	1.58 to 3.19	39	95	79	13	256	15	7
16/17	12 44.5	-34.26	12 47.2	-34.42	8.7	1.84	1.24	9.02	1.58 to 3.18	39	83	69	13	257	15	7

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
17/18	12 47.5	-34.07	12 50.2	-34.24	8.7	1.83	1.24	9.01	1.58 to 3.17	39	71	58	14	258	15	7
18/19	12 50.6	-33.49	12 53.3	-34.05	8.6	1.83	1.23	9.00	1.58 to 3.16	39	60	46	14	259	15	7
19/20	12 53.6	-33.29	12 56.3	-33.45	8.6	1.82	1.23	8.59	1.58 to 3.15	39	49	35	14	260	15	8
20/21	12 56.6	-33.09	12 59.3	-33.26	8.6	1.81	1.22	8.58	1.58 to 3.14	39	40	25	14	261	15	8
21/22	12 59.6	-32.49	13 2.4	-33.05	8.6	1.81	1.22	8.57	1.58 to 3.13	40	33	16	15	262	15	8
22/23	13 2.6	-32.29	13 5.4	-32.45	8.6	1.80	1.22	8.56	1.59 to 3.12	40	29	9	15	263	15	8
23/24	13 5.6	-32.08	13 8.3	-32.24	8.5	1.79	1.21	8.55	1.59 to 3.11	40	30	4	15	264	15	8
24/25	13 8.5	-31.47	13 11.3	-32.02	8.5	1.78	1.21	8.54	1.59 to 3.10	40	35	1	15	264	15	8
25/26	13 11.5	-31.25	13 14.3	-31.41	8.5	1.78	1.20	8.53	1.59 to 3.09	40	43	0	16	265	15	9
26/27	13 14.4	-31.03	13 17.2	-31.18	8.5	1.77	1.20	8.52	1.59 to 3.09	40	52	1	16	266	15	9
27/28	13 17.4	-30.40	13 20.2	-30.56	8.5	1.76	1.20	8.51	1.60 to 3.08	40	62	3	16	267	15	9
28/29	13 20.3	-30.17	13 23.1	-30.33	8.4	1.75	1.19	8.50	1.60 to 3.07	41	72	8	16	268	15	9
29/30	13 23.2	-29.53	13 26.0	-30.09	8.4	1.75	1.19	8.49	2.00 to 3.07	41	82	14	17	269	15	9
30/31	13 26.1	-29.29	13 28.9	-29.45	8.4	1.74	1.19	8.48	2.00 to 3.06	41	93	22	17	270	15	9
December 2000																
1/ 2	13 29.0	-29.05	13 31.8	-29.20	8.4	1.73	1.19	8.47	2.01 to 3.06	41	103	30	17	271	15	10
2/ 3	13 31.9	-28.40	13 34.7	-28.55	8.4	1.72	1.18	8.46	2.01 to 3.05	42	114	39	18	272	15	10
3/ 4	13 34.8	-28.15	13 37.6	-28.30	8.4	1.71	1.18	8.45	2.01 to 3.05	42	124	49	18	272	15	10
4/ 5	13 37.7	-27.49	13 40.5	-28.04	8.3	1.70	1.18	8.44	2.02 to 3.04	42	135	58	18	273	15	10
5/ 6	13 40.5	-27.23	13 43.3	-27.38	8.3	1.70	1.18	8.43	2.02 to 3.04	43	145	68	18	274	15	10
6/ 7	13 43.4	-26.56	13 46.2	-27.11	8.3	1.69	1.18	8.42	2.02 to 3.04	43	154	77	19	275	15	11
7/ 8	13 46.2	-26.28	13 49.0	-26.43	8.3	1.68	1.17	8.41	2.03 to 3.04	43	160	86	19	276	15	11
8/ 9	13 49.1	-26.00	13 51.9	-26.15	8.3	1.67	1.17	8.40	2.03 to 3.03	44	159	93	19	276	15	11
9/10	13 51.9	-25.32	13 54.7	-25.47	8.3	1.66	1.17	8.39	2.04 to 3.03	44	150	98	20	277	16	11
10/11	13 54.7	-25.03	13 57.5	-25.18	8.2	1.65	1.17	8.38	2.04 to 3.03	44	139	100	20	278	16	12

Ephemeris for comet 1999 T1 (McNaught-Hartley) (UK)

December 2000 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
11/12	13 57.6	-24.33	14 0.4	-24.48	8.2	1.64	1.17	8.36	Not Observable	45	126	100	20	278	16	12
12/13	14 0.4	-24.03	14 3.2	-24.18	8.2	1.63	1.17	8.35	Not Observable	45	112	97	20	279	16	12
13/14	14 3.2	-23.33	14 6.0	-23.47	8.2	1.62	1.17	8.34	Not Observable	46	98	91	21	280	16	12
14/15	14 6.0	-23.02	14 8.8	-23.16	8.2	1.61	1.17	8.33	Not Observable	46	84	83	21	281	16	13
15/16	14 8.8	-22.30	14 11.7	-22.44	8.2	1.61	1.17	8.32	6.32 to 6.34	47	71	73	21	281	16	13
16/17	14 11.7	-21.57	14 14.5	-22.11	8.2	1.60	1.17	8.31	6.23 to 6.34	47	57	62	21	282	16	13
17/18	14 14.5	-21.24	14 17.3	-21.38	8.2	1.59	1.17	8.30	6.15 to 6.35	48	44	50	22	282	16	13
18/19	14 17.3	-20.51	14 20.1	-21.05	8.2	1.58	1.17	8.29	6.07 to 6.36	48	32	39	22	283	16	13
19/20	14 20.1	-20.17	14 22.9	-20.30	8.1	1.57	1.18	8.27	5.59 to 6.36	49	20	29	22	284	16	14
20/21	14 22.9	-19.42	14 25.7	-19.55	8.1	1.56	1.18	8.26	5.52 to 6.37	49	11	20	22	284	16	14
21/22	14 25.7	-19.06	14 28.5	-19.20	8.1	1.55	1.18	8.25	5.44 to 6.37	50	12	13	23	285	16	14
22/23	14 28.5	-18.30	14 31.3	-18.43	8.1	1.54	1.18	8.24	5.37 to 6.38	50	22	7	23	285	16	15
23/24	14 31.3	-17.53	14 34.1	-18.06	8.1	1.53	1.18	8.23	5.30 to 6.38	51	33	2	23	286	16	15
24/25	14 34.1	-17.16	14 36.9	-17.29	8.1	1.52	1.19	8.22	5.23 to 6.38	51	44	0	23	286	16	15
25/26	14 36.9	-16.38	14 39.7	-16.51	8.1	1.51	1.19	8.21	5.17 to 6.39	52	55	0	23	287	16	15
26/27	14 39.7	-15.59	14 42.5	-16.12	8.1	1.50	1.19	8.19	5.10 to 6.39	52	67	1	23	287	16	16
27/28	14 42.5	-15.20	14 45.2	-15.32	8.1	1.49	1.19	8.18	5.03 to 6.39	53	78	4	24	288	16	16
28/29	14 45.3	-14.39	14 48.0	-14.52	8.1	1.48	1.20	8.17	4.57 to 6.39	53	90	9	24	288	16	16
29/30	14 48.1	-13.58	14 50.8	-14.11	8.1	1.48	1.20	8.16	4.50 to 6.40	54	101	15	24	289	16	17
30/31	14 50.9	-13.17	14 53.6	-13.29	8.1	1.47	1.20	8.15	4.44 to 6.40	55	113	23	24	289	17	17
31/32	14 53.7	-12.35	14 56.4	-12.47	8.1	1.46	1.21	8.14	4.37 to 6.40	55	124	31	24	289	17	17
January 2001																
1/ 2	14 56.5	-11.52	14 59.2	-12.03	8.1	1.45	1.21	8.12	4.31 to 6.40	56	136	41	24	290	17	17
2/ 3	14 59.3	-11.08	15 2.0	-11.19	8.1	1.44	1.22	8.11	4.25 to 6.40	57	148	51	24	290	17	18
3/ 4	15 2.1	-10.23	15 4.8	-10.35	8.1	1.43	1.22	8.10	4.19 to 6.40	57	160	61	24	290	17	18
4/ 5	15 4.9	-9.38	15 7.6	-9.50	8.1	1.42	1.22	8.09	4.12 to 6.39	58	172	71	24	291	17	18
5/ 6	15 7.7	-8.52	15 10.4	-9.03	8.1	1.42	1.23	8.08	4.06 to 6.39	58	173	81	24	291	17	19
6/ 7	15 10.5	-8.06	15 13.2	-8.17	8.1	1.41	1.23	8.07	4.00 to 6.39	59	159	89	24	291	17	19
7/ 8	15 13.3	-7.18	15 16.0	-7.29	8.1	1.40	1.24	8.06	3.54 to 6.39	60	145	95	24	291	17	19
8/ 9	15 16.1	-6.30	15 18.8	-6.41	8.1	1.39	1.24	8.04	3.48 to 6.38	60	131	99	24	292	17	20
9/10	15 18.9	-5.41	15 21.6	-5.52	8.1	1.38	1.25	8.03	3.42 to 6.38	61	116	100	24	292	17	20
10/11	15 21.7	-4.52	15 24.4	-5.02	8.1	1.38	1.26	8.02	3.36 to 6.37	62	101	98	24	292	17	20
11/12	15 24.5	-4.02	15 27.2	-4.12	8.1	1.37	1.26	8.01	3.30 to 6.37	62	87	94	24	292	17	20
12/13	15 27.3	-3.11	15 29.9	-3.21	8.1	1.36	1.27	7.60	3.24 to 6.36	63	73	86	24	292	17	21
13/14	15 30.2	-2.19	15 32.7	-2.29	8.1	1.36	1.27	7.59	3.18 to 6.36	64	59	77	24	293	17	21
14/15	15 33.0	-1.27	15 35.5	-1.37	8.1	1.35	1.28	7.58	3.12 to 6.35	64	46	67	24	293	17	21
15/16	15 35.8	-0.34	15 38.3	-0.44	8.1	1.34	1.29	7.56	3.06 to 6.34	65	34	56	24	293	17	22
16/17	15 38.6	0.19	15 41.1	0.10	8.1	1.34	1.29	7.55	2.60 to 6.34	66	24	45	24	293	17	22
17/18	15 41.4	1.13	15 43.9	1.04	8.1	1.33	1.30	7.54	2.54 to 6.33	66	17	35	23	293	17	22
18/19	15 44.2	2.08	15 46.7	1.59	8.2	1.33	1.31	7.53	2.48 to 6.32	67	18	26	23	293	17	22
19/20	15 47.0	3.03	15 49.5	2.54	8.2	1.32	1.31	7.52	2.42 to 6.31	68	25	17	23	293	17	23
20/21	15 49.8	3.59	15 52.3	3.50	8.2	1.32	1.32	7.51	2.36 to 6.30	68	35	11	23	293	17	23
21/22	15 52.7	4.55	15 55.1	4.47	8.2	1.31	1.33	7.50	2.30 to 6.29	69	45	5	23	293	17	23
22/23	15 55.5	5.52	15 57.9	5.44	8.2	1.31	1.33	7.48	2.24 to 6.28	69	56	2	22	293	17	23
23/24	15 58.3	6.49	16 0.7	6.41	8.2	1.30	1.34	7.47	2.18 to 6.27	70	66	0	22	293	17	23
24/25	16 1.1	7.47	16 3.5	7.39	8.2	1.30	1.35	7.46	2.12 to 6.26	71	77	0	22	293	17	24
25/26	16 3.9	8.45	16 6.3	8.37	8.2	1.30	1.36	7.45	2.06 to 6.25	71	87	1	22	293	17	24
26/27	16 6.7	9.44	16 9.1	9.36	8.3	1.30	1.36	7.44	1.60 to 6.24	72	97	5	21	293	17	24
27/28	16 9.5	10.43	16 11.9	10.35	8.3	1.29	1.37	7.43	1.54 to 6.23	73	108	10	21	293	17	24
28/29	16 12.3	11.42	16 14.6	11.34	8.3	1.29	1.38	7.41	1.48 to 6.22	73	117	17	21	293	17	24
29/30	16 15.1	12.41	16 17.4	12.34	8.3	1.29	1.39	7.40	1.41 to 6.20	74	127	25	21	293	17	24
30/31	16 17.9	13.41	16 20.2	13.34	8.3	1.29	1.40	7.39	1.35 to 6.19	74	135	34	20	293	16	24
31/32	16 20.7	14.41	16 23.0	14.34	8.3	1.29	1.40	7.38	1.29 to 6.18	75	142	44	20	293	16	24
February 2001																
1/ 2	16 23.4	15.41	16 25.7	15.34	8.4	1.29	1.41	7.37	1.23 to 6.16	76	146	55	20	292	16	24
2/ 3	16 26.2	16.41	16 28.5	16.34	8.4	1.29	1.42	7.36	1.16 to 6.15	76	146	65	19	292	16	25
3/ 4	16 29.0	17.41	16 31.2	17.35	8.4	1.29	1.43	7.34	1.10 to 6.13	77	141	76	19	292	16	25
4/ 5	16 31.8	18.41	16 34.0	18.35	8.4	1.29	1.44	7.33	1.04 to 6.12	77	134	85	19	292	16	25
5/ 6	16 34.5	19.41	16 36.7	19.35	8.5	1.29	1.45	7.32	0.57 to 6.10	78	124	93	18	292	16	25
6/ 7	16 37.3	20.41	16 39.4	20.35	8.5	1.29	1.46	7.31	0.51 to 6.09	78	113	98	18	292	16	25
7/ 8	16 40.0	21.41	16 42.2	21.36	8.5	1.29	1.47	7.30	0.44 to 6.07	79	102	100	18	291	15	24
8/ 9	16 42.8	22.41	16 44.9	22.36	8.5	1.29	1.47	7.28	0.38 to 6.06	79	91	100	17	291	15	24
9/10	16 45.5	23.40	16 47.6	23.35	8.6	1.30	1.48	7.27	0.31 to 6.04	80	80	96	17	291	15	24
10/11	16 48.2	24.40	16 50.3	24.35	8.6	1.30	1.49	7.26	0.25 to 6.02	80	70	90	17	290	15	24
11/12	16 50.9	25.39	16 53.0	25.34	8.6	1.30	1.50	7.25	0.18 to 6.00	81	61	82	16	290	15	24
12/13	16 53.6	26.38	16 55.7	26.33	8.6	1.31	1.51	7.23	0.11 to 5.59	81	55	72	16	290	15	24
13/14	16 56.3	27.36	16 58.4	27.32	8.7	1.31	1.52	7.22	0.04 to 5.57	82	50	62	16	290	14	24

14/15	16 59.0	28.34	17 1.0	28.30	8.7	1.32	1.53	7.21	23.57	to	5.55	82	48	52	15	289	14	24
15/16	17 1.7	29.32	17 3.7	29.28	8.7	1.32	1.54	7.19	23.50	to	5.53	82	49	42	15	289	14	24
16/17	17 4.4	30.29	17 6.3	30.25	8.8	1.33	1.55	7.18	23.43	to	5.51	83	51	32	15	289	14	23
17/18	17 7.0	31.25	17 8.9	31.22	8.8	1.33	1.56	7.17	23.36	to	5.49	83	56	23	14	288	14	23
18/19	17 9.7	32.22	17 11.5	32.18	8.8	1.34	1.57	7.16	23.29	to	5.47	83	61	16	14	288	13	23
19/20	17 12.3	33.17	17 14.2	33.14	8.8	1.34	1.58	7.14	23.21	to	5.45	84	67	9	14	288	13	23
20/21	17 14.9	34.12	17 16.7	34.09	8.9	1.35	1.59	7.13	23.14	to	5.43	84	73	4	14	287	13	22
21/22	17 17.5	35.07	17 19.3	35.04	8.9	1.36	1.60	7.11	23.06	to	5.41	84	80	1	13	287	13	22
22/23	17 20.1	36.01	17 21.9	35.58	8.9	1.36	1.61	7.10	22.58	to	5.39	85	86	0	13	286	13	22
23/24	17 22.7	36.54	17 24.4	36.51	9.0	1.37	1.62	7.09	22.50	to	5.37	85	93	0	13	286	12	22
24/25	17 25.2	37.47	17 26.9	37.44	9.0	1.38	1.63	7.07	22.42	to	5.35	85	99	2	12	286	12	21
25/26	17 27.8	38.39	17 29.4	38.36	9.0	1.39	1.64	7.06	22.34	to	5.33	85	104	6	12	285	12	21
26/27	17 30.3	39.30	17 31.9	39.28	9.1	1.40	1.65	7.04	22.25	to	5.31	86	109	12	12	285	12	21
27/28	17 32.8	40.21	17 34.4	40.19	9.1	1.41	1.66	7.03	22.17	to	5.29	86	113	19	11	284	11	21
28/29	17 35.2	41.10	17 36.8	41.09	9.2	1.41	1.67	7.01	22.08	to	5.26	86	115	28	11	284	11	20
March	2001																	
1/ 2	17 37.7	41.60	17 39.3	41.58	9.2	1.42	1.68	6.60	21.59	to	5.24	86	116	38	11	283	11	20
2/ 3	17 40.1	42.48	17 41.7	42.47	9.2	1.43	1.69	6.58	21.49	to	5.22	86	116	49	11	283	11	20
3/ 4	17 42.6	43.36	17 44.1	43.35	9.3	1.44	1.70	6.57	21.39	to	5.20	86	115	60	10	282	10	19
4/ 5	17 44.9	44.23	17 46.4	44.22	9.3	1.45	1.71	6.55	21.29	to	5.17	87	112	71	10	282	10	19
5/ 6	17 47.3	45.09	17 48.8	45.08	9.3	1.46	1.72	6.54	21.18	to	5.15	87	108	81	10	282	10	19
6/ 7	17 49.7	45.55	17 51.1	45.54	9.4	1.48	1.73	6.52	21.07	to	5.13	87	103	90	10	281	10	18
7/ 8	17 52.0	46.40	17 53.4	46.39	9.4	1.49	1.74	6.50	20.55	to	5.11	87	97	96	9	281	9	18
8/ 9	17 54.3	47.24	17 55.6	47.23	9.5	1.50	1.75	6.49	20.42	to	5.08	87	92	100	9	280	9	18
9/10	17 56.6	48.07	17 57.9	48.07	9.5	1.51	1.76	6.47	20.28	to	5.06	87	87	100	9	280	9	18
10/11	17 58.8	48.50	18 0.1	48.50	9.5	1.52	1.77	6.45	20.12	to	5.03	87	83	98	9	279	9	17
11/12	18 1.0	49.32	18 2.3	49.32	9.6	1.53	1.78	6.43	19.53	to	5.01	87	79	93	8	279	9	17
12/13	18 3.2	50.13	18 4.4	50.13	9.6	1.54	1.79	6.42	19.29	to	4.59	87	76	86	8	278	8	17
13/14	18 5.4	50.53	18 6.6	50.54	9.6	1.56	1.81	6.40	19.23	to	4.56	87	75	78	8	278	8	16
14/15	18 7.5	51.33	18 8.7	51.34	9.7	1.57	1.82	6.38	19.24	to	4.54	87	74	69	8	277	8	16
15/16	18 9.6	52.12	18 10.7	52.13	9.7	1.58	1.83	6.36	19.26	to	4.51	87	74	59	8	277	8	16
16/17	18 11.7	52.51	18 12.8	52.52	9.8	1.59	1.84	6.34	19.28	to	4.49	87	75	49	7	276	7	16
17/18	18 13.7	53.28	18 14.8	53.29	9.8	1.61	1.85	6.32	19.30	to	4.46	87	77	39	7	275	7	15
18/19	18 15.7	54.05	18 16.8	54.07	9.8	1.62	1.86	6.30	19.32	to	4.44	87	78	30	7	275	7	15
19/20	18 17.7	54.42	18 18.7	54.43	9.9	1.63	1.87	6.28	19.34	to	4.41	87	81	22	7	274	7	15
20/21	18 19.7	55.18	18 20.6	55.19	9.9	1.65	1.88	6.26	19.36	to	4.38	87	83	14	7	274	6	14
21/22	18 21.6	55.53	18 22.5	55.54	9.9	1.66	1.89	6.24	19.38	to	4.36	87	85	8	6	273	6	14
22/23	18 23.4	56.27	18 24.3	56.29	10.0	1.67	1.90	6.22	19.40	to	4.33	87	88	4	6	273	6	14
23/24	18 25.3	57.01	18 26.1	57.03	10.0	1.69	1.91	6.20	19.42	to	4.31	87	90	1	6	272	6	14
24/25	18 27.0	57.34	18 27.9	57.36	10.1	1.70	1.93	6.18	19.44	to	4.28	87	92	0	6	272	5	13
25/26	18 28.8	58.07	18 29.6	58.09	10.1	1.71	1.94	6.16	19.46	to	4.26	87	94	0	6	271	5	13
26/27	18 30.5	58.39	18 31.2	58.41	10.1	1.73	1.95	6.13	19.48	to	4.23	87	95	3	6	270	5	13
27/28	18 32.2	59.10	18 32.9	59.13	10.2	1.74	1.96	6.11	19.50	to	4.20	87	96	8	6	270	5	13
28/29	18 33.8	59.41	18 34.5	59.44	10.2	1.76	1.97	6.09	19.52	to	4.18	87	97	15	5	269	5	12
29/30	18 35.4	60.11	18 36.0	60.14	10.2	1.77	1.98	6.06	19.54	to	4.15	87	97	24	5	269	4	12
30/31	18 36.9	60.41	18 37.5	60.44	10.3	1.78	1.99	6.04	19.56	to	4.12	86	96	34	5	268	4	12
31/32	18 38.4	61.10	18 39.0	61.13	10.3	1.80	2.00	6.01	19.58	to	4.10	86	96	45	5	267	4	12
April	2001																	
1/ 2	18 39.8	61.39	18 40.4	61.42	10.4	1.81	2.01	5.59	20.01	to	4.07	86	95	56	5	267	4	11
2/ 3	18 41.2	62.07	18 41.7	62.10	10.4	1.83	2.02	5.56	20.03	to	4.04	86	94	68	5	266	4	11
3/ 4	18 42.6	62.35	18 43.0	62.38	10.4	1.84	2.04	5.54	20.05	to	4.01	86	93	78	5	265	3	11
4/ 5	18 43.9	63.02	18 44.3	63.05	10.5	1.86	2.05	5.51	20.07	to	3.59	86	92	87	5	265	3	11
5/ 6	18 45.1	63.28	18 45.5	63.32	10.5	1.87	2.06	5.48	20.09	to	3.56	86	91	94	4	264	3	11
6/ 7	18 46.3	63.54	18 46.6	63.58	10.5	1.89	2.07	5.45	20.11	to	3.53	86	90	99	4	263	3	10
7/ 8	18 47.4	64.20	18 47.7	64.23	10.6	1.90	2.08	5.42	20.14	to	3.50	86	89	100	4	263	3	10
8/ 9	18 48.5	64.45	18 48.8	64.49	10.6	1.92	2.09	5.40	20.16	to	3.48	86	89	100	4	262	2	10
9/10	18 49.5	65.10	18 49.8	65.13	10.6	1.93	2.10	5.37	20.18	to	3.45	85	89	96	4	261	2	10
10/11	18 50.5	65.34	18 50.7	65.37	10.7	1.94	2.11	5.34	20.20	to	3.42	85	89	91	4	260	2	10
11/12	18 51.4	65.58	18 51.5	66.01	10.7	1.96	2.12	5.30	20.23	to	3.39	85	89	83	4	260	2	9
12/13	18 52.3	66.21	18 52.4	66.25	10.7	1.97	2.14	5.27	20.25	to	3.36	85	90	75	4	259	2	9
13/14	18 53.1	66.44	18 53.1	66.47	10.8	1.99	2.15	5.24	20.27	to	3.34	85	90	66	4	258	1	9
14/15	18 53.8	67.06	18 53.8	67.10	10.8	2.00	2.16	5.21	20.29	to	3.31	85	90	56	4	257	1	9
15/16	18 54.4	67.28	18 54.4	67.32	10.8	2.02	2.17	5.18	20.32	to	3.28	85	90	47	3	256	1	9
16/17	18 55.0	67.50	18 54.9	67.53	10.9	2.03	2.18	5.14	20.34	to	3.25	85	91	37	3	256	1	8
17/18	18 55.6	68.11	18 55.4	68.15	10.9	2.05	2.19	5.11	20.37	to	3.22	84	91	28	3	255	1	8
18/19	18 56.0	68.31	18 55.8	68.35	11.0	2.06	2.20	5.07	20.39	to	3.19	84	91	20	3	254	1	8
19/20	18 56.4	68.52	18 56.2	68.56	11.0	2.08	2.21	5.04	20.41	to	3.17	84	90	13	3	253	0	8
20/21	18 56.7	69.11	18 56.4	69.16	11.0	2.09	2.23	4.60	20.44	to	3.14	84	90	7	3	252	0	8
21/22	18 56.9	69.31	18 56.6	69.35	11.1	2.11	2.24	4.56	20.46	to	3.11	84	89	2	3	251	0	8
22/23	18 57.1	69.50	18 56.7	69.54	11.1	2.12	2.25	4.52	20.49	to	3.08	84	89	0	3	250	0	7
23/24	18 57.2	70.09	18 56.8	70.13	11.1	2.14	2.26	4.48	20.51	to	3.05	84	88	0	3	249	0	7
24/25	18 57.2	70.27	18 56.7	70.31	11.1	2.15	2.27	4.44	20.54	to	3.02	84	87	2	3	248	0	7
25/26	18 57.1	70.45	18 56.6	70.49	11.2	2.17	2.28	4.40	20.56	to	2.59	83	87	6	3	247	0	7
26/27	18 57.0	71.02	18 56.4	71.06	11.2	2.18	2.29	4.36	20.59	to	2.57	83	86	12	3	246	0	7
27/28	18 56.7	71.19	18 56.1	71.23	11.2	2.19	2.30	4.32	21.01	to	2.54	83	85	21	3	245	0	7
28/29	18 56.4	71.36	18 55.7	71.40	11.3	2.21	2.32	4.28	21.04	to	2.51	83	85	31	3	244	0	6
29/30	18 56.0	71.52	18 55.3	71.56	11.3	2.22	2.33	4.23	21.07	to	2.48	83	85	42	3	243	0	6
30/31	18 55.5	72.08	18 54.7	72.12	11.3	2.24	2.34	4.19	21.09	to	2.45	83	86	54	3	242	0	6
May	2001																	
1/ 2	18 54.9	72.24	18 54.1	72.28	11.4	2.25	2.35	4.14	21.12	to	2.42	83	86	65	2	241	-1	6
2/ 3	18 54.3	72.39	18 53.4	72.43	11.4	2.27	2.36	4.09	21.15	to	2.39	83	87	76	2	240	-1	6
3/ 4	18 53.5	72.53	18 52.6	72.57	11.4	2.28	2.37	4.05	21.17	to	2.36	83	89	85	2	239	-1	6
4/ 5	18 52.7	73.08	18 51.7	73.12	11.5	2.30	2.38	3.60	21.20	to	2.33	82	90	92	2	238	-1	5
5/ 6	18 51.7	73.22	18 50.7	73.25	11.5	2.31	2.39	3.55	21.23	to	2.31	82	92	97	2	237	-1	5
6/ 7	18 50.7	73.35	18 49.6	73.39	11.5	2.32	2.41	3.50	21.25	to	2.28	82	93	100	2	235	-1	5
7/ 8	18 49.6	73.48	18 48.4	73.52	11.5	2.34	2.42	3.45	21.28	to	2.25	82	95	100	2	234	-1	5
8/ 9	18 48.4	74.01	18 47.1	74.04	11.6	2.35	2.43	3.40	21.31	to	2.22	82	96	98	2	233	-2	5
9/10	18 47.1	74.13	18 45.8	74.17	11.6	2.37	2.44	3.34	21.34	to	2.19	82	97	94	2	232	-2	5
10/11	18 45.7	74.25	18 44.3	74.28	11.6	2.38	2.45	3.29	21.37	to	2.16	82	98	88	2	230	-2	4
11/12	18 44.2	74.37	18 42.8	74.40	11.7	2.39	2.46	3.23	21.39	to	2.13	82	98	81	2	229	-2	4
12/13	18 42.6	74.48	18 41.1	74.51	11.7	2.41	2.47	3.18	21.42	to	2.10	82	98	73	2	228	-2	4
13/14	18 40.9	74.58	18 39.4	75.01	11.7	2.42	2.48	3.12	21.45	to	2.07	82	98	64	2	226	-2	4
14/15	18 39.1	75.09	18 37.6	75.11	11.7	2.44	2.50	3.06	21.48	to	2.05	81	97	54	2	225	-2	4
15/16	18 37.3	75.18	18 35.7	75.21	11.8	2.45	2.51	3.00	21.51	to	2.02	81	96	45	2	223	-2	4
16/17	18 35.3	75.28	18 33.7	75.30	11.8	2.46	2.52	2.55	21.54	to	1.59	81	95	35	2	222	-3	3
17/18	18 33.3	75.37	18 31.6	75.39	11.8	2.48	2.53	2.49	21.57	to	1.56	81	94	26	2	221	-3	3
18/19	18 31.2	75.45	18 29.4	75.47	11.9	2.49	2.54	2.42	21.60	to	1.53	81	92	18	2	219	-3	3
19/20	18 29.0	75.53	18 27.1	75.55	11.9	2.50	2.55	2.36	22.03	to	1.50	81	90	11	2	218	-3	3
20/21	18 26.7	76.01	18 24.8	76.03	11.9	2.52	2.56	2.30	22.06	to	1.47	81	88	5	2	216	-3	3
21/22	18 24.3	76.08	18 22.4	76.10	11.9	2.53	2.57	2.24	22.09	to	1.45	81	86	1	2	215	-3	2
22/23	18 21.9	76.15	18 19.9	76.16	12.0	2.54	2.58	2.17	22.12	to	1.42	81	84	0	2	213	-3	2

Ephemeris for comet 24P/Schaumasse (UK)

Omega= 57.8977 OMEGA= 79.8340 i= 11.7507 q= 1.204506 a= 4.082490
e=0.704958 P= 8.249 T= 2001 May 2.6604 Equinox= 2000
Magnitudes calculated from m= 6.5+5.0*Log(d)+35.0*Log(r)

Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
March 2001																
1/ 2	2 51.0	17.22	2 53.8	17.34	13.0	1.55	1.44	16.14	19.00 to 20.36	65	13	38	1	73	0	0
2/ 3	2 53.3	17.40	2 56.1	17.52	12.9	1.55	1.43	16.13	19.02 to 20.36	64	26	49	1	73	13	7
3/ 4	2 55.5	17.57	2 58.3	18.09	12.9	1.55	1.43	16.11	19.04 to 20.36	64	38	60	1	73	13	7
4/ 5	2 57.8	18.15	3 0.7	18.26	12.8	1.55	1.42	16.09	19.06 to 20.36	64	52	71	1	73	13	7
5/ 6	3 0.2	18.32	3 3.0	18.44	12.7	1.55	1.42	16.08	19.08 to 20.39	63	66	81	1	73	13	7
6/ 7	3 2.6	18.50	3 5.4	19.01	12.7	1.55	1.41	16.06	19.09 to 20.42	63	80	90	1	73	14	7
7/ 8	3 5.0	19.07	3 7.8	19.19	12.6	1.55	1.40	16.05	19.11 to 20.45	62	94	96	2	73	14	7
8/ 9	3 7.4	19.25	3 10.3	19.36	12.5	1.55	1.40	16.03	19.13 to 20.48	62	108	100	2	73	14	7
9/10	3 9.9	19.42	3 12.8	19.54	12.5	1.55	1.39	16.02	19.15 to 20.51	62	123	100	2	74	14	7
10/11	3 12.4	20.00	3 15.3	20.11	12.4	1.55	1.38	16.00	19.17 to 20.53	61	136	98	2	74	14	7
11/12	3 15.0	20.18	3 17.9	20.28	12.3	1.55	1.38	15.59	19.19 to 20.56	61	150	93	2	74	14	7
12/13	3 17.6	20.35	3 20.5	20.46	12.3	1.55	1.37	15.58	19.21 to 20.59	61	163	86	2	74	15	7
13/14	3 20.2	20.52	3 23.1	21.03	12.2	1.55	1.37	15.56	19.23 to 21.02	60	173	78	2	74	15	7
14/15	3 22.9	21.10	3 25.8	21.20	12.1	1.55	1.36	15.55	19.24 to 21.04	60	169	69	2	74	15	7
15/16	3 25.6	21.27	3 28.5	21.37	12.1	1.55	1.35	15.54	19.26 to 21.07	60	158	59	2	74	15	7
16/17	3 28.3	21.45	3 31.2	21.55	12.0	1.55	1.35	15.53	19.28 to 21.10	59	147	49	2	74	15	7
17/18	3 31.1	22.02	3 34.0	22.12	11.9	1.55	1.34	15.52	19.30 to 21.12	59	136	39	2	75	16	7
18/19	3 33.9	22.19	3 36.8	22.29	11.9	1.55	1.34	15.50	19.32 to 21.15	59	125	30	2	75	16	7
19/20	3 36.8	22.36	3 39.7	22.46	11.8	1.54	1.33	15.49	19.34 to 21.18	59	114	22	3	75	16	7
20/21	3 39.6	22.53	3 42.6	23.02	11.7	1.54	1.33	15.48	19.36 to 21.20	58	103	14	3	75	16	7
21/22	3 42.6	23.10	3 45.5	23.19	11.7	1.54	1.32	15.47	19.38 to 21.23	58	92	8	3	75	16	7
22/23	3 45.5	23.27	3 48.5	23.36	11.6	1.54	1.32	15.46	19.40 to 21.25	58	80	4	3	75	17	7
23/24	3 48.5	23.44	3 51.5	23.52	11.5	1.54	1.31	15.45	19.42 to 21.28	58	69	1	3	75	17	6
24/25	3 51.6	24.00	3 54.6	24.09	11.5	1.54	1.31	15.45	19.44 to 21.30	57	58	0	3	76	17	6
25/26	3 54.7	24.17	3 57.7	24.25	11.4	1.54	1.30	15.44	19.46 to 21.33	57	46	0	3	76	17	6
26/27	3 57.8	24.33	4 0.8	24.41	11.4	1.54	1.30	15.43	19.48 to 21.35	57	34	3	3	76	17	6
27/28	4 1.0	24.49	4 4.0	24.57	11.3	1.54	1.29	15.42	19.50 to 21.38	57	23	8	3	76	17	6
28/29	4 4.2	25.05	4 7.2	25.13	11.3	1.54	1.29	15.41	19.52 to 21.40	56	12	15	4	76	18	6
29/30	4 7.4	25.21	4 10.4	25.29	11.2	1.53	1.28	15.41	19.54 to 21.43	56	8	24	4	77	18	6
30/31	4 10.7	25.37	4 13.7	25.44	11.2	1.53	1.28	15.40	19.56 to 21.45	56	17	34	4	77	18	6
31/32	4 14.0	25.52	4 17.1	25.59	11.1	1.53	1.27	15.39	19.58 to 21.47	56	30	45	4	77	18	6
April 2001																
1/ 2	4 17.4	26.08	4 20.4	26.15	11.1	1.53	1.27	15.39	20.01 to 21.50	56	43	56	4	77	18	6
2/ 3	4 20.8	26.23	4 23.9	26.29	11.0	1.53	1.27	15.38	20.03 to 21.52	55	56	68	4	77	19	6
3/ 4	4 24.2	26.38	4 27.3	26.44	11.0	1.53	1.26	15.38	20.05 to 21.54	55	69	78	4	78	19	6
4/ 5	4 27.7	26.52	4 30.8	26.58	10.9	1.53	1.26	15.37	20.07 to 21.57	55	83	87	4	78	19	6
5/ 6	4 31.2	27.07	4 34.3	27.13	10.9	1.53	1.25	15.37	20.09 to 21.59	55	97	94	5	78	19	6
6/ 7	4 34.8	27.21	4 37.9	27.27	10.8	1.52	1.25	15.37	20.11 to 22.01	55	110	99	5	78	19	5
7/ 8	4 38.4	27.35	4 41.5	27.40	10.8	1.52	1.25	15.36	20.14 to 22.03	55	124	100	5	78	19	5
8/ 9	4 42.1	27.48	4 45.2	27.54	10.7	1.52	1.24	15.36	20.16 to 22.06	54	137	100	5	79	20	5
9/10	4 45.7	28.02	4 48.9	28.07	10.7	1.52	1.24	15.36	20.18 to 22.08	54	149	96	5	79	20	5
10/11	4 49.5	28.15	4 52.6	28.19	10.6	1.52	1.24	15.36	20.20 to 22.10	54	161	91	5	79	20	5
11/12	4 53.2	28.27	4 56.4	28.32	10.6	1.52	1.23	15.35	20.23 to 22.12	54	171	83	5	79	20	5
12/13	4 57.0	28.40	5 0.2	28.44	10.6	1.52	1.23	15.35	20.25 to 22.14	54	170	75	5	80	20	5
13/14	5 0.9	28.52	5 4.0	28.56	10.5	1.52	1.23	15.35	20.27 to 22.16	54	160	66	6	80	21	5
14/15	5 4.8	29.03	5 7.9	29.07	10.5	1.52	1.23	15.35	20.29 to 22.18	54	149	56	6	80	21	4
15/16	5 8.7	29.15	5 11.8	29.18	10.5	1.51	1.22	15.35	20.32 to 22.20	54	139	47	6	81	21	4
16/17	5 12.6	29.26	5 15.8	29.29	10.4	1.51	1.22	15.35	20.34 to 22.22	54	128	37	6	81	21	4
17/18	5 16.6	29.36	5 19.8	29.39	10.4	1.51	1.22	15.35	20.37 to 22.24	53	117	28	6	81	21	4
18/19	5 20.7	29.46	5 23.9	29.49	10.4	1.51	1.22	15.35	20.39 to 22.26	53	106	20	6	81	21	4
19/20	5 24.7	29.56	5 27.9	29.58	10.4	1.51	1.22	15.35	20.41 to 22.28	53	95	13	6	82	22	4
20/21	5 28.8	30.05	5 32.0	30.07	10.3	1.51	1.21	15.36	20.44 to 22.29	53	84	7	6	82	22	3
21/22	5 33.0	30.14	5 36.2	30.16	10.3	1.51	1.21	15.36	20.46 to 22.31	53	73	2	6	82	22	3
22/23	5 37.1	30.23	5 40.4	30.24	10.3	1.51	1.21	15.36	20.49 to 22.33	53	61	0	6	83	22	3
23/24	5 41.4	30.31	5 44.6	30.32	10.3	1.51	1.21	15.36	20.51 to 22.34	53	49	0	6	83	22	3
24/25	5 45.6	30.38	5 48.8	30.39	10.3	1.51	1.21	15.37	20.54 to 22.36	53	37	2	7	83	22	3
25/26	5 49.9	30.45	5 53.1	30.46	10.3	1.51	1.21	15.37	20.56 to 22.37	53	25	6	7	84	22	2
26/27	5 54.2	30.52	5 57.4	30.52	10.2	1.51	1.21	15.37	20.59 to 22.38	53	14	12	7	84	23	2
27/28	5 58.5	30.58	6 1.7	30.57	10.2	1.51	1.21	15.38	21.01 to 22.40	53	8	21	7	84	23	2
28/29	6 2.9	31.03	6 6.1	31.03	10.2	1.50	1.21	15.38	21.04 to 22.41	53	17	31	7	85	23	2
29/30	6 7.2	31.08	6 10.5	31.07	10.2	1.50	1.21	15.39	21.07 to 22.42	53	29	42	7	85	23	2
30/31	6 11.6	31.12	6 14.9	31.11	10.2	1.50	1.20	15.39	21.09 to 22.43	53	42	54	7	86	23	1
May 2001																
1/ 2	6 16.1	31.16	6 19.3	31.15	10.2	1.50	1.20	15.39	21.12 to 22.44	53	55	65	7	86	23	1
2/ 3	6 20.5	31.20	6 23.8	31.18	10.2	1.50	1.20	15.40	21.15 to 22.45	53	68	76	7	86	23	1
3/ 4	6 25.0	31.22	6 28.3	31.20	10.2	1.50	1.20	15.41	21.17 to 22.45	53	81	85	7	87	23	1
4/ 5	6 29.5	31.24	6 32.8	31.22	10.2	1.50	1.20	15.41	21.20 to 22.46	53	94	92	7	87	23	0
5/ 6	6 34.0	31.26	6 37.3	31.23	10.2	1.50	1.21	15.42	21.23 to 22.47	53	107	97	7	87	24	0
6/ 7	6 38.6	31.27	6 41.8	31.24	10.2	1.51	1.21	15.42	21.25 to 22.47	53	120	100	7	88	24	0
7/ 8	6 43.1	31.27	6 46.4	31.24	10.2	1.51	1.21	15.43	21.28 to 22.47	53	132	100	7	88	24	0
8/ 9	6 47.7	31.27	6 50.9	31.24	10.3	1.51	1.21	15.43	21.31 to 22.48	53	144	98	7	89	24	0
9/10	6 52.3	31.26	6 55.5	31.22	10.3	1.51	1.21	15.44	21.34 to 22.48	53	156	94	7	89	24	0
10/11	6 56.8	31.25	7 0.1	31.21	10.3	1.51	1.21	15.45	21.37 to 22.48	53	166	88	7	89	24	0
11/12	7 1.4	31.23	7 4.7	31.18	10.3	1.51	1.21	15.45	21.39 to 22.48	53	172	81	6	90	24	0
12/13	7 6.0	31.20	7 9.3	31.15	10.3	1.51	1.21	15.46	21.42 to 22.47	53	166	73	6	90	24	-1
13/14	7 10.7	31.17	7 13.9	31.12	10.3	1.51	1.21	15.47	21.45 to 22.47	53	157	64	6	91	24	-1
14/15	7 15.3	31.13	7 18.5	31.08	10.4	1.51	1.22	15.47	21.48 to 22.47	53	146	54	6	91	24	-1
15/16	7 19.9	31.09	7 23.1	31.03	10.4	1.51	1.22	15.48	21.51 to 22.46	53	136	45	6	92	24	-1
16/17	7 24.5	31.04	7 27.7	30.58	10.4	1.52	1.22	15.49	21.54 to 22.45	53	125	35	6	92	24	-2
17/18	7 29.1	30.58	7 32.3	30.52	10.4	1.52	1.22	15.49	21.57 to 22.45	53	114	26	6	92	24	-2
18/19	7 33.7	30.52	7 36.9	30.45	10.5	1.52	1.22	15.50	21.60 to 22.44	53	103	18	6	93	24	-2
19/20	7 38.3	30.45	7 41.5	30.38	10.5	1.52	1.23	15.51	22.03 to 22.43	53	91	11	6	93	24	-2
20/21	7 43.0	30.37	7 46.1	30.30	10.5	1.52	1.23	15.51	22.06 to 22.42	53	80	5	6	94	24	-3
21/22	7 47.5	30.29	7 50.7	30.22	10.6	1.52	1.23	15.52	22.09 to 22.40	54	68	1	5	94	24	-3
22/23	7 52.1	30.21	7 55.3	30.13	10.6	1.53	1.23	15.53	22.12 to 22.39	54	55	0	5	94	24	-3

Name	Number	T	q	e	w	W	i	H1	K1	Epoch	Source
Encke	2P	2000 09 09.6662	0.339537	0.846898	186.4834	334.6000	11.7555	11.5	15.0	2000	MPC 40671
Faye	4P	1999 05 06.1271	1.657939	0.568104	205.0122	199.3421	9.0481	8.0	15.0	2000	MPC 27081
Tempel 1	9P	2000 01 02.6018	1.500139	0.518820	178.9099	68.9667	10.5414	5.5	25.0	2000	MPC 29881
Tempel 2	10P	1999 09 08.5497	1.479913	0.523561	195.0552	118.1322	11.9868	5.0	25.0	2000	MPC 27082
Wolf	14P	2000 11 21.0512	2.412646	0.407062	162.3567	204.1202	27.5232	5.5	30.0	2000	MPC 29882
Brooks 2	16P	2001 07 19.7588	1.835133	0.492058	198.0745	176.9195	5.5479	7.5	25.0	2000	MPC 31664
Holmes	17P	2000 05 11.8602	2.165519	0.412244	23.3670	328.0026	19.1858	10.0	15.0	2000	MPC 29881
Schaumasse	24P	2001 05 02.6604	1.204506	0.704958	57.8977	79.8340	11.7507	6.5	35.0	2000	MPC 31663
Neujmin 1	28P	2002 12 27.1911	1.549214	0.775882	346.9527	347.0745	14.1964	8.5	15.0	2000	MPC 34424
Schwassmann-Wachmann 1	29P	2004 07 11.0663	5.720794	0.045741	49.0226	312.7463	9.3881	4.0	10.0	2000	MPC 23105
Reinmuth 1	30P	2002 12 24.8355	1.878988	0.501368	13.3240	119.7500	8.1297	9.5	15.0	2000	MPC 34424
Schwassmann-Wachmann 2	31P	2002 01 18.7142	3.398884	0.201925	18.3581	114.5483	4.5179	5.0	20.0	2000	MPC 34422
Whipple	36P	2003 07 05.6807	3.087797	0.259948	202.0626	182.4419	9.9307	8.5	15.0	2000	MPC 40670
Oterma	39P	2002 12 18.1740	5.473456	0.246145	56.0831	331.5749	1.9417	5.0	15.0	2000	MPC 34423
Tuttle-Giacobini-Kresak	41P	2001 01 06.9856	1.052255	0.659283	62.1809	141.1045	9.2256	10.0	40.0	2000	MPC 31662
Reinmuth 2	44P	2001 02 19.9697	1.889761	0.464670	46.0908	296.0689	6.9813	8.3	15.0	2000	MPC 31663
Ashbrook-Jackson	47P	2001 01 06.4560	2.305407	0.396152	348.8709	2.6030	12.5131	1.0	28.0	2000	MPC 31662
Arend-Rigaux	49P	1998 07 12.8884	1.367574	0.612014	330.6106	121.6831	18.2953	11.3	11.0	2000	CCO 13
Shajn-Schaldach	61P	2001 05 08.9207	2.330278	0.389461	216.5942	166.8815	6.0843	6.0	25.0	2000	MPC 31664
Gunn	65P	2003 05 12.7349	2.451397	0.317303	196.2983	68.4273	10.3852	5.0	15.0	2000	MPC 40670
Clark	71P	2000 12 02.0435	1.559143	0.500585	208.8498	59.6925	9.4952	9.8	15.0	2000	MPC 38309
Schwassmann-Wachmann 3	73P	2001 01 27.7284	0.937382	0.693815	198.7760	69.9208	11.4063	5.5	7.0	2000	MPC 39024
Smirnova-Chernykh	74P	2001 01 15.5791	3.545807	0.148156	86.6426	77.1573	6.6523	5.0	15.0	2000	MPC 31662
Kohoutek	75P	2001 02 27.4286	1.787050	0.496039	175.7300	269.6885	5.9094	10.5	10.0	2000	MPC 31663
West-Kohoutek-Ikemura	76P	2000 06 01.2672	1.595860	0.539762	0.0733	84.1249	30.4991	8.0	30.0	2000	MPC 29881
Longmore	77P	2002 09 04.1374	2.316972	0.357624	195.9015	15.1668	24.4200	7.0	20.0	2000	CCO 13
Gehrels 3	82P	2001 09 11.8341	3.618955	0.130645	229.4094	239.6625	1.1203	5.0	20.0	2000	MPC 31664
Gehrels 1	90P	2002 06 22.5954	2.967216	0.509300	28.0773	13.5455	9.6137	8.5	15.0	2000	MPC 34422
Metcalf-Brewington	97P	2001 04 15.0872	2.610815	0.455926	229.7302	186.4447	17.9908	5.5	15.0	2000	MPC 31663
Ciffreo	108P	2000 04 18.3776	1.713291	0.542432	358.0320	53.7210	13.0928	8.0	30.0	2000	MPC 36654
Hartley 3	110P	2001 03 21.7472	2.477743	0.314965	168.0121	287.7822	11.6819	1.0	30.0	2000	MPC 31663
Spitaler	113P	2001 02 25.9753	2.127154	0.423212	50.0899	14.5316	5.7781	13.5	10.0	2000	MPC 31663
Wild 4	116P	2003 01 19.7424	2.142420	0.381531	173.4407	21.6782	3.6535	2.5	25.0	2000	MPC 40670
Helin-Roman-Alu 1	117P	1997 02 08.9815	3.535946	0.194396	207.6352	70.8674	9.9837	2.5	20.0	2000	MPC 27080
Shoemaker-Levy 4	118P	2003 07 16.6878	2.014492	0.421789	301.9339	152.0557	8.4763	12.0	10.0	2000	MPC 40670
Parker-Hartley	119P	1996 06 26.6661	3.041434	0.291869	181.2308	244.1507	5.1894	3.5	20.0	2000	MPC 25513
Mrkos	124P	2002 07 27.0919	1.464514	0.543041	181.2817	1.4718	31.3861	13.5	7.0	2000	MPC 34422
Shoemaker-Holt 1	128P	1997 11 21.5093	3.049871	0.321995	210.4812	214.5011	4.3619	8.5	10.0	2000	MPC 30632
Shoemaker-Levy 3	129P	1998 03 04.9688	2.814259	0.248684	181.3313	303.6601	5.0091	11.0	10.0	2000	MPC 30739
Shoemaker-Levy 8	135P	1999 12 10.3132	2.720942	0.289260	22.5393	213.3165	6.0504	7.0	20.0	2000	MPC 34126
Mueller 3	136P	1999 03 16.8352	3.005187	0.287609	224.8893	137.7407	9.4123	11.0	10.0	2000	MPC 36654
Shoemaker-Levy 2	137P	2000 02 05.7181	1.868047	0.579738	141.9656	234.7532	4.6579	11.0	10.0	2000	MPC 35208
Vaisala-Oterma	139P	1998 09 29.6274	3.384565	0.247780	165.7403	242.4555	2.3337	9.5	10.0	2000	MPC 33190
Bowell-Skiff	140P	1999 05 14.8271	1.971077	0.691994	173.0815	343.4342	3.8354	11.5	15.0	2000	MPC 34126
Ge-Wang	142P	1999 06 20.6526	2.492177	0.500359	177.1923	177.0439	12.1631	8.5	15.0	2000	MPC 35815
Kowal-Mrkos	143P	2000 07 01.7860	2.546780	0.409081	320.5837	245.5010	4.6838	13.5	5.0	2000	MPC 39792
Lovas 2	P/1986 W1	2000 03 11.6642	1.453547	0.593034	71.5393	283.5560	1.5297	8.5	25.0	2000	MPC 29881
Shoemaker-Levy 5	P/1991 T1	2000 08 18.5014	1.988575	0.529501	6.2456	29.6903	11.7709	11.5	15.0	2000	MPC 29882
Helin-Lawrence	P/1993 K2	2002 12 23.3131	3.109206	0.306932	163.8323	92.0158	9.8720	10.0	8.0	2000	MPC 34423
Kushida-Muramatsu	P/1993 X1	2001 04 30.5331	2.751704	0.276899	347.7968	93.6988	2.3670	5.5	20.0	2000	MPC 31663
Kushida	P/1994 A1	2001 06 27.7919	1.431269	0.629003	216.0217	245.6249	4.1188	8.5	20.0	2000	MPC 31664
Hale-Bopp	C/1995 O1	1997 03 31.8525	0.915394	0.994929	130.5908	282.2814	89.4362	-2.0	10.0	2000	MPC 35204
Spacewatch	C/1997 BA6	1999 11 27.5875	3.436381	0.998722	285.9431	317.6579	72.7213	10.0	5.0	2000	MPC 40668
Larsen	C/1998 M3	1998 07 16.4012	5.765855	1.001601	20.7811	255.5539	113.4407	6.5	10.0	2000	MPC 34733
LINEAR	C/1998 M5	1999 01 24.5771	1.742223	0.996160	101.2870	333.3644	82.2008	6.0	10.0	2000	MPC 40668
Montani	C/1998 M6	1998 10 06.9844	5.979293	0.998768	9.1913	306.6278	91.5627	7.0	10.0	2000	MPC 33188
LINEAR	C/1998 T1	1999 06 25.2699	1.466973	0.999168	226.3507	153.3766	170.1568	8.0	10.0	2000	MPC 40668
Jager	P/1998 U3	1999 03 10.1843	2.133635	0.648685	180.9315	303.5155	19.1409	6.5	10.0	2000	MPC 34421

Spahr	P/1998 U4	1999	02	27.3395	3.844740	0.310183	251.8734	181.7239	31.5160	8.0	10.0	2000	MPC 36653
LINEAR	C/1998 U5	1998	12	21.8510	1.237035	0.988225	51.1657	66.6478	131.7801	8.0	10.0	2000	MPC 35206
LINEAR	P/1998 VS24	1998	11	03.1434	3.407317	0.243119	244.6020	159.2068	5.0309	13.0	5.0	2000	MPC 33651
LINEAR	C/1998 W3	1998	10	06.7062	4.916620	0.999693	6.9143	123.9114	129.1813	6.0	10.0	2000	MPC 36212
Li	P/1998 Y2	1998	12	17.9516	2.520634	0.588393	319.0677	91.8199	24.3209	9.5	10.0	2000	MPC 34421
Korlevic-Juric	P/1999 DN3	1998	09	29.0850	3.906436	0.135487	161.0536	5.9415	18.7180	12.0	5.0	2000	MPC 34734
Li	C/1999 E1	1999	02	01.0345	3.921020	0.760556	329.8153	127.8253	46.8686	6.5	10.0	2000	MPC 39021
Catalina	C/1999 F1	2002	02	13.5335	5.787297	0.999578	255.1492	20.0311	92.0454	9.5	5.0	2000	MPC 39021
Dalcanton	C/1999 F2	1998	08	23.3774	4.715921	0.997807	352.3062	210.2921	56.4246	5.0	10.0	2000	MPC 39021
LINEAR	C/1999 G1	1998	07	31.7979	4.038315	0.845414	135.9667	23.4784	76.3072	7.5	10.0	2000	MPC 34734
Lee	C/1999 H1	1999	07	11.1338	0.707864	0.999625	40.6907	162.6621	149.3399	7.0	10.0	2000	MPC 36212
LINEAR	C/1999 H3	1999	08	18.1904	3.500682	1.002801	101.9072	332.7338	115.8295	5.0	10.0	2000	MPC 39790
Skiff	C/1999 J2	2000	04	05.7772	7.109890	1.001634	127.1223	50.0432	86.4122	2.0	10.0	2000	MPC 39791
LINEAR	C/1999 J4	1999	11	17.6088	3.780400	1.000000	95.1591	264.4841	118.9108	11.5	5.0	2000	MPC 34734
LINEAR	P/1999 J5	1999	05	11.6426	3.711969	0.168972	132.1209	112.0116	13.7216	9.0	10.0	2000	MPC 35553
Ferris	C/1999 K2	1999	04	10.5518	5.290422	0.965447	4.5749	300.3317	82.2095	6.0	10.0	2000	MPC 35553
LINEAR	C/1999 K5	2000	07	04.3917	3.255435	1.001583	241.4867	106.3832	89.4737	6.0	10.0	2000	MPC 36653
LINEAR	C/1999 K6	1999	07	24.8719	2.250027	0.994324	56.8870	245.3548	46.3579	11.0	10.0	2000	MPC 36653
LINEAR	C/1999 K8	2000	04	24.4542	4.200684	1.001430	164.6439	195.3960	52.7221	5.0	10.0	2000	MPC 40988
LINEAR	C/1999 L3	2000	01	05.0023	1.989264	0.974934	353.3782	140.2119	166.1043	10.0	10.0	2000	MPC 37478
Lynn	C/1999 N2	1999	07	22.9960	0.761326	0.997270	357.8242	254.6770	111.6564	9.5	10.0	2000	MPC 35814
LINEAR	C/1999 N4	2000	05	23.6632	5.504718	1.004390	90.4270	345.9078	156.9226	6.0	10.0	2000	MPC 40823
McNaught-Watson	C/1999 S2	1997	11	22.2310	6.467047	1.004686	223.4739	74.4663	65.8188	2.0	10.0	2000	MPC 39022
LINEAR	C/1999 S3	1999	11	09.0277	1.895246	0.899963	44.1376	11.8816	70.5597	10.0	10.0	2000	MPC 39022
LINEAR	C/1999 S4	2000	07	26.1694	0.765040	0.999565	151.0334	83.1911	149.3906	9.0	10.0	2000	MPC 40988
McNaught-Hartley	C/1999 T1	2000	12	13.4682	1.171683	0.999954	344.7576	182.4823	79.9752	5.0	10.0	2000	MPC 37479
LINEAR	C/1999 T2	2000	11	24.4699	3.037365	1.001968	104.6690	14.8786	111.0022	6.0	10.0	2000	MPC 40988
LINEAR	C/1999 T3	2000	09	01.5309	5.365768	0.996914	211.3180	223.5118	104.7548	6.0	10.0	2000	MPC 37479
Ferris	C/1999 U1	1998	09	02.5550	4.143222	1.000552	291.1397	58.2578	105.8202	6.5	10.0	2000	MPC 37479
Catalina-Skiff	C/1999 U4	2001	10	27.7128	4.917264	1.008344	77.3970	32.3211	51.9511	4.5	10.0	2000	MPC 40988
Catalina	P/1999 V1	1999	10	25.1947	2.944522	0.550906	186.7305	294.3036	15.5850	10.0	10.0	2000	MPC 39022
Korlevic	P/1999 WJ7	2000	02	15.3110	3.167914	0.315898	154.4382	290.5283	2.9801	14.5	5.0	2000	MPC 38308
LINEAR	P/1999 XB69	2000	02	17.0628	1.639341	0.632096	220.1955	256.1647	11.3364	17.5	5.0	2000	MPC 39023
LINEAR	C/1999 XS87	1999	08	06.6052	2.772308	0.840392	151.3668	266.7285	14.8464	10.0	10.0	2000	MPC 39023
Catalina	P/1999 XN120	2000	05	01.5601	3.286300	0.212775	161.8312	285.4539	5.0319	13.5	5.0	2000	MPC 39023
LINEAR	C/1999 Y1	2001	03	24.0575	3.091365	1.000791	184.2657	188.8766	134.7963	5.5	10.0	2000	MPC 40988
Montani	C/2000 A1	2000	07	20.8116	9.738859	1.005194	14.6251	111.8322	24.5324	3.5	10.0	2000	MPC 40668
LINEAR	C/2000 B2	1999	11	09.9344	3.776036	1.000000	154.5683	284.9897	93.6545	13.0	5.0	2000	MPC 39023
LINEAR	P/2000 B3	2000	02	14.1856	1.700316	0.575332	130.5194	352.1466	11.1253	16.0	10.0	2000	MPC 40668
LINEAR	C/2000 B4	2000	06	16.6733	6.828766	0.621345	126.2875	0.6219	15.9098	11.5	5.0	2000	MPC 40823
Hergenrother	P/2000 C1	2000	03	19.8655	2.095493	0.406548	51.1682	127.0400	6.1053	14.0	10.0	2000	MPC 40669
LINEAR	C/2000 CT54	2001	06	19.4763	3.155573	0.999177	272.6541	18.9728	49.2108	11.0	5.0	2000	MPC 40669
LINEAR	C/2000 D2	2000	03	08.6123	2.297627	0.867110	117.6825	235.8874	156.9918	15.0	5.0	2000	MPC 40669
LINEAR	P/2000 G1	2000	03	09.8065	1.002812	0.672079	343.2917	191.0221	10.3769	19.5	5.0	2000	MPC 40823
LINEAR	C/2000 G2	2000	02	06.1533	2.716730	0.809007	101.7505	328.3872	170.4791	11.5	10.0	2000	MPC 40669
LINEAR	C/2000 H1	2000	01	28.8754	3.636630	1.000000	78.7991	356.4441	118.2393	9.5	10.0	2000	MPC 40823
Ferris	C/2000 J1	2000	05	11.3482	2.542640	0.954845	147.2347	28.4400	98.7929	15.5	5.0	2000	MPC 40823
LINEAR	C/2000 K1	1999	12	14.5218	6.275662	1.002130	15.7919	260.1985	116.7897	4.0	10.0	2000	MPC 40823
LINEAR	C/2000 K2	2000	10	11.3625	2.437195	0.995576	106.8191	195.2638	25.6337	11.0	10.0	2000	MPC 40988
Koehn	C/2000 O1	2000	01	27.9094	5.922220	0.999719	55.1868	88.8871	148.1050	6.0	10.0	2000	MPC 40989
Spacewatch	C/2000 OF8	2001	08	05.0028	2.167793	1.000000	256.2561	117.1050	152.4104	9.5	10.0	2000	MPC 41159
LINEAR	P/2000 R2	2000	09	12.7665	1.392287	0.590057	147.2011	187.3825	3.2336	18.0	10.0	2000	MPEC 2000-S04
Skiff	P/2000 S1	2000	07	08.217	2.48410	0.62614	305.699	29.547	20.689	10.0	10.0	2000	MPEC 2000-S60
Shoemaker-LINEAR	P/2000 S2	2000	07	14.2917	1.319021	0.666835	317.7452	55.3594	21.6197	15.0	10.0	2000	IAUC 7499
Skiff 2	D 2000 S3	2000	7	15.867	2.66273	0.77299	298.162	41.137	25.179	12.0	10.0	2000	IAUC 7501
Gehrels	P 2000 S4	2000	10	19.2225	2.265755	0.682838	172.3746	174.6363	28.3383	12.0	10.0	2000	IAUC 7502

Source: CBAT web pages. H1 and K1 are also from the CBAT; alternative values are given in the main section and on the Section web pages.

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

TA format (example)

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c   DC tt.tt  ppp    Observer
970313.02 S [13.4  VB   30  R    18 290                         Shanklin
970328.89 S    9.5 NP  20   T    10  75  2.5   2                Shanklin
961214.70 S    3.8 AA    8  B        20  6     7/  0.50   40    Baroni
```

ICQ format (example)

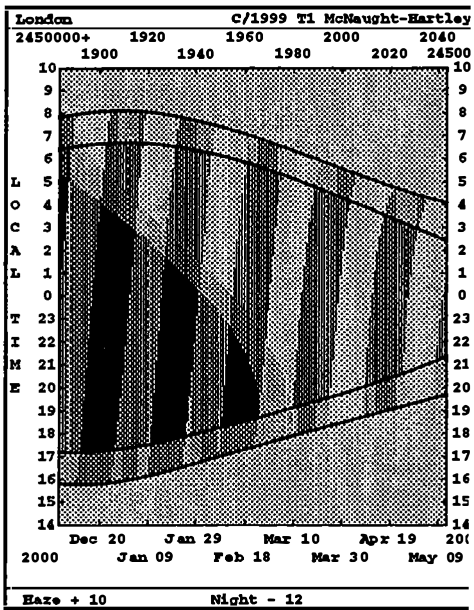
```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
 991992    1992  5 18.94  S  9.3 AA   7.5R     50    6    4        135 ICQ XX BEA
  P1955A1  1955  6 18.08     5.0 BD  5  R       6    5    s5    0.75 335 ICQ XX ST001
```

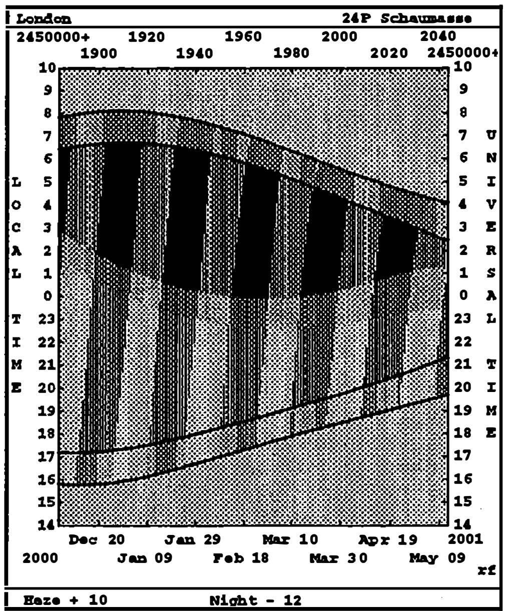
Charts

The diagram on this page shows when the moon interferes with observations of 1999 T1 (McNaught-Hartley) and 24P/Schaumasse and was produced using software written by Richard Fleet. There is no moon in the dark regions and the moon will interfere in the light regions. 1999 T1 is a morning object when it moves north in December, becoming visible all night by mid March, though by then it will be probably be a telescopic object. 24P/Schaumasse is an evening object throughout the apparition, so there is plenty of opportunity to try observing it.

The other comets move too quickly for it to be practical to give charts showing stars of the same magnitude as the comet.

If you would like your own copy of Richard's software it is available at http://www.naas.btinternet.co.uk





How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

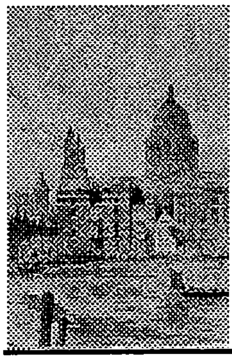
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail Len	Tail PA	Sky	Rel	Comments



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 8, No 1 (Issue 15), 2001 April

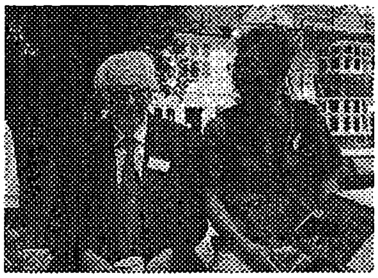
GEORGE ALCOCK REMEMBERED

an appreciation by Martin Mobberley

"We will not see his like again"; these seven words are often used when great men die, but they could not be more appropriate when the man in question is George Alcock. George was simply the greatest visual discoverer who ever lived under the cloudy British skies. His ten discoveries (five comets and five novae) surpass even the achievements of Caroline Herschel, who discovered eight comets from Britain and did not have to battle against the likes of Honda, Seki, Ikeya, Mrkos and Burnham, competing with George from much clearer skies. As most TA members will know, George also had to memorise the northern Milky Way to eighth magnitude (and fainter in some regions) to make his binocular nova patrol viable. His extraordinary success in this area implies that, locked in his brain, were thousands of star patterns, containing maybe more than 30,000 stars, as seen through his binoculars.

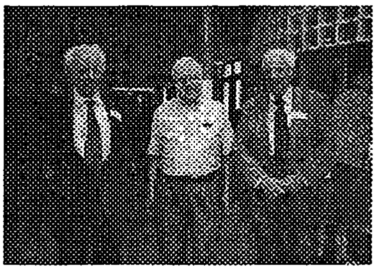
The Early Years

George was born in Peterborough on August 28th 1912 during the time of the great East Anglian flood. He died, in hospital, on December 15th 2000, 88 years and 109 days later, with the river Nene once again at dangerously high levels. Excluding the war years, George would spend his whole life in the Peterborough region.



George Alcock and Kesao Takamizawa at the IWCA in August 1999 [MPM]

George's first big encounter with Astronomy was as an eight year old, when he saw the large partial eclipse of April 8th 1921. The eclipse was annular at around 9am from NW Scotland and the Sun was 86% obscured from Peterborough. George and his schoolmates observed the eclipse through smoked glass. But, while George had learned much about astronomy from this experience, and developed a keen interest in the night sky in the following years, it was not the event which fired his latent desire to contribute observations; this was to come some 9 years later.



George Alcock, Brian Marsden and John Alcock at the IWCA11 in 1999. [MPM]

On December 30th 1930, whilst crossing the Peterborough town bridge, George saw a bright meteor "as bright as Venus". This single event spurred him to contact the BAA meteor section director, J.P.M.Prentice, with his first serious observation. Manning Prentice lived at Stowmarket, a small town midway between Bury St Edmunds and Ipswich and, critically, some 60 miles SE of Peterborough, a useful baseline distance for meteor triangulation observations. Prentice invited George to join the BAA's Meteor Section and George (although not yet a full BAA member) attended his first Meteor Section meeting in July 1931 (aged 18), in the library of Sion College. W.F. Denning, discoverer of five comets and a 3rd mag nova in Cygnus (V476 Cyg) had just died and the meeting began with a minutes silence in memory of the great man. During the meeting, George was approached by the veteran ninety year old meteor observer Grace Cook, who let George know that he would take the place of Denning. Whether she was endowed with clairvoyant abilities or was simply a good judge of character, we will never know; however, she would surely have been aware, via Prentice, that the young Alcock was a meticulous observer, fully familiar with the night sky and one who showed great promise.

Continued on page 4

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way. Renewals should be sent to the Director and cheques made payable to the BAA. Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

Whilst I was away in the Antarctic I heard the sad news of George Alcock's death. An appreciation by Martin Mobberley appears elsewhere in this issue. I was back in time to attend his memorial service in Peterborough Cathedral, along with several other members of the Comet Section. At the reception afterwards many of George's sketches were on display, not just of comets, but also of churches, weather and wildlife, all things that I myself am interested in. It is hoped that it will be possible to publish a book featuring these sketches in due course. In the meantime I can recommend George's biography 'Under an English Heaven', written by Kay Williams, which has a few of his sketches in it. If you would like to obtain a copy, contact Kay at kwilliams@kayor.demon.co.uk or 3 Vandyke Road, Leighton Buzzard, Beds LU7 8HG

Also whilst I was away, I heard the news that Albert Jones had discovered his second comet, 54 years after the first and in similar circumstances. I was able to email Albert from the Antarctic congratulating him on his discovery. He replied commenting how communication had changed since his first discovery! At the time I was deep in the Southern Hemisphere summer twilight, but fortunately we were heading north and I eventually managed to glimpse the comet through a gap in the clouds. Unfortunately it only survived a short time after perihelion and faded rapidly. I also observed 1999 T1 from the Falkland Islands and was lucky enough to see the green flash and a display of noctilucent clouds whilst at sea.

Whilst on board ship I did enter the remaining long period comet observations from the 1970s, and now all I need to do in order to complete the archive of BAA comet observations is to include the observations that were sent to the ICQ in the 1980s. Also whilst south I completed the bulk of the work on the papers on the comets of 1997 and 1998. I finished these off on my return and they are now being reviewed for publication in the BAA Journal. One rather disappointing aspect that arose from analysis of these observations is that one or two visual observers are reporting what they would like to see, rather than what is actually there. In particular:

1. The reported position angle of the tail of a binocular or fainter comet is often in significant disagreement between observers. There are several possibilities to explain this. Some observers may be using a star diagonal and failing to correct for the east-west reversal caused by the reflection in the light path. Others may be measuring the position angle with respect to the horizon when they should be measuring it with reference to the RA/dec co-ordinate frame. A final possibility is that the observer is reporting a feature that is of uncertain reality, but the detail is given using the normal TA or ICQ coded format. Any feature that you are unsure about should be reported as a remark in plain language, for example:
1999T1 2001 01 28.25 Possible tail 5' long in pa 345.

2. The light curves of some comets appear highly unusual as the magnitude of the comet gets towards the sky limit in medium and large apertures. Here it seems probable that a real comet is not being seen at all. As the eye strains to see something at the limits of visibility it starts to

supply information of its own making to the brain, which is then interpreted as being the comet and hence a magnitude estimate can be made. It is akin to seeing a ghost - you can be convinced that it is there, but it is in reality a mirage that would not be seen with better instrumentation. Again in such cases it is probably better to give the report in plain language rather than to code it up, for example:

1999T2 2001 01 28.25 Comet possibly seen at mag 13.6 (S, HS) in 20cm f10 T x120, with coma 1.0' DC 1.

The revised edition of the Section Guide to Observing Comets is now with the printers and will soon be available at BAA events or through the BAA Office. The new edition has significant changes, including revised sections on comet discovery procedures, observing very bright comets and electronic submission of observations. It also draws attention to some of the points made above.

Michael Oates has continued scouring the SOHO archives and has now discovered over 100 comets out of the SOHO total of 299. I am very pleased to be able to say that for this achievement the BAA is awarding him the Steavenson prize. This award is the Association's recognition of an outstanding contribution to observational astronomy. The citation for the award read: 'It is unusual for an amateur astronomer to discover a comet. It is unheard of for one to discover over 100 in the course of a single year! Michael Oates attended a meeting of the SPA at the beginning of 2000 at which Jonathan Shanklin told how he had discovered three comets in real time SOHO imagery. Michael was so enthused by this that within 48 hours he had reported a discovery of his own, although the comet had in fact already been reported. Nothing daunted he stuck to the task and soon made an independent discovery. This led him to develop processing techniques that he applied first to real time imagery and then to archive imagery, which lead to the discovery of large numbers of sun grazing comets that had been missed by the professional astronomers. His success has led other amateurs to develop the same systematic approach to scanning the images. These discoveries have together provided the foundation for a reappraisal of the flux of Kreutz group comet members and scientific papers are already being written as a result.

In every branch of observational astronomy it is essential to follow a methodical approach to the observing process and Michael's success sets a splendid example to all amateur astronomers. Such success does not come easy, it requires a tremendous investment of time and effort to acquire, process and scan the many images that are available. We believe that his approach, diligence and astounding success make Michael Oates a worthy recipient of the Steavenson Award.'

Since the last newsletter observations or contributions have been received from the following BAA members: Mark Armstrong, Sally Beaumont, William Davies, Len Entwisle, Mark Green, Werner Hasubick, Morton Henderson, Nick James, Geoffrey Johnstone, Albert Jones, Cliff Meredith, Martin Mobberley, Michael Oates, Gabriel Oksa, Jonathan Shanklin, David Storey, David Strange, John Vetterlein and Alex Vincent

and also from: Jose Aguiar, Alexandre Amorim, Alexandr Baransky, Sandro Baroni, Nicolas Biver, Reinder Bouma, Jose Carvajal, Matyas Csukas, Rafael Ferrando, Stephen Getliffe, Antonio Giambersio, Massimo Giuntoli, Bjorn Granslo, Michael Jager, Andreas Kammerer, Heinz Kerner, Martin Lehky, Rolando Ligustri, Pepe Manteca, Michael Mattiazzo, Maik Meyer, Antonio Milani, Andrew Pearce, Stuart Rae, Maciej Reszelski, David Seargent, Carlos Segarro, Giovanni Sostero and the Ageo Survey Team (KenIchi Kadota and Seiichi Yoshida) (apologies for any errors or omissions). Without these contributions it would be impossible to produce the comprehensive light curves that appear in each issue of *The Comet's Tale*.

Comets under observation were: 24P/Schaumasse, 41P/Tuttle-Giacobini-Kresak, 47P/Ashbrook-Jackson, 73P/Schwassmann-Wachmann 3, 74P/Smirnova-Chernykh, 110P/Hartley 3, 1999 K5 (LINEAR), 1999 K8 (LINEAR), 1999 T1 (McNaught-Hartley), 1999 T2 (LINEAR), 1999 U4 (Catalina-Skiff), 1999 WJ7 (Korlevic), 1999 Y1 (LINEAR), 2000 K2 (LINEAR), 2000 S1 (Skiff), 2000 W1 (Utsunomiya-Jones), 2000 WM1 (LINEAR) and 2001 A2 (LINEAR).

There is a proposal to drop the numeric suffix from periodic comets, so that for example 110P/Hartley 3 becomes 110P/Hartley. All comets are now uniquely identified, either by their periodic number or by their year designation and the suffix has become superfluous. The ICQ have already implemented this change and in future issues I may follow suit. Another change is that periodic comets of one apparition and period longer than 30 years are given a C/ designation rather than D/ or P/.

As part of a scheme to revise the format of the BAA meetings programme I am planning to hold a Section meeting on 2002 February 23. This will be part of a BAA Saturday meeting at Savile Row in London, with the Section meeting from 11:00 - 13:00, followed by lunch at Savile Row and the main BAA meeting in the afternoon. I will provide further details in the next newsletter.

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, and BAA Journals Sky.

150 Years Ago: Interestingly the first page of the November 1850 Monthly Notices proclaims the discovery of two new planets - Egeria and Victoria. There was some controversy over the name Victoria, the Roman goddess of victory rather than the British Queen, and it was noted "Some objection has been taken, though, we believe, only by one or two persons in the United States....". There were suspicions that this type of object was a different class

After only 7 months sweeping with the new binoculars, on the 25th of August 1959, 3 days prior to his 47th birthday, George spotted an intruder in Corona Borealis. The next night, with a new star atlas, he checked the field again - the suspect had moved one degree. George had made his first discovery, Comet Alcock 1959e, the first comet discovered from Britain since Denning's final comet discovery in 1894.

After more than 6 years of sweeping, the second Comet Alcock was discovered only 5 days later (!), 2 days after his 47th birthday, on August 30th. Comet 1959f was discovered in the morning sky in Cancer. After a 65 year dearth of British comet discoveries (and not for the lack of people trying) the discovery of two British comets in a week was, and still is, a fairytale event. Over the years, many astronomers, including myself, have stood in the back garden of Antares and wondered if they were standing on sacred ground.

George was a well-known observer in the BAA prior to August 1959, but he would always be a legend after that month. It is sobering to speculate as to what might have happened if August 1959 had been a really cloudy month. George's third Comet was discovered in March 1963; how long would George have carried on without a discovery - we will never know.

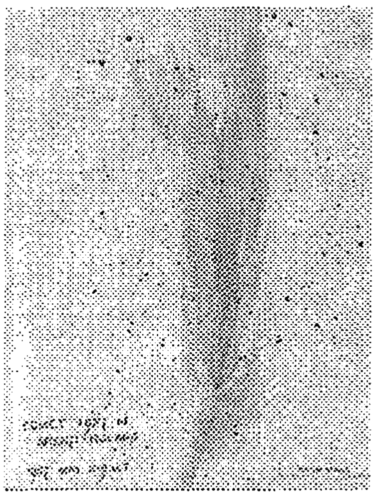
George made his fourth comet discovery in September 1965. He would not discover his fifth for another 18 years; thus the 6 year period from 1959 - 1965 marked George's golden period of comet discovery.

The Nova Discovery Years

After 1965, George placed more emphasis on nova hunting; after all, he had a unique talent in that field, he had memorised the northern Milky Way! During the 1970s he became increasingly frustrated by the encroaching skyglow from Peterborough, making nova hunting, not comet hunting, the natural direction in which to continue.

As most TA members will be aware, The Astronomer started its life as The Casual Astronomer in April 1964, founded by John Larard and Jim Muirden. George was one of the strongest supporters of the magazine, right from the very start. It filled a number of voids not then covered by the BAA, and particularly attractive to an observer like George. Most importantly, rapid publication of observations and discoveries, especially of comets and variable stars, were its speciality. In today's Internet & CCD dominated world it's hard to imagine a world where observers had to wait months or years to see their observations in print. But that was quite often the case in the 1960s, until the Casual Astronomer appeared. George was a lifelong supporter of TA from its inception, and of Guy Hurst, who took over the magazine in 1975.

From 1967 to 1976 George used his memory of the northern Milky Way to full advantage, sweeping up 4 novae in an 11 year period. He had rivals in this field too, most notably the Japanese photographic patrollers. Once again, Honda was a major rival. But George was the only successful observer at that time who was searching visually. On clear nights he had a huge advantage over the photographers. Bright novae would be spotted almost instantly by him; there was no additional hassle of developing films, mounting negatives and stereo merging or blinking. He could also observe in an instant and between cloud banks, his visual approach had much more flexibility than photography.



Comet 1956 R1 (Arend-Roland) drawn by Alcock on 1957 May 2.9

His first nova success came on July 8th 1967 when he swept up Nova Delphini rising through 6th magnitude. At last, the 12 years of memorising the Milky Way through binoculars had paid off; it must have been a huge relief. George now had 5 discoveries to his credit: 4 comets and a nova. In the late seventies and eighties, US observers Peter Collins and Kenneth Beckman would follow George's example and memorise the Milky Way stars too, but George had shown the way.

Nova Delphini 1967, or HR Del as it became known, is still the only nova to have been discovered in Delphinus. It was the first British Nova to be discovered since Prentice discovered DQ Her in 1934. The nova rose to a peak of 3.5 on 1967 December 13th, dropped slowly, then peaked again at 4.2 on 1968 May 5th; an extraordinary object.

George's second nova was discovered a mere 9 months after the first and was a much faster nova. This one was in Vulpecula and was designated LV Vul. It was discovered on 1968 April 14th, rising to a peak of mag 4.8 a week later, on April 21st. Remarkably, with HR Del on the rise to it's final fourth magnitude peak, there were two British naked eye novae, only 15 degrees apart, in the April 1968 dawn sky!! George has often stated that the sight of those two novae together was "the greatest thrill of my observing career"

The proximity of LV Vul to the bright nova of 1670 was also of considerable importance to George. Two years later, George notched up his third and faintest (at mag 6.9) nova, in Scutum, V368 Scuti. Another 6 years would elapse before he bagged his fourth, on October 21st 1976, NQ Vul, a nova right next to the famous Coathanger Asterism. This was an especially important discovery for George as his morale was somewhat dented by 'missing' the 1st mag nova V1500 Cyg on August 29th 1975, the day after his 63rd birthday. George only missed the spectacular nova by a few hours and the loss nearly made him give up. I well remember hearing George describe his feelings towards Nova Cyg 1975 at a meeting of the JAS (now SPA) on April 29th 1978 at the Holborn Library in

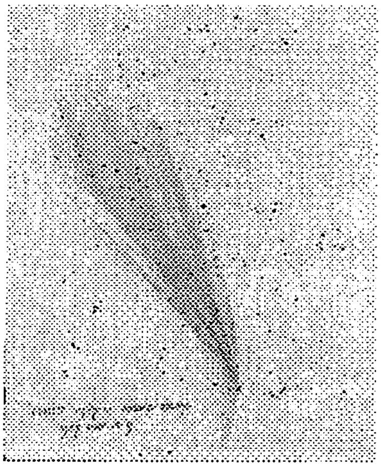
London. I had walked 7 miles from Enfield to hear George (and Jocelyn Bell of Pulsar fame) give a rare talk - it was well worth the blisters! I would not see George again until the 1989 TA AGM.

Even for an observer as dedicated as George, comet and nova discoveries are generally separated by years, not days! One can only marvel at the mental stamina of the man, notching up literally thousands of fruitless hours of searching between discoveries as well as caring for his bedridden wife and teaching by day (up to 1977). Somehow George managed to find the strength to go on, year after year and retain his cheery disposition. It is simply mind-boggling!

The last two discoveries

The last two discoveries of George, his fifth comet and his fifth nova must have stretched even his patience, occurring after discovery gaps of 7 and 8 years, but the stories associated with them have gone down in astronomical history.
George swept up Comet 1983d (C/1983 H1) at 22h UT on 1983 May 3rd after putting his wife to bed. It was in Draco, already 6th magnitude and 12' in diameter. Unlike his previous 8 discoveries, this one was made from indoors (!) with George kneeling on the floor beneath the Antares landing window and using 15 x 80 binoculars. It ultimately transpired that Araki had spotted it fractionally earlier and the Infra-Red Astronomy Satellite (IRAS) had secured images of it as early as April 25th, but the team had failed to appreciate it's true significance. George was not happy that the TV report made it sound as if he was simply 'checking out' the IRAS discovery; he would definitely have been happier for the comet to have been named Araki-Alcock, with IRAS left out! This was the only time George had to share a comet discovery. IRAS-Araki-Alcock became the third closest comet flyby of all time, after Lexell (1770) and Tempel-Tuttle (1366). It passed within 3 million miles of Earth on May 11th and plunged 40 degrees in declination in one day! It was the brightest comet George had discovered and the fact he'd done it from indoors, aged 70, with hand-held 15x80 binoculars just added to the legendary status of the man.

Two years later, on Jan 30th 1985, George made the observation which he personally considered was his tenth discovery, he spotted an outburst of the recurrent Nova RS Ophiuchi, again while observing from indoors. Although not a new nova, George had missed the 1967 flare-up due to driving home after visiting Manning Prentice. So, although not a discovery of a new object, it was a satisfying success for George.



Comet 1956 R1 (Arend-Roland) drawn by Alcock on 1957 May 18.9

His final discovery, on 1991 March 25th, when George was 78 years old, was a remarkable one in many ways. Firstly, George had a strong feeling that he was going to be lucky that night, so strong in fact, that he was not at all surprised when he spotted the 5th magnitude intruder. Secondly, he was, once again, observing from indoors, through a downstairs double glazed window, using only 10x50 binoculars. Thirdly, the confirmation was itself, equally remarkable. At the time of the discovery, 0435 UT, nautical twilight had already arrived. From his satellite images he knew that Denis Buczynski in Lancashire was clear and phoned him with the details. Within minutes of the call, Denis was in the dome and his astrograph was being slewed to the right position, offsetting from Deneb, the ONLY star visible in the twilight sky! Astoundingly, Denis photographed the object and secured a position. An independent discovery was made by Sugano in Japan and the new object (V838 Her) was one of the fastest fading novae of all time, dropping 3 magnitudes in 2.8 days!

Tributes and awards

Although V838 Her was the last discovery for George he continued to search the sky from indoors and to sketch comets, like Hyakutake and Hale-Bopp, that came along. On September 1st 1991 I visited 55 Broadway, Farcet with Denis Buczynski and Glyn Marsh. Denis was a man George trusted and with Denis acting as an expert interviewer I secured 3 hours of footage, while George related his life story. It's compulsive viewing! Five years later, Kay Williams, inspired by a suggestion from Brian Marsden's wife Nancy, completed her excellent and meticulous biography of George's life. The book, "Under an English Heaven, the life of George Alcock" should be on every astronomer's bookshelf.
Only by reading that book and watching the TA video can the true quality of the man be appreciated.

In this tribute I have concentrated on the astronomical side of George's life, but this is only a tiny part of the story. George was an avid bird watcher, nature watcher, weather watcher and sky watcher. He loved cathedral and church architecture and was forever producing the finest sketches of buildings, flaura, fauna, wildlife, comets and planets. As Richard McKim, a fellow Peterborough schoolteacher and astronomer noted, observers generally have a good eye for fine detail or very sensitive night vision; George had both. His drawings of comet tails are in a league of their own.

George was also a schoolteacher with a difference; he was universally popular with his students, many of whom kept in contact with him for decades after their schooldays were over. Unlike so many people today, George was also a modest and kind man, never bragging about his colossal achievements and having no interest in broadcasting his opinions; his achievements spoke for themselves. He also wrote in the most exquisite "copper-plate" handwriting one could ever wish to see!

Buzzwords and spin had no place in George's life, for him actions spoke louder than words.

George was showered with accolades during his life. No other visual observer since Denning had discovered more than one object from the UK. Only Candy, Hosty and Panther (a friend of George since the 1940s) had discovered any others! He received the MBE, for services to astronomy in 1979, and was awarded the BAA Goodacre Award in 1976. The RAS awarded him the Jackson-Gwilt medal in 1963 for his first two comet discoveries.

He was the only triple recipient of the BAA Merlin medal in 1961, 1972 and 1992. George also received the first ever Astronomical Society of the Pacific's "International Amateur Achievement Award" in 1981 as well as 3 AAVSO plaques for all of his nova discoveries. In 1992 he was invited to be a member of the elite New York Academy of Sciences, which he accepted with pride. He was also recognised by Peterborough town council at a presentation in the Town Hall in 1997.

The last time I saw George was on August 15th 1999 at the International Workshop on Cometary Astronomy II at Cambridge, just after the Total Solar Eclipse. Many legendary figures were there including Don Machholz, Kesao Takamizawa, Bill Liller, Alan Hale and Brian Marsden. But only one man got a standing ovation and that was George, who had come to the meeting accompanied by his younger brother John (who spotted those crucial binoculars 40 years earlier at the 1959 boat show). George was an amateur astronomer's astronomer. A discoverer who actually went out in the cold and dark and used his eyes and brain to discover comets and novae. George was rarely beaten by any astronomical challenge, despite the disadvantages of searching from the cloudy skies of Britain. Candy stole a comet from him at Xmas 1960; Panther stole another at Xmas 1980; George lost the ultimate battle at Xmas 2000.

At the end of the TA video, Denis asks George how he would like to be remembered. After a pause, George replies "As an observer". And surely, that is how we will remember George Alcock.

The Ten Discoveries of George Alcock

Year	Object	Date found
1959	Comet 1959 Q1 (Comet Alcock 1959e)	August 24
1959	Comet 1959 Q2 (Comet Alcock 1959f)	August 30
1963	Comet 1963 F1 (Comet Alcock 1963b)	March 1
1965	Comet 1965 S2 (Comet Alcock 1965h)	September 26
1967	HR Del (=Nova Del 1967)	July 8
1968	LV Vul (=Nova Vul 1968 No 1)	April 15
1970	V368 Sct (=Nova Sct 1970)	July 31
1976	NQ Vul (=Nova Vul 1976)	October 21
1983	Comet 1983 H1 (Comet IRAS-Araki-Alcock 1983 d)	May 3
1991	Nova Herculis 1991	March 25

'The Comet Man' A. C. D. Crommelin, B. A., D. Sc., F. R. A. S.

John Fletcher
Mount Tuffley Observatory

This biography of A. C. D. Crommelin, written in 1992 April, all came about after I received a call from a most interesting lady aged 84 years who lives in Gloucester and only about a five minute drive from my home and private observatory in Gloucester, England. The lady's name is Sara Crommelin who married Peter the son of A. C. D. Crommelin, the comet man. Sara tells me she and Peter are the sole relatives of this famous astronomer who was famed for his computations of cometary orbits. Sadly his son Peter is in a nursing home at the moment and also Sara's own eyesight is not too grand she tells me. Sara also told me things about his private life including that of the great man's sadness when he lost his eldest son and a daughter in a climbing accident.

Andrew Claude de la Cherios Crommelin was born in Chushendun, N. Ireland on 1865 February 6th and died in London on 1939 September 20th, some 9 months after he had been knocked down by a motor cyclist almost outside his home when on his way to church. He was the third son of the late Nicholas de la Cherois Crommelin, a descendant of Louis Crommelin, a Huguenot who was the founder of the linen trade in Ulster. He was educated at Marlborough College and then went on to Trinity College Cambridge, and graduated in 1886. In 1897 he married Letitia the daughter of Rev. Robert Noble, and had two sons and two daughters.

After graduation he went to Lancing College on the teaching staff. Then he tried his hand at electricity but soon gave that up. He had always been throughout his childhood keen on watching the sky and observing the stars and at Cambridge was a keen observer of the stars and built up a reputation for his knowledge of astronomy. He was elected into the Royal Astronomical Society before leaving the University in 1888. It was fortunate that in 1891 the appointment of an assistant at the Royal Observatory in Greenwich, was authorised by the Admiralty. Andrew sitting in competition with the late E. W. Brown secured the appointment. He joined the staff of the Royal Observatory on 1891 May 11th. He took his place among the members of the regular staff making routine observations with the transit circle and the Sheepshanks equatorial. He was also put in charge of the altazimuth instrument designed by Airy for observing the Moon. Observing the occultations of stars by the Moon, and comets was put in his care.

Crommelin's work was extensive at Greenwich and he was an expert in all his research as both observer and a computer. In 1911 he made an accurate determination of the Lunar parallax and prepared the ephemerides of both the Moon and outer planets including the path of Jupiter's eighth satellite. Crommelin went on many eclipse expeditions organized by the B.A.A. From Brazil Crommelin observed the 1919 Solar eclipse using a 4 inch refractor of 19 feet focus and secured some fine photographs, which determined there was a deflection of light in the gravitational field of the Sun beyond any question of doubt. He also determined the orbits of many comets and minor planets. This was recorded in an early number of the Journal of the British Astronomical Association.

Indeed for many years he was the director of the comet section of the British Astronomical Association and President between 1904 and 1906 and in the year 1937 he received the Goodacre Medal. He was also a fellow of the Royal Astronomical Society for over fifty years and served on their Council from 1906 to 1932. He was also was Secretary from 1917 to 1922 and became their President during the years 1929 and 1931. He wrote their annual reports on minor planets and from 1916 the reports on comets as well. Crommelin was also the President of the International Astronomical Union's sub commission on periodic comets from the year 1935 until his death.

The Memoirs of the British Astronomical Association, Vol XXVI, Part 2, Comet Catalogue (1925), prepared by A. C. D. Crommelin.

At a meeting of the Astronomical Union in Rome (May 1922) Crommelin expressed his desire to produce a sequel to Galle's Cometenbahnen to bring up to date and enter improved orbits of comets for the period of time prior to 1893. The work was carried out with the help of the computing section of the comet section of the British astronomical Society. The comet catalogue was later published in 1925. Throughout this work he had been under great pressure at work and with very little co-operation from colleagues. He did however acknowledged the help he received by Miss Mary Proctor, who copied the orbits given in Astronomische Nachrichten and the bulletin Astronomique. Crommelin included the results of Dr Cowell and himself of the ancient returns of Halley's Comet. He also included many predicted elements of periodic comets even in the case when the comet was not observed. For their work Crommelin and Cowell were awarded the Lindemann Prize of the Astronomische Gesellschaft and also both received a D. Sc degree at Oxford University.

According to the records from the British Astronomical Memoir, Crommelin and Cowell computed the details for the following apparitions of comet Halley: BC240 from China, AD141 from China, AD530, AD607 from China, AD684 from China, AD837 from China, AD1066 from China and Europe, AD1145 from China and Japan, AD1301 from China and Europe, AD1835 and AD1909 (first photo August 24th). Crommelin also computed orbits for comets: Grigg - AD1902 (J.Grigg & Crommelin), Lowe - AD1913 (M.Viljev & Crommelin), Encke - AD1924 (L.Matkiewicz & Crommelin) and Wolf - AD1925 (Crommelin & A.Kahrstedt).

Crommelin was famed for computing that comet Forbes 1928 (III), comet Coggia-Winnecke 1873 (VII) and comet Pons 1818 (1) were all the same object and he predicted that the same object would return in 27.4 years, which it did. In 1948 the International Astronomical Union changed the name of the comet from Pons-Coggia-Winnecke-Forbes to Crommelin. The history of these many separate discoveries goes like this. Crommelin's comet, not so named then, had been first observed by one of the greatest comet observers of all times, namely Jean-Louis Pons. Prior to sighting comet (1818 I) on 1818 February 23rd Pons had discovered no less than 16 out of the 17 comets observed during the beginning of the nineteenth century. The 1818 comet was skilfully discovered by Pons from his observing site (Marseille, France) at +40°N when the comet was at -15° and only 54° to the Sun. It was slightly fainter than 7th magnitude. Pons was able to measure four positions of the comet but he could not determine an orbit. The comet was rediscovered later by Coggia also in Marseille and one day later by Winnecke in Strasbourg but very poor conditions allowed for only six days viewing. The comet of Pons and Coggia-Winnecke was not known to be the same comet at that time.

The orbital period of the comet had indeed remained unknown until Crommelin tackled the problem in 1928. In a long series of papers Crommelin had shown that Pons (1818 I), Coggia-Winnecke (1873 VII) and Forbes (1928 II) were three apparitions of the same comet. The 1845 and 1901 returns were sadly missed due to poor sky conditions. When it reappeared according to Crommelin's prediction in 1956 it was renamed after him. On this apparition it returned to perihelion only four days later than his prediction. Also in 1956, for the first time on record the comet displayed a short tail and it was favourably positioned for observation. It returned on schedule again in 1984 and this time again it was singled out for unusual attention. The International Halley Watch, while preparing to observe the most famous periodic comet of all (Halley) chose Comet Crommelin for a trial in preparation for the coming apparition of Halley's comet. The first visual sightings were from France on 1983

December 29th and of 12th magnitude. Only a few days later on 1984 January 3.8 it was of magnitude 10.5. It was observed in great detail especially in March 1984, even though the weather was poor for observing and the comet was not a dramatically bright object.

Nevertheless the comet has been very useful to science and indirectly contributed to the great success of the observations of Halleys comet. All this has greatly increased our understanding of comets in general (including of course Comet Crommelin). One of his most famous writings was "Essay On The Return Of Halleys Comet" in Publikation der Astronomischen Gesellschaft, No. 23 (1910), written with P.H.Cowell; and also the Comet Catalogue, Memoirs of the British Astronomical Association, 26, pt. 2 (1925), continued ibid., 30,pt.1 (1932).

Great astronomers like Crommelin must never be forgotten. It is their computing work (as it was called then) that has paved the way to our modern knowledge of astronomy. Crommelin's sequel to Galle's Cometenbahnen certainly advanced cometry science in his day.

I wish to thank Sara and Peter De La Cherois Crommelin, his daughter in law and son for the information I have received to make this account of the great astronomer A. C. D. Crommelin possible. I would also like to thank H. Ridley (Comet Section, British Astronomical Association) and P. G. Hingley (Librarian, Royal Astronomical Society). Also thanks to Patrick Moore for his encouragement, given to myself, to delve into the history of this great astronomer's life and work.

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

Alan Fitzsimmons recently sent me reprints of a couple of his papers on the CCD photometry of distant Jupiter family comets. The observations show that most of these objects are a few kilometres in radius and have no more than 10% of their surfaces active. There are some exceptions: 9P/Tempel 1, 81P/Wild 2 and 87P/Bus seem more active. The output of 87P/Bus seems variable, whilst 65P/Gunn and 74P/Smirnova-Chernykh are active right round their orbits.

The following abstracts (some shortened further for publication) are taken from the Cambridge Conference Network (CCNet), which is a scholarly electronic network devoted to catastrophism, but which includes much information on comets. To subscribe, contact the moderator Benny J Peiser at <b.j.peiser@livjm.ac.uk>. Information circulated on this network is for scholarly and educational use only. The abstracts, taken from daily bulletins, may not be copied or reproduced for any other purposes without prior permission of the copyright holders. The electronic archive of the CCNet can be found at http://abob.libs.uga.edu/bobk/cccmenu.html

Astronomers Conducting Post-Mortem on Comet LINEAR [Office of News and Information Johns Hopkins University]

New analysis of observations of Comet LINEAR, a comet whose breakup in late July and early August made headlines worldwide, has shown that the comet might have been starting to come apart as early as the second week of June.

"The first hint of trouble for Comet LINEAR came from ground-based observations at the Lowell Observatory from June 10 to June 12, when significant variations in the comet's brightness were first detected," says Hal Weaver, a research scientist in the physics and astronomy at The Johns Hopkins University. [*...which is what I commented in the comet review in the last issue*]

These variations were originally attributed to rotation of the comet's nucleus, a common phenomenon known to change the brightness of comets. But when Weaver recently looked back at the data he began to suspect the change had links to the comet's eventual demise.

"Although no fragments were detected near the comet at that time, we now believe that this was the first indication that the comet was coming apart," says Weaver, who is reviewing the results on the recently deceased Comet LINEAR at the Division of Planetary Sciences Meeting in Pasadena, Calif., on October 26.

Observations early in July had suggested the comet was growing less stable. On July 7, Weaver and his collaborators used the Hubble Space Telescope to study the comet and captured pictures of a large chunk of the comet breaking away and moving down its tail, presumably being pushed away by jets of gas emanating from its surface. These jets are produced as sunlight boils ice on the comet directly into water vapour. The gas jets also eject small particles of dust into the coma, or atmosphere of the comet. Radiation pressure from the sun then sends this dust streaming behind the comet to form the comet's tail.

Extreme variations in the comet's brightness were detected by optical and radio telescopes during July 20-24, and astronomers observing the comet over the next 12 days complained that it looked like little more than a cloud of dust. Puzzled by what appeared to be a rapid disintegration of the nucleus, Weaver and colleagues decided to look more carefully at the comet using the Hubble Space Telescope. The Hubble images revealed a spectacular field of about a dozen mini-comets near the edge of the broad tail of dust seen in the earlier ground-based images. Each of the fragments had its own comet-like tail.

After a scramble to arrange time for follow-up observations, Weaver and his team observed the comet again on Aug, 6 using the Very Large Telescope in Chile. Although its resolution was not quite as good as Hubble's, the VLT's mirror has 10 times the collecting area, and it was able to detect about 17 mini-comets.

When they went back to the comet on Aug. 9 with the VLT, they were surprised to find that the mini-comets had virtually disappeared. Poor atmospheric conditions made it difficult to determine if a real change had taken place, or if atmospheric turbulence was hindering their view. But observations on Aug. 14 under excellent conditions confirmed that the mini-comets had faded dramatically.

Weaver and his colleagues are continuing to analyze the data they gathered to see if they can find clues to how LINEAR came apart. A better understanding of the comet's breakup could lead to a better understanding of how it came together 4.6 billion years ago in the early days of the solar system.

"If the comet broke up by shedding small pieces, then it's possible that the most massive object remaining in the field of mini-comets could be identified as its original nucleus," Weaver says. "On the other hand, it may be that the destruction of the comet was so complete that it's pointless to search for the 'original' object, much like you wouldn't call any particular piece of a badly shattered glass the 'original glass.'"

Astronomers have seen many other comets fragment, Weaver says, but very few have done so as dramatically as LINEAR. Current cometary theory suggests a range of forces that could have torn the comet apart, most of which should manifest more strongly as the comet gets closer and closer to the sun. These may include sharp temperature and pressure differences between the sunward and dark sides of the comet, and sudden vaporization of internal pockets of ice.

"We still do not understand what caused this comet to come apart, and don't generally understand what causes fragments to break off comets," says Weaver. "By continuing to investigate the data from Comet LINEAR, and folding in everything we know about other comets as well, maybe somewhere downstream we can explain what happened with a detailed physical model."

The discovery of a faint glow of scattered sunlight from the dust trail of the Leonid parent comet 55P/Tempel-Tuttle. R. Nakamura, Y. Fujii, M. Ishiguro, K. Morishige, S. Yokogawa, P. Jenniskens, T. Mukai: ASTROPHYSICAL JOURNAL 540: (2) 1172-1176, Part 1 SEP 10 2000

A meteoric cloud is the faint glow of sunlight scattered by small meteoroids in the dust trail along the orbit of a comet as seen by an earthbound observer. While these clouds were previously only known from anecdotes of past meteor storms, we now report the detection of a meteoric cloud by modern techniques in the direction of the dust trail of comet 55P/Tempel-Tuttle, the parent of the Leonid meteor stream. Our photometric observations, performed on Mauna Kea, Hawaii, reveal the cloud as a local enhancement in sky brightness during the Leonid shower in 1998. The radius of the trail, deduced from the spatial extent of the cloud, is approximately 0.01 AU and is consistent with the spatial extent mapped out by historic accounts of meteor storms. The brightness of the cloud is approximately similar to 2%-3% of the background zodiacal light and cannot be explained by simple model calculations based on the zenith hourly rate and population index of the meteor stream in 1998. If the typical size of cloud particles is 10 µm and the albedo is 0.1, the brightness translates into a number density of 1.2×10^{-10} m^{-3}. The meteoroid cloud would be the product of the whole dust trail and not only the part that was crossed in 1998. © 2000 Institute for Scientific Information

A CATALOG OF OBSERVED NUCLEAR MAGNITUDES OF JUPITER FAMILY COMETS
G. Tancredi, J.A. Fernandez, H. Rickman, J. Licandro: ASTRONOMY & ASTROPHYSICS SUPPLEMENT SERIES 146: (1) 73-90 OCT 2000

A catalogue of a sample of 105 Jupiter family (JF) comets (defined as those with Tisserand constants $T > 2$ and orbital periods $P < 20$ yr) is presented with our "best estimates" of their absolute nuclear magnitudes H-N V(1,0,0). The catalogue includes all the nuclear magnitudes reported after 1950 until August 1998 that appear in the International Comet Quarterly Archive of Cometary Photometric Data, the Minor Planet Center (MPC) data base, IAU Circulars, International Comet Quarterly, and a few papers devoted to some particular comets, together with our own observations. Photometric data previous to 1990 have mainly been taken from the Comet Light Curve Catalogue (CLICC) compiled by Kamel (1991). We discuss the reliability of the reported nuclear magnitudes in relation to the inherent sources of errors and uncertainties, in particular the coma contamination often present even at large heliocentric distances. A large fraction of the JF comets of our sample indeed shows various degrees of activity at large heliocentric distances, which is correlated with recent downward jumps in their perihelion distances. The reliability of coma subtraction methods to compute the nuclear magnitude is also discussed. Most absolute nuclear magnitudes are found in the range 15 - 18, with no magnitudes fainter than H-N ~ 19.5. The catalogue can be found at: http://www.fisica.edu.uy/~gonzalo/catalog/. © 2000 Institute for Scientific Information

MISSION OVERVIEW: ROSETTA'S PURPOSE [ESA web page]

The International Rosetta Mission was approved in November 1993 by ESA's Science Programme Committee as the Planetary Cornerstone Mission in ESA's long-term space science programme. The mission goal is a rendezvous with comet 46 P/Wirtanen. On its eight-year journey to the comet, the spacecraft will pass close to two asteroids, (Otawara and Siwa). Rosetta will study the nucleus of comet Wirtanen and its environment in great detail for a period of nearly two years, the near-nucleus phase starting at a heliocentric distance of about 3.25 AU, with far-observation activities leading ultimately to close observation (from about one km distance).

Rosetta will be launched in January 2003 by an Ariane-5 from Kourou, French Guiana. To gain enough orbital energy to reach its target, one Mars and two Earth gravity assists will be required. The long mission duration required the introduction of extended hibernation periods.

COMA BERENICIDS, YES; COMET CONNECTIONS, NO
Brian Marsden

I was quite startled to read in the Jan. 11 CCNet, not only of the suggested association of a recently observed meteor shower with "the poorly observed Comet Lowe 1913 I", but also of the suggested identity of the 1913 object with another comet, "observed, again rather badly, in 1750".

The fact is that the 1913 object was recorded only by its discoverer, an "enthusiastic" Australian amateur astronomer, who on Jan. 7 of that year reported to the Adelaide Observatory _very_ rough (and initially quite erroneous) positional data obtained by him with a 3-inch telescope on four mornings during the previous week. Even when the data were amended and attempts made to compute an orbit, no observations by others came to light, which was a little surprising since the object should have been an easy object for northern-hemisphere astronomers at and before its alleged discovery. This situation is reminiscent of many that continue to arise at the IAU Central Bureau for Astronomical Telegrams, and perusal of the Lowe information preserved in the Astronomische Nachrichten and the Journal of the British Astronomical Association cannot help but place the existence of the object in doubt. Although the various orbits computed at the time by Viljev and Crommelin agreed on a nodal longitude of 300 to 305 degrees (and the possibility of a very close approach to the earth around Jan. 25 if the comet had come to perihelion some weeks later than indicated), there was disagreement as to whether the orbital inclination was 80 degrees or 120 degrees: if I wish to contend with residuals of well over a degree, I get an inclination of something like 110 degrees. Nevertheless, as stated in the introduction to the Catalogue of Cometary Orbits already in the 1972 edition, I felt it wise to exclude this comet from consideration, and it was not given a new-style designation when the comet-designation system was revised at the end of 1994.

What about the comet of 1750? The positional information was also provided by just a single observer, who saw the comet on three nights in January of that year. In this case the recorder was the distinguished astronomer and demographer and secretary of the Royal Swedish Academy of Sciences, Pehr Wargentin. The observations were made with the naked eye and two different telescopes, and the comet was also seen by a colleague. Given that this was in the days before comet hunting became a sport (with comets named for their discoverers), I have little doubt that the object existed and discussed it in my paper in the Astronomical Journal in 1973 on the orbit of the comet associated with the Perseid meteors. Interestingly, the nodal longitude is also around 300 degrees, and the inclination could be as low as 120 degrees. The orbit I actually published does in fact bear a superficial resemblance to some computed from Lowe's 1913 data, although the published perihelion distance, 0.2 AU, is only half that derived in 1913. Furthermore--as I actually remarked in my paper--if the 1750 perihelion distance were as large as 0.4 AU, the argument of perihelion would drop to 240 degrees, which is significantly less than the 280-degree value that best fits the 1913 data.

Even if one accepts the reality of the 1913 data, there is no reason to believe that the comet had a period as short as a century or two, and there is in any case no way to satisfy both apparitions of data with the same orbit. Given my predilection for the reality of the 1750 comet, one might wish to consider it a better candidate for the parent of the Coma Berenicid meteors. But it does not seem that the orbit of the 1750 comet comes particularly close to the earth. Although the date was close to the anticipated previous perihelion passage of the 1862 parent of the Perseid meteors, Wargentin's comet was clearly not it. My acceptance instead of Kegler's 1737 comet as "a far better candidate" and consequent prediction of the late-1992 return was of course later amply demonstrated.

So while I give Gorelli and McBeath credit for attempting a meteor-comet association, the least said about the 1913 and the 1750 events, the better.

MASS OF OORT CLOUD 10 TIMES SMALLER THAN THOUGHT? MEDIA RELATIONS OFFICE, JET PROPULSION LABORATORY

Recurring collisions between comets during the solar system's formation may have ground smaller comets to bits, leaving only big comets larger than 20 kilometers to survive, according to a new model developed by researchers at NASA's Jet Propulsion Laboratory, Pasadena, Calif., and the Southwest Research Institute, Boulder, Colo.

The finding, by Dr. Paul Weissman of JPL and Dr. Alan Stern of Southwest Research Institute, published in the February 1 issue of the journal Nature, demonstrates that previous models may have significantly overestimated the mass of the Oort cloud -- a region far beyond the planets populated by comets flung outward in the solar system's youth.

"We're introducing a new wrinkle in the process of how the Oort cloud formed," said Weissman. One result of the new finding, he said, is that "the cloud may be 10 times less massive than previously thought."

By studying comets of different sizes, the scientists predicted how the comets would collide with each other, and how the collisions would erode the comet's cores, dirty snowballs of dust and ice. Their model showed that comets with nucleus diameters smaller than 20 kilometers would have been destroyed in the early solar system's demolition derby. Previous Oort cloud formation models neglected the effects of these collisions.

Another apparent implication of this violent collisional environment is that the comets in the Oort cloud could be smaller than previously thought, said the scientists. If comets were so eroded that they would never have left the region of the giant planets, then few of them would have survived to be ejected to the Oort cloud. Taking into account their new findings, Weissman estimates that typical comets in the Oort cloud may be about half as large across as compared with current best estimates.

The endurance lifetime of ice fragments in cometary streams Beech M, Nikolova S: PLANETARY AND SPACE SCIENCE 49: (1) 23-29 JAN 2001

The endurance lifetime against sublimation of meter- to decameter-sized ice fragments are calculated for typical cometary orbits. It is found that such bodies can survive for multiple perihelion passages. For fragments traveling along orbits similar to those of typical meteor shower producing comets, the sublimation mass loss rate drives radial variations equivalent to 1-0.5 m per orbit. We review the available data with respect to the possible presence of large objects within the Perseid, Lyrid, Leonid and alpha-Capricornid streams. Invoking cometary aging and surface fragmentation events as the mechanism for placing large meteoroids within cometary streams, we find no compelling reasons to doubt that large meteoroids are intermittently present in most, if not all cometary-derived meteoroid assemblages. © 2001 Elsevier Science Ltd.

STING IN THE TAIL: WITHOUT EVEN HITTING EARTH, A COMET COULD BE AS LEATHAL AS AN ASTEROID From New Scientist, 24 March 2001

AS GOVERNMENTS around the world prepare to spend millions studying the threat of nearby asteroids hitting the Earth, an astronomer in Northern Ireland is warning that comets might pose a greater danger. "We may be looking for a swarm of bees while standing on a railway line with the train coming," says Bill Napier of the Armagh Observatory.

Icy comets with their tails of gas and dust are much rarer than rocky asteroids, but they don't even have to hit the Earth to do damage. A giant comet evaporating under the Sun's glare would release billions of tonnes of dust into the path of the Earth, Napier has shown in a new study. If this dust rains down on Earth, it could blot out the Sun and trigger a new ice age.

Astronomers already know of four objects they believe are giant comets hundreds of kilometres across. And there may be as many as 2000 more lurking in the Oort Cloud far beyond Pluto. Such comets visit the inner Solar System so rarely that the risk of an impact is negligible. But Napier calculates that they could release millions of tonnes of dust into our atmosphere, which would linger for as long as 10,000 years, blocking out most of the Sun's light and heat.

Astronomers had thought that the amount of dust around the inner planets remains fairly constant because dust from the break-up of comets and asteroids is balanced by dust falling into the Sun. But this can be upset by just a single large comet.

Napier and his colleagues believe that the Earth has already suffered at least once from the effects of comet dust. Data collected in the 1980s shows an unexpectedly large amount of minute interplanetary dust particles, each with a mass of about a nanogram. The excess can be explained if a giant comet broke up in the inner Solar System around 70,000 years ago--the onset of the last ice age. "I think we should be looking for cometary dust in polar cores," says Napier.

Napier rates the chance of being swamped by comet dust as 1 in 100,000, the same as a chance of a collision with a near-Earth object. Others are more doubtful. "I don't know if we've discovered enough comets to do a statistical analysis," says Robert McMillan of the University of Arizona's Spacewatch project, which tracks near-Earth objects.

But David Williams of University College London, who served on the British government's Near Earth Objects task force last year, agrees with Napier that work needs to be done on the risks posed by comets. "This area is perhaps one that's opening up now," he says. "We thought it was too controversial for the report."

SEVEN ENCOUNTERS WITH MINOR BODIES IN THE NEXT 5 YEARS Daniel Fischer

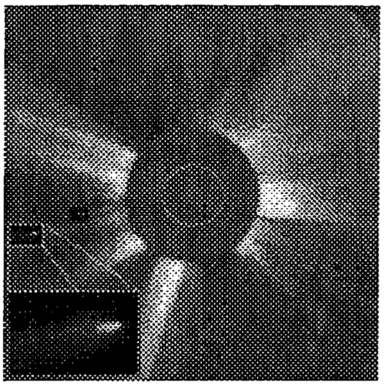
In the next 5 or so years there will be, if everything works out, no fewer than seven encounters of spacecraft with comets and asteroids. All the following missions are fully funded, though only 2 of the 6 have already been launched (the others will follow in 2002 to 2004):

2001	Sept.	22	Comet	Borrelly	Deep Space One	(simple flyby)
2003	Nov.	12	Comet	Encke	CONTOUR	(simple flyby)
2004	Jan.	1	Comet	Wild 2	Stardust	(coma sample return)
2005	July	3	Comet	Tempel 1	Deep Impact	(big mass impact)
2005	Sept.	XX	Asteroid	1998 SF36	Muses-C	(sample return)
2006	June	18	Comet	S.-W. 3	CONTOUR	(simple flyby)
2006	July	11	Asteroid	Otawara	Rosetta	(simple flyby)

There are more scheduled flybys in 2008 (CONTOUR & Rosetta again) - and in 2011 we'll then have Rosetta as the first comet orbiter and eventually its RoLand as the first comet lander (though both might well be beaten by a clever Discovery mission - it's still 10 years to go).

All the missions listed above are funded by civilian space agencies (NASA, ISAS and ESA) - but there were also two NEA missions under consideration in the 1990's, Clementine 2 by the BMDO and NEAP by the company SpaceDev. The former seems to have disappeared completely after the 1997 death of its chief-scientist-to-be Gene Shoemaker, and the latter is apparently in limbo: NEAP will be launched "within the next 3-5 years", according to http://www.spacedev.com/missions/neap.htm .

SOHO analyses a kamikaze comet [ESA News release]

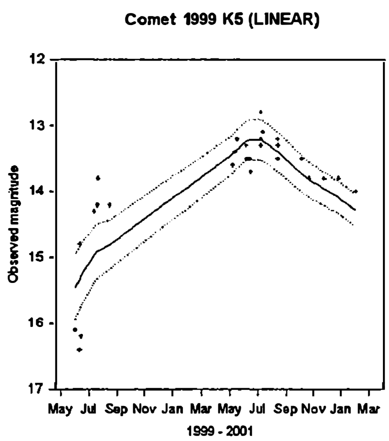


A comet that fell into the Sun on 7 February was tracked by two different instruments on the ESA-NASA SOHO spacecraft, enabling scientists to characterise it quite precisely. This was just one of nearly 300 comets discovered by SOHO since 1996, thanks mainly to the privileged view of the sky around the Sun given by the visible-light coronagraph LASCO. On this occasion SOHO's ultraviolet coronagraph UVCS also observed the comet repeatedly. It gave valuable additional information, both about the comet and about the solar wind close to the Sun.

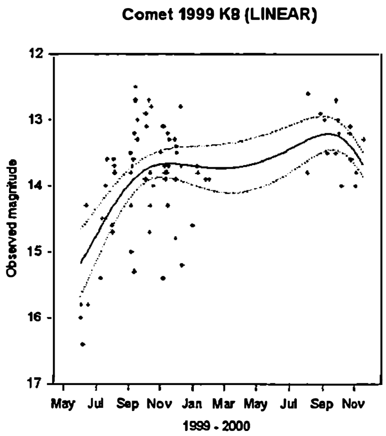
The picture shows, superimposed on a LASCO visible-light image, two of the ultraviolet images obtained by Michael Uzzo of the UVCS team at the Smithsonian Astrophysical Observatory (SAO) in Cambridge, Massachusetts. They were timed about an hour apart, when the comet's head was 2.7 and 1.6 million kilometres from the Sun's surface. The blow-up of the first image shows a wide and well-defined gas tail more than 500 000 kilometres long. The white ring on the LASCO coronagraph mask, which shields the instrument from the glare of direct sunlight, denotes the size and position of the visible Sun. Sebastian Hoenig in Germany and Xing Ming Zhou in China discovered the comet on 6 February in the LASCO images that are available every day to comet hunters via the Internet. Data from successive observations, supplied by the LASCO team, enabled Brian Marsden at SAO to compute the comet's orbit and to make the discovery official on behalf of the International Astronomical Union by designating it as Comet C/2001 C2 (SOHO). Like most of the comets found by SOHO it belonged to a family of small "sungrazers" that are believed to be fragments of a large comet that broke up long ago. For C/2001 C2 (SOHO) the encounter with the Sun was fatal. The UVCS images show ultraviolet light from hydrogen atoms, made by the break-up of water vapour released from the comet by the Sun's heat. John Raymond of SAO estimates that the comet was letting off steam at about 100 kilograms per second, and that the comet nucleus was only 10-20 metres wide. In large objects like Halley's Comet the nucleus is measured in kilometres. At 2.7 million kilometres out (as in the first of the two UVCS images) the comet was flying through a relatively tenuous solar wind but, closer in, the density seems to have increased almost tenfold. This is interpreted as an effect of the comet passing out of the region of a fast solar wind into a slower windstream of higher density. Further analysis may refine all of these estimates.

Review of comet observations for 2000 October - 2001 March

The information in this report is a synopsis of material gleaned from IAU circulars 7506 – 7606 and The Astronomer (2000 October – 2001 March). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.



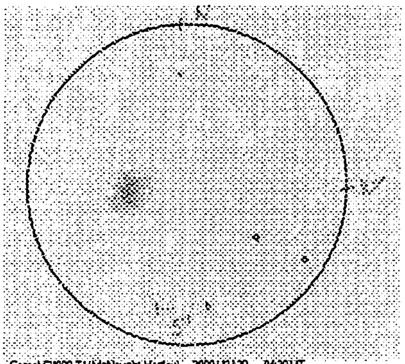
1999 K5 LINEAR. Michael Mattiazzo and Andrew Pearce continued observing the 14th magnitude comet until the end of January. 32 observations give an aperture corrected preliminary light curve of 5.3 + 5 log d + 8.8 log r



Scattered observations of **1999 K8 LINEAR** continued until mid November, with observers estimating it at around 14th magnitude. 85 observations give an uncertain corrected preliminary light curve of -0.2 + 5 log d + [15] log r

1999 T1 McNaught-Hartley D. Schleicher, Lowell Observatory, reports that he obtained eight sets of narrowband photometry of comet C/1999 T1 on 2000 Dec. 28 and 2001 Jan. 2 with the Hall 1.1-m telescope at Lowell Observatory, yielding the following averaged results: log Q(OH) = 28.67; log Q(CN) = 26.10; log Af(rho) = 3.06 (cf. IAUC 7342). The equivalent log Q(water; vectorial) is 28.76. No significant temporal or aperture variations were observed. [IAUC 7558, 2001 January 9]

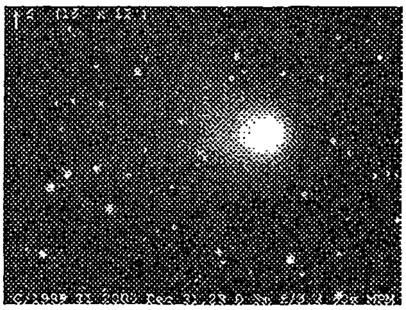
N. Biver, D. Bockelee-Morvan, and J. Crovisier, Observatoire de Paris-Meudon; D. C. Lis, California Institute of Technology; and H. Weaver, Johns Hopkins University, report: "The CO J(3-2) line at 345.8 GHz has been detected on Jan. 5.7 UT at the Caltech Submillimeter Observatory (CSO) with a line area of 0.17 +/- 0.03 K km/s in main-beam brightness temperature. During Jan. 5-7 at CSO, we also detected the HCN J(3-2) line (0.19 +/-0.01 K km/s) and CH_3OH lines at 307.2 (0.23 +/- 0.02), 304.2 (0.16 +/- 0.02), and 241.79 GHz (0.17 +/- 0.03 K km/s). The average production rates relative to water, using the water-production rate from Schleicher et al. (cf. IAUC 7558), are: CO, 40 percent; CH_3OH, 5 percent; HCN, 0.11 percent. This is until now the highest mixing ratio of CO observed in a comet that is relatively close to the sun." [IAUC 7559, 2001 January 11]



1999 T1 drawn by Gabriel Oksa on December 20

M. J. Mumma, N. Dello Russo, and M. A. DiSanti, Goddard Space Flight Center, NASA; K. Magee-Sauer, Rowan University; R. Novak, Iona College; and A. Conrad and F. Chaffee, W. M. Keck Observatory, report: "Water and CO were detected simultaneously near 4.67 microns on Jan. 13.7 UT in observations made at the NASA Infrared Telescope Facility (+ CSHELL). Three lines in the 1-0 band of CO (R0, R1, and P2) and two lines in the nu_3-nu_2 band of H_2O yielded production rates (x 10**27 molecules s**-1) of 14 for CO and 82 for H_2O. On Jan. 14.7, C_2H_6 (nu_7, nine Q-branches), CH_3OH (nu_3 Q-branch and other lines), and OH 'prompt' emission were detected using NIRSPEC at the W. M. Keck Observatory. The water-production rate derived from OH 'prompt' emission (P12.5 1- and 1+, near 3042 cm**-1) was 160 (calculated using g-factors from comet C/1999 H1), and other production rates were 2.7 for CH_3OH and 1.1 for C_2H_6. A residual 2-sigma signal was seen at the expected position of CH_4 R0 (nu_3 band), and this is formally consistent with a 3-sigma upper limit of 2.5 for CH_4. The mixing ratios are then H_2O:CO = 100:17 on Jan. 13.7, and H_2O:CH_3OH: C_2H_6:CH_4 = 100:1.7:0.65:(<1.6) on Jan. 14.7. A rotational temperature of 70 K was adopted for all species on both dates. Multiple lines of HCN and C_2H_2 were detected on Jan. 14, and quantitative analysis is in progress. The CO mixing ratio in this comet is similar to that found for native CO in comets C/1996 B2 and C/1995 O1, but it is much higher than those found for comets C/1999 H1 and C/1999 S4. Abundances of C_2H_6 and CH_3OH are similar to those in comets C/1996 B2, C/1995 O1, and C/1999 H1." [IAUC 7578, 2001 February 2]

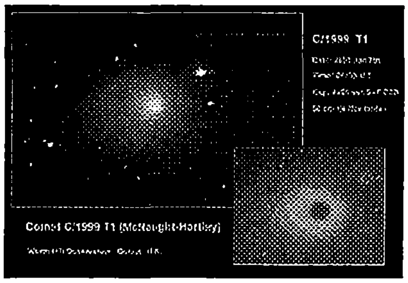
D. K. Lynch, R. W. Russell, and D. Kim, The Aerospace Corporation; and M. L. Sitko and S. Brafford, University of Cincinnati, report 3- to 14-micron spectroscopy of this comet on Jan. 31.62 and Feb. 1.7 UT using BASS at the Infrared Telescope Facility: "The spectrum on the first night showed a silicate emission feature extending about 12 percent above the continuum defined by a blackbody fitted to the 8- and 13-micron points. Two prominent emission features at 10.3 and 11.2 microns appeared above the silicate band, the latter seemingly indicative of crystalline olivine. The 8- to 13-micron color temperature was 260 +/- 10 K, about 10 percent above the blackbody radiative equilibrium temperature of 235 K. The magnitude at 10.5 microns was [N] = 3.0 +/- 0.1. On the second night, the two prominent emission features were absent, although the silicate emission feature maintained its trapezoidal shape with breaks at 9.5 and 11.1 microns." [IAUC 7582, 2001 February 13]



1999 T1 imaged by Martin Mobberley on 2000 December 31.23

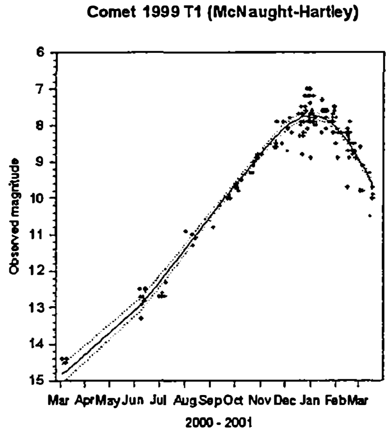
C. E. Woodward, J. E. Lyke, and R. D. Gehrz, University of Minnesota (UM), report 7- to 23-micron photometry of this comet on Feb. 21.51 UT at the Mt. Lemmon Observing Facility 1.52-m telescope (+ UM bolometer + IRTF narrowband 'silicate' filters). No evidence for strong silicate emission (cf. IAUC 7582) was observed at 11 microns; a blackbody fit to the observed spectral energy distribution yields a color temperature of 270 +/- 20 K. Observed magnitudes: [7.9 microns] = 3.19 +/- 0.25, [8.8 microns] = 3.24 +/- 0.22, [9.8 microns] = 2.93 +/- 0.27, [10.3 microns] = 2.91 +/- 0.12, [11.7 microns] = 1.68 +/- 0.12, [12.5 microns] = 2.05 +/- 0.22, [18.3 microns] = 0.42 +/- 0.23, and [23.0 microns] = 0.62 +/- 0.30. [IAUC 7594, 2001 March 6]

E. A. Bergin, Harvard-Smithsonian Center for Astrophysics (CfA); D. A. Neufeld, Johns Hopkins University; and S. C. Kleiner, Z. Wang, and G. J. Melnick, CfA, write: "The 1(10)-1(01) transition of water vapor near 557 GHz was detected toward comet C/1999 T1 by the Submillimeter Wave Astronomy Satellite. During the periods Feb. 2.01-11.06 and 23.01-28.95 UT, the average integrated antenna temperatures were 0.58 +/- 0.02 and 0.39 +/- 0.03 K km s**-1, respectively, within a 3'.3 x 4'.5 (FWHM) elliptical beam. For a spherical outflow model with an assumed water lifetime of 7.3 x 10**4 s and an assumed water ortho-para ratio of 3, the inferred total water production rates (x 10**28 molecules/s) are 5.7 and 4.4, respectively." [IAUC 7596, 2001 March 13]



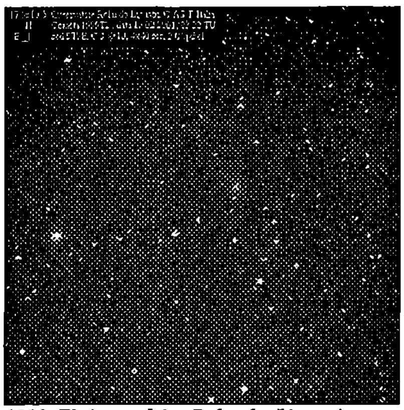
1999 T1 imaged by David Strange on 2001 January 7.27

I was able to observe the comet from the Falkland Islands on November 19 and 20. A gusty wind and ever brightening sky made observation difficult, however I located the 8th magnitude comet in my short focus 90mm refractor, noting a distinct central condensation in 4' diameter coma. I viewed it again from the UK on January 23.20 when it was an easy binocular object at 7.9. An observation in bright moonlight on February 12.09 put it at 8.2 in 20x80B. By early March it had become much more diffuse and was around 9th magnitude, fading to 10th magnitude by the end of the month.



160 observations give an uncorrected preliminary light curve of 6.2 + 5 log d + 8.8 log r

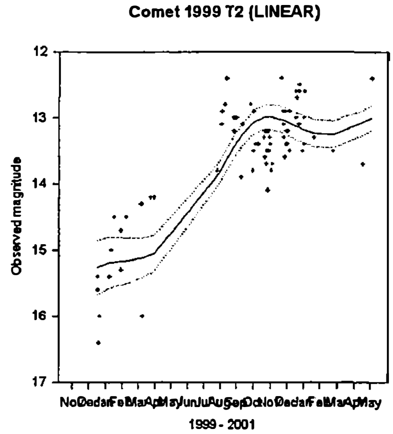
1999 T2 LINEAR. Observers have kept the comet under observation, with estimates around 13th magnitude.



1999 T2 imaged by Rolando Ligustri on 2001 February 15.14

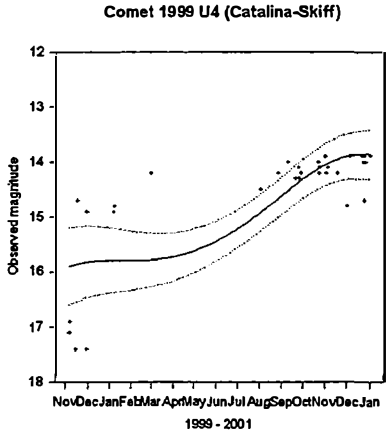
84 observations give an uncorrected preliminary light curve of 6.4 + 5 log d + 8.5 log r

1999 WJ7 P/Korlevic Pepe Manteca imaged the comet at 16th magnitude in March, rather brighter than its expected magnitude.

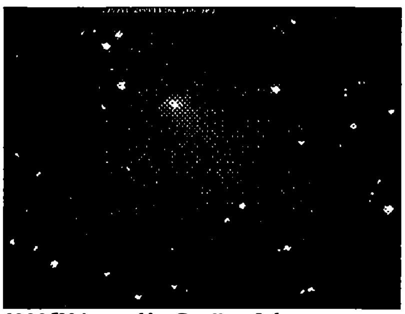


1999 U4 Catalina-Skiff. Visual observers estimated the comet at around 14th magnitude in November and December.

34 observations give a corrected preliminary light curve of -1.3 + 5 log d + 14.1 log r

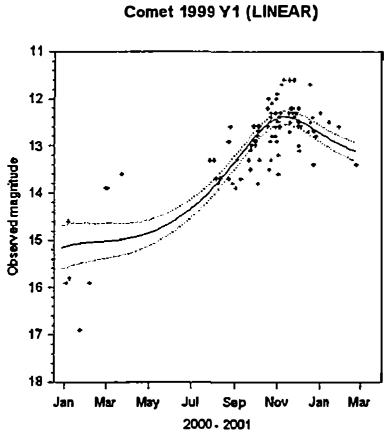


1999 Y1 LINEAR Observations of the 13th magnitude comet continued until February. It is currently in solar conjunction, but Southern Hemisphere observers will be able to observe it when it emerges from the solar glare in May.

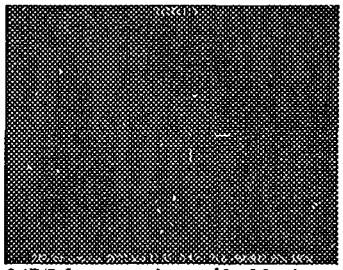


1999 Y1 imaged by Geoffrey Johnson on 2000 November 26

104 observations give a corrected preliminary light curve of 5.5 + 5 log d + 7.4 log r



Martin Mobberley imaged **Comet 24P/Schaumasse** on February 13 and estimates the CCD magnitude as around 15 - 16. I observed on February 14.8 with the Northumberland refractor and immediately saw a diffuse object in the expected position, which I estimated at 13.6. This is rather brighter than the CCD magnitude and will need further confirmation. A further observation on March 12.8 put the comet at 13.2 and further observations show it brightening, but about a magnitude fainter than expected.



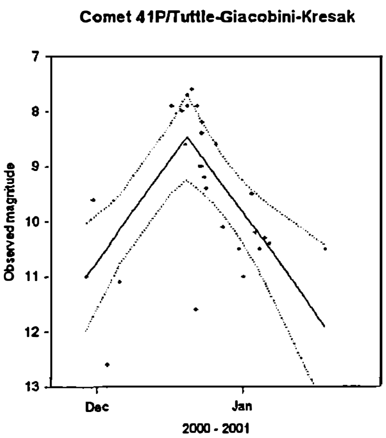
24P/Schaumasse imaged by Martin Mobberley on 2001 March 13.83

Comet 41P/Tuttle-Giacobini-Kresak. The comet appears to be in outburst, as indicated by the following visual m_1 estimates: 2000 Nov. 27.53 UT, 10.2: (A. Hale, Cloudcroft, NM, 0.41-m reflector); 28.83, 10.5 (Y. Nagai, Yamanashi, Japan, 0.32-m reflector); Dec. 1.82, 10.4 (M. Tsumura, Wakayama, Japan, 0.32-m reflector). [IAUC 7536, 2000 December 5]

The comet appears to be continuing its rapid brightening (cf. IAUC 7536), as indicated by the following m_1 estimates: Dec. 5.82 UT, 11.1 (S. Yoshida, Ibaraki, Japan, 0.25-m reflector; visual); 6.52, 11.4 (A. Hale, Cloudcroft, New Mexico, 0.41-m reflector; visual); 15.83, 8.7 (K. Kadota, Ageo, Saitama, Japan, 0.18-m reflector + CCD; 3' coma and 16' tail). [IAUC 7543, 2000 December 15]

41P/Tuttle-Giacobini-Kresak imaged by Rolando Ligustri on 2000 December 22.17

28 observations give a preliminary light curve of 6.1 + 5 log d + 0.1148 * abs(t - T - 17.9)



A few further observations of **Comet 47P/Ashbrook-Jackson** were made during November and December, when the comet was around 13th magnitude.

10 observations give an uncorrected preliminary light curve of m = 6.2 + 5 log d + [15] log r.

Comet 73P/Schwassmann-Wachmann 3 A. Nakamura, Kuma, Ehime, Japan, reported that a CCD image taken low in the morning sky by K. Kadota (Ageo, Saitama, 0.18-m reflector) on Nov. 4.84 UT shows this comet unexpectedly bright at m_1 = 13.2, with coma diameter 0'.5 and a 0'.8 tail in p.a. 310 deg. [IAUC 7518, 2000 November 10] Recent observations suggest that three nuclear components of comet 73P are now visible: what appear to be components B and C from the observed 1995 outburst and splitting (IAUC 6246, 6274, 6301) and an apparent new component (E). Assuming that component C (T = 2001 Jan. 27) is the primary nucleus, components B and E are separated by Delta(T) = +0.27 and +0.74 day, respectively. Component E was observed by K. Kadota (Ageo, Japan, 0.18-m reflector + CCD) on Nov. 28.84 UT and by M. Jaeger (Puchenstuben, Austria, 0.3-m reflector + Technical Pan film) on Dec. 1.19 and 2.20 – the latter indicating that it is about 28' tailward from, and about 1.5-2 mag fainter than, component C. Observations by Jaeger and earlier by A. Galad and P. Koleny (Modra, 0.6-m reflector + CCD) on Nov. 19.19 indicate that component B is about 2.5-3 mag fainter than component C. Jaeger adds that component C has a 20' tail in p.a. 296 deg. Total visual magnitude estimates (cf. IAUC 7523) for component C: Nov. 25.51 UT, 11.9: (A. Hale, Cloudcroft, NM, 0.2-m reflector; low altitude, zodiacal light); 28.84, 11.4 (S. Yoshida, Ibaraki, Japan, 0.25-m reflector). [IAUC 7534, 2000 December 2] In addition to the above observations Seiichi Yoshida and Nicolas Biver also observed the comet at around 10th magnitude in December and January.

Visual estimates put **Comet 110P/Hartley 3** at around 14th magnitude in November and December.

11 observations give an uncorrected preliminary light curve of m = 6.8 + 5 log d + [15] log r.

2000 K2 LINEAR. Martin Lehky and Werner Hasubick reported further observations of the 14th magnitude comet in October and November.

22 observations received give a rather uncertain corrected preliminary light curve of m = 5.1 + 5 log d + 15.7 log r.

2000 S1 P/Skiff. Martin Lehky and Werner Hasubick reported the comet at 15th magnitude in October and November.

2000 S4 LINEAR-Spacewatch. The IAU Committee on Small Bodies Nomenclature has given the name LINEAR-Spacewatch to comet P/2000 S4. [IAUC 7553, 2000 December 31]

2000 SV74 An apparently asteroidal 18th mag object reported by LINEAR on two nights in September (first observation on September 24.34), and published on MPS 19881 under the designation 2000 SV_74, has been found to be cometary (diffuse with 16" coma and 20" tail at p.a. 150 deg) by M. Tichy on CCD images taken on Oct. 19.8 UT with the 0.57-m f/5.2 reflector at Klet. [IAUC 7510, 2000 October 19] The comet could reach 14th magnitude in the summer.

2000 SO253 Anderson-LINEAR An apparently asteroidal 20th magnitude object discovered by LINEAR on September 24.35 (MPS 20197, 21370; discovery observation below) has been found to be cometary (highly condensed 5" coma and a 15" tail in p.a. 45 deg) on 300-s R-band CCD exposures taken on Nov. 24.3 UT by C. W. Hergenrother and A. E. Gleason with the Steward Observatory 1.54-m reflector. Additional observations and orbital elements (T = 2001 May 2.1 TT, q = 1.694 AU, i = 3.7 deg, P = 7.04 yr) are given on MPEC 2000-W39. [IAUC 7524, 2000 November 25]
S. Nakano, Sumoto, Japan, reports his identification of comet P/2000 SO_253 (cf. IAUC 7524) with P/1963 W1 = 1963 IX (cf. IAUC 2013), which had been recorded on four Palomar Schmidt plates taken 1963 Nov. 22-25. The resulting orbital elements for the earlier apparition are T = 1963 Oct. 28.5 TT, q = 1.985 AU, i = 4.5 deg, P = 7.89 yr. The comet made approaches of 0.10 and 0.40 AU from Jupiter in 1961 Aug. and 1985 Apr., respectively. [IAUC 7548, 2000 December 23]

2000 T2 P/Kushida-Muramatsu S. Nakano, Sumoto, Japan, reported the recovery by T. Oribe of comet P/1993 X1 (= 1993t = 1993 XIX) on CCD frames obtained with the 1.03-m reflector at Saji Observatory on Oct. 3.72 and 4. The images were clearly cometary with coma diameter 10". The indicated correction to the prediction by B. G. Marsden on MPC 31663 was Delta(T) = -0.04 day, but neither Nakano nor Marsden was able to obtain a link to the 1993-1995 data without dramatically systematic residuals, particularly in declination. Oribe later found faint images of the comet on frames obtained on Sept. 26. C. E. Delahodde, European Southern Observatory, independently recovered the comet (as a pointlike object measured by A. Maury) with the Danish 1.54-m reflector on Oct. 8. A further orbit computation by Marsden indicated that it was possible to link the 2000 data to the observations made after the 1994 conjunction. This computation revealed that single-night candidates for the comet found by C. W. Hergenrother, Lunar and Planetary Laboratory, with the 2.3-m Steward Observatory reflector at Kitt Peak in Sept. and Nov. 1999 indeed belong to the comet, which showed a possible 5" tail in p.a. 270 deg on the first occasion. Orbital elements satisfactorily linking the 49 observations during 1994 Dec. 8-1995 June 23 and 1999 Sept. 13-2000 Oct. 8 are given on MPEC 2000-T45, together with the 1999-2000 observations. [IAUC 7507, 2000 October 14]

2000 U5 LINEAR A 17th mag object with unusual motion that was reported as asteroidal by the LINEAR survey on October 29.38 and posted on the NEO Confirmation Page has been found to be cometary by other observers. The object seemed diffuse with a 14" coma and 18" tail in p.a. 170 deg on CCD images obtained by J. Ticha and M. Tichy (Klet) on Oct. 30.0 UT. Images taken on Oct. 30.2 by D. A. Klinglesmith III (Socorro, NM) show slight diffuseness and a tail about 20" long in p.a. 220 deg; images by Y. Ikari (Moriyama, Japan) also show a tail in p.a. 220 deg on Oct. 30.6. J. Biggs (Perth Observatory) notes that images of C/2000 U5 were larger than nearby stars and elongated toward the south-southwest on Oct. 31.6. D. T. Durig (Sewanee, TN) found a tail about 25" long in p.a. 170 deg on Nov. 1.4 images. [IAUC 7515, 2000 November 1]

2000 U6 P/Tichy An 18th mag object found by Milos Tichy on images taken at Klet with J. Ticha and M. Kocer on Oct. 23.08, originally reported as asteroidal, was subsequently noted to be diffuse on Klet images taken during Oct. 28.9-29.2 UT; Tichy also noted a 10" coma on Oct. 29.8 images. Images obtained on Nov. 1 by S. Sanchez and M. Blasco at Mallorca and by D. T. Durig at Sewanee also showed diffuseness. MPEC 2000-V03 contains the available astrometry and orbital elements (T = 2000 Oct. 4.6 TT, i = 19.3 deg, q = 2.150 AU, P = 7.3 yr). [IAUC 7515, 2000 November 1]

A/2000 VU2 An interesting asteroid 2000 VU2 = 2000 VW55 was announced on MPEC 2000-W29. This has an 18.4 year period with a perihelion at 3.1 AU. The circular said: Reports of the stellar nature of 2000 VU2 have been received from T. B. Spahr on CCD images obtained on Nov. 20 UT with the 1.2-m Mount Hopkins reflector and C. W. Hergenrother on CCD images obtained on Nov. 23 and 24 with the 1.5-m Catalina reflector. [2000 November 24]

2000 W1 Utsunomiya-Jones On November 19, S. Nakano, Sumoto, Japan, reported the visual discovery on November 18.82 by Syogo Utsunomiya (Aso, Kumamoto; 25x150 binoculars) of a possible 9th magnitude comet with coma diameter 5' moving rapidly southeastward in Vela. Attempts by several observers (including A. Hale, D. Seargent, J. Biggs, T. Urata, and J.Kobayashi) to confirm the object, at the request of Nakano and the Central Bureau, were unsuccessful. On November 25, A. C. Gilmore (Mount John University Observatory) reported the visual discovery of an apparent 8th magnitude comet by Albert F. Jones (Nelson, New Zealand, 0.078-m f/8 refractor, 30x) while observing the variable star T Aps at dawn on November 25.64; Jones reported the comet as being diffuse with coma diameter about 4' in morning twilight. The possibility that Jones' object might be the same as that reported by Utsunomiya was explored by the Central Bureau, and a search ephemeris from plausible parabolic orbital elements fitted to the November 18 and 25 approximate positions was circulated to numerous southern-hemisphere observers. Confirming CCD astrometry was made by Gilmore with the 1.0-m f/7.7 reflector at Mt. John. [IAUC 7526, 2000 November 28] This is Albert Jones' second comet discovery; the first was discovered in 1946!

This is how the comet was discovered:
On November 18 UT Japanese comet hunter Syogo Utsumoniya saw a possible comet in Vela, very low in his southern sky. Utsunomiya watched the eighth magnitude comet through his 25 x 150 mm binoculars for 40 minutes as dawn approached. During that time the comet moved southeastward about 10 minutes of arc, one third of a full-moon's diameter. Utsunomiya passed the information onto the International Astronomical Union's Central Bureau. They asked a few southern hemisphere observers (none in NZ!) to confirm the discovery. They were unable to locate the comet.

A week later, on Sunday morning Nov. 26 NZ date, Albert Jones of Nelson found the sky had cleared. He got out his 78 mm refractor with the 30x eyepiece and aimed it at the variable star T Apodis. He had intended to observe T Aps two mornings earlier but "ran out of dark sky" before he got to it. Just 50' northwest of the variable Albert saw a hazy spot which he instantly recognised as a comet. He made position and magnitude estimates as dawn came up and phoned them to the University of Canterbury's Mt John Observatory. We immediately emailed Albert's discovery position to the IAU Bureau.

At the Bureau Brian Marsden and Dan Green surmised that the two fast-moving eighth magnitude comets were one and the same object. Brian fitted a parabolic orbit to the two positions and emailed search ephemerides to a few southern hemisphere observers. (The Bureau is very cagey about a suspected comet lest an unscrupulous person 'discovers' it.)
As luck would have it, Mt John had a CCD camera on its 1m telescope. Glen Bayne was taking direct images of Magellanic Cloud eclipsing binary stars as part of his PhD project. (The same CCD is in frequent use on the 1m but attached to a large spectrograph, not available for direct picture taking.) Glen was happy to get pictures of the comet in the twilight.

Using a 15 cm finder 'scope on one of Mt John's other telescopes, Alan Gilmore located the comet in the twilight. This allowed quick setting of the 1m onto the comet and CCD images to be taken. Alan measured these and sent the results off to the IAU Bureau. Three hours later another set of CCD images were obtained by Glen and Alan and the futher positions sent off.

Brian Marsden was then able to fit a semi-accurate orbit to the three nights' observations and show conclusively that the comets seen by Utsunomiya and Jones were indeed the same object. IAU Circular 7526 appeared a few hours later, announcing the discovery and designating the comet 2000 W1. Numerous CCD measurements over the next four days allowed a more accurate orbit to be calculated. This appeared in Minor Planet Electronic Circular 2000-W62 on Nov. 30.

At 80 years old, Albert Jones is the oldest person ever to discover a comet. The next nearest was Lewis Swift who was 79 when he found his last comet in 1899. Albert also holds the record for the longest interval between comet discoveries. His previous comet, also found in a variable star field, was 1946 P1 found in October 1946.

At discovery Comet Utsunomiya-Jones was about 50 million km from earth, hence its rapid movement across the sky. Perspective slows the apparent movement as the comet moves directly away from us and on toward the sun. The angle between the comet and the sun will shrink, causing the comet to sink into the south-west evening twilight. Counterbalancing this, to a greater or lesser degree, is the comet's expected increase in brightness as it nears the sun. So nobody can predict how long the comet will remain visible. It is likely to have disappeared by December 22 when it will be just 19 degrees from the sun.

Comet Utsunomiya-Jones passes closest to the sun on December 26.6 UT. It will remain hidden in the sun's glare till mid January when it will start climbing up the dawn sky. If it behaves like a 'normal' comet then it should have a total magnitude (m1) around nine, visible in medium-sized telescopes.
-- Alan Gilmore & Pam Kilmartin

Albert described his discovery thus:
On the morning of November 26, I was up early (as I do on clear mornings) observing variable stars before dawn, then as I was pointing the telescope to view a faint variable star south of the Southern Cross and Pointers, I noticed a fuzzy object that was new to the region and recognising that it was a comet and not permanent celestial scenery like a nebula, star cluster or galaxy, I noted its position and other details. Then I phoned Alan Gilmore at the Mount John University Observatory (by Lake Tekapo) and told him about it and asked he if he knew about it and its name, but he had no information about it so he e-mailed a message to the International Central Bureau for Astronomical Telegrams (CBAT) at Cambridge, Mass. USA. At breakfast that morning Carolyn wondered why I did not get back to bed before bright daylight - I replied that I had been on the phone to Alan about a comet asking about whether it was a known one. After breakfast a message came from the CBAT saying that it might be the same object that a Japanese comet hunter had seen a week beforehand but which had not been seen again because it was moving south so fast and was thus unconfirmed Using the Japanese positions for the comet and mine, they determined that it was the same object to be known as Comet 2000 W1 Utsunomiya-Jones It has quickly moved towards the west and is moving north again. December 5 was the last evening that I saw it, as it was too low in the sky and behind trees the next night. Next January when the comet's motion brings it into the eastern sky before dawn, it will be much fainter as it races away to the outer reaches of the Solar System. Over 50 years ago, I spent some time looking for unknown comets, and now I find one while pointing the telescope to a variable star ! The moral of the story is to keep looking and you never know what you might see. You just need to be lucky enough to look at the right place at the right time ! By the way, I am told that I am the oldest person to have discovered a comet.

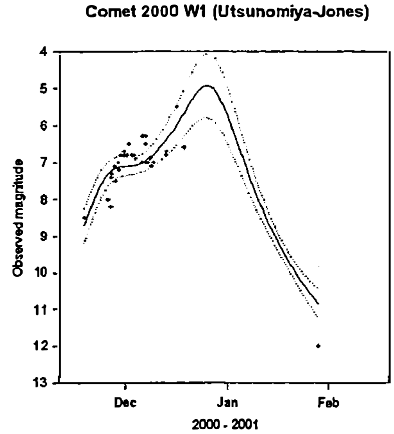
C. W. Hergenrother, Lunar and Planetary Laboratory, reports that this comet has undergone a rapid fading, with R-band photometry showing m_1 about 16.5 for a 1'.7 coma on a co-added 2400-s CCD exposure taken on Feb. 12.6 UT with the Catalina 1.5-m reflector. No nuclear condensation was visible to a limiting mag of 21.0. Earlier visual m_1 estimates: Jan. 17.86, 10.1 (Y. Nagai, Yamanashi, Japan, 0.32-m reflector); 22.88, 10.5 (K. Yoshimoto, Yamaguchi, Japan, 0.25-m reflector); 28.77, 12.0: (M. Mattiazzo, Wallaroo, S. Australia, 0.20-m reflector); 30.28, 11.6 (P. M. Raymundo, northwest of Salvador, Brazil, 0.25-m reflector). [IAUC 7586, 2001 February 22]

Further to the report on IAUC 7586, A. C. Gilmore reports that 3-min unfiltered CCD images taken on Mar. 3.61 UT with the University of Canterbury's Mount John Observatory 1-m f/7.7 telescope showed only a diffuse parabolic glow at the comet's expected position. The glow was brighter and about 1' across at the 'head' end. The 'tail', in p.a. 80 deg, was at least 10' long and widened to about 2' across at the frame's edge. No stellar central condensation was found, though anything brighter than red mag 20 should have been detected. [IAUC 7594, 2001 March 6]

Michael Mattiazzo observed it with 7x50B on November 28.52, estimating it at 7.0, DC4, diameter 5'. It displayed a faint ion tail in 25x100B. I was in the Southern Ocean on board the RRS Ernest Shackleton and made several attempts at observing the comet. These were generally foiled by bright skies or cloud, but I successfully glimpsed it in 10x50B on December 6.09 when it was 6.3 and again the following night.

The comet had a perihelion distance of 0.3 AU, but was intrinsically faint and was therefore not expected to survive perihelion passage. The comet transited the SOHO LASCO C3 field at the end of December and early January, and it was significantly fainter than indicated by the visual light curve. Michael Mattiazzo did make a final post perihelion observation on 2001 January 28.77 when he estimated it at 12.0 and very diffuse.

32 observations received give a corrected preliminary light curve of m = 10.5 + 5 log d + 12.6 log r.



2000 WM1 LINEAR An apparently asteroidal 18th mag object with unusual motion reported by the LINEAR team on Dec. 16.07 was posted on the NEO Confirmation Page. Subsequent astrometry permitted a linkage to another set of observations by LINEAR on Nov. 16.14 and 18, designated 2000 WM_1 on MPS 22800. An observation of 2000 WM_1 by T. B. Spahr (Smithsonian Astrophysical Observatory 1.2-m reflector at Mt. Hopkins) on Dec. 20.148 UT shows the object to have a 10" coma and a broad, faint tail some 10"-20" long in p.a. 45 deg: [IAUC 7546, 2000 December 20]

Brian Marsden notes on MPEC 2001-D29 [2001 February 21], which gives the latest orbit for the comet, that 'The "original" and "future" barycentric values of 1/a are +0.000510 and -0.000256 (+/- 0.000041) AU**-1, respectively.' The original value is greater than 10E-04, hence the comet is probably not a new arrival from the Oort cloud and has made at least one previous visit to the inner solar system.

The comet does not reach perihelion until January 2002 when it could reach 4th magnitude. It should be possible to pick it up from the UK in late July 2001 and we should see it as a naked eye object in November. It will be too far south at perihelion, but will return to northern skies and will be visible until August 2002. Several CCD imagers already have it under observation, reporting it around 17[th] magnitude.

2000 WT168 (LONEOS-LINEAR) After the publication (MPS 23043) of the initial observations of the apparently asteroidal 17th mag object 2000 WT_168 by LONEOS on November 25.44 and LINEAR on November 27.37, linkage to further observations (including prediscovery data) showed the orbit to be cometary, although observations did not show cometary activity in December (cf. MPEC 2000-Y21). CCD exposures taken with the 1.5-m reflector at Catalina on 2001 Feb. 13.3 UT by C. W. Hergenrother, however, do show the object to be cometary (highly condensed 9".7 coma with red mag 16.3 and 8".0 tail in p.a. 110 deg). Confirmation of cometary activity has been obtained in CCD observations by J. Ticha and M. Tichy at Klet on Feb. 16.9 (0.57-m reflector; 9" tail in p.a. 155 deg and faint asymmetric coma) and by M. Hicks and B. Buratti at Palomar on Feb. 17.2 (1.5-m reflector; faint teardrop-shaped tail about 15" long in p.a. 60 deg). The comet has a 7.7 year period, with perihelion at 1.76 AU on 2001 March 23. [IAUC 7584, 2001 February 17] It is not clear at this time what, if any, name the comet will receive.

R. M. Stoss, Starkenburg-Sternwarte, Heppenheim; and R. H. McNaught, Siding Spring Observatory, report the identification with P/2000 WT_168 of two asteroidal trails appearing on U.K. Schmidt plates taken by M. R. S. Hawkins and P. R. Standen on 1978 Mar. 6 and 1986 Mar. 14. Astrometric measurements by McNaught, M. Read, and Stoss appear on MPEC 2001-F17, together with orbital elements by B. G. Marsden from 190 observations spanning 1978-2001 (T = 1978 Jan. 21, 1985 Oct. 22, 1993 July 18, and 2001 Mar. 23). [IAUC 7600, 2001 March 20]

2000 Y1 Tubbiolo R. S. McMillan, Lunar and Planetary Laboratory, reports the discovery by Andrew F. Tubbiolo of a faint 19th mag comet with the 0.9-m Spacewatch telescope at Kitt Peak on December 16.18. The object showed a 20"-30" tail on December 16 and 17. Parabolic orbital elements (T = 2001 February 6, i = 138 deg, q = 7.97 AU) are given on MPEC 2000-Y06. [IAUC 7544, 2000 December 18]

2000 Y2 B. Skiff, Lowell Observatory, reports the discovery of a 17th magnitude comet by the LONEOS program on December 27.34. Confirming CCD images by L. Wasserman (1.07-m Lowell Observatory telescope) show a coma diameter of about 9" and a tail about 14" long toward the southwest. [IAUC 7549, 2000 December 27] The comet is in a distant parabolic orbit and will not get much brighter.

2000 Y3 Scotti J. V. Scotti, Lunary and Planetary Laboratory, reports his discovery of a 19th magnitude comet with the 0.9-m Spacewatch telescope on December 30.16. The comet shows a coma diameter of 7" and a 0'.93 tail in p.a. 269 deg; he also measures m_2 = 19.7. [IAUC 7552, 2000 December 30]
Additional astrometry, including prediscovery observations by LINEAR on Nov. 29 and Dec. 21 identified by B. G. Marsden, appear on MPEC 2000-Y47, together with the following orbital elements showing this to be a short-period comet. The elements indicate an approach to within 0.05 AU of Jupiter in Sept. 1998. Further to IAUC 7552, J. V. Scotti notes that the comet showed a 7" coma and a 1'.16 tail in p.a. 270 deg on a Spacewatch CCD image taken on Dec. 31.174 UT. An image obtained at Klet on Dec. 30.79 shows a coma diameter of 8" and m_1 = 17.5. [IAUC 7553, 2000 December 31] The comet will fade.

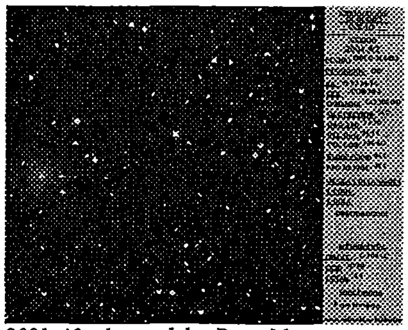
2000 Y6 SOHO 2000 Y7 SOHO Further to IAUC 7565, D. Hammer reports his measurements for two comets (initial observations given below) that appear to be two components of an earlier single comet. C/2000 Y6 and C/2000 Y7 were found by M. Meyer and by S. Hoenig, respectively, in C2 coronagraph data on SOHO website images. D. Biesecker provides V magnitudes for C/2000 Y6: Dec. 20.463 UT, 7.8; 20.504, 7.8; 20.580, 7.5; 20.588, 7.6; 20.604, 8.0; 20.646, 8.3. The reduced observations and parabolic orbital elements (T = 2000 Dec. 20.85 TT, q = 0.025 AU, Peri. = 88-89 deg, Node = 229 deg, i = 87-89 deg) by B. G. Marsden, together with a search ephemeris for groundbased observers, are given on MPEC 2001-B08.

2000 Y10 P/Mueller 4 S. Nakano, Sumoto, Japan, reports the recovery of P/1992 G3 (= 1992g = 1992 IV) by T. Oribe (Saji Observatory) on CCD images taken with a 1.03-m reflector. The comet is faint and of stellar appearance on 2000 Dec. 22.85 (m_2 = 20.5). The indicated correction to the orbital elements on MPC 31663 (ephemeris on MPC 41213) is Delta(T) = +0.23 day. [IAUC 7577, 2001 February 1]

SOHO Kreutz group comets
1996 L1 SOHO (IAUC 7606, 2001 April 2)
1997 M5 SOHO (IAUC 7606, 2001 April 2)
2000 A2 SOHO (IAUC 7562, 2001 January 14)
2000 H3 SOHO (IAUC 7572, 2001 January 25)
2000 H4 SOHO (IAUC 7572, 2001 January 25)
2000 H5 SOHO (IAUC 7572, 2001 January 25)
2000 J6 SOHO (IAUC 7467, 2001 January 19)
2000 J7 SOHO (IAUC 7572, 2001 January 25)
2000 K7 SOHO (IAUC 7467, 2001 January 19)
2000 K8 SOHO (IAUC 7467, 2001 January 19)
2000 L6 SOHO (IAUC 7572, 2001 January 25)
2000 T1 SOHO (IAUC 7506, 2000 October 10)
2000 T3 SOHO (IAUC 7508, 2000 October 16)
2000 T4 SOHO (IAUC 7508, 2000 October 16)
2000 U1 SOHO (IAUC 7514, 2000 November 1)
2000 U2 SOHO (IAUC 7514, 2000 November 1)
2000 U3 SOHO (IAUC 7514, 2000 November 1)
2000 U4 SOHO (IAUC 7514, 2000 November 1)
2000 V1 SOHO (IAUC 7520, 2000 November 17)
2000 V2 SOHO (IAUC 7520, 2000 November 17)
2000 W2 SOHO (IAUC 7548, 2000 December 23)
2000 W3 SOHO (IAUC 7548, 2000 December 23)
2000 W4 SOHO (IAUC 7562, 2001 January 14)
2000 W5 SOHO (IAUC 7562, 2001 January 14)
2000 X1 SOHO (IAUC 7562, 2001 January 14)
2000 X2 SOHO (IAUC 7562, 2001 January 14)
2000 X3 SOHO (IAUC 7562, 2001 January 14)
2000 X4 SOHO (IAUC 7562, 2001 January 14)
2000 X5 SOHO (IAUC 7562, 2001 January 14)
2000 X6 SOHO (IAUC 7562, 2001 January 14)
2000 X7 SOHO (IAUC 7562, 2001 January 14)
2000 Y4 SOHO (IAUC 7562, 2001 January 14)
2000 Y5 SOHO (IAUC 7567, 2001 January 19)
2000 Y8 SOHO (IAUC 7567, 2001 January 19)
2000 Y9 SOHO (IAUC 7567, 2001 January 19)
2001 A3 SOHO (IAUC 7567, 2001 January 19)
2001 A4 SOHO (IAUC 7573, 2001 January 27)
2001 B3 SOHO (IAUC 7573, 2001 January 27)
2001 C2 SOHO (IAUC 7580, 2001 February 7)
2001 C3 SOHO (IAUC 7582, 2001 February 13)
2001 C4 SOHO (IAUC 7582, 2001 February 13)
2001 C6 SOHO (IAUC 7601, 2001 March 21)
2001 F2 SOHO (IAUC 76xx, 2001 April xx)
were discovered with the SOHO LASCO coronographs and have not been observed elsewhere. They were sungrazing comets of the Kreutz group and were not expected to survive perihelion.

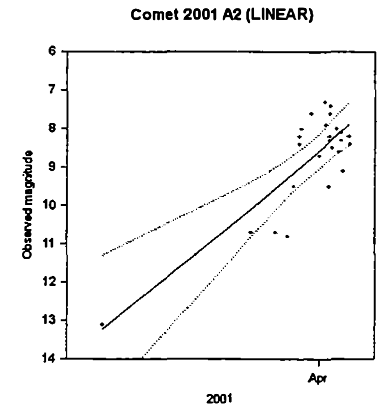
2001 A1 LINEAR M. Blythe reports the discovery by LINEAR of a new comet on January 7.47. Following posting on the NEO Confirmation Page, several other CCD observers confirmed the object's cometary nature: M. Dawson (Luxembourg) found the object to be diffuse with a 9" coma on Jan. 13.0 UT; Jan. 14.2 images taken by L. Kornos and P. Koleny (Modra) and by L. Sarounova (Ondrejov) showed coma diameters of about 15" (m_1 = 16.3) and about 20" (m_1 = 16.4), respectively; and images taken on Jan. 14.9 by J. Ticha and M. Tichy (Klet) showed a diffuse coma of diameter 17" and a faint 30" tail in p.a. 200 deg. [IAUC 7561, 2001 January 14] The comet will fade.

2001 A2 LINEAR An apparently asteroidal object discovered by LINEAR on January 15 and posted on the NEO Confirmation Page has been found to have cometary appearance on CCD images taken by P. Pravec and L. Sarounova (Ondrejov; 0'.3 coma on Jan. 16.0 UT) and by M. Tichy and M. Kocer (Klet; diffuse, 10" coma on Jan. 16.9; m_1 = 17.2). The object also links with one observed on Jan. 3.31 and 5. [IAUC 7564, 2001 January 16] The comet will reach perihelion at 0.8 AU towards the end of May.



2001 A2 observed by Pepe Manteca on March 25.8.

This comet has apparently undergone a rapid brightening. M. Mattiazzo, Wallaroo, South Australia, notes that the total visual magnitude has brightened by about 2.5 mag in the 24 hr ending Mar. 30.5 UT, with the comet becoming noticeably more condensed in the same period. [IAUC 7605, 2001 March 30]



David Seargent reported a visual observation at 13.1 on March 14, a little brighter than expected. It rapidly brightened, reaching mag 8 by the end of the month. It is uncertain if this level of activity will be sustained, but if it is, the comet could be 5th magnitude when it returns to northern skies at the beginning of July.

2001 B1 LINEAR M. Blythe, Lincoln Laboratory, reports the discovery by LINEAR of an apparent 17th magnitude comet on January 22.08. Additional observations have been received following posting on the NEO

Confirmation Page. [IAUC 7570, 2001 January 24] The comet is in a distant parabolic orbit which reached perihelion last September and it will fade.

2001 B2 NEAT E. F. Helin, S. Pravdo, and K. Lawrence, Jet Propulsion Laboratory, report that their CCD images of this comet taken on Jan. 24.6 and 25.6 UT with the 1.2-m NEAT telescope at Haleakala show a coma diameter of about 29"; there is no convincing evidence for a tail, though some images suggest a certain asymmetry toward the northwest. Additional astrometry is reported on MPEC 2001-B47 [IAUC 7573, 2001 January 27] The comet is distant, but should brighten a little as it does not reach perihelion until June.

2001 BB50 LINEAR-NEAT S. Pravdo, K. Lawrence, and E. Helin, Jet Propulsion Laboratory, reported the discovery of aN 18th mag comet on Mar. 20 CCD images taken with the NEAT 1.2-m reflector at Haleakala, the object showing a short eastward tail, a nuclear condensation of size < 3", and a coma diameter of about 10". T. B. Spahr, Minor Planet Center, linked this object first with an object reported as asteroidal by LINEAR on Mar. 18 (m_2 = 19.5) and then to the LINEAR object 2001 BB_50, observed on Jan. 21 and 26 (MPS 25734). Following posting on the NEO Confirmation Page, C. Jacques, Belo Horizonte, Brazil, also reported a 10" coma and m_1 = 18.6 on CCD images taken on Mar. 21 (0.3-m reflector). Full astrometry and the orbital elements appear on MPEC 2001-F26. [IAUC 7601, 2001 March 21] The comet has a perihelion distance of 2.35AU and is intrinsically faint. Its period is 13.6 years.

2001 C1 LINEAR L. Manguso, Lincoln Laboratory, reports the discovery of an apparent 19th mag comet by LINEAR on February 1.48. Confirming CCD observations by G. Hug (Eskridge, KS) reveal a condensed coma and a suggestion of a faint, broad tail in p.a. about 325 deg. [IAUC 7578, 2001 February 2] The preliminary orbit suggests that the comet is in a distant parabolic orbit and will not come within visual range.

2001 C5 SOHO Michael Oates discovered a 6th mag non Kreutz object on C2 images on February 14. The reduced observations and retrograde parabolic orbital elements (T = 2001 Feb. 13.3 TT, q = 0.026 AU, i = 166.3 deg) by B. G. Marsden appear on MPEC 2001-D07 [2001 February 18], though Marsden notes "The above retrograde orbit solution seems more problem than a direct one." The comet could reach an elongation that would permit observation by large telescopes by the end of February.

Further to IAUC 7582, D. Hammer reports his measurements for a comet found by M. Oates on SOHO website images. C/2001 C5 was visible in both the C3 and C2 coronagraphs, and D. Biesecker provides the following post-perihelion V magnitudes from the C2 data (the C3 data being poor due to vignetting): Feb. 13.854, 5.4; 13.896, 5.0; 13.938, 5.0; 13.979, 4.9; 14.021, 4.9; 14.064, 4.9; 14.104, 5.3; 14.146, 5.6; 14.163, 6.3; 14.188, 7.4. [IAUC 7585, 2001 February 20]

2001 CV8 P/LINEAR A 19th mag object that was reported as asteroidal by LINEAR on February 1.35, and given the designation 2001 CV_8, has been found by other CCD observers to show cometary activity. M. Hicks, Jet Propulsion Laboratory, reports that nonphotometric images (with imperfect tracking) obtained with the 0.61-m f/16 reflector at Table Mountain Observatory by D. Esqueda, A. Esqueda, and T. H. Ha on Feb. 4 indicate this object to be diffuse without condensation but with a faint, 5" fan-shaped tail toward the west. Images taken by D. T. Durig (Sewanee, TN; 0.3-m f/5.8 Schmidt- Cassegrain telescope; moonlight and tracking problems) on Feb. 6 show the object to be more diffuse than nearby stars. Observations by J. Ticha and M. Tichy at Klet (0.57-m f/5.2 reflector) on Feb. 10 show the object to be diffuse with a 9" coma and a faint 15" tail in p.a. 270 deg. Additional astrometry, orbital elements and an ephemeris by B. G. Marsden appear on MPEC 2001-C24. The elements indicate that the comet passed about 0.14 AU from Jupiter in Nov. 1998 and has a period of 7.8 years with perihelion at 2.12 AU. [IAUC 7581, 2001 February 10]

2001 E1 SOHO Michael Oates discovered a faint non Kreutz object on C2 images on March 15.

2001 F1 P/NEAT E. F. Helin, S. Pravdo, and K. Lawrence, Jet Propulsion Laboratory, report the discovery of a mag 20 comet with a faint tail about 40" long toward the west-northwest on CCD images taken with the NEAT 1.2-m reflector at Haleakala on March 24.42. Additional observations, together with orbital elements (T = 2001 Jan. 21, q = 4.3 AU, i = 19 deg, P = 15.4 yr) by B. G. Marsden, are given on MPEC 2001-F51. The object appears diffuse on Mar. 28.5 UT CCD images taken by G. J. Garradd, Loomberah, N.S.W. (0.45-m f/5.4 reflector). CCD observations by M. Tichy and M. Kocer at Klet (0.57-m f/5.2 reflector) on Mar. 29.0 show a diffuse 10" coma. P. G. Comba, Prescott, AZ, reports that CCD images taken with a 0.46-m f/4.5 reflector on Mar. 29.3 show a tail in p.a. 285 deg. [IAUC 7604, 2001 March 29] The comet will fade.

2001 G1 An apparently asteroidal 17th mag object discovered on CCD images taken with the LONEOS 0.59-m Schmidt telescope on April 1.20 and posted on the NEO Confirmation Page has been found by other astrometric observers to be cometary on their CCD images. The object was reported as being diffuse by J. Ticha, M. Tichy, and P. Jelinek at Klet (Apr. 1.9 and 2.9 UT; 9" coma on Apr. 2.9) and by C. E. Lopez and M. R. Cesco at El Leoncito (Apr. 2.2), and as having a 10" coma by M. Busch and S. Kluegl at Heppenheim, Germany (Apr. 1.9) and by J. Broughton, Reedy Creek, Queensland (Apr. 2.5). Additional astrometry and very uncertain parabolic orbital elements are given on MPEC 2001-G03. [IAUC 7606, 2001 April 2] The comet is very distant and will fade.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Introduction

This issue has ephemerides for the comets that are likely to be brighter than 11th magnitude:

- 19P/Borrelly (UK)
- 24P/Schaumasse (UK)
- 2000 WM1 (LINEAR) (UK)
- 2001 A2 (LINEAR) (Southern Hemisphere & UK)

Several other comets, including 1999 T1 (McNaught-Hartley), 1999 T2 (LINEAR) and 1999 Y1 (LINEAR) may be brighter than 14m. 29P/Schwassmann-Wachmann 1 has frequent outbursts and is best seen from the Southern Hemisphere. 45P/Honda-Mrkos-Pajdusakova may be visible in the dusk sky from near equatorial latitudes in April and May as it fades from 8th magnitude; it is best seen from northern subtropical latitudes. 2001 A2 (LINEAR) is best seen from the Southern Hemisphere when brightest; note that its future magnitude is uncertain. Current ephemerides for the fainter comets are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations are used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for comet 19P/Borrelly (UK)

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Omega=353.3778 OMEGA= 75.4247 i= 30.3250 q= 1.358216 a=  3.610279
e= 0.623792  P=    6.860  T= 2001 September 14.7388
Magnitudes calculated from m= 4.5+5.0*Log(d)+25.0*Log(r)
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Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
July 2001																
1/ 2	3 34.8	-1.31	3 37.4	-1.21	11.1	2.02	1.60	8.57	Not Observable	52	162	88	3	239	17	7
6/ 7	3 48.6	-0.06	3 51.2	0.03	10.9	1.98	1.57	8.51	Not Observable	52	112	99	4	241	17	7
11/12	4 2.6	1.20	4 5.2	1.28	10.7	1.93	1.55	8.45	Not Observable	53	59	67	4	243	17	7
16/17	4 16.8	2.46	4 19.4	2.54	10.4	1.89	1.52	8.40	Not Observable	53	15	19	5	246	17	7
21/22	4 31.2	4.13	4 33.8	4.19	10.2	1.85	1.50	8.35	Not Observable	54	71	2	6	248	17	7
26/27	4 45.8	5.39	4 48.5	5.44	10.0	1.81	1.47	8.30	Not Observable	54	137	45	7	250	18	7
31/32	5 0.7	7.04	5 3.4	7.08	9.8	1.78	1.45	8.25	Not Observable	55	156	91	8	253	18	7
August 2001																
5/ 6	5 15.7	8.29	5 18.5	8.32	9.6	1.74	1.43	8.20	Not Observable	56	104	98	9	256	18	7
10/11	5 31.0	9.54	5 33.8	9.56	9.4	1.71	1.42	8.16	Not Observable	56	50	64	10	258	18	7
15/16	5 46.6	11.17	5 49.4	11.18	9.3	1.67	1.40	8.12	2.36 to 3.03	57	18	14	11	261	19	6
20/21	6 2.3	12.40	6 5.2	12.39	9.1	1.64	1.39	8.08	2.23 to 3.16	57	85	5	12	264	19	6
25/26	6 18.3	14.00	6 21.2	13.59	9.0	1.61	1.38	8.04	2.10 to 3.27	58	150	52	13	266	19	6
30/31	6 34.5	15.20	6 37.4	15.17	8.9	1.58	1.37	8.01	1.57 to 3.38	59	151	93	14	269	19	6
September 2001																
4/ 5	6 51.0	16.37	6 53.8	16.33	8.8	1.56	1.36	7.57	1.46 to 3.49	60	96	96	15	272	19	6
9/10	7 7.6	17.52	7 10.5	17.47	8.8	1.53	1.36	7.54	1.35 to 3.59	61	38	59	16	274	19	6
14/15	7 24.4	19.05	7 27.3	18.58	8.7	1.51	1.36	7.51	1.25 to 4.09	62	29	8	16	277	19	6
19/20	7 41.3	20.15	7 44.2	20.08	8.7	1.49	1.36	7.49	1.15 to 4.19	63	99	9	16	279	19	5

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
24/25	7 58.3	21.22	8 1.3	21.14	8.7	1.46	1.36	7.46	1.06 to 4.29	64	161	56	16	282	19	5
29/30	8 15.5	22.27	8 18.4	22.18	8.7	1.44	1.37	7.43	0.58 to 4.38	65	143	95	16	284	19	5
October	2001															
4/ 5	8 32.6	23.29	8 35.5	23.19	8.8	1.43	1.38	7.41	0.50 to 4.47	67	86	95	16	286	19	5
9/10	8 49.7	24.28	8 52.7	24.17	8.8	1.41	1.39	7.38	0.43 to 4.56	68	24	52	15	289	19	4
14/15	9 6.8	25.25	9 9.7	25.13	8.9	1.39	1.40	7.35	0.37 to 5.04	70	45	4	15	290	19	4
19/20	9 23.7	26.20	9 26.6	26.06	9.0	1.38	1.42	7.33	0.30 to 5.13	71	113	12	14	292	18	4
24/25	9 40.4	27.12	9 43.3	26.58	9.1	1.37	1.44	7.30	0.24 to 5.21	73	168	59	13	294	18	4
29/30	9 56.9	28.03	9 59.8	27.48	9.2	1.35	1.46	7.26	0.19 to 5.30	75	130	96	12	295	18	4

Ephemeris for comet 24P/Schaumasse (UK)

Omega= 57.8731 OMEGA= 79.8310 i= 11.7515 q= 1.205005 a= 4.082714
e= 0.704852 P= 8.249 T= 2001 May 2.6570
Magnitudes calculated from m= 6.5+5.0*Log(d)+35.0*Log(r)

April 2001

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
21/22	5 33.0	30.14	5 36.2	30.16	11.3	1.51	1.21	15.36	20.46 to 21.60	53	73	2	3	82	21	4
26/27	5 54.2	30.51	5 57.4	30.52	11.3	1.51	1.21	15.37	20.59 to 22.07	53	14	12	4	84	22	3
May	2001															
1/ 2	6 16.1	31.16	6 19.3	31.15	11.2	1.50	1.21	15.39	21.12 to 22.13	53	55	65	4	86	23	2
6/ 7	6 38.6	31.27	6 41.8	31.24	11.2	1.51	1.21	15.42	21.25 to 22.16	53	120	100	4	88	23	0
11/12	7 1.4	31.23	7 4.6	31.18	11.3	1.51	1.21	15.45	21.39 to 22.16	53	172	81	4	90	24	0
16/17	7 24.5	31.04	7 27.7	30.57	11.4	1.52	1.22	15.49	21.54 to 22.13	53	125	35	3	92	24	-1
21/22	7 47.5	30.29	7 50.6	30.22	11.6	1.53	1.23	15.52	Not Observable	54	67	1	3	94	24	-2
26/27	8 10.3	29.40	8 13.4	29.31	11.8	1.54	1.25	15.55	Not Observable	54	8	18	3	96	24	-4
31/32	8 32.7	28.37	8 35.7	28.26	12.0	1.56	1.26	15.58	Not Observable	54	64	73	2	98	24	-5
June	2001															
5/ 6	8 54.5	27.21	8 57.5	27.10	12.3	1.58	1.29	15.60	Not Observable	54	125	100	2	99	24	-6
10/11	9 15.7	25.55	9 18.6	25.42	12.6	1.60	1.31	16.01	Not Observable	55	173	79	2	101	23	-7
15/16	9 36.0	24.19	9 38.9	24.06	13.0	1.63	1.34	16.02	Not Observable	55	123	32	1	102	23	-7
20/21	9 55.6	22.36	9 58.4	22.22	13.3	1.67	1.36	16.01	Not Observable	55	61	0	1	104	22	-8
25/26	10 14.3	20.48	10 17.1	20.32	13.7	1.71	1.39	16.00	Not Observable	55	9	26	1	105	21	-9
30/31	10 32.3	18.55	10 35.0	18.39	14.1	1.75	1.43	15.59	Not Observable	55	72	80	1	106	21	-9

Ephemeris for comet 2000 WM1 (LINEAR) (UK)

Omega=276.7924 OMEGA=237.8866 i= 72.5641 q= 0.555108 a=**********
e=1.000182 P=********* T= 2002 January 22.6954
Magnitudes calculated from m= 6.5+5.0*Log(d)+10.0*Log(r)

August 2001

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	3 54.2	48.30	3 57.8	48.38	13.8	3.25	2.97	7.15	0.05 to 2.27	65	135	96	0	271	5	1
6/ 7	4 0.7	48.46	4 4.4	48.54	13.6	3.12	2.91	7.02	23.50 to 2.40	68	87	94	1	269	5	1
11/12	4 7.1	49.01	4 10.8	49.09	13.4	2.99	2.84	6.49	23.35 to 2.53	72	39	54	1	268	5	1
16/17	4 13.3	49.16	4 17.0	49.24	13.2	2.87	2.78	6.35	23.20 to 3.06	75	49	6	1	267	5	1
21/22	4 19.3	49.31	4 23.0	49.38	13.0	2.73	2.71	6.22	23.04 to 3.18	78	112	12	1	266	4	1
26/27	4 25.1	49.46	4 28.8	49.52	12.8	2.60	2.65	6.08	22.48 to 3.29	81	150	62	1	265	4	1
31/32	4 30.6	50.00	4 34.4	50.06	12.6	2.47	2.58	5.54	22.18 to 3.41	85	115	97	1	263	4	1
September	2001															
5/ 6	4 35.7	50.14	4 39.5	50.19	12.3	2.33	2.51	5.39	21.47 to 3.51	88	64	92	1	262	4	1
10/11	4 40.5	50.26	4 44.3	50.32	12.1	2.20	2.44	5.24	21.14 to 4.02	92	29	48	2	261	3	1
15/16	4 44.7	50.38	4 48.5	50.44	11.8	2.06	2.37	5.09	20.40 to 4.11	95	76	3	2	259	3	0
20/21	4 48.3	50.49	4 52.2	50.54	11.5	1.93	2.30	4.53	20.04 to 4.21	99	137	17	2	258	2	0
25/26	4 51.2	50.58	4 55.1	51.03	11.3	1.79	2.23	4.36	19.26 to 4.30	103	139	66	3	256	2	0
30/31	4 53.2	51.05	4 57.1	51.10	10.9	1.65	2.16	4.18	19.00 to 4.40	107	90	98	3	254	1	0
October	2001															
5/ 6	4 54.1	51.10	4 58.0	51.14	10.6	1.52	2.09	3.59	18.48 to 4.49	111	40	89	4	251	0	0
10/11	4 53.6	51.09	4 57.5	51.14	10.3	1.38	2.02	3.39	18.36 to 4.57	115	46	41	4	248	0	0
15/16	4 51.5	51.03	4 55.4	51.08	9.9	1.25	1.95	3.17	18.25 to 5.06	120	108	0	5	245	-1	0
20/21	4 47.2	50.48	4 51.0	50.53	9.5	1.12	1.87	2.53	18.15 to 5.15	124	151	21	6	241	-3	-1
25/26	4 40.2	50.18	4 44.0	50.23	9.0	0.99	1.80	2.26	18.05 to 5.23	130	112	68	8	236	-5	-2
30/31	4 29.9	49.26	4 33.6	49.32	8.5	0.87	1.72	1.56	17.56 to 5.32	135	58	99	9	229	-8	-4

Ephemeris for comet 2001 A2 (LINEAR) (Southern Hemisphere, 40° South)

Note: the future magnitude of this comet is uncertain.

Omega=295.3253 OMEGA=295.1272 i= 36.4831 q= 0.779039 a=**********
e= 0.999448 P=53018.835 T= 2001 May 24.5229
Magnitudes calculated from m=11.5+5.0*Log(d)+10.0*Log(r)

April 2001

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
21/22	5 54.0	-13.01	5 56.3	-13.01	11.2	0.86	1.00	15.56	18.26 to 20.56	64	76	2	4	111	-1	-8
26/27	5 52.7	-14.46	5 55.0	-14.46	10.8	0.83	0.94	15.35	18.20 to 20.48	61	37	12	5	115	-1	-8
May	2001															
1/ 2	5 51.0	-16.38	5 53.2	-16.37	10.5	0.79	0.89	15.13	18.14 to 20.40	58	71	65	7	121	-2	-9
6/ 7	5 48.2	-18.35	5 50.4	-18.35	10.2	0.75	0.85	14.51	18.09 to 20.30	56	124	100	8	127	-3	-9
11/12	5 43.9	-20.36	5 46.1	-20.35	9.9	0.70	0.82	14.27	18.04 to 20.19	53	132	81	10	134	-5	-10
16/17	5 37.4	-22.36	5 39.5	-22.34	9.6	0.65	0.79	14.01	18.00 to 20.04	52	93	35	12	142	-7	-9
21/22	5 27.9	-24.29	5 30.0	-24.27	9.3	0.59	0.78	13.31	17.57 to 19.46	50	52	1	13	151	-10	-9
26/27	5 14.6	-26.07	5 16.6	-26.04	9.1	0.53	0.78	12.58	17.54 to 19.22	50	63	18	15	161	-15	-8

31/32	4 56.4	-27.17	4 58.4	-27.13	8.9	0.48	0.79	12.20	17.53 to 18.52 5.49 to 6.03	50	113	73	16	173	-20	-5
June	2001															
5/ 6	4 32.2	-27.46	4 34.2	-27.40	8.7	0.42	0.82	11.36	17.51 to 18.12 5.01 to 6.06	51	131	100	16	187	-26	-2
10/11	4 1.1	-27.12	4 3.2	-27.04	8.6	0.36	0.85	10.46	4.11 to 6.08	53	91	79	17	201	-34	2
15/16	3 21.9	-25.07	3 24.1	-24.57	8.5	0.32	0.89	9.47	3.18 to 6.10	58	42	32	17	217	-44	10
20/21	2 34.1	-20.58	2 36.4	-20.46	8.4	0.28	0.94	8.39	2.25 to 6.12	66	61	0	18	231	-55	20
25/26	1 38.7	-14.23	1 41.1	-14.08	8.5	0.25	0.99	7.24	1.32 to 6.13	78	136	26	17	242	-67	32
30/31	0 39.4	-5.50	0 41.9	-5.34	8.6	0.24	1.05	6.06	0.44 to 6.13	92	141	80	15	247	-73	42
July	2001															
5/ 6	23 41.9	2.56	23 44.4	3.13	9.0	0.25	1.11	4.48	0.02 to 6.12	106	69	100	11	245	-67	43
10/11	22 51.2	10.08	22 53.7	10.24	9.5	0.28	1.18	3.38	23.27 to 6.11	119	21	76	7	238	-62	35
15/16	22 9.3	15.08	22 11.8	15.23	10.0	0.33	1.24	2.36	22.59 to 6.09	128	73	28	5	226	-50	25
20/21	21 36.1	18.14	21 38.4	18.28	10.6	0.38	1.31	1.43	22.37 to 4.50	134	135	0	3	212	-39	15
25/26	21 10.2	19.59	21 12.5	20.11	11.1	0.44	1.38	0.57	22.20 to 3.35	138	120	34	2	198	-30	8
30/31	20 50.2	20.49	20 52.4	21.00	11.7	0.51	1.45	0.18	22.09 to 2.27	141	67	84	1	184	-23	4

Ephemeris for comet 2001 A2 (LINEAR) (UK)

July 2001

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	0 27.5	-4.02	0 30.1	-3.45	8.7	0.24	1.06	5.50	Not Observable	95	127	88	14	247	-73	42
6/ 7	23 31.1	4.32	23 33.6	4.49	9.1	0.26	1.13	4.34	23.29 to 1.12	109	56	99	10	244	-66	42
11/12	22 42.1	11.18	22 44.6	11.34	9.6	0.29	1.19	3.25	22.45 to 1.26	121	27	67	7	235	-60	33
16/17	22 2.0	15.53	22 4.4	16.08	10.1	0.34	1.26	2.25	22.32 to 1.41	129	86	19	4	223	-48	22
21/22	21 30.4	18.41	21 32.7	18.54	10.7	0.39	1.32	1.34	22.18 to 1.55	135	142	2	3	210	-37	13
26/27	21 5.7	20.12	21 8.0	20.25	11.2	0.46	1.39	0.49	22.03 to 2.10	139	109	45	2	195	-28	7
31/32	20 46.8	20.54	20 49.0	21.05	11.8	0.53	1.46	0.10	21.49 to 2.24	141	58	91	1	182	-22	3
August	2001															
5/ 6	20 32.2	21.03	20 34.5	21.14	12.2	0.60	1.53	23.36	21.34 to 2.37	141	45	98	1	169	-16	0
10/11	20 21.2	20.52	20 23.4	21.02	12.7	0.68	1.60	23.05	21.20 to 2.51	141	84	64	1	157	-12	0
15/16	20 13.0	20.27	20 15.2	20.36	13.1	0.76	1.67	22.37	21.05 to 3.03	140	131	14	1	146	-9	-2
20/21	20 7.0	19.53	20 9.2	20.02	13.5	0.85	1.74	22.12	20.51 to 2.46	138	119	5	0	137	-7	-2
25/26	20 2.9	19.15	20 5.1	19.24	13.9	0.94	1.80	21.48	20.37 to 2.19	135	68	52	0	129	-4	-3
30/31	20 0.3	18.35	20 2.5	18.43	14.3	1.03	1.87	21.26	20.23 to 1.53	133	41	93	0	122	-3	-3

Format for electronic submission of observations

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

TA format (examples)

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c  DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                       Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5  2               Shanklin
961214.70 S   3.8  AA   8   B       20  6     7/  0.50   40   Baroni
```

ICQ format (examples)

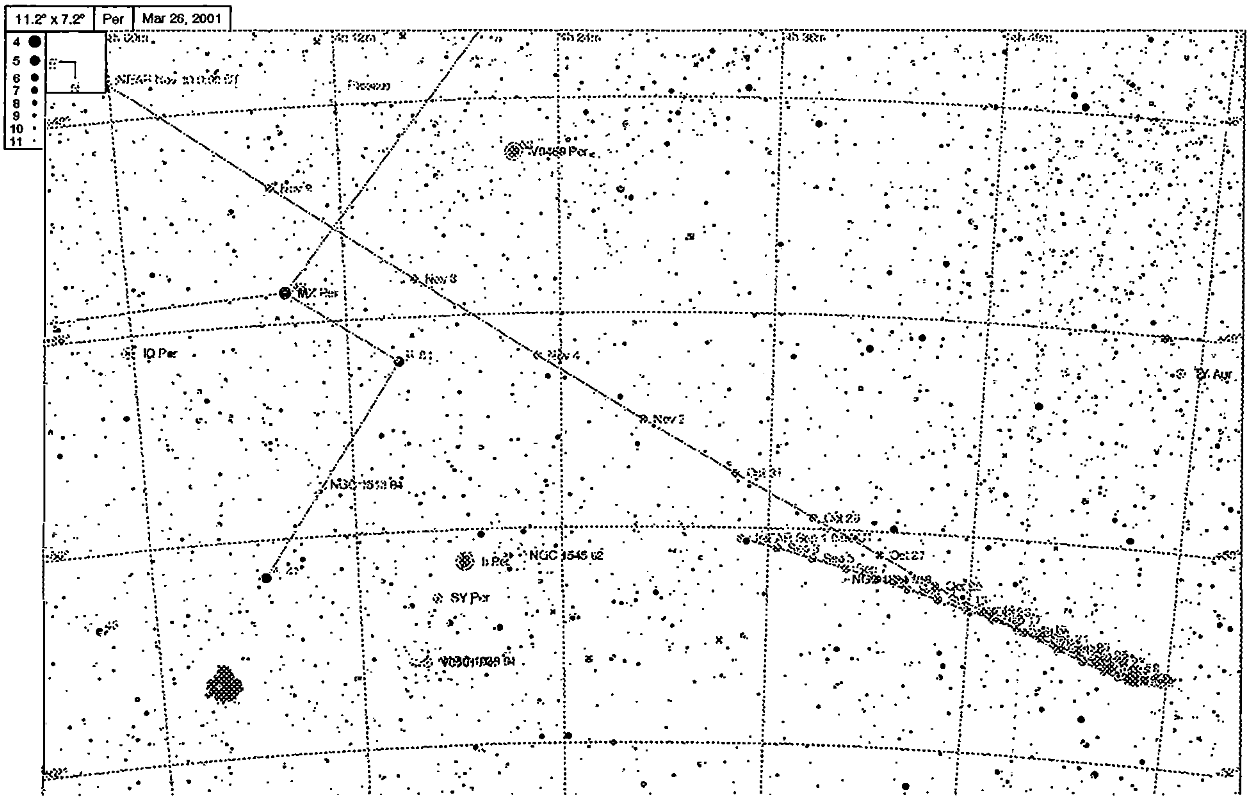
```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
   1992F1  1992  5 18.94  S  9.3 AA  7.5R   50   6    4          135 ICQ XX BEA
  1        1985 11 16.04  S  6.9 AA 20  R14  40   6   s7    0.12 130 ICQ 59 SHA02
   1999T2  2001  1 28.25 Comet possibly seen at mag 13.6 (S, HS) in 20cm f10 T x120,
with coma 1.0' DC 1.
   1999T1  2001 01 28.25 Possible tail 5' long in pa 345.
```

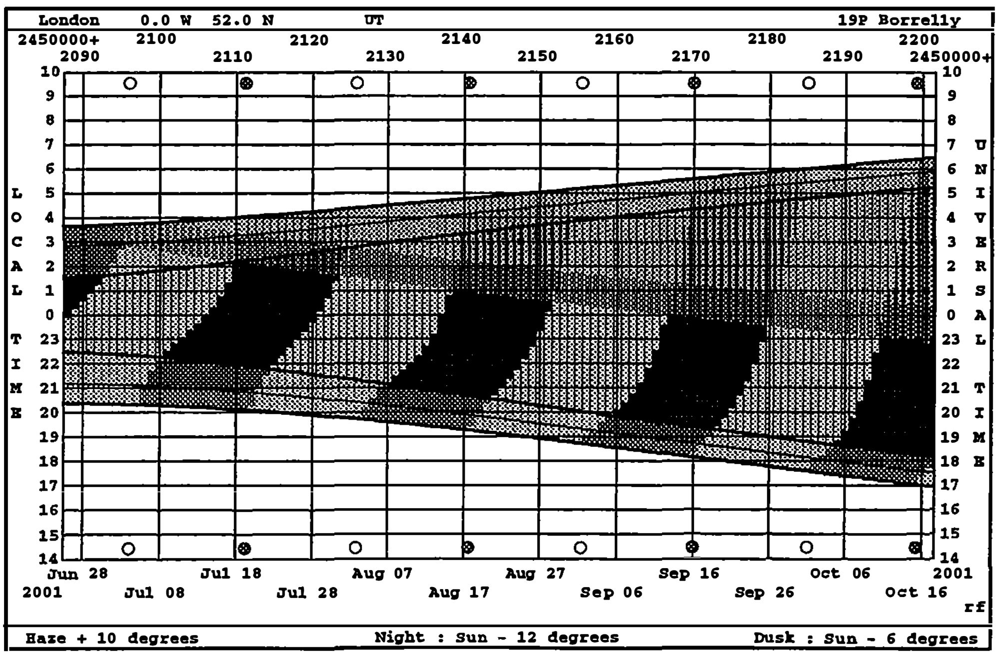
Charts

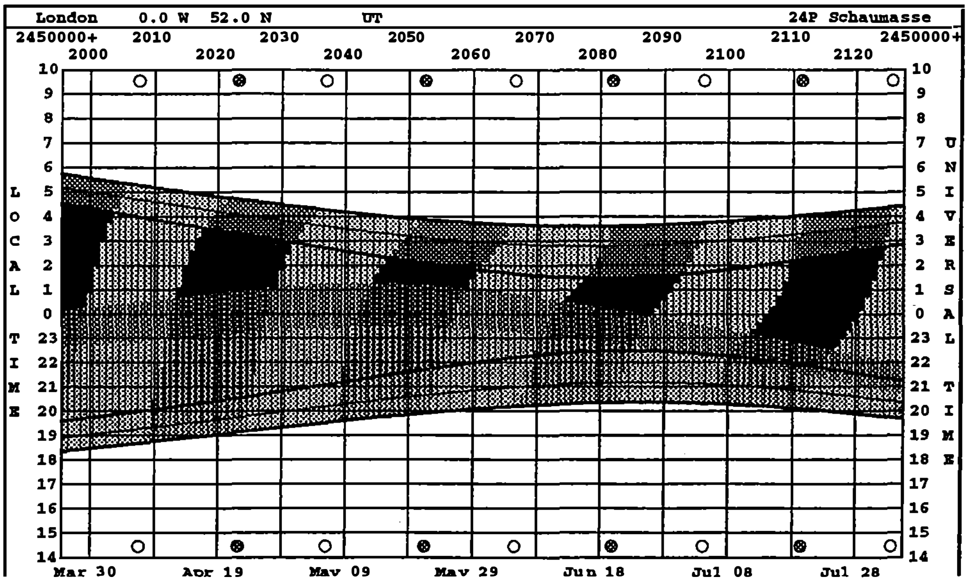
The visibility diagrams show when the moon interferes with observations of 19P/Borrelly, 24P/Schaumasse and 2001 A2 (LINEAR) and were produced using software written by Richard Fleet. There is no moon in the dark regions and the moon will interfere in the light regions. 19P/Borrelly is a morning object and should be visible as soon as it moves into the dawn sky. Please make every effort to observe it as it is a target for the DS1 spacecraft. 24P/Schaumasse is an evening object throughout the apparition, so there is plenty of opportunity to try observing it. 2000 WM1 is visible all night and moves relatively slowly during September and October (observing chart on page iv). 2001 A2 (LINEAR) is an evening object in early April as it heads south. It returns to UK skies in early July, but fades quite rapidly.

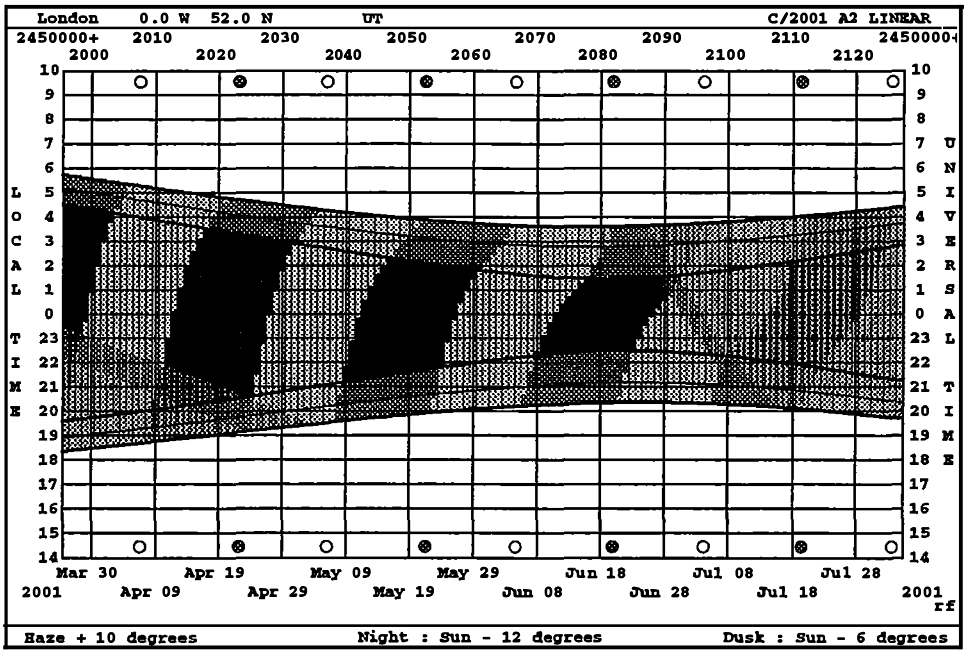
If you would like your own copy of Richard's software it is available at http://www.naas.btinternet.co.uk

Observing chart for comet 2000 WM1 (LINEAR)






London 0.0 W 52.0 N UT 24P Schaumasse
2450000+ 2010 2030 2050 2070 2090 2110 2450000+
2000 2020 2040 2060 2080 2100 2120
LOCAL TIME
UNIVERSAL TIME
10 9 8 7 6 5 4 3 2 1 0 23 22 21 20 19 18 17 16 15 14
Mar 30 Apr 19 May 09 May 29 Jun 18 Jul 08 Jul 28


London 0.0 W 52.0 N UT C/2001 A2 LINEAR
2450000+ 2010 2030 2050 2070 2090 2110 2450000+
2000 2020 2040 2060 2080 2100 2120
LOCAL TIME
UNIVERSAL TIME
10 9 8 7 6 5 4 3 2 1 0 23 22 21 20 19 18 17 16 15 14
Mar 30 Apr 19 May 09 May 29 Jun 18 Jul 08 Jul 28
2001 Apr 09 Apr 29 May 19 Jun 08 Jun 28 Jul 18 2001
rf
Haze + 10 degrees
Night : Sun - 12 degrees
Dusk : Sun - 6 degrees

Name	Number	T	q	e	w	W	i	H1	K1	Epoch	Source
Faye	4P	1999 05 06.0818	1.659055	0.567945	205.0404	199.3452	9.0463	8.0	15.0	2000	MPC 27081
d'Arrest	6P	2002 02 03.6032	1.352496	0.612853	178.1244	138.9505	19.4973	7.5	40.0	2000	MPC 34422
Pons-Winnecke	7P	2002 05 15.7829	1.258800	0.633831	172.2776	93.4494	22.2843	10.0	15.0	2000	MPC 34422
Tempel 1	9P	2000 01 02.5387	1.500795	0.518631	178.9249	68.9671	10.5413	5.5	25.0	2000	MPC 29881
Tempel 2	10P	1999 09 08.8760	1.475252	0.524551	194.9824	118.0762	12.0106	5.0	25.0	2000	MPC 27082
Wolf	14P	2000 11 21.1236	2.412666	0.407371	162.3780	204.1198	27.5197	5.5	30.0	2000	MPC 29882
Finlay	15P	2002 02 07.1478	1.033962	0.710646	323.6339	41.9691	3.6750	12.0	10.0	2000	CCO 13
Holmes	17P	2000 05 11.9554	2.165130	0.412728	23.4355	327.9382	19.1888	10.0	15.0	2000	MPC 29881
Borrelly	19P	2001 09 14.7388	1.358216	0.623792	353.3778	75.4247	30.3250	4.5	25.0	2000	MPC 31664
Schaumasse	24P	2001 05 02.6570	1.205005	0.704852	57.8731	79.8310	11.7515	6.5	35.0	2000	MPC 31663
Neujmin 1	28P	2002 12 27.3388	1.550495	0.775719	346.9453	347.0598	14.1902	8.5	15.0	2000	MPC 34424
Schwassmann-Wachmann 1	29P	2004 07 15.4308	5.720822	0.045497	49.3325	312.7338	9.3902	4.0	10.0	2000	MPC 23105
Reinmuth 1	30P	2002 12 24.6281	1.877948	0.501601	13.3265	119.7557	8.1304	9.5	15.0	2000	MPC 34424
Schwassmann-Wachmann 2	31P	2002 01 17.9978	3.407659	0.198465	18.3330	114.2244	4.5415	5.0	20.0	2000	MPC 41899
Whipple	36P	2003 07 06.0621	3.087960	0.259820	202.1128	182.4284	9.9299	8.5	15.0	2000	MPC 40670
Forbes	37P	1999 05 08.6212	1.425708	0.574793	314.5615	330.4251	7.2401	10.5	12.0	2000	MPC 34736
Oterma	39P	2002 12 19.5495	5.471959	0.245836	56.1996	331.5739	1.9424	5.0	15.0	2000	MPC 34423
Tuttle-Giacobini-Kresak	41P	2001 01 06.9685	1.052209	0.659343	62.1659	141.1055	9.2255	10.0	40.0	2000	MPC 41717
Ashbrook-Jackson	47P	2001 01 06.5139	2.305381	0.396108	348.8908	2.6020	12.5132	1.0	28.0	2000	MPC 31662
Arend-Rigaux	49P	1998 07 13.1255	1.367331	0.612100	330.6359	121.6688	18.2998	11.3	11.0	2000	CCO 13
Harrington	51P	2001 06 05.8881	1.568127	0.561860	233.6041	119.1807	8.6562	11.5	20.0	2000	MPC 31664
Van Biesbroeck	53P	2003 10 09.8948	2.415031	0.551250	134.1577	149.0080	6.6114	7.7	12.0	2000	MPC 40671
Kearns-Kwee	59P	1999 09 16.5407	2.340546	0.476534	127.5423	313.0228	9.3499	7.0	15.0	2000	MPC 36213
Shajn-Schaldach	61P	2001 05 08.9848	2.330091	0.389427	216.6167	166.8809	6.0845	6.0	25.0	2000	MPC 31664
Swift-Gehrels	64P	2000 04 21.7615	1.339014	0.694433	92.4118	306.1342	8.4380	8.5	30.0	2000	MPC 41899
Gunn	65P	2003 05 12.1421	2.449031	0.317793	196.3028	68.4264	10.3850	5.0	15.0	2000	MPC 40670
Churyumov-Gerasimenko	67P	2002 08 18.2530	1.292799	0.631604	11.4028	50.9827	7.1210	11.0	10.0	2000	MPC 34423
Kojima	70P	2000 09 14.8867	2.003436	0.454531	1.9845	119.2975	6.5993	11.0	15.0	2000	MPC 29882
Smirnova-Chernykh	74P	2001 01 15.7918	3.545803	0.148454	86.6768	77.1571	6.6523	5.0	15.0	2000	MPC 31662
Kohoutek	75P	2001 02 27.3307	1.787289	0.496112	175.6861	269.6830	5.9101	10.5	10.0	2000	MPC 31663
West-Kohoutek-Ikemura	76P	2000 06 01.2878	1.596180	0.539761	0.0949	84.1238	30.4990	8.0	30.0	2000	MPC 29881
Longmore	77P	2002 09 04.2568	2.312061	0.358234	196.1983	15.0459	24.3992	7.0	20.0	2000	CCO 13
Gehrels 3	82P	2001 09 05.3590	3.625875	0.128007	228.2997	239.7000	1.1273	5.0	20.0	2000	MPC 31664
Giclas	84P	1999 08 24.9499	1.846682	0.493052	276.4149	112.4765	7.2820	9.5	20.0	2000	MPC 27082
Wild 3	86P	2001 06 18.6176	2.310279	0.364441	179.1670	72.6128	15.4388	11.0	15.0	2000	MPC 31664
Bus	87P	2000 12 29.7620	2.180914	0.375095	24.1473	182.2060	2.5741	7.2	25.0	2000	MPC 29882
Howell	88P	1998 09 27.8408	1.394581	0.555230	234.6564	57.6160	4.3972	11.0	15.0	2000	MPC 36213
Russell 2	89P	2002 03 23.0246	2.289650	0.397879	249.2564	42.4869	12.0296	11.5	15.0	2000	CCO 13
Metcalf-Brewington	97P	2001 04 14.9848	2.610866	0.456449	229.7137	186.4379	17.9864	5.5	15.0	2000	MPC 41159
Ciffreo	108P	2000 04 18.3566	1.713549	0.542309	358.0367	53.7219	13.0927	8.0	30.0	2000	MPC 36654
Hartley 3	110P	2001 03 21.4039	2.478306	0.314652	167.9365	287.7527	11.6888	1.0	30.0	2000	MPC 31663
Spitaler	113P	2001 02 25.8474	2.127265	0.423563	50.0568	14.5195	5.7762	13.5	10.0	2000	MPC 31663
Maury	115P	2002 12 24.0481	2.040537	0.520599	119.9424	176.7635	11.6858	10.5	15.0	2000	MPC 34424
Wild 4	116P	2003 01 20.9802	2.156857	0.378929	173.3026	21.5102	3.6321	2.5	25.0	2000	MPC 40670
Helin-Roman-Alu 1	117P	1997 02 15.5739	3.432214	0.207836	205.6354	70.8340	9.9654	2.5	20.0	2000	MPC 27080
Parker-Hartley	119P	2005 05 22.5930	3.041559	0.291848	181.2741	244.1504	5.1895	3.5	20.0	2000	MPC 25513
Mrkos	124P	2002 07 27.0564	1.465895	0.542832	181.2532	1.4449	31.3639	13.5	7.0	2000	MPC 34422
Spacewatch	125P	2002 01 28.0514	1.528963	0.511388	87.2812	153.2399	9.9806	13.0	15.0	2000	MPC 34422
Shoemaker-Holt 1	128P	1997 11 20.2943	3.047038	0.321272	210.2187	214.5270	4.3617	8.5	10.0	2000	MPC 30632
Shoemaker-Levy 3	129P	1998 03 05.4099	2.812809	0.248952	181.3431	303.6530	5.0104	11.0	10.0	2000	MPC 30739
Mueller 2	131P	1997 11 22.6303	2.417611	0.343440	179.9002	214.2706	7.3543	11.0	10.0	2000	MPC 30244
Mueller 3	136P	1999 03 15.9946	3.002953	0.287448	224.7297	137.7246	9.4169	11.0	10.0	2000	MPC 36654
Shoemaker-Levy 2	137P	2000 02 05.5989	1.867372	0.579517	141.9162	234.7527	4.6578	11.0	10.0	2000	MPC 35208
Vaisala-Oterma	139P	1998 09 29.8414	3.386507	0.247592	165.8202	242.4529	2.3337	9.5	10.0	2000	MPC 33190
Ge-Wang	142P	1999 06 20.2059	2.489202	0.500120	177.1036	176.9842	12.1663	8.5	15.0	2000	MPC 35815
Kowal-Mrkos	143P	2000 07 01.7390	2.546550	0.409175	320.5662	245.5005	4.6838	13.5	5.0	2000	MPC 39792
Kushida	144P	2001 06 27.7065	1.431228	0.628993	216.0311	245.6247	4.1188	8.5	20.0	2000	MPC 41159
Shoemaker-Levy 5	145P	2000 08 16.9529	1.988101	0.629347	6.1912	29.6724	11.7676	13.5	10.0	2000	MPC 41159
Shoemaker-LINEAR	146P	2000 07 14.2732	1.318735	0.666810	317.7294	55.3562	21.6190	15.0	10.0	2000	MPC 41338
Kushida-Muramatsu	147P	2001 04 29.6669	2.752354	0.277506	347.5386	93.7535	2.3678	14.0	10.0	2000	MPC 41527
Anderson-LINEAR	148P	2001 05 01.9726	1.693673	0.539522	6.7254	89.8007	3.6824	16.0	5.0	2000	MPC 41899
Mueller 4	149P	2001 02 07.8941	2.646735	0.388643	43.6196	145.3683	29.7483	8.0	20.0	2000	MPC 42109
Helin	P/1987 Q3	2001 09 24.7175	2.530838	0.565803	215.4107	143.5362	4.7169	10.0	15.0	2000	MPC 31664
Mueller 4	P/1992 G3	2001 02 07.8569	2.646960	0.388511	43.6748	145.3654	29.7475	8.0	20.0	2000	MPC 31663
Helin-Lawrence	P/1993 K2	2002 12 22.9678	3.109758	0.307054	163.7781	92.0139	9.8717	10.0	8.0	2000	MPC 34423
Hale-Bopp	C/1995 O1	1997 03 31.6684	0.917329	0.994941	130.6269	282.2408	89.4431	-2.0	10.0	2000	MPC 35204

Meunier-Dupouy	C/1997 J2	1998 03	10.2829	3.052597	1.000649	122.7025	148.8879	91.2670	3.5	10.0	2000	MPC 35204
Lagerkvist-Carsenty	P/1997 T3	1998 03	12.4945	4.247019	0.364796	334.4620	63.1985	4.8349	13.0	5.0	2000	MPC 35205
Larsen	P/1997 V1	1997 09	14.9594	3.301537	0.330926	133.0883	234.8287	12.0889	9.0	10.0	2000	MPC 31205
Larsen	C/1998 M3	1998 07	15.9507	5.764132	1.000953	20.7440	255.5560	113.4409	6.5	10.0	2000	MPC 34733
LINEAR	C/1998 M5	1999 01	24.5308	1.742520	0.996121	101.2928	333.3463	82.1815	6.0	10.0	2000	MPC 40668
LONEOS-Tucker	P/1998 QP54	1998 10	06.0490	1.885155	0.551046	30.1477	341.9355	17.7315	15.0	5.0	2000	MPC 33650
LINEAR	C/1998 T1	1999 06	25.2742	1.465885	0.999044	226.3258	153.3819	170.1525	8.0	10.0	2000	MPC 40668
Jager	P/1998 U3	1999 03	10.3196	2.133538	0.648844	180.9578	303.5004	19.1441	6.5	10.0	2000	MPC 34421
Spahr	P/1998 U4	1999 02	27.7239	3.846174	0.310180	251.9403	181.7281	31.5109	8.0	10.0	2000	MPC 36653
LINEAR	P/1998 VS24	1998 11	03.2824	3.409051	0.242919	244.6645	159.2077	5.0302	13.0	5.0	2000	MPC 33651
LINEAR	C/1998 W3	1998 10	06.6390	4.918262	0.999347	6.9280	123.9050	129.1806	6.0	10.0	2000	MPC 36212
Li	P/1998 Y2	1998 12	17.9398	2.522336	0.588287	319.1159	91.8138	24.3203	9.5	10.0	2000	MPC 34421
Korlevic-Juric	P/1999 DN3	1998 09	28.8930	3.905096	0.135685	161.0104	5.9277	18.7172	12.0	5.0	2000	MPC 34734
Li	C/1999 E1	1999 02	01.2037	3.922325	0.760737	329.8568	127.8147	46.8625	6.5	10.0	2000	MPC 39021
Catalina	C/1999 F1	2002 02	13.6243	5.787313	0.999162	255.1531	20.0249	92.0372	9.5	5.0	2000	MPC 39021
Dalcanton	C/1999 F2	1998 08	23.2541	4.714179	0.997674	352.2837	210.2805	56.4215	5.0	10.0	2000	MPC 39021
LINEAR	C/1999 G1	1998 07	31.7929	4.037050	0.845455	135.9495	23.4676	76.2974	7.5	10.0	2000	MPC 34734
Lee	C/1999 H1	1999 07	11.0619	0.708575	0.999609	40.7107	162.6637	149.3573	7.0	10.0	2000	MPC 36212
LINEAR	C/1999 H3	1999 08	18.0972	3.500598	1.002534	101.8979	332.7344	115.8193	5.0	10.0	2000	MPC 41897
Skiff	C/1999 J2	2000 04	05.7724	7.109459	1.002257	127.1186	50.0454	86.4084	2.0	10.0	2000	MPC 41897
LINEAR	C/1999 J4	1999 11	17.6088	3.780400	1.000000	95.1591	264.4841	118.9108	11.5	5.0	2000	MPC 34734
LINEAR	P/1999 J5	1999 05	10.7928	3.710945	0.168845	131.9905	112.0152	13.7230	9.0	10.0	2000	MPC 35553
Ferris	C/1999 K2	1999 04	10.3474	5.289770	0.965071	4.5546	300.3421	82.2148	6.0	10.0	2000	MPC 35553
LINEAR	C/1999 K5	2000 07	04.3935	3.255527	1.001284	241.4917	106.3855	89.4737	6.0	10.0	2000	MPC 41897
LINEAR	C/1999 K8	2000 04	24.6292	4.201404	1.001522	164.6795	195.3893	52.7082	5.0	10.0	2000	MPC 41524
LINEAR	C/1999 N4	2000 05	23.4729	5.504332	1.004325	90.4167	345.9191	156.9207	6.0	10.0	2000	MPC 40823
McNaught-Watson	C/1999 S2	1997 11	21.6885	6.466696	1.003807	223.4526	74.4672	65.8185	2.0	10.0	2000	MPC 41897
LINEAR	C/1999 S3	1999 11	09.0393	1.895700	0.900030	44.1505	11.8882	70.5493	10.0	10.0	2000	MPC 39022
LINEAR	C/1999 S4	2000 07	26.1713	0.764785	0.999618	151.0206	83.1927	149.3909	9.0	10.0	2000	MPC 40988
McNaught-Hartley	C/1999 T1	2000 12	13.4637	1.171636	0.999741	344.7480	182.4816	79.9737	5.0	10.0	2000	MPC 41524
LINEAR	C/1999 T2	2000 11	24.4645	3.037367	1.002161	104.6691	14.8833	111.0000	6.0	10.0	2000	MPC 41525
LINEAR	C/1999 T3	2000 09	01.7992	5.365996	0.996532	211.3488	223.5112	104.7536	6.0	10.0	2000	MPC 41897
Ferris	C/1999 U1	1998 09	01.8400	4.142650	0.999090	291.0919	58.2570	105.8174	6.5	10.0	2000	MPC 41158
Catalina-Skiff	C/1999 U4	2001 10	28.1897	4.915642	1.007944	77.4716	32.3007	51.9311	4.5	10.0	2000	MPC 41525
Catalina	P/1999 V1	1999 10	25.3583	2.945037	0.551155	186.7733	294.2941	15.5848	10.0	10.0	2000	MPC 39022
Korlevic	P/1999 WJ7	2000 02	15.9985	3.168019	0.316026	154.5849	290.5298	2.9798	14.5	5.0	2000	MPC 41716
Catalina	P/1999 XN120	2000 05	01.6076	3.286593	0.212481	161.8461	285.4554	5.0323	13.5	5.0	2000	MPC 39023
LINEAR	C/1999 Y1	2001 03	24.1114	3.091180	1.000622	184.2856	188.8842	134.7868	5.5	10.0	2000	MPC 41525
Montani	C/2000 A1	2000 07	14.6320	9.743524	1.005052	14.3372	111.8309	24.5370	3.5	10.0	2000	MPC 41716
LINEAR	C/2000 B2	1999 11	09.9344	3.776036	1.000000	154.5683	284.9897	93.6545	13.0	5.0	2000	MPC 39023
LINEAR	C/2000 B4	2000 06	15.3140	6.830021	0.621480	126.1745	0.6367	15.9064	11.5	5.0	2000	MPC 41897
LINEAR	C/2000 CT54	2001 06	19.4783	3.155683	0.998967	272.6545	18.9673	49.2077	11.0	5.0	2000	MPC 41158
LINEAR	C/2000 H1	2000 01	28.8754	3.636630	1.000000	78.7991	356.4441	118.2393	9.5	10.0	2000	MPC 40823
Ferris	C/2000 J1	2000 05	11.3167	2.542386	0.954766	147.2225	28.4368	98.7878	15.5	5.0	2000	MPC 40823
LINEAR	C/2000 K1	1999 12	14.1900	6.274911	1.001718	15.7651	260.2004	116.7915	4.0	10.0	2000	MPC 40823
LINEAR	C/2000 K2	2000 10	11.3602	2.437118	0.995322	106.8252	195.2599	25.6340	11.0	10.0	2000	MPC 41898
Koehn	C/2000 O1	2000 01	28.2156	5.922976	0.999919	55.2146	88.8851	148.1048	6.0	10.0	2000	MPC 41159
Spacewatch	C/2000 OF8	2001 08	05.0028	2.167793	1.000000	256.2561	117.1050	152.4104	9.5	10.0	2000	MPC 41159
Skiff	P/2000 S1	2000 07	14.8296	2.514315	0.618816	308.4896	29.1374	21.0026	10.0	10.0	2000	MPC 41716
	C/2000 S3	2000 07	16.2788	2.662181	0.772182	298.2643	41.1526	25.1646	12.0	10.0	2000	MPC 41898
LINEAR-Spacewatch	P/2000 S4	2000 10	19.1028	2.265372	0.681903	172.3258	174.6453	28.3258	17.5	5.0	2000	MPC 41526
LINEAR	C/2000 SV74	2002 04	30.4092	3.541977	1.004735	76.2085	24.1865	75.2460	5.5	10.0	2000	MPC 41716
LINEAR	C/2000 U5	2000 03	14.0661	3.483828	1.009649	299.0205	65.2989	93.4909	7.0	10.0	2000	MPC 41898
Tichy	P/2000 U6	2000 10	04.5024	2.154588	0.431475	11.8273	24.4175	19.3645	13.5	10.0	2000	MPC 41898
LINEAR	C/2000 WM1	2002 01	22.6954	0.555108	1.000182	276.7924	237.8866	72.5641	6.5	10.0	2000	MPEC 2001-D29
	P/2000 WT168	2001 03	23.3232	1.761726	0.546605	245.4988	272.5524	18.5200	13.5	10.0	2000	MPEC 2001-F17
Tubbiolo	C/2000 Y1	2001 02	03.6682	7.973133	1.001037	181.8258	239.3961	137.9656	11.0	5.0	2000	MPC 41898
	C/2000 Y2	2001 03	21.8041	2.768783	0.994356	326.8170	185.8481	12.0876	11.0	10.0	2000	MPEC 2001-D21
Scotti	P/2000 Y3	2000 10	31.8796	4.047307	0.198241	88.6326	355.0405	2.2482	9.0	10.0	2000	MPC 41898
LINEAR	C/2001 A1	2000 09	17.5224	2.404569	0.990342	107.8181	339.6097	59.9052	10.5	10.0	2000	MPC 42108
LINEAR	C/2001 A2	2001 05	24.5229	0.779039	0.999448	295.3253	295.1272	36.4831	13.0	10.0	2000	MPC xxxxx
LINEAR	C/2001 B1	2000 09	19.5962	2.929929	1.000000	284.9247	49.8458	104.1167	9.0	10.0	2000	MPC 42108
NEAT	C/2001 B2	2000 09	01.7417	5.305289	1.000000	304.7607	145.1035	150.5974	4.0	10.0	2000	MPEC 2001-D20
LINEAR-NEAT	P/2001 BB50	2001 01	30.3429	2.347221	0.587682	189.3139	355.8217	10.6196	13.0	10.0	2000	IAUC 7601
LINEAR	C/2001 C1	2002 03	31.2989	5.079085	1.000000	220.4789	33.7030	68.9964	7.5	10.0	2000	MPC 42316
LINEAR	P/2001 CV8	2001 01	23.3533	2.122429	0.459019	142.8087	0.8554	8.6908	13.0	10.0	2000	IAUC 7581

Source: CBAT web pages. H1 and K1 are also from the CBAT; alternative values are given in the main section and on the Section web pages.

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' webpage, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA. Do not report tail details unless you are certain of their reality.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

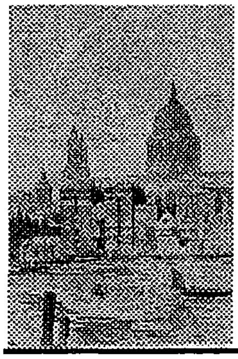
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Rel	Comments



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 8, No 2 (Issue 16), 2001 October

DEEP SPACE 1 ENCOUNTERS 19P/Borrelly

Donald K. Yeomans

NASA/JPL, Near-Earth Object program office

On Saturday evening at 7:00 PM, sustained applause broke out in the Deep Space 1 spacecraft control room at the Jet Propulsion Laboratory. The first high resolution images of comet's Borrelly nucleus had reached Earth (Figure 1). The images were sharper than expected and revealed a very dark, outgasing nucleus shaped a bit like a bowling pin except this bowling pin was nearly the size of Mt. Everest. Examination of the surface features reveals ridges, fault lines, and bright areas that are thought to be source regions for the nucleus' jets that emanate toward the solar direction. These jets are thought to be the vaporization of the comet's ices as the active regions are heated by sunlight (Figure 2). The strong linearity, or collimation, of these jets is a bit of a mystery that scientists will have to solve in the near future. Although the infrared spectral data and charged particle detector data have not yet been completely analyzed, this information should help determine the composition of these gases and hence the nature of the parent ices of the comet's nucleus.

While the Deep Space 1 spacecraft (DS1) was not designed to encounter a comet and lacked any dust shielding to protect it from the bullet-like dust particle environment through which it was moving, DS1 survived the flyby without a problem. All the science data were successfully received on Earth within a few hours after the flyby itself. The DS1 spacecraft was designed to test various space technologies including the ion drive engine that first ionizes xenon and then electrostatically accelerated these charged particles to form a modest, but continuous, rocket thrust.

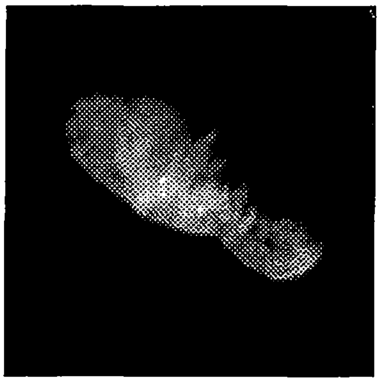


Figure 1 This black and white image of comet Borrelly's nucleus was taken while the spacecraft was about 3400 km from the comet. The dimensions of the nucleus are about 8 kilometers long by at least 3.5 kilometers wide. While the contrast of this image has been altered to show surface features, the entire nucleus would appear coal black to the naked eye.

Before running out of fuel, and without the used of a star tracker to provide orientation information to the spacecraft, the DS1 operations team had to work hard to keep the spacecraft operating and pointed properly. They did so with remarkable success. The lessons learned from this comet encounter will be used in the next ten years to facilitate the five upcoming cometary encounters provided by the CONTOUR, Stardust, Deep Impact, and Rosetta spacecraft.

For more information, see:
http://nmp.jpl.nasa.gov/ds1/

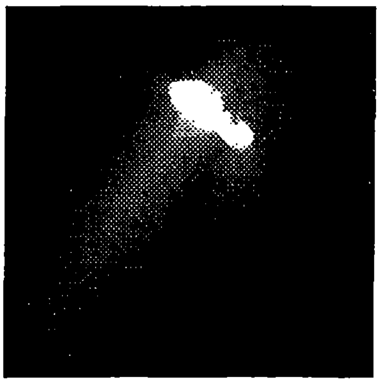


Figure 2 This image of comet Borrelly's nucleus has been purposely overexposed to show the strongly collimated jets on the sunward side of the nucleus. These jets are thought to be composed mostly of water vapor and entrained dust particles.

Images: courtesy of NASA/JPL

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way, for example by submitting observations or articles. **Renewals should be sent to the Director and cheques made payable to the BAA.** Those due to renew should receive a reminder with this mailing.

Section news from the Director

Dear Section member,

It has been rather a busy summer for me, so this edition of the comet's tail is a little late in appearing. The weather has not been very favourable for observing, but the odd gap in the cloud has allowed me, and I hope you, to make occasional observations. Hopefully the autumn will be better and we will get good views of 2000 WM1 (LINEAR) as it brightens on its way to perihelion. Two significant comet discoveries have been made - 2001 Q2 discovered by amateur Vance Petriew at a star party and 2001 Q4 (NEAT) discovered a long way from perihelion and which may become a prominent object in 2004. In addition Deep Space 1 flew past 19P/Borrelly and produced some exciting images of the comet.

The revised edition of the Section Guide to Observing Comets is taking a little longer to produce than anticipated should be available at BAA events or through the BAA Office early next year. The new edition has significant changes, including revised sections on comet discovery procedures, CCD observations, observing very bright comets and electronic submission of observations. One problem has been that every time I've re-read it I've found further points that I'd like to amend. Hopefully I won't find any more!

Many more observers are taking up CCD imaging and submitting their images. Quite a few of these get submitted as linear.jpg or something similar. This makes it rather hard to identify once I've archived it and I'm having to spend a lot of time re-naming images. Please try and use the standard format of comet_yyyymmdd_(hhmm)_observer.img where (hhmm) is optional. As an example 2001a2_20010701_sha.jpg would be an image of 2001a2 that I took on July 1st. More details are on the web page and in the Section guide.

Since the last newsletter observations or contributions have been received from the following BAA members: Tom Boles, Neil Bone, Len Entwisle, John Fletcher, Mario Frassatti, Maurice Gavin, Peter Grego, Werner Hasubick, Guy Hurst, Nick James, Albert Jones, John Mackey, Nick Martin, Steve Martin, John McCue, Cliff Meredith, Martin Mobberley, Michael Oates, Gabriel Oksa, Roy Panther, Robin Scagell, Jonathan Shanklin, David Storey, Melvyn Taylor and Alex Vincent and also from: Jose Aguiar, Alexandre Amorim, Alexander Baransky, Sandro Baroni, Nicolas Biver, Reinder Bouma, Jose Carvajal, Tim Cooper, Matyas Csukas, Fraser Farrell, Mike Feist, Rafael Ferrando, Stephen Getliffe, Antonio Giambersio, Guus Gilein, Shelagh Godwin, Bjorn Granslo, Roberto Haver, Michael Jager, Andreas Kammerer, Paul Kemp, Heinz Kerner, Martin Lehky, Rolando Ligustri, Pepe Manteca, Michael Mattiazzo, Maik Meyer, Antonio Milani, Yurij Nesterov, Andrew Pearce, Stuart Rae, Maciej Reszelski, Tony Scarmato, Carlos Segarro, Giovanni Sostero, Graham Wolf, Seiichi Yoshida (apologies for any errors or omissions). Without these contributions it would be impossible to produce the comprehensive light curves that appear in each issue of *The Comet's Tale*.

Comets under observation include: 19P/Borrelly, 24P/Schaumasse, 29P/Schwassmann-Wachmann, 44P/Reinmuth, 45P/Honda-

Mrkos-Pajdusakova, 74P/Smirnova-Chernykh, 1999 J2 (Skiff), 1999 T1 (McNaught-Hartley), 1999 T2 (LINEAR), 1999 U4 (Catalina-Skiff), 1999 Y1 (LINEAR), 2000 CT54 (LINEAR), 2000 OF8 (Spacewatch), 2000 SV74 (LINEAR), 2000 WM1 (LINEAR), 2001 A2 (LINEAR), 2001 B2 (NEAT), 2001 HT50 (LINEAR-NEAT), 2001 K3 (Skiff), 2000 K5 (LINEAR), 2001 MD7 (LINEAR), 2001 Q2 (Petriew) and 2001 Q6 (NEAT).

Section Meeting

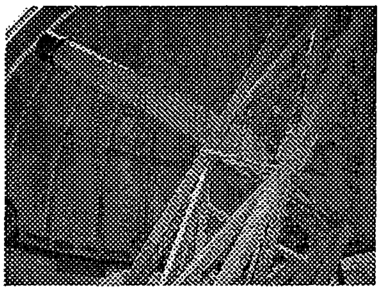
Finally some details about the Section meeting on February 23. This will be at the Scientific Societies Lecture Theatre at Savile Row in London and will take place prior to the afternoon BAA meeting, starting at 10:30am for coffee. The main speakers are Alan Fitzsimmons of Queen's University of Belfast speaking on "Big comets and little comets: how many of each" and Giovanni Sostero of Remanzacco Observatory in Italy, speaking on his experiences of CCD imaging. I'm allowing plenty of time for informal discussion over coffee, and lunch will be available at Savile Row, so do come along and make a day of it. After lunch the main BAA meeting begins at 14:30, with the main speakers being David Whitehouse speaking on 'A biography of the Moon' and Melvyn Taylor on 'Variable Stars'. The meeting will also feature Martin Mobberley's famous Sky Notes. Please book lunch through the BAA office, enclosing a cheque payable to the BAA. If you would like a vegetarian meal please state this clearly. The cost of lunch is not known at the time of going to press, but will be about £5 - £10; the exact price will be given on the Section and BAA Web pages, in a BAA Circular and in the Journal. The booking deadline is 2002 February 1 and there is a limit of 75 places. If you would like to make a provisional booking let me know. Hopefully stocks of the revised Section Observing Guide will be available on the day!

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices, and BAA Journals Sky.

150 Years Ago: An astrometric observation of Faye's comet by Professor Challis with the Northumberland equatorial in Cambridge on March 4 has the note 'Of the last degree of faintness on account of the zodiacal light: could scarcely be observed.'. [I wish this were still true today, as light pollution is now the major enemy]



The Northumberland equatorial as it is today. The dome was replaced in the 1930s, and the telescope had a new lens in 1988 to mark its 150th anniversary. Much of the rest of the telescope is unchanged since Professor Challis observed with it. For more details see http://www.ast.cam.ac.uk/IoA/northumberland.html

100 Years Ago: The May Journal notes 'The first comet of the new century is one of a rather sensational nature. It is probably the brightest comet that has appeared since 1882'. [comet 1901 G1 'Great Comet'] A note from W G Lavender at Willow Dam Camp, near Mafeking sent on April 25 notes: 'We have to stand to arms at 5.30 every morning, and it is then, of course, dark. In the east there has been for two days a most beautiful comet - due east, almost end on - 24th and 25th April, just above the rising sun; brighter today than yesterday'. The *Times* reported that Botha sent a message to his forces saying that this comet was the presage of peace and independence for the Boers. The *Daily Mail* reported that a soldier had written home describing it like a veldt fire with a rocket on top of it. At the May meeting Mr Crommelin showed a diagram of the positions of the comet on the epidiascope. There had been a lot of confusion over the comet. Yerkes observatory had reported seeing a bright object 15 degrees north of the sun on April 26 and Mr Chambers reported seeing a comet's tail in the morning sky at 3.00 am. It later transpired that neither of these reports matched the real comet and comet seekers had wasted a lot of time in searching for it. Mr Crommelin said that the comet must have been well placed for observation some weeks or months before it was discovered, so that it seemed strange it was not discovered sooner. This was a point that might make comet seekers feel ashamed of themselves. It was possible that the comet might have been seen at the total eclipse in Sumatra. Several newspaper reports said that it had been seen from England, but sadly they were false. Captain Noble commented how carefully one ought to eschew newspapers when they required any real astronomical information. If the statements which he had seen in some of the newspapers had any foundation in fact, this new comet must have squirmed round the sun like one of the penny snakes which were sold in the streets! At the June meeting Mr Chambers described his observations of a tail in detail and said that it was definitely there on May 1, but not on the two following nights, but he could not otherwise explain the observation. Lantern slides of observations and drawings of the comet were exhibited but unfortunately when slides from photos of recent comets were being shown for comparison, the acetylene lamp exploded, fortunately without doing any damage. The final issue for the session includes a paper from Rev J T Bird, Chaplain to Her Majesty's Forces in the Transvaal. He describes his observations of the great comet and also describes the ideas of the Kaffirs about the comet. He notes that these were remarkably similar to those of Britain a few centuries earlier and that it portended plague or war.

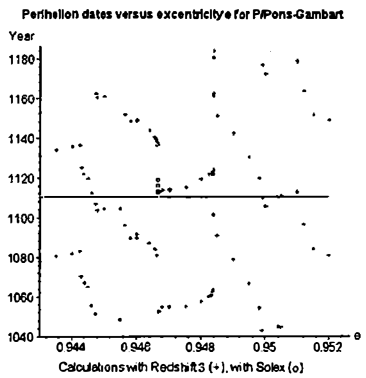
50 Years Ago: During the May meeting Dr Merton reported on observations of comet 1950b Minkowski by Albert Jones, drawings of comet 2P/Encke by George Alcock and several other comets. This generated considerable discussion on split comets and motion in comet tails.

Awaiting Comet P/Pons-Gambart

Volker Kasten, Garbsen, Germany

It is often a difficult task to predict the behaviour of a comet. For example, no one knows for sure the evolution of a comet's brightness or tail. And there are still a few periodic comets with poorly known orbits, making predictions about their next perihelion date very uncertain. One prominent example was comet P/Swift-Tuttle, the progenitor of the Perseids, which finally came to perihelion in 1992, ten years later than most had expected.

A similar case is that of comet P/Pons-Gambart. This periodic comet was only seen at one apparition, in 1827, when it passed perihelion on June 7. Due to investigations by Ogura (1917) and Nakano (1978), the period of revolution seems to be in the range of 46 - 67 years. In 1979, Hasegawa considered the possible identity P/Pons-Gambart = C/1110 K1. According to his computations, comet C/1110 K1 had fairly similar elements, reaching perihelion on 1110 May 18. More about comet C/1110 K1 can be found in Gary Kronks book "Cometography", Volume 1, p. 193 ff.



In their paper "Periodic Comets Found in Historical Records" (Publ. Astron. Soc. Japan 47, 699-710, 1995), Hasegawa and Nakano tried to link the orbits of Pons-Gambart and 1110 K1, resulting in a period of revolution of 65.58 years for Pons-Gambart in 1827, the eccentricity of its orbit being e = 0.9503946. With these elements, the next perihelion of the comet would be as late as 2022 Jan 31.

In addition, the authors present a table of previous perihelion times of Pons-Gambart, starting from the year -194 until 2022. According to this table, there should have been five additional perihelia with good observing conditions after the apparition of 1110, including that of 1827. But there is only one historical record of a comet in 1239, which could have been comet Pons-Gambart. According to Hasegawa and Nakano, a more recent perihelion passage took place on 1892 June 12. With this perihelion date, the comet should have been visible as a 4 mag circumpolar object in the northern sky at the end of June of that year, strolling through the Big Dipper at the beginning of July with a magnitude of 5.5 mag. However, no appropriate comet was observed. It seems unlikely to assume that such a bright object was simply overseen in 1892. Thus, if one is not willing to accept the ad hoc assumption that the comet was unusually faint during this apparition, serious doubts arise about the given perihelion time in 1892. As a consequence, the orbital resolution of Hasegawa and Nakano for Pons-Gambart in 1827 must be considered as uncertain.

I therefore found it interesting to make my own investigations regarding the orbit of comet Pons-Gambart. With the help of integration machines in REDSHIFT3, SOLEX 7.0 (a public- domain program written by Aldo Vitagliano) and DANCE OF THE PLANETS, I integrated various sets of osculating elements of Pons-Gambart backward in time until 1110, starting from the year 1827. The starting elements were chosen from GUIDE7, with the exception of the eccentricity e, which I varied in the range e=0.943 to e=0.952, corresponding to osculating periods of revolution in 1827 from 53 to 69 years.

In the adjacent figure, the resulting perihelion times are plotted as a function of the osculating eccentricity in 1827. The "predicted" perihelion in 1110 is indicated by a horizontal line. Integrations performed with REDSHIFT 3 are labelled by a cross (+), those computed with SOLEX 7 are shown as a circle (o); the Hasegawa-Nakano-solution is marked with a red circle. The results of both used programs seem to be consistent. Also, some tests with DANCE yield fairly similar results.

As the figure demonstrates, there are several possible intervals for the eccentricity in 1827 that yield perihelia not far from the year 1110. The first such interval goes from e=0.9446 to 0.9455 with computed perihelion times between 1103 and 1112. Given such eccentricities, Pons-Gambart would have returned as early as 1990 - 1995, but the comet was not discovered during those years.

The solution e=0.9503946 of Hasegawa and Nakano fits very well in this figure, lying in the interval e=0.9499 - 0.951 of possible values for the eccentricity. As already mentioned above, in this case we have to wait another twenty years for the next return of comet Pons-Gambart.

However, there is some hope for an earlier return of the comet. As can be seen from the figure, there are two other good fits for the eccentricity, namely around e=0.94667 and at the sharply defined value e=0.948379, were the perihelia make a steep jump backward in time (resulting in 12 revolutions of the comet until 1827 in each case). This jump could have its origin in the 14th century, where due to DANCE the comet in 1365 had an aphelion unusual far from the sun, although the program didn't reveal any single reason for this.

Integrating from 1827 onward, the former value of e yields the next return at the end of the year 2003, while the latter value results in a perihelion in 2012. Anyway, if the comet has not already been overlooked in recent years and has yet to come, a return of Pons-Gambart prior to the end of the year 2003 seems to be very unlikely.

See also the article by Andreas Kammerer published in The Comet's Tale in 1997 November, which is additionally available at http://www.fg-kometen.de/ponsetab.htm

Comet Prospects for 2002

2002 sees a number of returns of periodic comets, however none of them are particularly exciting. The brightest periodic comet of the year is predicted to be P/Brewington, which is making its first predicted return early in 2003 and this comet may reach 10^{th} magnitude at the end of the year. Several long period comets discovered in previous years are still visible. Theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. This would make a useful project for CCD observers. Ephemerides for new and currently observable comets are published in the *Circulars*, Comet Section Newsletters and on the Section, CBAT and Seiichi Yoshida's web pages. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook; details of subscription to the ICQ are available from the comet section Director. The section booklet on comet observing is available from the BAA office or the Director; a new edition is at the printers.

7P/Pons-Winnecke was discovered by Jean Louis Pons with a 0.12-m refractor at Marseilles in 1819, but was then lost until rediscovered by Friedrich August Theodor Winnecke with a 0.11-m refractor in Bonn in 1858. He demonstrated the identity and recovered the comet in 1869. The perihelion distance has slowly been increasing since the early 1800s. It can make close approaches to the Earth and did so in 1927 (0.04 AU), 1939 (0.11), 1892 (0.12), 1819 (0.13) and 1921 (0.14). An outburst of the meteor shower associated with the comet, the June Bootids, occurred on 1998 June 27.6.

It will be a morning object, becoming visible in February and reaching 11^{th} magnitude in May after which it is unfavourably placed for observation from the UK. Observers at lower latitudes will be able to follow it until September. It moves eastwards, being in Serpens in February, Ophiuchus in March, Aquila in April and Aquarius in May.

Comet **19P/Borrelly** reached perihelion in September 2001 and begins the year at 11^m moving northward in Canes Venatici. It remains quite well placed as it fades, passing into Ursa Major in late February when it is 12^{th} magnitude.

22P/Kopff was discovered photographically by A Kopff at Konigstuhl Observatory in 1906, when it was around 11^m. The next return was unfavourable, but it has been seen at every return since then. Following an encounter with Jupiter in 1942/43 its period was reduced and the perihelion distance decreased to 1.5 AU. The following return was one of its best and it reached 8^m. The next return was unusual, in that it was 3^m fainter than predicted until perihelion, when it brightened by 2^m. It suffered another encounter with Jupiter in 1954, but this made significant changes only to the angular elements. 1964 was another good return and the comet reached 9^m.

UK observers may pick up the comet in March, when it is at opposition and follow it as it retrogrades in Virgo until May, but the comet is only 13^{th} magnitude. Although it continues to brighten, the solar elongation decreases and it is poorly placed when at its brightest (11^m) at the end of the year.

29P/Schwassmann-Wachmann 1 is an annual comet which has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. It spends the year in Capricornus reaching opposition in early August, fairly close to Neptune. The comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. Unfortunately opportunities for UK observers are limited, as its altitude will not exceed 20° from this country.

Carl A Wirtanen discovered **46P/Wirtanen** at Lick in 1948. It is in a chaotic orbit, and its perihelion distance was much reduced due to approaches to Jupiter in 1972 and 1984. It has been reported to outburst, but BAA data suggests that it was just rejuvenated after the perihelion distance was reduced. It is a target for the Rosetta mission. A December perihelion would give a close approach to the Earth, however the present period is exactly 5.5 years so that perihelia alternate between March and September.

The comet is also a morning object. More southerly placed observers may pick it up in June, but UK observers will probably not find it until August, when it is fading from its best magnitude of 11. The solar elongation only increases from around 40° to 60° by the end of the year, so it is never very well placed. In June it is in Cetus, moving into Taurus in July, Gemini in August and Virgo in November.

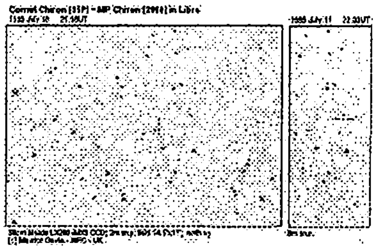
67P/Churyumov-Gerasimenko was discovered in 1969 September, by Klim Churyumov and Svetlana Gerasimenko on a plate taken for 32P/Comas Sola at Alma Ata observatory. It reached its present orbit after a very close encounter (0.05 AU) with Jupiter in 1959, which reduced the perihelion distance from 2.74 to 1.28 AU. At a good apparition, such as in 1982, when it approached the Earth to 0.4 AU and was well observed by the comet section, it can reach 9^m.

The comet is another morning object, and even at best it probably won't exceed 12^{th} magnitude. Southern observers may pick it up around the solstice, but from the UK we won't pick it up before August, when it will be fading. Again the elongation is not good, increasing from around 50° to 100° at the end of the year. The comet's track closely parallels that of 46P/Wirtanen, entering Gemini in August and ending the year on the border of Leo and Virgo.

81P/Wild 2 is a new comet that made a very close (0.006 AU) approach to Jupiter in September 1974. Prior to this it was in a 40 year orbit that had perihelion at 5 AU and aphelion at 25 AU. The comet was discovered by Paul Wild with the 40/60-cm Schmidt at Zimmerwald on 1978 January 6. The Stardust spacecraft is due to visit the comet in 2004 and recover material for return to earth in 2006.

The comet is at opposition in Taurus in December when it will be around magnitude 13.5. It will brighten into 2003, when it is at perihelion, but is too close to the Sun for observation when at its brightest (11^m).

95P/Chiron is an unusual comet in that it is also asteroid 2060. It reaches 17^m when at opposition in June in Sagittarius. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically. It was at perihelion in 1996 when it was 8.5 AU from the Sun and will be nearly 19 AU from the Sun at aphelion in around 50 years time.



95P/Chiron imaged by Maurice Gavin in 1999 July.

Comets reaching perihelion in 2002

Comet	T	q	P	N	H1	K1
1999 F1 (Catalina)	Feb 13.7	5.79			5.0	7.5
2000 SV74 (LINEAR)	May 1.3	3.54			5.0	10.0
2000 WM1 (LINEAR)	Jan 22.7	0.56			6.5	10.0
2001 C2 (LINEAR)	Mar 28.3	5.10			6.0	10.0
2001 K5 (LINEAR)	Oct 12.1	5.18			2.5	10.0
2001 N2 (LINEAR)	Aug 19.9	2.67			7.5	10.0
2001 R1 (P/LONEOS)	Feb 17.5	1.36	6.48	0	14.0	10.0
2001 T3 (NEAT)	Jan 27.3	2.52	16	0	12.0	10.0
2001 T4 (NEAT)	Jan 4.7	8.56	53	0	5.5	10.0
6P/d'Arrest	Feb 3.6	1.35	6.53	17	10.0	20.0
7P/Pons-Winnecke	May 15.7	1.26	6.38	21	10.0	15.0
15P/Finlay	Feb 7.2	1.03	6.75	12	12.0	10.0
18D/Perrine-Mrkos	Sep 10	1.29	6.76	5	11.5	20.0
22P/Kopff	Dec 12.1	1.58	6.46	14	6.6	12.5
26P/Grigg-Skjellerup	Nov 29.7	1.12	5.31	18	12.0	40.0
28P/Neujmin 1	Dec 27.4	1.55	18.2	5	8.5	15.0
30P/Reinmuth 1	Dec 24.4	1.88	7.32	9	9.5	15.0
31P/Schwassmann-Wachmann 2	Jan 18.4	3.41	8.72	11	6.7	11.3
39P/Oterma	Dec 22.2	5.47	19.5	3	5.0	15.0
46P/Wirtanen	Aug 27.0	1.06	5.44	8	9.0	15.0
54P/de Vico-Swift	Aug 7.5	2.15	7.32	3	10.0	15.0
57P/du Toit-Neujmin-Delporte	Jul 31.2	1.73	6.42	5	12.5	15.0
67P/Churymov-Gerasimenko	Aug 18.3	1.29	6.57	5	9.5	10.0
77P/Longmore	Sep 4.7	2.31	6.83	4	7.0	20.0
89P/Russell 2	Mar 23.0	2.29	7.42	3	10.0	15.0
90P/Gehrels 1	Jun 23.0	2.97	14.8	2	8.5	15.0
92P/Sanguin	Sep 23.1	1.81	12.4	2	12.0	15.0
96P/Machholz 1	Jan 8.6	0.12	5.23	3	13.0	12.0
115P/Maury	Dec 23.9	2.04	8.79	2	11.5	15.0
124P/Mrkos	Jul 27.0	1.47	5.74	2	13.1	15.0
125P/Spacewatch	Jan 28.1	1.53	5.54	2	15.5	10.0
P/Shoemaker 3	Dec 15.0	1.81	17.1	1	10.5	10.0
P/Helin-Lawrence	Dec 22.4	3.11	9.52	1	10.0	10.0

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns ( ) and the magnitude parameters H1 and K1 are given for each comet.

Note: $m_1 = H1 + 5.0 * \log(d) + K1 * \log(r)$

The orbit of **96P/Machholz 1**. is very unusual, with the smallest perihelion distance of any short period comet (0.13 AU), which is decreasing further with time, a high eccentricity (0.96) and a high inclination (60°). Studies by Sekanina suggest it has only one active area, which is situated close to the rotation pole and becomes active close to perihelion. The comet may be the parent of the Quadrantid meteor shower. It is rarely sufficiently well placed to see visually and this return is no exception. However, at perihelion on 2002 January 8 it is only a few degrees from the Sun and may be seen in the SOHO LASCO coronagraphs from January 5 to 11.

116P/Wild 4 was discovered on 1990 January 21.98 by Paul Wild with the 0.40-m Schmidt at the Zimmerwald station of the Berne Astronomical Institute at a photographic magnitude of 13.5. At its brightest the comet only reached 12^m, but it was surprisingly well observed. The comet was perturbed into its present orbit after a close approach to Jupiter in mid 1987.

The comet emerges from the solar glare in November, moving south-eastwards in Virgo, but is poorly placed for viewing from the UK. It brightens from 13^{th} magnitude near the end of the year to 12^{th} magnitude in April as it nears opposition but is a long way south and will be difficult to observe from the UK. It is at perihelion in January 2003.

P/Shoemaker 3 (1986 A1) is also making its first return since discovery. It will be quite faint, around $14\text{-}13^{th}$ magnitude, when it is picked up in November and does not get much brighter by the time it reaches opposition in February 2003. It moves eastwards from Cancer into Leo at the end of the year.

P/Brewington 2 (1992 Q1) makes its first return since its discovery in 1992. It was discovered by Howard J Brewington of Cloudcroft, New Mexico, as a small diffuse 10^m object on August 28.41 using a 0.40-m reflector x55. This was his fourth discovery and his second periodic one. The comet is in a Jupiter crossing orbit, but has not approached the planet for several revolutions. At a favourable return it could reach 7^m.

It will be too far south for viewing from the UK when it gets into visual range in June. It reaches opposition in August when it may be 12^{th} magnitude and continues to brighten. We may pick it up in November as it brightens to 10^{th} magnitude and we will be able to follow it into the New Year as it continues to move north. It is an evening object, but its solar elongation decreases from 80° in November to 50° at the end of the year. It will not reach perihelion until 2003. By October it is moving north-eastwards in Capricornus and ends the year in Aquarius.

Several recently discovered parabolic comets will be visible during 2002. 2000 SV74 (LINEAR) will be fading from 13^{th} magnitude and may remain visible until December. 2000 WM1 (LINEAR) begins the year too far south to be visible from the UK, but it is well placed for Southern Hemisphere observers and may be a binocular object. In March it will have moved far enough north for UK observation and should still be a binocular object as it emerges into the morning sky in Sagittarius. It continues to move rapidly north and will probably be best for northern viewers in mid month when the moon is out of the sky. It passes from Aquila into Hercules in April and will probably be too faint for easy observation by June. 2001 N2 (LINEAR) may reach 13^{th} magnitude between May and August. 2001 HT50 (LINEAR) will become visible towards the end of the year as it brightens towards its perihelion in mid 2003. 2001 MD7 (P/LINEAR) may be visible to Southern Hemisphere observers at the beginning of the year fading from around 13^{th} magnitude.

Several other comets return to perihelion during 2002, however they are unlikely to become bright enough to observe visually or are poorly placed. 6P/d'Arrest, 15P/Finlay, 26P/Grigg-Skjellerup and 28P/Neujmin 2 have unfavourable returns. 30P/Reinmuth 1, 31P/Schwassmann-Wachmann 2, 39P/Oterma, 54P/de Vico-Swift, 57P/du Toit-Neujmin-Delporte, 77P/Longmore, 89P/Russell 2, 90P/Gehrels 1, 92P/Sanguin, 115P/Maury, 124P/Mrkos, 125P/Spacewatch, 1999 F1 (Catalina), 2001 C2 (LINEAR), 2001 K5 (LINEAR) and 2001 R1 (P/LONEOS) are intrinsically faint or distant comets. Ephemerides for these can be found on the CBAT WWW pages. 18D/Perrine-Mrkos has not been seen since 1968.

Looking ahead, 2003 has a good return of **2P/Encke,** which might be observable from September until the end of the year, when it could be 6^{th} magnitude. This may however be optimistic as observations from the SOHO spacecraft in 2000 showed that it suddenly brightened after perihelion, which does not occur until late December 2003.

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Jonathan Shanklin

Professional Tales

Many of the scientific magazines have articles about comets in them and this regular feature is intended to help you find the ones you've missed. If you find others let me know and I'll put them in the next issue so that everyone can look them up.

The following abstracts (some shortened further for publication) are taken from the Cambridge Conference Network (CCNet), which is a scholarly electronic network devoted to catastrophism, but which includes much information on comets. To subscribe, contact the moderator Benny J Peiser at <b.j.peiser@livjm.ac.uk>. Information circulated on this network is for scholarly and educational use only. The abstracts, taken from daily bulletins, may not be copied or reproduced for any other purposes without prior permission of the copyright holders. The electronic archive of the CCNet can be found at http://abob.libs.uga.edu/bobk/cccmenu.html

NASA to track more asteroids with new NEAT camera. Ron Baalke, Media Relations Office, Jet Propulsion Laboratory

Asteroid search efforts got a boost from a new, improved camera installed for NASA's Near Earth Asteroid Tracking system on the 1.2-meter (48-inch) Oschin telescope at the Palomar Observatory, near San Diego, Calif. The camera has a new three-eyed design with three lenses. It can provide three times more data and survey 1.5 times more sky than the present NEAT camera that operates currently at the Maui Space Surveillance Site's 1.2-meter telescope in Hawaii. The NEAT team can operate the telescope from their desks at JPL, as though the camera were a spacecraft.

"The new camera has the flexibility to do a wide and shallow sky survey, or one not-so-wide but deeper," said Dr. Steven Pravdo, NEAT project manager at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "We plan to do more deep observing, so that we can see as many objects as possible." The asteroid observers will be able to take panoramic views of the sky with the three camera eyes or to take a deep exposure showing many faint objects in a narrow swath.

The whole control system on the Oschin telescope was upgraded to a computer-controlled system. The old manual system pointed to only 10 positions each night, but the camera now needs to point to different positions 1,000 times a night. The new system captures about 3.75 square degrees of the sky per image, hundreds of square degrees per night, and most of the accessible sky each month.

The new NEAT camera takes pictures with 48 million pixels, three times more than the system it replaced, and it can see fainter objects. The Palomar staff, headed by Superintendent Bob Thicksten, has helped with the improvements. Palomar Observatory is a facility of the California Institute of Technology.

"This will be a new lease on life for a very famous survey telescope, which conducted the first comprehensive survey of the northern skies in the 1950s and which is now targeting some exciting astronomical goals - searching for near-Earth asteroids and examining supernovae and their role in determining the fate of the cosmos," said Richard Ellis, the director of Palomar Observatory.

The new camera's installation closes the era of using photographic plates, and marks the rebirth of Palomar Observatory's Oschin telescope in the electronic age. "It has been a dream 20 years in the making," says NEAT's principal investigator Eleanor Helin, who has been discovering asteroids from Palomar's two wide-field telescopes since the early days of near-Earth object search.

This new camera system will continue NASA's effort to find 90 percent of all large, near-Earth asteroids by 2010. "We installed the camera on April 9th, and hope to get results in the next few days," Pravdo said. [It has been remarkably successful in discovering new comets, with 14 so far this year.]

ASTEROIDS, COMETS, METEORS - ACM2002

The next meeting of the International Conference ASTEROIDS, COMETS, METEORS - ACM2002 will be held in Berlin from July 29 to August 2, 2002. The Conference will take place on the campus of the Technical University (TU-Berlin), located in the centre of Berlin. Further information will be provided in the second announcement, and on the web page http://earn.dlr.de/ACM2002

LIGHTCURVE & COLOURS OF UNUSUAL MINOR PLANET 1998 WU24 Davies JK, Tholen DJ, Whiteley RJ, Green SF, Hillier JK, Foster MJ, McBride N, Kerr TH, Muzzerall E: ICARUS 150 (1): 69-77 MAR 2001

Minor planet 1998 WU24 is unusual in having the orbital characteristics of a Halley family comet but showing no sign of cometary activity. We present optical data that reveal a double-peaked lightcurve with a period of 7.283 +/- 0.003 h and a peak-to-peak amplitude of similar to0.54 mag. Infrared spectroscopy and quasi-simultaneous BVRIJHK photometry reveal a featureless K-band spectrum and colors typical of D-type asteroids, and suspected "bare" comet nuclei (B-V 0.78 +/- 0.034, V-R 0.53 +/- 0.037, V-I 0.99 +/- 0.035,V-J 1.67 +/- 0,043, V-H 2.10 +/- 0.076 and V-K 2.34 +/- 0.102). Image profiles from co-added frames in the R band indicate no apparent cometary activity, with an implied upper limit to the dust production rate of 150 g s(-1). Assuming a D-type albedo of 0.04 we derive a spherical equivalent diameter of 5.28 +/- 0.07 km although the lightcurve amplitude implies an irregular body with an axial ratio of 1.64: 1. We conclude that 1998 WU24 is probably an inactive comet nucleus. (C) 2001 Academic Press.

COMET LINEAR 1999 S4 [An amalgam of several reports on this comet, which were published in the journal Science]

Astronomers analyzing debris from this comet that broke apart last summer spied pieces as small as smoke-sized particles and as large as football-field-sized fragments. But it's the material they didn't see that has aroused their curiosity.

Tracking the doomed comet, named C/1999 S4 (LINEAR), NASA's Hubble Space Telescope's Wide Field and Planetary Camera 2 found tiny particles that made up the 100,000-kilometer-long dust tail and 16 large fragments, some as wide as 100 meters. Hubble detected the small particles in the dust tail because, together, they occupy a large surface area, which makes them stand out in reflected sunlight. However, the estimated mass of the observed debris doesn't match up to the comet's bulk before it cracked up.

The mass of the original, intact nucleus is estimated to be about 300 billion kilograms, according to some ground-based observers who were measuring its gas output. However, the total mass in the largest fragments measured by the Hubble telescope and the VLT is only about 3 billion kilograms, and the dust tail has an even smaller mass of about 0.3 billion kilograms. In other words, the total mass measured following the breakup is about 100 times less than the estimated total mass prior to the breakup.

So where is the rest of the comet's fractured nucleus? Perhaps, suggest Weaver and other investigators, most of the comet's bulk after the breakup was contained in pieces between about 2.5 millimetres and 50 meters across. These pebble-sized to house-sized fragments cannot be seen by visible-light telescopes because they do not have enough surface area to make them stand out in reflected sunlight.

If the midsized cometary fragments exist, then the fundamental building blocks that comprised LINEAR's nucleus may be somewhat smaller than what current "rubble pile" theories of the solar system's formation suggest. These theories generally favour football-field-sized fragments, like the ones observed by the VLT and the Hubble telescope. The analysis of LINEAR's fragments indicates that the "rubble" comprising cometary nuclei may be somewhat smaller than previously thought.

Another puzzling question is why the comet broke apart between June and July of last year as it made its closest approach to the Sun. "We still don't know what triggered the comet's demise," Weaver says. "But we do know that carbon monoxide (CO) ice probably did not contribute to the breakup." Hubble's Space Telescope Imaging Spectrograph detected low levels of this volatile material, about 50 times less than was observed in comets Hale-Bopp and Hyakutake. Carbon monoxide ice sublimates [changes directly from a solid to a vapor] vigorously, even at the cold temperatures in a comet's interior. This activity could lead to a buildup of pressure within the core that might cause the nucleus to fragment.

"One question we tried to answer was, 'Did everything happen at one time, or did the pieces of the comet slowly fragment off?'" said Dr. Zdenek Sekanina of JPL. He identified some of the fragments in the pictures from Hubble and the Very Large Telescope, determined their sizes and relative motions and the times they separated. "We found that the comet's breakup was gradual but episodic. Also, the distances among the mini-comets grew as time went by, and we wanted to find out how rapidly."

There are two forces working on the different distances between the mini-comets, Sekanina said. One is that the fragments broke off at different times. The other is that gases flowing from the broken chunks of dust and ice were propelling them to different speeds depending on their size.

Sekanina predicted that the tail would become a narrow, bright band, made from the sunlight-reflecting dust released as the comet crumbled. While the new tail was relatively bright at first, the comet's original head disappeared, confusing calculations of the orbit. The last pictures of the tail were taken in the second half of August 2000, about four weeks after the event. Then the comet's remains vanished forever.

The French-Finnish SWAN instrument on the SOHO spacecraft observed Comet LINEAR by ultraviolet light from late May, and continued to watch it till the remnants faded from view in mid-August. The SWAN team reports that their observations showed four major outbursts in June and July.

The fragmentation seen by SWAN began on 21 July, almost a week before observers on the ground noticed it. Between 25 May and 12 August, the dying comet released altogether 3.3 million tonnes of water vapour into space, as its ice evaporated in the warmth of the Sun. The data also suggest that the density of Comet LINEAR was extremely low.

"Only SWAN on SOHO saw the entire drama of this self-destroying object," comments Teemu Mäkinen of the Finnish Meteorological Institute, lead author of the report in Science. "The ice on the surface of the comet's nucleus did not simply vaporize as in a normal comet, but came away in large chunks. We saw 90 per cent of the ice falling off before the complete fragmentation of the remainder began."

SWAN's unique capability in observing comets comes from its continuous scanning of the whole sky, at just the right ultraviolet wavelength to see the cloud of hydrogen atoms that surrounds every moderately active comet. The hydrogen comes from the break-up of water molecules released from the comet by the Sun's warmth. SWAN also benefits from its location on the ESA-NASA SOHO spacecraft 1.5 million kilometres from the Earth, well clear of a hydrogen cloud that surrounds the Earth itself.

The character of the comet did not change throughout the months of observation by SWAN, even when deep layers inside the nucleus were being laid bare. Comet scientists usually have to consider the possibility that the surface of the nucleus is different in composition from the interior. One lesson from Comet LINEAR seems to be that, in this case at least, the surface exposed at the outset was representative of the whole nucleus.

The SWAN team also suspects that Comet LINEAR was as flimsy and light as the expanded polystyrene used for packing fragile equipment. The density of its water ice may have been as low as 15 kilograms per cubic meter, compared with 917 kg/m3 for familiar non-porous ice on the Earth. Even allowing for a possibly equal mass of dust grains within the comet, a total density of 30 kg/m3 would be far less than the 500 kg/m3 often assumed by comet scientists. By this reckoning, the initial diameter of Comet LINEAR on its approach to the Sun was about 750 metres.

"Our opinion about the low density is tentative and controversial," says Jean-Loup Bertaux. "We expect plenty of arguments with our colleagues when we put all the observations of Comet LINEAR together. But we start with the advantage of having seen the whole course of events, which no one else did."

Dr. Tony L. Farnham, a planetary scientist at The University of Texas at Austin, and his colleagues discovered a deficiency in the molecule carbon-2 in Comet C/1999 S4 (LINEAR). The carbon-2 deficiency indicates that the comet formed near Neptune, probably billions of years ago. Most comets were formed during the solar system's earliest years in two regions: near Jupiter and Saturn, and farther out, near Neptune. They didn't stay in those regions, however, because the force of gravity of those giant planets catapulted the comets away, and created two comet habitats: the Oort Cloud (a halo of Jupiter-origin comets enveloping the solar system) and the Kuiper Belt (a belt of Neptune-origin comets orbiting in the plane of the solar system along with the planets, beyond Neptune's orbit).

Different lines of evidence may indicate another history for C/1999 S4 (LINEAR). Other researchers found the comet to be lacking in other carbon-chain molecules, pointing to a Jupiter-region origin. He said the discrepancy "may be telling us that it has a surface material different from what's inside. It's possible that the comet formed near the Jupiter region, and other materials formed on the surface as it migrated out," into the outer solar system. But Farnham cautioned that there is no proof of this.

Farnham also calculated a lower limit for the radius of the comet's nucleus before break-up: about 0.4 kilometers.

FORCED PRECESSION MODELS FOR SIX ERRATIC COMETS. Krolikowska M, Sitarski G, Szutowicz S: ASTRONOMY AND ASTROPHYSICS 368 (2): 676-688 MAR 2001

The non-gravitational motion of six "erratic" short-period comets is studied on the basis of published astrometric observations. We present the precession models which successfully link all the observed apparitions of the comets: 16P/Brooks 2, 21P/Giacobini-Zinner, 31P/Schwassmann-Wachmann 2, 32P/Comas Sola, 37P/Forbes and 43P/Wolf-Harrington. We used the Sekanina's forced precession model of the rotating cometary nucleus to include the non-gravitational terms into equations of the comet's motion. Values of six basic parameters (four connected with the rotating comet nucleus and two describing the precession of spin-axis of the nucleus) have been determined along the orbital elements from positional observations of the comets. The solutions were derived with additional assumptions which introduce instantaneous changes of modulus of reactive force, and of maximum cometary activity with respect to perihelion time. The present precession models impose some constraints on sizes and rotational periods of cometary nuclei. According to our solutions the nucleus of 21P/Giacobini-Zinner with oblateness along the spin-axis of about 0.29 (equatorial to polar radius of 1.41) is the most oblate among six investigated comets.

NASA gives go-ahead to build 'Deep Impact' spacecraft. Media relations office, Jet Propulsion Laboratory.

The Deep Impact mission, has successfully completed its preliminary design phase and has been approved by NASA to begin full-scale development for a launch in January 2004. The encounter with Comet Tempel 1 on July 4, 2005 will reveal clues to the origin of comets and the composition and structure of perhaps the most mysterious objects in our solar system.

Now the Deep Impact team is completing the final design details and will begin building the mission's two spacecraft: a flyby spacecraft and a 350-kilogram impactor spacecraft. They will be launched together in early 2004 and travel to Comet Tempel 1's orbit where they will separate and operate independently. The flyby spacecraft will release the impactor into the comet's path, then watch from a safe distance as the impactor guides itself to collide with the comet, making a football field-sized crater in the comet's nucleus.

As the gases and ice inside the comet are exposed and expelled outward by the impact, the flyby spacecraft will take pictures and measure the composition of the outflowing gas. The images and data will be transmitted to Earth as quickly as possible. Many observatories on Earth should be able to see the comet dramatically brighten just after the impact on July 4, 2005.

CONTOUR to provide first surface 'fingerprint' of comet Encke's nucleus. Andrew Yee, News Service, Cornell University

Instruments aboard a spacecraft that will be launched next year to explore two, and perhaps three or more, comets in the solar system will for the first time provide a "fingerprint" of the surface of cometary nuclei, giving the first firm evidence of the composition of the icy, rocky objects. The spacecraft's infrared imaging spectroscopy will map the composition of the nucleus of comet Encke at a resolution of 100 meters to 200 meters, detailed enough to see craters and other large geologic features and to determine their composition.

Comet Encke will be the first target of NASA's Cornell University-led Comet Nucleus Tour (CONTOUR), scheduled for launch July 1, 2002. The surface resolution of Encke's nucleus by the CONTOUR spectrometer will be even better than that obtained by the infrared spectrometer on the Near Earth Asteroid Rendezvous spacecraft during its recent orbital mission to asteroid 433 Eros. "The CONTOUR spacecraft will come within about 100 to 160 kilometres of the nucleus, although the exact distance is still in doubt because we don't know the orbital position of the nucleus with extreme precision".

The imaging instrument, called the CONTOUR remote image/spectrograph, also will send back digital-camera images of Encke's nucleus. The camera will capture the images as the spacecraft speeds through the comet's coma, at 28 kilometres a second in November 2003. Joseph Veverka, Cornell professor of astronomy and principal investigator on the $155 million mission, noted that "success" will be defined as obtaining digital images of the nucleus showing automobile-size details, such as rocks, about 4 meters (4 yards) across. Encke, first discovered 225 years ago, is about 8 kilometres long and has an average radius of about 2.5 kilometres. It orbits the sun once every 3.2 years, and its most recent apparition from Earth was last year. It is unique in that it has been observed from Earth on 56 of its apparitions, more than any other comet, including Halley.

Encke will not be the only comet on CONTOUR's agenda. In June 2006 the spacecraft is scheduled to encounter Comet Schwassmann-Wachmann 3 and, possibly, Comet d'Arrest in 2008. These targets are so-called "Jupiter family" comets because they are thought to have had their orbital periods shortened by previous gravitational encounters with the giant planet. The science team hopes it also might be possible to visit other kinds of comets, particularly primitive members of the so-called "dynamically young" family that are in long elliptical orbits and might be making one of their first close passes by the sun.

The scientific team will be particularly searching the coma for evidence of curious particles previously detected in interstellar clouds by Jochen Kissel, a comet researcher at the Max-Planck-Institute for Extraterrestrial Physics in Garching, Germany. Kissel made his discovery in data sent back by NASA's Stardust mission, which will reach comet Wild 2 in 2004. The mission is using the same dust analyzer as will be carried by the CONTOUR. Said Veverka, "The particles have a completely weird composition and don't seem to have minerals in them but seem to be made of chains of carbon-hydrogen and oxygen-nitrogen, like polymers. But there isn't any polymer with that kind of composition that we are normally familiar with."

There is an indication, said Veverka, that some particles might have weathered the massive meltdown of material when the sun and planets were formed from interstellar dust and clouds. "The question now is, have any of these particles been preserved in comets? We have to get close enough to a comet to find out." Although Encke has been much studied from ground-based observatories, little is known about its composition. Most assumptions about Encke, are drawn from data gathered by the European Space Agency's Giotto spacecraft, which visited comet Halley in 1986. Much of what astronomers know about comets "comes from the one object we've come close to, comet Halley," noted Casey Lisse. However, the CONTOUR images from Encke will be 25 times higher resolution than those from Halley.

The CONTOUR web site is at http://www.contour2002.org/

LOW ALBEDOS AMONG EXTINCT COMET CANDIDATES Fernandez YR, Jewitt DC, Sheppard SS: ASTROPHYSICAL JOURNAL 553 (2): L197-L200, Part 2 JUN 8 2001

We present radiometric effective radii and visual geometric albedos for six asteroids in comet-like orbits. Our sample has three of the four known retrograde asteroids (1999 LE31, 2000 DG(8), and 2000 HE46) and three objects [(18916) 2000 OG(44), 2000 PG(3), and 2000 SB1] on prograde but highly elliptical orbits. These measurements more than double the number of known albedos for asteroids with a Tisserand invariant in the cometary regime. We find that all six of our objects, and nine of the 10 now known, have albedos that are as low as those of active cometary nuclei, which is consistent with their supposed evolutionary connection to that group. This albedo distribution is distinct from that of the whole near-Earth and unusual asteroid population, and the strong correlation between Tisserand invariant and albedo suggests that there is a significant cometary contribution to this asteroid population.

Two Amateur Astronomers from the Pacific Rim to Share the 2001 Edgar Wilson Award for the Discovery of Comets.
Ron Baalke

This year's award is to be shared by comet hunter Syogo Utsunomiya of Kumamoto, Japan, and Albert Jones, the dedicated variable star observer from Nelson, New Zealand. Their co-discovery of comet C/2000 W1 is an example of astronomical and international coordination. On the night of November 18, 2000, Syogo Utsunomiya was observing the southern constellation of Vela with his 25x100mm binoculars when he spotted a fast-moving comet low on his southern horizon. Utsunomiya dutifully noted the comet to be approximately 5 arcmin across, magnitude 8.5 and moving rapidly to the southeast. The fast moving comet would soon be unobservable from his position.

On November 19, after confirming his observation, Utsunomiya relayed his report to the Central Bureau for Astronomical Telegrams (CBAT) at the Smithsonian Astrophysical Observatory. Soon afterwards, a description of the comet and its predicted position was sent from CBAT to a few other observers for confirmation. Despite the efforts of those astronomers, Utsunomiya's fast-moving comet went unnoticed for almost another week. Then in the early morning on November 26, the 80-year-old eagle-eyed Jones spotted what he recognized as a comet with his 78-mm refractor, not knowing it to be one that Utsunomiya had seen a week earlier further to the north. Jones had chanced upon the comet as he was quickly moving from star to star or "star hopping." He was actually trying to observe the variable star T Apodis before the approaching morning sun ruined the sky. Jones' luck that morning would earn him two more distinctions:

he is now the oldest person to have discovered a comet, and he has set the record for the longest time interval between discovering comets at 54 years!

Damn those damocloids.
Duncan Steel

I'd like to make a few comments about the significance of the newly-discovered 'Damocloid' 2001 OG108 likely the largest known Earth-crossing asteroid and similar objects; that is, Earth-crossing asteroids on Halley-type orbits. The high inclination of this object (80 degrees) adds weight to the conviction that it may well be an extinct (or dormant) comet. That in turn leads to an idea that the albedo is low (a few percent) and so the size in somewhat larger than would be calculated based on typical asteroidal albedos, as Ted Bowell suggested: 15 km or maybe more. To tie this down it would be useful if thermal infra-red observations could be made as the object get closer to the Sun, rendering the albedo and hence the size. Similarly a cometary nature - cometary outgassing activity, I mean - might be indicated by high spatial resolution imaging showing a coma, or high spectral resolution observations showing emission lines.

Let me compliment the LONEOS team on their interesting discovery. There is more to it than that, though. Two Damocloids are now known with Earth-crossing orbits, this one and 1999 XS35, the latter being 1-2 km in size (absolute magnitude H7.2). Both have been found by LONEOS. Given that LONEOS discovers only a small fraction of all NEOs (due to the high productivity of LINEAR, NEAT and Spacewatch, rather than any fault of LONEOS), this requires an explanation unless one puts it down to chance. There are of course various other Damocloids with perihelia outside the terrestrial orbit (such as 1996 PW found by NEAT, and 1997 MD10, 1998 QJ1, 2000 AB229, 2000 DG8, 2001 QF6 and (20461) 1999 LD31 found by LINEAR, and (15504) 1999 RG33 found by the Catalina Sky Survey, and 2000 VU2 found by W.K. Yeung, plus 2000 HE46 found by LONEOS: see http://cfa-www.harvard.edu/iau/lists/Others.html), but the fact remains that it is LONEOS that has turned up the two Earth-crossers amongst them all.

Let us step back a decade. After we found Damocles at the Anglo-Australian Observatory in 1991 (it was actually Rob McNaught who spotted it, as 1991 DA, on a photographic plate taken using the UK Schmidt Telescope), we predicted that awaiting discovery there must be many dark asteroids on elongated, comet-like orbits crossing the path of the Earth. It is nice to see that prediction being borne out at last, even if they do pose a worrying danger to us. (5335) Damocles itself has a present orbit that comes sunwards only so far as to just overlap the aphelion distance of Mars, but its orbital instability is obvious (see, for example, D.J. Asher, M.E. Bailey, G. Hahn & D.I. Steel, 'Asteroid 5335 Damocles and its implications for cometary dynamics,' Monthly Notices of the Royal Astronomical Society, 267, 26-42, 1994), and so the name given it should not be surprising to anyone knowing the story of the Sword of Damocles.

Based solely on the existence of Damocles, David Asher and I suggested that perhaps ten percent of the large-body (>1-km) impact hazard might be due to dark Halley-type asteroids: D.I. Steel & D.J. Asher, 'The past and future orbit of (extinct comet?) 1991 DA,' pp.65-73 in Periodic Comets (eds. J.A. Fernandez & H. Rickman), Universidad de la Republica, Montevideo, Uruguay, 1992.

Damocles itself, though, is large (H3.3, much the same as the H3.0 of 2001 OG108). Asher and I were working on the assumption that some form of usual mass distribution would rule among Damocloids, with much larger numbers of smaller objects yet unseen. Both the LONEOS discoveries in question are rather larger than the norm for present NEO discoveries, 2001 OG108 very much so. One might then suggest that this is because LONEOS has a small aperture (limiting discoveries to brighter objects), but its wide field explains why the other programmes have not turned up similar objects. However, if indeed there are many smaller (<2-km) Earth-crossing Damocloids then one might expect the search projects using larger apertures (LINEAR, NEAT, Spacewatch) to have turned some of them up. One wonders, then, whether they do exist; or is there some systematic selection effect that is stopping the other searches from detecting them? Let me caution again, though, that this is based on a statistic of just two objects. On the other hand, all the Damocloids known are large (bigger than 2 km, most much larger).

The existence or otherwise of a significant population of (say) 0.3 to 2 km dark asteroids in Halley-type orbits is an important one from the perspective of planetary defence. For the sake of argument, let us assume that the above given proportion of the impact hazard due to these Damocloids (10 percent) is broadly correct. There are arguments over the proportion due to active comets, long-period or otherwise, but again 10 percent is in the right ballpark. Together those make 20 percent, leaving 80 percent as being the contribution of asteroids in inner solar system orbits. I won't worry about renormalisation: the figures are hazy, and if we knew the real figures then we'd know a lot more than we do now.

The point from that is that the NASA Spaceguard goal (of 90 percent of inner solar system asteroids larger than 1 km), which many people have criticized as being not ambitious enough, may in fact be overdoing it. Think carefully about the figures. Once one has found three-quarters of such objects then one has 60 percent of the hazard tied up (that is, three-quarters of 80 percent), with 20 percent of the hazard still available for attack by present means (80 minus 60): the brighter asteroids in inner solar system orbits, being found by relatively small telescopes. But that 20 percent is equalled by the 20 percent of the hazard (by my assumed figures) posed by Damocloids and active comets: objects on moderate-to long-period orbits that must be found on their apparition of impact when they are still at least beyond Saturn, and so in essence all are dark. This requires a deep, at least annual search of the whole sky with apertures of at least three metres, and preferably more. That is what needs to be done to make the biggest inroads into the hazard, once 75 percent of the larger inner solar system Earth-crossing asteroids have been found. The time is upon us.

Finally I note that the existence of large objects like 2001 OG108 on Earth-crossing orbits must lead to a re-assessment of the expected frequency of impacts of sufficient energy to cause a mass extinction event.

OBSERVATIONS REQUESTED FOR COMET LINEAR (2000 WM1)

Professional observers associated with the Ulysses spacecraft have put in the following request for observations. Could CCD and photographic observers who are able to obtain good images of the comet please send them to the contacts given below, with copies to me. Jonathan Shanklin

Observations of comet LINEAR in December 2001 and January 2002 could be valuable in understanding the solar-wind/comet interaction at high solar latitudes near solar maximum. The ULYSSES spacecraft has established that the solar wind consists of distinct equatorial and polar regions. The equatorial solar wind has an average speed of 450 km s^{-2} and a proton-electron density of 9 cm^{-3}. Variations in these quantities can be large. This region also contains the heliospheric current sheet (HCS). The polar solar wind has an average speed of 750 km/sec and a proton-electron density of 3 cm^{-3}. Variations in these quantities are small. Specifically, the HCS does not extend into the polar region. The boundary is determined by the maximum extent of the HCS in latitude. The HCS is expected to have a small latitude extent near solar minimum and a large latitude extent near solar maximum. This picture is expected to hold for most of the solar cycle, but its applicability at the time of solar maximum, when the solar magnetic field reverses, is open to question.

These solar-wind properties are reflected in the plasma tails of comets. In the equatorial region, the plasma tails appear relatively disturbed, the orientation of the plasma tail is consistent with the average solar-wind speed of 450 km/sec, and disconnection events (DEs) occur when a comet pierces the HCS. In the polar region, the plasma tails appear relatively undisturbed, the orientation of the plasma tail is consistent with the solar-wind speed of 750 km/sec, and DEs do not occur. These properties are described in ICARUS, Vol. 148, pp. 52-64, November 2000. The ULYSSES spacecraft made a South Polar Pass from September 2000 to January 2001 and will make a North Polar Pass from September to December 2001.

Comet LINEAR (2000 WM1) can also serve as a probe of solar-wind conditions near solar maximum. It should be a good Northern Hemisphere object in December 2001 and a good Southern Hemisphere object in January 2002. During January 2002, the comet will probe high southern latitudes, reaching ecliptic latitude 72.5° South on January 21, 2002. Thus, comet LINEAR will be a true probe of the solar wind with an extensive range in latitude. Properly exposed images of the plasma tail in December 2001 and January 2002 will document this comet and help determine the state of the solar-wind flow and the location or existence of the HCS at high latitudes near solar maximum.

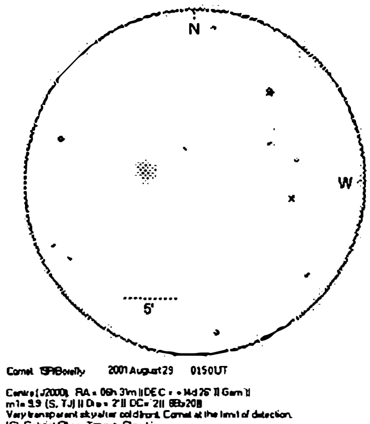
Specific observations that have potential scientific value are time sequences of plasma tail images. These could provide data on the rate of tail ray folding (information on the solar-wind velocity), the frequency of ray occurrence (information on the rate at which discontinuities encounter the comet), and kinematic information on DEs (if any are seen). Images posted on the Comet Observation Home Page or other sites with the usual documentation and sufficient field to allow identification of stars for the reduction will be fine. For further information or to make suggestions, contact: Jack Brandt <jbrandt@as.unm.edu> or Martin Snow <snow@lasp.colorado.edu>

All observations, of course, will be used only with the permission of the observer and will be fully credited to the observer.

Review of comet observations for 2001 April - 2001 October

The information in this report is a synopsis of material gleaned from IAU circulars 7606 – 7739 and The Astronomer (2001 April – 2001 September). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course.

Comet 19P/Borrelly This is the comet's 13th observed return, with two poor ones having been missed. The solar elongation is only slowly increasing, but the comet moves north, although remaining a morning object. Slowly fading as it passes through the Leos (October) and into Ursa Major (November), the comet begins to move north more rapidly and ends the year at 11^m in Canes Venatici. It begins 2002 at 11m moving northward in Canes Venatici. It remains quite well placed as it fades, passing into Ursa Major in late February when it is 12th magnitude.



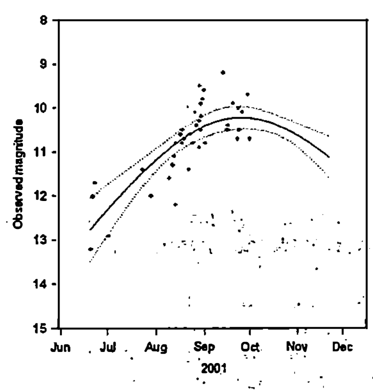
Comet 19P/Borrelly 2001 August 29 0150UT

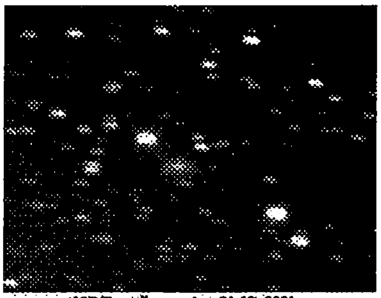
Very transparent sky after cold front. Comet at the limit of detection.

(C) Gabriel ..., Trnava, Slovakia

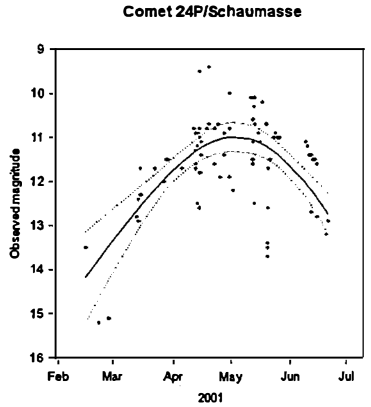
19P/Borrelly drawn by Gabriel Oksa on August 29.

The comet was first picked up by Michael Mattiazzo, who estimated it at 13th mag in mid June. By July 22 it had brightened to 11.4, a bit fainter than expected. Observing on August 28.11 with my 0.20-m SCT x75 I made it 10.3, DC4, diameter 1.7'. It reached a peak of around 10th magnitude in September, shortly after perihelion, and is now slowly fading. The spacecraft Deep Space 1 successfully imaged the comet on September 22. The uncorrected preliminary light curve from 43 observations is $m = 6.8 + 5 \log d + 19.2 \log r$

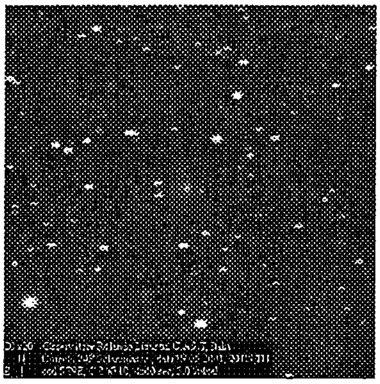




19P/Borrelly - Aug 21.13, 2001
Average of 5 x 30 sec exposures
0.3m f/2.8 Baker + Hi-Sis 24 CCD + R filter
0.5' x 1' elliptical coma
G. Sostero (Remanzacco Observatory, Italy)



Comet 24P/Schaumasse The comet peaked in brightness in late April at around 11^{th} magnitude. The uncorrected preliminary light curve from 78 observations is $m = 7.7 + 5 \log d + 29.2 \log r$

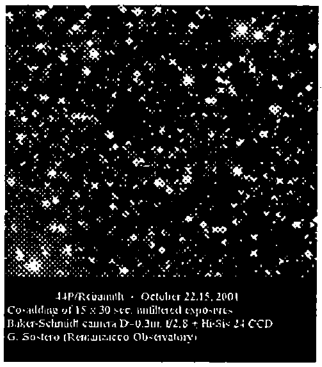


24P/Schaumasse imaged by Rolando Ligustri on May 19.

Comet 29P/Schwassmann-Wachmann 1 This annual comet has frequent outbursts and over the past couple of years seems to be more often active than not, though it rarely gets brighter than 12m. It is possible that its pattern of behaviour is changing. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet. The comet was noted in outburst in June, July and August. The comet will be observable in Libra for the rest of the year, though it is not well placed for observing from the UK. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity.

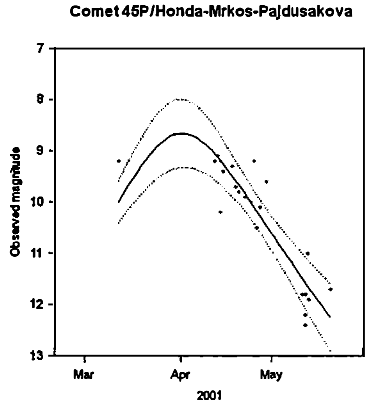
29P/Schwassmann-Wachmann 1 imaged by Rolando Ligustri and the CAST team on August 15.

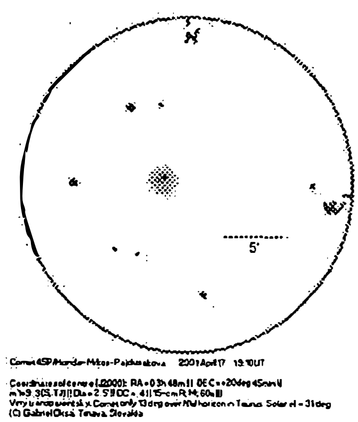
Comet 44P/Reinmuth has been image by Giovanni Sostero in October at around 16^{th} magnitude.



44P/Reinmuth on October 22.

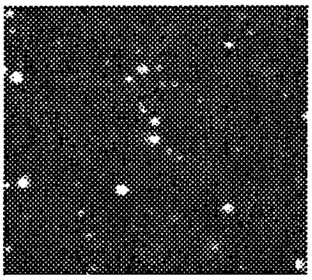
Comet 45P/Honda-Mrkos-Pajdusakova made its 10th observed return since discovery in 1948 (it was missed in 1959). On Apr. 4.42 UT, K. Kadota, Ageo, Saitama, Japan, reported m_1 = 10.5 and coma diameter 0'.8 (0.18-m reflector + CCD. [IAUC 7608, 2001 April 9] Gabriel Oksa reported a visual observation on April 17.8, when he estimated the comet at 9.3 in a 0.15m R x60, coma 2.5' diameter, DC4. The uncorrected preliminary light curve from 22 observations is $m = 11.0 + 5 \log d + 11.1 \log r$





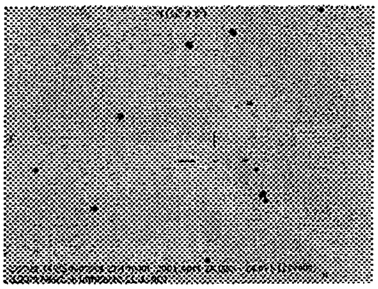
45P/ drawn by Gabriel Oksa on April 17.

51P/Harrington has been imaged by a few CCD observers, who show it as well condensed with a faint tail.

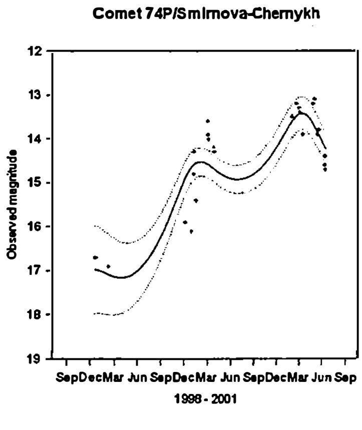


51P/Harrington imaged by Rolando Ligustri on September 24.

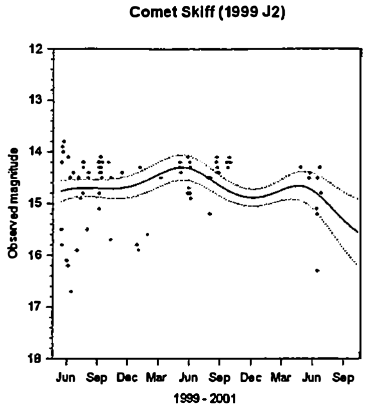
Comet 74P/Smirnova-Chernykh was at perihelion in January 2001. The uncorrected, rather unlikely, preliminary light curve from 27 observations is m = -9.8 + 5 log d + 38.4 log r



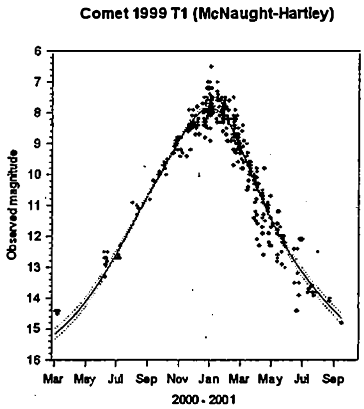
74P/Smirnova-Chernykh imaged by Nick James on April 24.

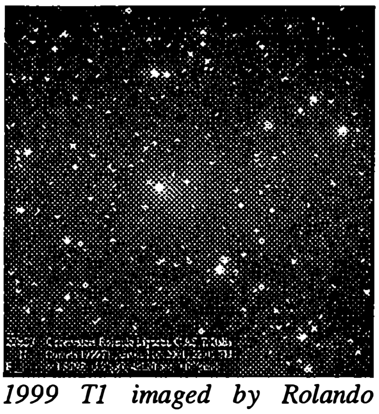


1999 J2 Skiff The comet is at high northern declination, and is very distant at over 7 AU, with perihelion in October 1999. It will remain near 15th mag for some time. The uncorrected preliminary light curve from 93 observations is m = -1.2 + 5 log d + 13.4 log r



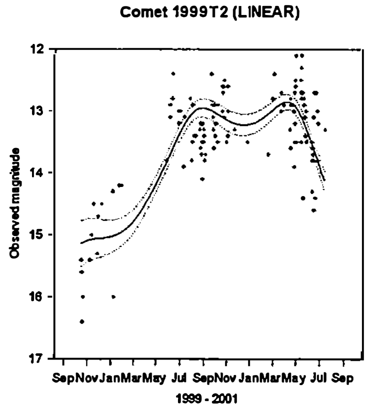
1999 T1 McNaught-Hartley On April 24 I estimated it at around 12th mag in the Thorrowgood refractor. It continued to fade and became quite diffuse. The uncorrected preliminary light curve from 419 observations is m = 6.3 + 5 log d + 9.4 log r

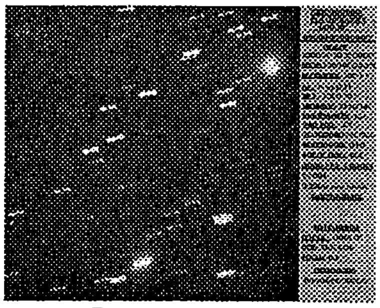




1999 T1 imaged by Rolando Ligustri on May 12.

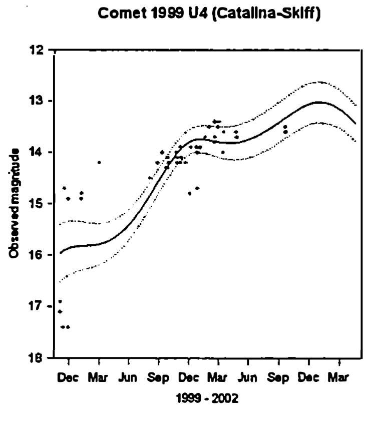
1999 T2 LINEAR On 2001 April 24 I was able to see the comet clearly in the Northumberland refractor, estimating it at 13.5. Observations are generally quite scattered. The uncorrected preliminary light curve from 151 observations is m = 6.5 + 5 log d + 8.2 log r



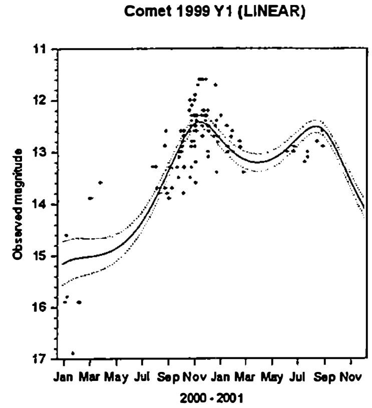


1999 T2 imaged by Rafael Ferrando on April 30.

1999 U4 Catalina-Skiff The object is very distant, but the extrapolated light curve suggests that it should be visible until mid 2002, fading from 13th mag. Pepe Manteca imaged the comet on August 25. The uncorrected preliminary light curve from 49 observations is m = 1.0 + 5 log d + 12.7 log r



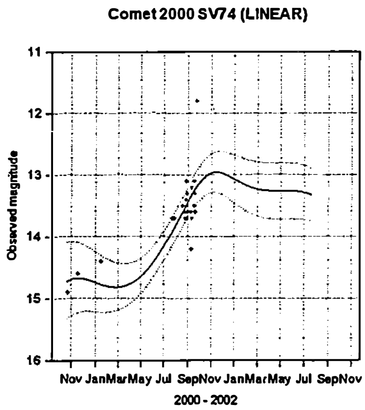
1999 Y1 LINEAR The comet is now beginning to fade and is a southern hemisphere object. Pepe Manteca imaged the comet on several times in August. Michael Mattiazzo has been following it from the Southern Hemisphere. The uncorrected preliminary light curve from 120 observations is m = 6.4 + 5 log d + 7.6 log r

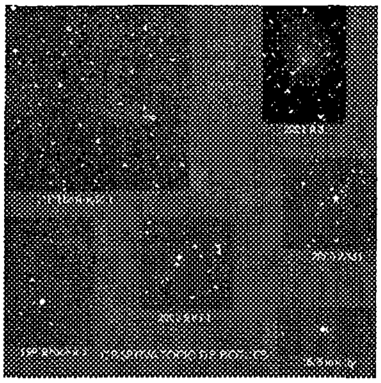


2000 CT54 LINEAR Yet another apparently asteroidal LINEAR object, of 19th mag, discovered on February 2.44. Reinder Bouma made a few observations in June when it was 14[th] mag.

2000 OF8 Spacewatch The comet reached perihelion in August 2001 at 2.2 AU. An improved hyperbolic orbit published on MPEC 2001-H34 [2001 April 24] gives 1/a (orig) as 0.000047, showing that the comet is a new one from the Oort cloud. Reinder Bouma estimated it around 14[th] mag.in June.

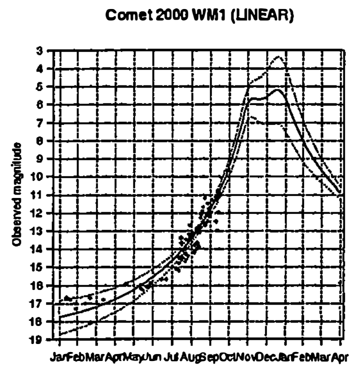
2000 SV74 The extrapolated light curve suggests that the comet will slowly fade from 13th magnitude. As with many comets the visual observations generally put the comet as being brighter than CCD observations. The uncorrected preliminary light curve from 26 observations is m = 8.0 + 5 log d + 4.1 log r.

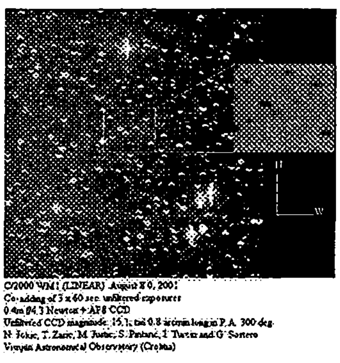




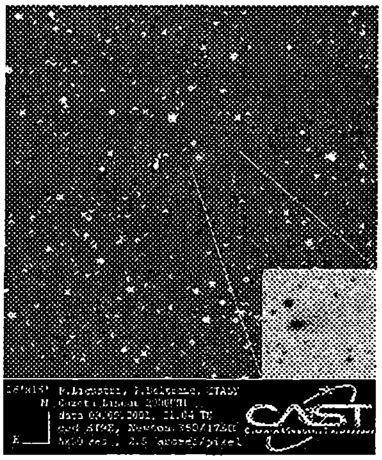
Montage of 6 comets imaged by Pepe Manteca on August 16/17

2000 WM1 LINEAR Brian Marsden notes on MPEC 2001-M50 [2001 June 28] that 'The "original" and "future" barycentric values of 1/a are +0.000516 and -0.000250 (+/-0.000010) AU**-1, respectively.' The original value is greater than 10E-04, hence the comet is probably not a new arrival from the Oort cloud and has made at least one previous visit to the inner solar system. The corrected preliminary light curve from 76 CCD and visual observations is m = 6.5 + 5 log d + 9.7 log r, which predicts a peak magnitude in the range 4 - 7. The comet does not reach perihelion until January 2002. It will be too far south at perihelion, but will return to northern skies and will then be visible until August 2002.





2000 WM1 imaged by Giovanni Sostero and colleagues from the Visnjan observatory in Croatia on August 8.



2000 WM1 imaged by the CAST team on September 9.

2000 WM1 imaged by the CAST team on October 22.

Previously unnamed comets The IAU Committee on Small Bodies Nomenclature has agreed upon the names for the following five comets: C/2000 S3 (LONEOS); 150P/2000 WT_168 (LONEOS); C/2000 Y2 (Skiff); C/2001 G1 (LONEOS); C/2001 HT_50 (LINEAR-NEAT). [IAUC 7674, 2001 July 30]

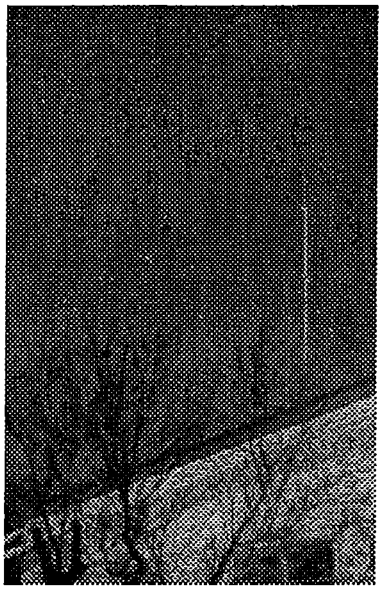
SOHO Kreutz group comets

1996 A2 SOHO (IAUC 7718, September 17)
1996 B4 SOHO (IAUC 7726, 2001 October 3)
1996 B5 SOHO (IAUC 7730, 2001 October 9)
1996 L1 SOHO (IAUC 7606, 2001 April 2)
1996 R4 SOHO (IAUC 7730, 2001 October 9)
1997 K7 SOHO (IAUC 7646, 2001 June 20)
1997 M5 SOHO (IAUC 7606, 2001 April 2)
1997 W3 SOHO (IAUC 7650, 2001 June 23)
1998 V7 SOHO (IAUC 7612, 2001 April 23)
2001 G2 SOHO (IAUC 7613, 2001 April 25)
2001 G3 SOHO (IAUC 7613, 2001 April 25)
2001 H1 SOHO (IAUC 7613, 2001 April 25)

2001 H2 SOHO (IAUC 7613, 2001 April 25)
2001 H3 SOHO (IAUC 7613, 2001 April 25)
2001 H4 SOHO (IAUC 7613, 2001 April 25)
2001 H6 SOHO (IAUC 7631, 2001 May 23)
2001 H7 SOHO (IAUC 7631, 2001 May 23)
2001 J2 SOHO (IAUC 7631, 2001 May 23)
2001 J3 SOHO (IAUC 7631, 2001 May 23)
2001 J4 SOHO (IAUC 7631, 2001 May 23)
2001 K2 SOHO (IAUC 7631, 2001 May 23)
2001 K4 SOHO (IAUC 7634, 2001 May 28)
2001 K6 SOHO (IAUC 7641, 2001 June 6)
2001 K7 SOHO (IAUC 7641, 2001 June 6)
2001 K8 SOHO (IAUC 7641, 2001 June 6)
2001 K9 SOHO (IAUC 7642, 2001 June 8)
2001 L1 SOHO (IAUC 7642, 2001 June 8)
2001 L2 SOHO (IAUC 7642, 2001 June 8)
2001 L3 SOHO (IAUC 7642, 2001 June 8)
2001 L4 SOHO (IAUC 7642, 2001 June 8)
2001 L5 SOHO (IAUC 7646, 2001 June 20)
2001 L6 SOHO (IAUC 7646, 2001 June 20)
2001 L7 SOHO (IAUC 7646, 2001 June 20)
2001 L8 SOHO (IAUC 7646, 2001 June 20)
2001 L9 SOHO (IAUC 7646, 2001 June 20)
2001 M2 SOHO (IAUC 7650, 2001 June 23)
2001 M3 SOHO (IAUC 7650, 2001 June 23)
2001 M4 SOHO (IAUC 7650, 2001 June 23)
2001 M5 SOHO (IAUC 7650, 2001 June 23)
2001 M6 SOHO (IAUC 7650, 2001 June 23)
2001 M7 SOHO (IAUC 7655, 2001 July 2)
2001 M8 SOHO (IAUC 7655, 2001 July 2)
2001 M9 SOHO (IAUC 7655, 2001 July 2)
2001 M11 SOHO (IAUC 7667, 2001 July 19)
2001 O1 SOHO (IAUC 7667, 2001 July 19)
2001 R3 SOHO (IAUC 7718, September 17)
2001 R4 SOHO (IAUC 7718, September 17)
2001 R5 SOHO (IAUC 7718, September 17)
2001 S2 SOHO (IAUC 7730, 2001 October 9)
2001 T2 SOHO (IAUC 77xx, 2001) and several other comets not yet given identities were discovered with the SOHO LASCO coronographs and have not been observed elsewhere. They were sungrazing comets of the Kreutz group and were not expected to survive perihelion.

2001 A2 LINEAR The latest orbit has 1/a (orig) of 0.001164, demonstrating that this is not the first time that the comet has visited the inner solar system. Michael Mattiazzo points out that the orbital plane crossing took place around July 15-16th. This should have enhanced the dust tail in the solar and anti solar directions.

C. W. Hergenrother, M. Chamberlain, and Y. Chamberlain, Lunar and Planetary Laboratory, University of Arizona, report that 60-s R-band images of C/2001 A2 taken on Apr. 30.12 UT with the Catalina 1.54-m reflector show a double nucleus. The two components are nearly equal in brightness and 3".5 apart and aligned precisely on an east-west line. Both components are highly condensed. Observations (with the same telescope) on Apr. 24.14 show only a single nucleus. [IAUC 7616, 2001 May 1] Using the absolute astrometry for Apr. 30 (see IAUC 7616) and May 9 given on MPC 42656 (where the western primary is labeled B and the eastern secondary is labeled A), Z. Sekanina, Jet Propulsion Laboratory, obtained a separation time of Mar. 17 +/- 12 and an acceleration of 7.1 +/- 2.4 (in units of 10**-5 solar gravity). [IAUC 7625, 2001 May 15]



Photograph by Michael Mattiazzo on 2001 June 12

Z. Sekanina, Jet Propulsion Laboratory, writes: "Astrometric offsets of component A from B reported between Apr. 30 and May 18 (IAUC 7616, 7625, 7627, MPC 42656, MPEC 2001-K14) indicate that the splitting occurred on Mar. 29.9 +/- 1.6 UT (thus coinciding with the major outburst) and that the companion's relative deceleration is 15.2 +/- 0.7 units of 10**-5 solar attraction. Assuming that the separation of component C (IAUC 7627) from B coincided with the outburst of May 11, the single available offset suggests that C is subjected to a deceleration of approximately 40 units of 10**-5 solar attraction.

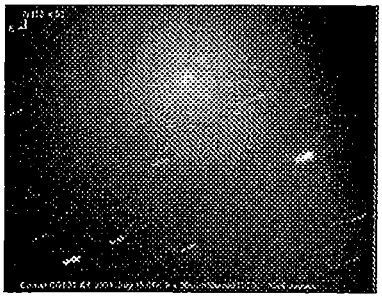
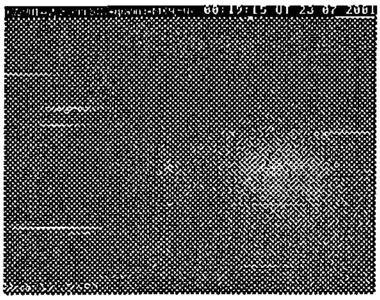


Image by Nick James on July 15

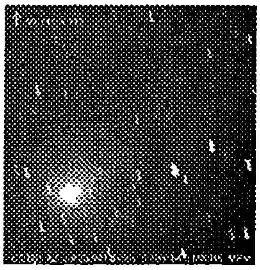
O. Schuetz, E. Jehin, X. Bonfils, H. Boehnhardt, K. Brooks, A. Delsanti, O. Hainaut, E. Jourdeuil, P. Leisy, M. Sterzik, and E. Wenderoth, European Southern Observatory (ESO); J. Helbert, DLR, Berlin; G. Garradd, Loomberah, N.S.W.; F. Marchis, University of California at Berkeley; B. Stecklum, TLS-Tautenburg; and G. Tozzi, Osservatorio Astrofisico di Arcetri, report that an intensive high-resolution monitoring of the inner coma on June 16-21 indicates that the comet continues to fragment. The images obtained at ESO (La Silla) in the thermal infrared with the 3.6-m telescope (+ TIMMI2, N band), and in the optical region with the 3.5-m New Technology Telescope (+ EMMI, R filter) and the ESO/MPG 2.2-m telescope (+ WFI, R filter), show faint companions drifting away from the principal nucleus (B) in an approximately antisolar direction. Analysis by Z. Sekanina, Jet Propulsion Laboratory, shows that all the observations can be satisfied by three fragments, D, E, and F. The analysis implies that fragment D separated from B on June 3.5 +/- 1.8 with a differential nongravitational deceleration of 17 units (of 10**-5 the solar attraction) and with an initial velocity of 1.0 +/- 0.1 m/s (approximately normal to the orbit plane); fragment E on June 9.5 +/- 0.7 with a deceleration of 53 units and a velocity of 0.3 +/- 0.1 m/s; and fragment F on June 11.3 +/- 0.5 with a deceleration of 102 units and a velocity of 0.8 +/- 0.2 m/s. These breakup events apparently triggered another major outburst (cf. IAUC 7630), reported by visual observers to have peaked on June 12.

L. M. Woodney and D. G. Schleicher, Lowell Observatory; and R. Greer, Wittenberg University, report narrowband gas and dust imaging of this comet: "On June 29-30, the comet displayed CN jet(s) symmetrical about p.a. 250 deg. Three successive arcs separated by approximately 12 000 km were observed on each side; outward motion of the arcs was detected. These arcs were not observed in the dust continuum." [IAUC 7666, 2001 July 18]



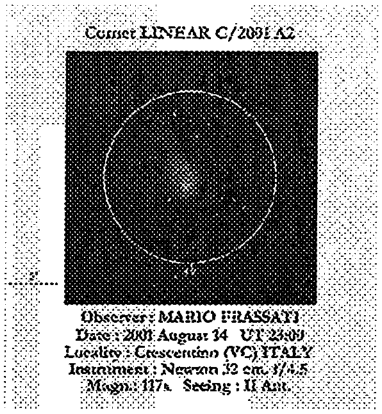
Spectral scan of the coma by Maurice Gavin on July 23

P. D. Feldman, H. A. Weaver, and E. B. Burgh, Johns Hopkins University, report observations of comet C/2001 A2 with the Far Ultraviolet Spectroscopic Explorer beginning July 12.58 UT and coinciding with the photometric event reported on IAUC 7679: "Spectra (range 91-118 nm; spectral resolution 0.03 nm) were obtained using the 30" x 30" aperture. Several new cometary emissions were identified, particularly the (0,0) bands of the CO Birge-Hopfield systems (C-X and B-X) at 108.8 and 115.1 nm, respectively; O I [(^1)D-(^1)D] at 115.2 nm; and three lines of the H_2 Lyman system at 107.16, 111.86, and 116.68 nm, pumped by solar Lyman-beta fluorescence. Also detected were O I multiplets at 98.9, 102.7, and 104.0 nm, and several lines of the H I Lyman series. The rotational envelopes of the CO bands are resolved and appear to consist of both cold and warm components, the cold component accounting for 80 percent of the flux and having a rotational temperature of 60 K. The warm component may be indicative of a CO_2 source. Both the CO bands and the O I 115.2-nm emission (an indicator of H_2O production) decreased by a factor of two over the 7.5 hr observation. Preliminary estimates of the production rates at the beginning of the observation are Q(CO) = 4 x 10^(27) s^(-1) and Q(H_2O) = 3 x 10^(29) s^(-1) (vectorial model). These values may be uncertain by as much as a factor of two, due to uncertainties in the solar flux. No emission is detected from Ar I at 104.8 and 106.7 nm and He I at 58.4 nm (in second order). We derive Q(Ar) </= 6 x 10^(25) s^(-1) (5-sigma upper limit), which implies that Ar/O is more than a factor of ten less than solar. In addition to the features listed above, more than two dozen other emissions remain unidentified." [IAUC 7681, 2001 August 15]

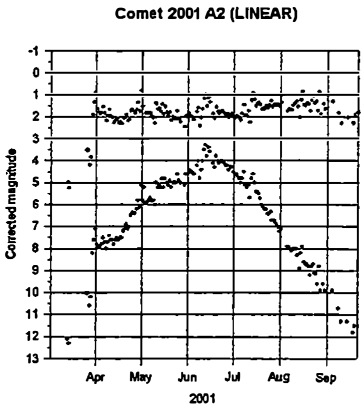


2001 A2 imaged by Martin Mobberley on 2001 July 23

David Seargent reported a visual observation at 13.1 on March 14, a little brighter than expected. It brightened very rapidly and reached 8th mag by the end of the month. It continued to brighten and became more condensed as it approached the sun. An estimate by Andrew Pearce on April 20.51 put it at 7.1 in 20x80B. Several estimates on April 24 commented that the comet had brightened rapidly in the last 24 hours and was now around 6.5. By the end of April it had reached 6th mag, but during early May the rate of brightening has slowed significantly, perhaps associated with the nuclear splitting observed at the end of April. More rapid brightening resumed around May 10 and the comet reached around 5th mag. An obsevation from Michael Mattiazzo on May 17.42 put it at 5.2 in 7x50B with a tail at least 1.6 degrees long; the comet was also visible to the naked eye. As of May 21 it was still 5th mag. Andrew Pearce reported that the comet had brightened to 4.8 on May 31.44 and the comet had a 1.5 degree long tail. The coma was noticeably blue-green in colour. On June 11.91 Andrew reported further brightening, estimating the comet at 3.6 to the naked eye and a 1.7 degree long tail in 20x80B. Michael Mattiazzo photographed the comet on June 12.



In the Northern Hemisphere, Giovanni Sostero recovered the comet on June 27. I picked it up on July 1.05 with 7x50B and estimated it at 5.3. It was an easy object, well condensed and diameter 11'. On July 10.9 it was an easy object in 8x30B of about mag 5.5, DC3 and diameter 12'. A further outburst took place on July 12, and on July 12.95 it was just visible to the naked eye from central Cambridge. The comet is now fading quite rapidly and has become very diffuse, making it a difficult object to pick out against the Milky Way background. Observations in mid August put it at around 9th magnitude, DC 1 - 2 and around 6' diameter. Observing on August 28.06 with my 0.20-m SCT x75 I made it 10.8, DC1 and diameter 2.3'



The uncorrected preliminary light curve from 879 observations is m = 7.3 + 5 log d + 10.6 log r, with several small outbursts after the major one at the end of March. One a week or so later and another in mid June. The light curve also suggests that there was quasi- periodic variation in the light curve with an amplitude of about a magnitude.

2001 H5 P/NEAT E. F. Helin, S. Pravdo, and K. Lawrence, Jet Propulsion Laboratory, report the discovery of a 17th mag comet on April 24.35, on CCD images taken with the 1.2-m Oschin Schmidt telescope at Palomar in the course of the NEAT program. CCD images taken on Apr. 25.0 UT by M. Tichy and M. Kocer at Klet (0.57-m f/5.2 reflector) show the diffuse object to have a coma diameter of 9". C. E. Lopez reports that CCD observations obtained on Apr. 25.2 at El Leoncito (0.5-m f/7.5 double astrograph) also show the object to be diffuse. Additional astrometry (including LINEAR prediscovery observations on Mar. 20 identified by B. G. Marsden) and orbital elements (T = 2001 Jan. 27.0 TT, q = 2.390 AU, i = 8.4 deg, P = 15.0 yr) are given on MPEC 2001-H37. [IAUC 7613, 2001 April 25] The comet will fade.

2001 HT50 LINEAR-NEAT S. Pravdo, E. Helin and K. Lawrence, Jet Propulsion Laboratory, report the discovery of a possible 18th mag comet by NEAT on CCD images obtained with the 1.2-m Schmidt at Palomar on May 14.22. T. B. Spahr, Minor Planet Center, has identified the object with the apparently asteroidal object 2001 HT50, observed by LINEAR on Apr. 23 and by LONEOS on Apr. 26 (MPS 30375), and has now found observations back to Mar. 3. Further details and parabolic orbital elements (T = 2003 July 8, q = 2.80 AU, Peri = 324 deg, Node = 43 deg, Incl. = 163 deg, equinox 2000.0) are given on MPEC 2001-J31. [IAUC 7624, 2001 May 14] The comet could reach 11th mag or brighter at its two oppositions in 2003.

2001 J1 NEAT S. Pravdo, E. Helin, and K. Lawrence, Jet Propulsion Laboratory, report the discovery of a 17th mag comet by NEAT on CCD images taken with the 1.2-m reflector at Haleakala on May 11.25. The object appears diffuse also on confirming CCD observations taken by L. Sarounova at Ondrejov (coma diameter about 15") and by M. Tichy and J. Ticha at Klet (coma diameter about 8"-10"). [IAUC 7623, 2001 May 11] The comet is intrinsically very faint.

As hinted on IAUC 7625, this is a short-period comet, and observations by C. W. Hergenrother, T. B. Spahr, and M. Nelson with the 1.8-m f/1 VATT Lennon telescope on May 27 make it clear that the orbital period is about 7.5-7.9 years. Spahr has also identified the comet with a very faint object (not described as cometary) discovered by A. E. Gleason with the Spacewatch telescope on 2000 Oct. 7 and placed on The NEO Confirmation Page but removed on Oct. 20 for lack of follow-up. The additional astrometry and orbital elements (P = 7.64 yr) are given on MPEC 2001-K43. S. Nakano has noted some rough similarity to the orbit of comet 3D/Biela. [IAUC 7635, 2001 May 29]

Brian Marsden has provided some additional information about this possibility: *While I cannot exclude with 100-percent certainty the possibility that the new comet P/2001 J1 (NEAT) is the long-lost 3D/Biela, I really don't think it is.*

What, indeed, happened to 3D/Biela after 1852? Did it break up completely? Some 30 years ago I looked into the possibility of finding that comet again and published a number of different orbits based on different possibilities for the action of the nongravitational forces on the comet after 1852. For an epoch around 1971 these orbits all had perihelion distances under 0.83 AU and inclinations to the ecliptic under 8.1 degrees.

Coming now to the recent comet, although unusually large inconsistencies among the observations made it particularly difficult to establish the orbit, and given that the comet's position in the sky makes it difficult to observe, I note that some careful observations on May 27 by Carl Hergenrother and Tim Spahr with the Vatican Advanced Technology Telescope in Arizona isolated the revolution period to 7.5-7.9 years. Tim then realized that the object had in fact been reported as unusual--though not of cometary appearance--by Arianna Gleason at Spacewatch on October 7 last year. The object was then listed on The NEO Confirmation Page for almost two weeks, although it was obviously too faint for essentially all of the likely follow-up observers, and Spacewatch itself evidently just missed the comet's position when it recorded the region again on October 19. The October 7 linkage is clearly correct, and this pins down the current period as 7.64 years.

Running this orbit back gives a moderately close approach to Jupiter (0.8 AU) in 1972, before which the P/2001 J1 perihelion distance was 0.96 AU and the inclination 11 degrees. While there was tolerably good agreement in orbital eccentricity, argument of perihelion and nodal longitude, it is difficult to reconcile the perihelion distance and inclination with the 3D/Biela values. To get these elements to agree would require the nongravitational forces to act in some special way, together with the gravitational effects of occasional approaches to Jupiter.

Whether or not the comets are identical, why was the current comet not observed earlier in the twentieth century? After all, the perihelion distance of under 1 AU does allow moderately close approaches to the earth--with a minimum orbital distance of perhaps 0.15 AU and an actual minimum distance of perhaps 0.5 AU in 1955. Actually, it is quite clear that at many passages through perihelion the small elongation from the sun would completely preclude observations, and by the time the object had moved around to opposition it would be as faint as when Spacewatch fortuitously observed it last October. Even under the more favorable circumstances of the 1955 perihelion passage, the best one could hope for at a 90-degree elongation from the sun would be magnitude 15, and more typically (as this year), one would have to contend with a maximum elongation of 70-80 degrees and magnitude 16 if one were lucky. We _were_ lucky that NEAT was observing this year so far from opposition, and there would have been no observing program with the capability of making the discovery at the previous comparable elongation in 1985. Unless the comet is now anomalously faint, that it escaped prior detection is fully reasonable--a situation not a bit like that of 3D/Biela on several occasions in the late eighteenth and early nineteenth centuries.

2001 K1 P/NEAT S. Pravdo, E. Helin and K. Lawrence, Jet Propulsion Laboratory, report the discovery of a 19th mag comet by NEAT on CCD images taken with the 1.2-m reflector at Haleakala on May 20.5 and 21.4 UT. M. Tichy and M. Kocer, Klet Observatory, note that the object had a 14" coma on May 21.9. P. Pravec and P. Kusnirak, Ondrejov Observatory, report a 0'.3 coma and a 0'.8 tail in p.a. 290 deg on May 21.9. T. B. Spahr, Minor Planet Center, has identified asteroidal observations of the object in LONEOS and LINEAR data back to Feb. 2. Full details are on MPEC 2001-K17. [IAUC 7629, 2001 May 21] The comet is periodic and will fade.

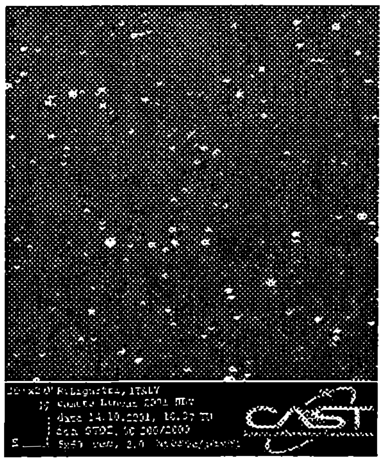
2001 K3 Skiff B. A. Skiff, Lowell Observatory, reports his discovery of a 16th mag comet on images taken with the LONEOS 0.59-m Schmidt on May 22.4; the coma was well condensed, about 20" in diameter, and a tail extended about 60" in p.a. 225 deg. Following placement in The NEO Confirmation Page, further observations were reported, and they are listed on MPEC 2001-K24, together with preliminary parabolic orbital elements (T = 2001 Jan. 12, q = 1.87 AU, Peri. = 315 deg, Node = 281 deg, Incl. = 37 deg, equinox 2000.0). M. Tichy and M. Kocer (Klet, 0.57-m reflector) reported a compact 8" coma; D. T. Durig (Sewanee, TN, 0.30-m reflector) a 30" tail; K. Smalley (Olathe, KS, 0.75-m reflector) a tail approximately 30 deg wide, brightest along the southern edge (p.a. about 210 deg), where it extended for about 2'; R. Dyvig (Quinn, SD, 0.66-m reflector) a possible coma and faint tail in p.a. about 225 deg. [IAUC 7631, 2001 May 23]

2001 K5 LINEAR A 17th mag object reported as asteroidal by the LINEAR program on May 17.28 (with prediscovery LINEAR observations on Apr. 30 identified by G. V. Williams) and posted on The NEO Confirmation Page has been found to be slightly diffuse with coma diameter 8" on CCD images taken at Klet on May 27.0 UT by M. Tichy and J. Ticha and to be strongly condensed with a 12" coma and a 13" tail in p.a. 210 deg on 300-s R-band exposures taken with the 1.8-m f/1 Vatican Advanced Technology Telescope at Mt. Graham on May 27.3 by C. W. Hergenrother, T. B. Spahr, and M. Nelson. [IAUC 7634, 2001 May 28] The comet is distant and will remain at around 14th mag visually for some time. This is LINEARs 64th comet.

2001 M1 P/Helin M. Busch, A. Seib, F. Hormuth, and R. Stoss, Starkenburg-Sternwarte, Heppenheim; and A. Gnadig and A. Doppler, Archenhold-Sternwarte, Berlin, report the recovery of P/1987 Q3 (= 1987w = 1987 XVII) on CCD images taken by Busch, Seib, and Hormuth with the EOCA 1.52-m reflector at Calar Alto on June 20.14 at 20th magnitude. The indicated correction to the prediction by B. G. Marsden on MPC 31664 (ephemeris on MPC 42160) is Delta(T) = -1.0 day. [IAUC 7648, 2001 June 21] The comet will brighten a little.

2001 M10 NEAT K. J. Lawrence, E. F. Helin, and S. Pravdo, Jet Propulsion Laboratory, report the discovery by NEAT of a 19th mag comet on 2001 July 20.28 with the Palomar 1.2-m Schmidt and the Haleakala 1.2-m reflector on June 29.58. [IAUC 7654, 2001 June 30] The comet is in a distant (q=5.3) orbit with a period of 138 years. M. D. Hicks, Jet Propulsion Laboratory, reports that this comet shows a diffuse coma of diameter about 5" and a faint tail about 7" long in p.a. 240 deg in a 10-min R-band CCD exposure obtained on June 30.3 UT with the 0.61-m reflector at Table Mountain (observers D. Esqueda, Hicks, and T. Ha). Hicks' name also should be added to the list of NEAT team members on IAUC 7654. [IAUC 7655, 2001 July 2]

2001 MD7 P/LINEAR N. Blythe, Lincoln Laboratory Experimental Test System, reports the discovery by LINEAR of an 17th mag comet on images obtained on July 11.22, when it appeared diffuse. Subsequent observations permitted identification with the object 2001 MD_7, so designated on MPS 31852 as a result of LINEAR observations made on June 21.31 and 24. L. Sarounova reports that CCD images of the comet obtained on July 12.9 UT at Ondrejov show a bright nucleus and faint coma. [IAUC 7660, 2001 July 12] The comet could reach 13th magnitude in the autumn. This is LINEARs 65th comet. Michael Mattiazzo observed it on October 14 when it had brightened to 14.2 in his 0.27-m SCT x88.



2001 MD7 imaged by the CAST team on October 14.

2001 N1 SOHO Discovered by Xavier Leprette, the orbit for this SOHO comet published on MPEC 2001-N24 [2001 July 11] is substantially different from the bulk of the Kreutz group members. Although the comet has a similar perihelion distance to that of the Kreutz group, the inclination, at 95 degrees, is far from the usual value of around 144 degrees. This is SOHO's 340th comet.

2001 N2 LINEAR An apparently asteroidal 18th mag object reported by LINEAR on July 11.38, which was posted on the NEO Confirmation Page, has been found to have a diffuse coma and a faint 5" tail in p.a. about 90 deg in a 3 min r-band CCD exposure taken with the 0.6-m reflector at Table Mountain by M. Hicks, D. Esqueda, and T. Ha. [IAUC 7661, 2001 July 13] The comet reaches perihelion in August 2002 and could reach 13th magnitude.

2001 O2 NEAT K. J. Lawrence, S. Pravdo, and E. F. Helin, Jet Propulsion Laboratory, report the discovery by NEAT of a diffuse 19th mag comet with some central condensation on July 25.42; on July 29, it showed nebulosity 12" toward the east. [IAUC 7673, 2001 July 30] Regarding the announcement of this comet on IAUC 7673, the observations on July 25 were made at Haleakala, while those on July 29 were made at Palomar. Additional astrometry and very uncertain parabolic orbital elements (from 17 observations, July 25-Aug. 1) and an ephemeris appear on MPEC 2001-P01. [IAUC 7676, 2001 August 1].

The comet is a distant one, past perihelion and will fade.

A/2001 OG108 (LONEOS) This asteroid was discovered by LONEOS on July 28.39 at 19th magnitude. It has a high inclination cometary type orbit, though no activity has so far been detected. With a period of 51 years it doesn't reach its perihelion of 1AU until March 2002, when it may reach 14th magnitude at high northern declination. If it does show any cometary activity it may well be brighter than this. Details of the observations and orbit were given on MPEC 2001-P40 on August 13.

Large Earth-Crossing Asteroid Found. A newly discovered rare asteroid may be the largest Earth-crosser known. Vanessa Thomas, Astronomy.com, 24 August 2001

During the past decade, astronomers have begun finding members of an unusual breed of asteroids. Called Damocloids after the first of their kind discovered, 5335 Damocles, these asteroids have elliptical orbits that resemble those of short-period comets like Comet Halley. A new member of this strange astronomical club has now been found, and its brightness suggests that it might be the largest Earth-crossing asteroid known.

Provisionally titled 2001 OG108, the object was first spotted on July 28 by Michael Van Ness, an observer for the Lowell Observatory Near-Earth-Object Search (LONEOS) program in Arizona. Over the next two weeks, observers tracked the newfound asteroid to determine its path about the sun. Like other Damocloids, 2001 OG108 has an elongated orbit. Each trip about the sun takes it from beyond Uranus to just within Earth's orbital path.

Because Damocloids mimic the course of short-period comets, astronomers suspect these unique asteroids might actually be "dead" comets. While the gas and ices that cause comets to flare up when they approach the sun may have been exhausted, the dark, rocky remains continue to travel through the solar system. If this notion is correct, these asteroids should have the same dark surfaces typical of short-period comet nuclei.

However, 2001 OG108 is one of the brightest Earth-crossing asteroids found so far. According to LONEOS director Ted Bowell, just two other Earth-crossers rival it in brightness. But 1866 Sisyphus and 2000 WF129 orbit the sun in the inner solar system and are unlikely to be as intrinsically dark as 2001 OG108, Bowell says. If the newly discovered asteroid is darker and reflects less light than Sisyphus and 2000 WF129, but appears just as bright, it must be larger.

Based on its brightness, its current distance, and an expectation of its albedo, Bowell estimates that 2001 OG108 could be as large as 10 miles (15 kilometers). The median size of the approximately 800 known Earth-crossing asteroids is less than one kilometer, so "this object really sticks out," he says.

Although 2001 OG108 will occasionally zip past Earth during its 50-year journey about the sun, Bowell assures that Earthlings need not worry that the asteroid will impact Earth - at least not in the near future. In its present orbit, the Damocloid will not come any closer to us than about 28 million miles (about 45 million kilometers), or more than 100 times the distance between Earth and its moon. The astronomer points out, however, that the asteroid could potentially pass within 100 million miles of Jupiter, which may result in an orbital adjustment by the giant planet's gravitational manipulation.

Currently passing through the main asteroid belt toward the inner solar system, 2001 OG108 will make its next close approach to Earth in April of next year. As it zooms past Polaris in our northern skies, the asteroid will be bright enough for amateur astronomers to spot with moderately sized telescopes. Professional astronomers will likely take interest in this rare space rock as well, in order to study its composition and attempt to confirm its once-cometary nature.

2001 P1 SOHO Discovered by Tony Scarmato, the orbit for this SOHO comet published on MPEC 2001-P22 [2001 August 8] is substantially different from the bulk of the Kreutz group members. Although the comet has a similar perihelion distance to that of the Kreutz group, the inclination, at 151 degrees, is far from the usual value of around 144 degrees and the value of L is around 208. This is SOHO's 343rd comet.

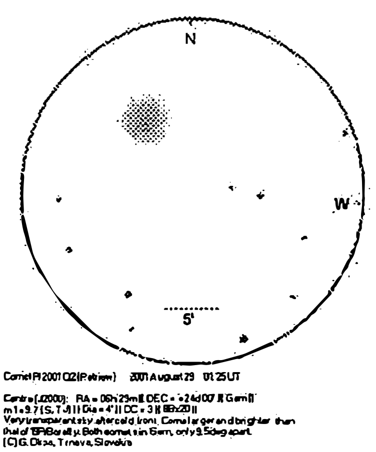
2001 P2 SOHO Discovered by Sebastian Hoenig, the orbit for this SOHO comet published on MPEC 2001-Q02 [2001 August 16] is substantially different from the bulk of the Kreutz group members. Although the comet has a similar perihelion distance to that of the Kreutz group, the inclination, at 130 degrees, is far from the usual value of around 144 degrees and the value of L is around 220 degrees. This is SOHO's 344th comet.

2001 P3 39P/Oterma Y. R. Fernandez, University of Hawaii, reports his recovery of comet 39P on CCD frames obtained on Aug. 13.42 at 22nd mag with the 2.2-m University of Hawaii reflector, confirmatory images being obtained on Aug. 20 and 21 by K. J. Meech and J. Pittichova. The object, a point source, was located about 2' from the prediction by B. G. Marsden on MPC 34423 (ephemeris on MPC 42373). Meech then succeeded in locating the comet on her CCD frames from 1999 May 9 and July 15. M. A. Kadooka and J. M. Bauer assisted, and the measurements by Meech are given on MPEC 2001-Q35. The recovery also confirms the correctness of positions tentatively measured by G. V. Williams from images obtained by D. C. Jewitt, J. X. Luu, and C. A. Trujillo on 1998 May 1 and 22. MPEC 2001-Q35 also includes orbital elements from 227 observations (1942-2001) and a revised ephemeris. Last observed in Aug. 1962, comet 39P passed 0.095 AU from Jupiter on 1963 Apr. 12, after which q increased from 3.4 to 5.5 AU and P from 7.9 to 19 years (with T = 1983 June 18 and 2002 Dec. 22). [IAUC 7689, 2001 August 24]

A/2001 PT13 This is a distant asteroid, with perihelion at 8.5 AU in 1999 February, with a period of 35 years.

2001 Q1 NEAT K. J. Lawrence, E. F. Helin, and S. Pravdo, Jet Propulsion Laboratory, report the discovery by the Near Earth Asteroid Tracking program of a new 19th mag comet on CCD images obtained with the 1.2-m Oschin Schmidt telescope at Palomar on August 17.20 Lawrence notes that the object is diffuse with a nuclear condensation of diameter about 3". Following posting on the NEO Confirmation Page, P. Pravec and P. Kusnirak (Ondrejov 0.65-m reflector) confirmed its cometary appearance on CCD images obtained on Aug. 18.9 UT, and M. Kocer (Klet 0.57-m reflector) reports that the object is diffuse and at m_1 = 18.0 on Aug. 18.9. T. B. Spahr, Minor Planet Center, has also identified the object in data obtained by LONEOS on July 16.2. Full astrometry and parabolic orbital elements appear on MPEC 2001-Q18. [IAUC 7685, 2001 August 18]. The comet is distant and will not get any brighter.

2001 Q2 P/Petriew Vance Avery Petriew, Regina, SK, reported his visual discovery of an 11th mag comet with a round coma of diameter 3' and condensed nucleus and no tail during a star party at Cypress Hills Interprovincial Park, Saskatchewan on August 18.42 using a 0.51-m f/5 reflector at 80x. The object's presence was also confirmed visually by R. Huziak (0.25-m reflector) and P. Campbell (0.32-m reflector) at Cypress Hills. [IAUC 7686, 2001 August 19] Additional astrometry and orbital elements by B. G. Marsden, Smithsonian Astrophysical Observatory, appear on MPEC 2001-Q31. The eccentricity is very uncertain, and the orbit indicates a close approach to Jupiter in 1982. S. Nakano, Sumoto, Japan, has also computed an elliptical orbit and notes the similarity to the orbit of comet 103P. [IAUC 7688, 2001 August 21] The ephemeris suggests that the comet should have been within visual range since July, which suggests that either the comet has recently outburst (or has a steep light curve) or that the morning sky is not being well patrolled by amateur comet hunters.



2001 Q2 drawn by Gabriel Oksa on August 29.

The following is taken from the SPA ENB 2001 August 27 : In centuries past astronomers discovered new comets the old-fashioned way: they peered through telescopes or simply looked toward the sky, hunting for faint smudges that no one had seen before. It was hard work, but lots of people did it. Comets are named after their discoverers, after all, and finding a new one can mean instant fame. Hale-Bopp, Hyakutake and Shoemaker-Levy are just a few of the names we know ... because of comets.

But lately it seems just about every new comet is called "LINEAR" or "NEAT." Those are names, too, but not the names of humans. They're robots -- automated, computer controlled telescopes that scan the skies in a relentless search for near-Earth asteroids and comets. This year between January and mid-August such telescopes recorded 18 new comets, while humans had found none. Comet hunters -- the human kind -- just can't compete! At least that's how many beleaguered sky watchers have been feeling. But now Canadian amateur astronomer Vance Petriew has proved humans can still discover a comet the old-fashioned way.

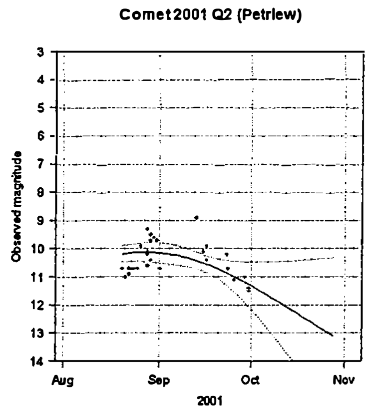
Petriew was at the Saskatchewan Summer Star Party on August 18th when he turned his 20" telescope toward the Crab Nebula. Hopping from one star to another across the constellation Taurus, Petriew guided his telescope toward the famous supernova remnant -- but he never made it. He stopped instead at a curious smudge that appeared unexpectedly in his eyepiece. Thinking it might be a galaxy, he looked at his star charts to see if any were nearby, but there was no galaxy in the vicinity.

Petriew announced his comet discovery hours later, and since then astronomers have been monitoring the newfound comet to learn more about it. Based on data spanning less that a week, it appears that Comet Petriew may be travelling around the Sun once every 5.5 years following an elliptical path that stretches from a point just inside Earth's orbit (0.95 AU) out to the realm of the giant planet Jupiter (5.3 AU).

Says Brian Marsden of the Smithsonian Institution's Minor Planet Center: "We're still not completely sure of the orbital period, but Comet Petriew might have passed close to Jupiter in 1982 -- an encounter that could have nudged the comet into its current orbit." Before 1982 Comet Petriew's orbit was probably bigger than it is now. It couldn't have come so close to Earth in decades past, which might explain why it was never spotted before.

2001 Q2 imaged by Pepe Manteca on August 21.

The comet was a relatively easy object in the morning sky. Observing on August 27.12 with 20cm T x75 I made it 10.1, DC3 and 1.6' diameter, and in 14x100B it was 9.3, DC3 and 4.7' diameter. An observation in mid September suggested that it had changed little in brightness, however it is now fading and is likely to be fainter than 13th magnitude by the end of October. The uncorrected preliminary light curve from 30 observations is m = 10.8 + 5 log d + 20.3 log r



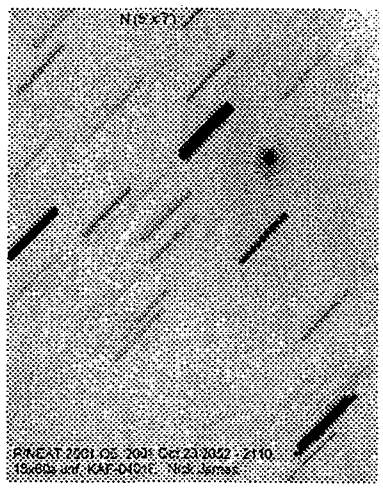
2001 Q3 SOHO This non Kreutz comet was discovered by Chen Hua Dong on SOHO imagery on August 25. Further to IAUC 7689, D. Hammer reports astrometric measurements of a comet found by Chen Dong Hua on SOHO website images. The object was first detected on August 25.34 at mag 8.3 in LASCO C2 coronagraph images, moving southward from directly underneath the occulter; the comet brightened and showed a nice tail before entering the C3 field-of-view, where it began to fade, as indicated by the following additional V magnitudes provided by D. Biesecker and Hammer: Aug. 25.393 UT, 7.6; 25.463, 7.4; 25.977, 5.7; 26.102, 4.8; 26.221, 5.2; 26.227, 4.6; 26.446, 5.8; 26.811, 8.0. [IAUC 7694, 2001 August 28]

2001 Q4 NEAT S. H. Pravdo, E. F. Helin, and K. J. Lawrence, Jet Propulsion Laboratory, report the discovery of a 20th mag comet on CCD images taken on August 24.40 with the 1.2-m Schmidt telescope at Palomar in the course of the NEAT program; their images on Aug. 24, 26, and 27 show a spherically symmetrical nebulosity with diameter about 8". CCD total magnitude estimates: Aug. 27.08 UT, 17.8 (J. Ticha, M. Tichy, and P. Jelinek, Klet Observatory, 0.57-m reflector); Aug. 27.47, 17.3 (P. J. Shelus, McDonald Observatory, 0.76-m reflector). [IAUC 7695, 2001 August 28] The comet was discovered when still over 10 AU from the Sun.

The elements on MPC 43604 give T as mid May 2004, with q of 0.96 AU. The uncertainty in the elements is greater than the precision to which they are given so extrapolation of the comet's position could lead to predictions which are considerably in error. Magnitude parameters are also extremely uncertain. At the moment they suggest an object of perhaps 0 magnitude in early May, though as it brightens it is at high southern declination. Perihelion a little earlier than given by the elements would give a potentially spectacular object in April 2004, whereas a month later the apparition would be fairly average.

2001 Q5 P/LINEAR-NEAT K. J. Lawrence, E. F. Helin, and S. H. Pravdo, Jet Propulsion Laboratory, reported the discovery by the NEAT program of a comet, of 17th mag, having a nuclear condensation of diameter about 6" and a 100" tail toward the southwest, on CCD images taken with the 1.2-m Schmidt telescope at Palomar on Aug. 28.35. Following posting on the NEO Confirmation Page, T. B. Spahr (Minor Planet Center) identified this object with an object reported as asteroidal by the LINEAR program (first detected on Aug. 17.40 at m_2 = 18.6-19.4). Other reported physical descriptions from CCD images include: Aug. 29.04 UT, m_1 = 16.0, tail 50" long in p.a. 237 deg (M. Tichy, Klet, 0.57-m reflector); 29.05, small coma, tail at least 4' long (L. Sarounova, Ondrejov, 0.65-m reflector); 29.08, diffuse (A. Galad and D. Kalmancok, Modra, 0.6-m reflector); 29.30, 40" tail in p.a. 243 deg (K. Smalley, Louisburg, KS, 0.75-m reflector); 29.38, well-condensed coma, broad tail 2' long in p.a. 246 deg (D. Balam, Dominion Astrophysical Observatory, 1.82-m Plaskett telescope); 29.43, m_1 = 16.9, tail about 70" long in p.a. about 240 deg (P. J. Shelus, McDonald Observatory, 0.76-m reflector). Additional astrometry and orbital elements by B. G. Marsden (from 35 observations, Aug. 17-29) appear on MPEC 2001-Q69 [IAUC 7697, 2001 August 29] The comet was at perihelion in June and will not get significantly brighter. It has a period of 6.6 years. This is LINEAR's 65th comet.

2001 Q6 NEAT S. H. Pravdo, E. F. Helin, and K. J. Lawrence, Jet Propulsion Laboratory, report the discovery of another comet, of 18th mag on CCD images taken with the 1.2-m Schmidt telescope at Palomar in the course of the NEAT program; their discovery image on Aug. 28.41 shows a central nebulosity of diameter about 3" and a tail about 10" long toward the west-southwest. Other reported physical descriptions from CCD images include: Aug. 28.98 UT, diffuse (M. Tichy, Klet, 0.57-m reflector); 29.05, diffuse object (m_1 = 16.4) with a bright nucleus, m_2 = 17.9 (L. Sarounova and M. Wolf, Ondrejov, 0.65-m reflector); 29.38, coma diameter about 10" (K. Smalley, Louisburg, KS, 0.75-m reflector); 29.44, well-condensed coma, broad tail 15" long in p.a. 240 deg (D. Balam, Dominion Astrophysical Observatory, 1.82-m Plaskett telescope); 29.47, fuzzy with a hint of a bulge to the southwest (P. J. Shelus, McDonald Observatory, 0.76-m reflector). Additional astrometry and preliminary parabolic orbital elements (from 25 observations, Aug. 28-29) appear on MPEC 2001-Q70. [IAUC 7698, 2001 August 29] Initial observations suggested that the comet could reach 14th mag at high northern declination in October, however it was unexpectedly a couple of magnitudes brighter. This is NEAT's 15th comet and their 13th this year.



P/2001 Q6 imaged by Nick James on October 23.

2001 Q7 SOHO A non Kreutz object of 8th magnitude discovered by R Kracht on C2 images on August 21.

A/2001 QF6 (LINEAR) Discovered by LINEAR on August 16.27, this 19th mag asteroid has a 23 year period, with perihelion at 2.2 AU. It will reach perihelion in February 2002.

A/2001 QL169 (NEAT) Discovered by NEAT on August 17.47, this 20th mag asteroid has a 5.5 year period, with perihelion at 1.53 AU and is just past perihelion. The orbit is typical of a short period comet and makes close approaches to Jupiter. The orbit is not significantly changed by approaches in 1860 (0.74 AU), 1943 (0.74 AU), 2014 (0.78 AU) and 2098 (0.84 AU). [MPEC 2001-R05, 2001 September 1]

2001 R1 P/LONEOS An apparently asteroidal 18th mag (red) object discovered by LONEOS on September 10.19 and posted on the NEO Confirmation Page has been found cometary. It has a period of 7.89 years and will be at perihelion on 2002 January 30. [IAUC 7713, 2001 September 11] It will brighten a little, but will not come within visual range. Improved orbital elements by B. G. Marsden were published on MPEC 2001-S05, including prediscovery observations on Aug. 19 by LINEAR and these indicate that this comet will pass only 0.014 AU from Mars on 2002 Jan. 10.7 TT, as first suggested by C.-I. Lagerkvist (Uppsala) and G. Hahn (German Aerospace Center, Berlin). [IAUC 7720, 2001 September 19]

2001 R6 P/LINEAR-Skiff B. A. Skiff, Lowell Observatory, reports his discovery of a 17th mag comet on CCD images taken by him with the LONEOS telescope on Sept. 25.32. The object shows a moderately condensed 15" coma and a broad tail about 25" toward the west-northwest. T. B. Spahr identified this comet with an object observed on two nights (Sept. 11 and 16, previously linked; m_2 = 19.4-20.0) and reported as asteroidal in appearance by LINEAR; subsequently LINEAR observations from Aug. 19 were also identified. J. G. Ries reports that CCD images obtained with the 0.76-m reflector at McDonald Observatory on Sept. 27.3 UT also show this object to be diffuse. [IAUC 7723, 2001 September 27] The comet has a period of 8.3 years and a perihelion distance of 2.1 AU.

2001 RX14 LINEAR The linkage by the Minor Planet Center of subsequent observations of an apparent 19th mag main-belt minor planet observed by LINEAR on Sept. 10.32 and 11 showed that this object, designated 2001 RX_14 on MPS 34978, had a nearly parabolic orbit. After placement on the NEO Confirmation Page, many further observations were received, with M. Tichy (Klet, 0.57-m f/5.2 reflector + CCD) on Oct. 18.7 UT indicating that the comet appeared to be diffuse with a coma of diameter 13" and red mag 16.7. R-band images taken by C. Hergenrother and J. Barnes (Lunar and Planetary Laboratory) with the 1.54-m Catalina reflector on Oct. 24.32 show a highly condensed coma of diameter 6" and no hint of a tail. [IAUC 7739, 2001 October 26] The comet reaches perihelion at 2.06 AU in January 2003 and could reach 10th magnitude. It will come within visual range in August 2002.

2001 S1 Skiff B. Skiff, Lowell Observatory, reports his discovery of an apparent 20th mag comet on LONEOS telescope images obtained on Sept. 26.4 UT, when the object appeared distinctly less well concentrated than nearby stars (despite poor seeing), with an apparent 17" coma. Observations by R. H. McNaught at Siding Spring on Sept. 26 show a coma barely different from the 2"-3" seeing but with a short tail (< 10" long) in p.a. about 40 deg. J. G. Ries reports that CCD images obtained with the 0.76-m reflector at McDonald Observatory on Sept. 28.4 confirm the northeastward tail of length about 10". [IAUC 7725, 2001 September 29] The comet is distant and past perihelion and will fade.

A/2001 SS287 (LINEAR) A 19th mag asteroid discovered by LINEAR on September 27.41 has a perihelion distance of 1.07 AU and a period of 6.13 in a typical Jupiter family comet orbit. Perihelion is due on Oct. 20.75.

2001 T1 SOHO A non Kreutz object discovered by Xavier Leprette on C2 images on Oct. 9.

2001 T3 P/NEAT K. Lawrence, S. Pravdo, and E. F. Helin, Jet Propulsion Laboratory, report the discovery on October 14.45 by the NEAT program of an 18th mag comet with a faint coma on CCD images taken with the Palomar 1.2-m Schmidt telescope. The object also appears cometary on CCD images taken by P. Pravec and P. Kusnirak at Ondrejov (moderately condensed coma of diameter 0'.2 on Oct. 14.9 UT) and by J. Ticha, M. Tichy, and P. Jelinek at Klet (diffuse 11" coma on Oct. 14.9; 10" coma and m_1 = 17.0 on Oct. 15.8). [IAUC 7733, 2001 October 15] The comet is in a 16 year periodic orbit with perihelion at 2.5 AU. It will fade.

2001 T4 NEAT S. Pravdo, E. F. Helin, M. Hicks, and K. Lawrence, Jet Propulsion Laboratory, report the discovery by the NEAT program of a 20th mag comet with a diffuse coma of diameter about 4" and a southward tail about 10" long on CCD images taken on Oct. 15.35 with the Palomar 1.2-m Schmidt telescope. Additional NEAT images on Oct. 21.4 UT show the comet as very diffuse and faint, elongated east-west. The comet has a perihelion distance of 8.6 AU and a period of 53 years. [IAUC 7738, 2001 October 23]

A/2001 TD45 (LINEAR) is another faint asteroid of 20th magnitude, discovered by LINEAR on October 15.40. It's 0.72 year orbit takes it to within 0.17 AU of the Sun at perihelion and out to the orbit of Mars at aphelion.

A/2001 TX16 (LINEAR) is an asteroid, of 17th magnitude, discovered by LINEAR on October 13. With a period of 6.77 years, the orbit is typical of a Jupiter family comet. There were approaches to Jupiter of 0.80 AU in 1985 and 0.73 AU in 1937. No observer has reported this object to have cometary appearance. [MPEC 2001-U45, 2001 October 25] It reaches perihelion at 1.44 AU in January, so may yet show cometary activity.

A/2001 UO16 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on October 21.26. With a period of 6.13 years, the orbit is typical of a Jupiter family comet. It was at perihelion at the beginning of October.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Introduction

This issue has ephemerides for the comets that are likely to be brighter than 13th magnitude:

- 7P/Pons-Winnecke (UK)
- 19P/Borrelly (UK)
- 22P/Kopff (UK)
- 2000 WM1 (LINEAR) (UK)

The exact magnitudes of 2000 WM1 (LINEAR) and 22P/Kopff are uncertain and may differ from that given here by several magnitudes. Several other comets, including 1999 U4 (Catalina-Skiff), 2000 SV74 (LINEAR), 2001 MD7 (P/LINEAR) and 2001 Q2 (P/Petriew) may be brighter than 14m. 29P/Schwassmann-Wachmann 1 has frequent outbursts and is currently best seen from the Southern Hemisphere. Many comets undergo outbursts and it is worth monitoring all periodic comets that are well placed for observation in case they are in outburst. 96P/Machholz 1 may be visible in SOHO imagery from 2002 January 6 to 10. Current ephemerides for the fainter comets are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are generally for the UK at a latitude of 53° N on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations may be used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for comet 7P/Pons-Winnecke (UK)

Omega=172.2926 OMEGA= 93.4504 i= 22.2848 q= 1.258199 a= 3.437627
e=0.633992 P= 6.374 T= 2002 May 15.7313
Magnitudes calculated from m=10.0+5.0*Log(d)+15.0*Log(r)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
February 2002																
1/ 2	15 37.3	5.56	15 39.7	5.47	14.5	1.56	1.73	6.52	3.39 to 6.17	83	44	78	0	288	16	-1
6/ 7	15 50.6	5.33	15 53.1	5.24	14.3	1.49	1.70	6.45	3.35 to 6.09	84	33	25	1	286	16	-1
11/12	16 4.2	5.10	16 6.7	5.02	14.1	1.42	1.66	6.39	3.32 to 6.01	85	84	0	1	284	16	-1
16/17	16 18.2	4.47	16 20.7	4.40	13.8	1.36	1.63	6.34	3.28 to 5.52	86	134	18	1	282	17	-1
21/22	16 32.4	4.24	16 34.9	4.18	13.6	1.30	1.59	6.28	3.26 to 5.42	87	150	66	1	281	17	-1
26/27	16 47.0	4.02	16 49.5	3.57	13.3	1.24	1.56	6.23	3.23 to 5.31	88	94	100	1	279	18	-1
March 2002																
3/ 4	17 2.0	3.38	17 4.5	3.34	13.1	1.18	1.53	6.18	3.21 to 5.20	89	34	72	1	277	18	-1
8/ 9	17 17.3	3.13	17 19.8	3.10	12.9	1.13	1.49	6.14	3.20 to 5.09	89	44	22	1	275	19	-2
13/14	17 32.9	2.46	17 35.4	2.45	12.6	1.07	1.46	6.10	3.10 to 4.57	90	92	0	1	273	19	-2
18/19	17 48.9	2.17	17 51.4	2.17	12.4	1.03	1.44	6.06	2.58 to 4.44	91	139	20	2	271	19	-2
23/24	18 5.3	1.45	18 7.8	1.45	12.2	0.98	1.41	6.03	2.47 to 4.31	91	143	71	2	269	20	-2
28/29	18 22.0	1.08	18 24.6	1.10	12.0	0.94	1.38	5.60	2.39 to 4.18	91	83	100	2	267	20	-3
April 2002																
2/ 3	18 39.2	0.27	18 41.7	0.30	11.8	0.90	1.36	5.57	2.32 to 4.05	92	29	67	3	265	21	-3
7/ 8	18 56.7	-0.20	18 59.2	-0.16	11.6	0.86	1.34	5.55	2.27 to 3.51	92	48	19	3	263	21	-3
12/13	19 14.5	-1.13	19 17.1	-1.07	11.4	0.82	1.32	5.53	2.24 to 3.37	92	96	0	3	261	22	-4
17/18	19 32.8	-2.12	19 35.4	-2.05	11.2	0.79	1.30	5.52	2.23 to 3.23	92	146	24	4	259	22	-4
22/23	19 51.3	-3.19	19 53.9	-3.11	11.1	0.76	1.29	5.51	2.24 to 3.09	93	138	77	4	258	23	-5
27/28	20 10.1	-4.33	20 12.8	-4.24	10.9	0.73	1.28	5.50	2.27 to 2.54	93	74	99	4	256	23	-6

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
May 2002																
2/ 3	20 29.2	-5.55	20 31.9	-5.44	10.8	0.71	1.27	5.49	2.32 to 2.40	93	19	63	5	255	23	-6

Ephemeris for comet 19P/Borrelly (UK)

Omega=353.3741 OMEGA= 75.4248 i= 30.3244 q= 1.358196 a= 3.611445
e=0.623919 P= 6.863 T= 2001 September 14.7312
Magnitudes calculated from m= 6.8+5.0*Log(d)+19.2*Log(r)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
November 2001																
1/ 2	10 6.6	28.33	10 9.5	28.18	10.6	1.35	1.47	7.24	0.50 to 5.35	76	96	100	5	296	17	4
6/ 7	10 22.5	29.22	10 25.3	29.07	10.8	1.34	1.49	7.20	0.45 to 5.43	78	35	67	5	296	17	4
11/12	10 38.0	30.11	10 40.8	29.55	10.9	1.33	1.51	7.16	0.39 to 5.51	80	39	13	4	297	16	4
16/17	10 53.0	31.00	10 55.7	30.44	11.0	1.32	1.54	7.11	0.34 to 5.59	82	103	3	4	297	16	4
21/22	11 7.4	31.51	11 10.1	31.34	11.1	1.31	1.57	7.06	0.28 to 6.06	85	155	41	4	298	15	4
26/27	11 21.2	32.43	11 23.9	32.26	11.3	1.30	1.59	7.00	0.22 to 6.13	87	135	85	3	297	14	4
December 2001																
1/ 2	11 34.4	33.37	11 37.0	33.20	11.4	1.30	1.62	6.53	0.15 to 6.19	89	78	99	3	297	13	4
6/ 7	11 46.8	34.33	11 49.4	34.17	11.5	1.29	1.65	6.46	0.07 to 6.25	92	26	60	3	296	12	4
11/12	11 58.4	35.33	12 1.0	35.16	11.7	1.29	1.68	6.38	23.59 to 6.30	95	63	9	2	295	11	4
16/17	12 9.2	36.36	12 11.7	36.20	11.8	1.28	1.72	6.29	23.50 to 6.34	97	120	4	2	294	10	5
21/22	12 19.0	37.43	12 21.5	37.26	12.0	1.28	1.75	6.19	23.40 to 6.37	100	149	42	2	292	9	5
26/27	12 27.9	38.53	12 30.4	38.36	12.2	1.28	1.78	6.08	23.29 to 6.39	103	112	87	2	290	8	5
31/32	12 35.7	40.07	12 38.2	39.50	12.3	1.28	1.81	5.56	23.16 to 6.40	106	57	97	1	287	7	6
January 2002																
5/ 6	12 42.5	41.23	12 44.8	41.07	12.5	1.28	1.85	5.43	23.03 to 6.39	109	42	52	1	284	6	6
10/11	12 48.0	42.42	12 50.3	42.26	12.6	1.29	1.88	5.29	22.49 to 6.38	111	90	6	1	281	5	6
15/16	12 52.2	44.03	12 54.5	43.47	12.8	1.29	1.92	5.14	22.34 to 6.35	114	133	5	1	276	3	6
20/21	12 55.1	45.25	12 57.4	45.09	13.0	1.30	1.95	4.57	22.10 to 6.31	117	130	43	1	272	2	6
25/26	12 56.5	46.45	12 58.8	46.29	13.1	1.31	1.99	4.38	21.43 to 6.26	120	85	89	1	267	1	6
30/31	12 56.5	48.04	12 58.8	47.47	13.3	1.32	2.02	4.19	21.14 to 6.19	122	44	94	1	261	0	6
February 2002																
4/ 5	12 55.0	49.18	12 57.3	49.02	13.5	1.34	2.06	3.57	20.45 to 6.12	124	72	46	1	254	-1	6
9/10	12 52.1	50.26	12 54.4	50.10	13.6	1.36	2.10	3.35	20.14 to 6.04	126	117	5	0	247	-2	5
14/15	12 47.8	51.27	12 50.0	51.10	13.8	1.38	2.13	3.11	19.42 to 5.55	128	134	6	0	239	-3	5
19/20	12 42.2	52.17	12 44.5	52.01	14.0	1.41	2.17	2.46	19.10 to 5.46	129	102	45	0	231	-4	4
24/25	12 35.5	52.57	12 37.9	52.40	14.2	1.44	2.20	2.19	18.51 to 5.36	130	56	92	0	222	-5	3

Ephemeris for comet 22P/Kopff (UK)

Omega=162.7598 OMEGA=120.9223 i= 4.7187 q= 1.583627 a= 3.467589
e=0.543306 P= 6.457 T= 2002 December 12.0996

Magnitudes calculated from m= 6.6+5.0*Log(d)+12.5*Log(r)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
March 2002																
1/ 2	12 18.2	4.14	12 20.8	3.58	13.9	1.99	2.93	1.42	22.42 to 4.42	157	16	90	0	280	-4	2
6/ 7	12 15.0	4.46	12 17.6	4.29	13.8	1.94	2.90	1.19	22.16 to 4.23	163	86	40	0	274	-4	2
11/12	12 11.3	5.19	12 13.9	5.03	13.7	1.89	2.87	0.56	21.48 to 4.04	168	148	3	0	263	-4	2
16/17	12 7.3	5.54	12 9.9	5.37	13.6	1.85	2.84	0.32	21.21 to 3.44	173	151	7	0	236	-5	2
21/22	12 3.0	6.29	12 5.6	6.12	13.5	1.82	2.81	0.08	20.53 to 3.24	173	88	49	0	183	-5	2
26/27	11 58.6	7.03	12 1.2	6.46	13.4	1.80	2.78	23.44	20.25 to 3.04	169	16	96	0	150	-5	2
31/32	11 54.2	7.35	11 56.7	7.19	13.4	1.78	2.75	23.20	19.58 to 2.43	164	60	86	0	136	-5	2
April 2002																
5/ 6	11 49.8	8.06	11 52.4	7.49	13.3	1.77	2.72	22.56	20.09 to 2.22	158	127	37	0	130	-5	2
10/11	11 45.7	8.33	11 48.2	8.16	13.2	1.77	2.70	22.32	20.20 to 2.01	152	172	3	0	126	-5	2
15/16	11 41.9	8.56	11 44.4	8.39	13.2	1.77	2.67	22.09	20.31 to 1.40	147	111	9	0	123	-4	1
20/21	11 38.5	9.14	11 41.1	8.58	13.1	1.78	2.64	21.46	20.43 to 1.19	141	45	55	0	121	-4	1
25/26	11 35.7	9.29	11 38.2	9.12	13.1	1.79	2.61	21.23	20.56 to 0.58	135	29	99	1	120	-3	1
30/31	11 33.4	9.38	11 36.0	9.21	13.0	1.81	2.58	21.01	21.09 to 0.37	130	102	82	1	119	-2	0

Ephemeris for comet 2000 WM1 (LINEAR) (UK)

Omega=276.7703 OMEGA=237.8971 i= 72.5508 q= 0.555391 a=**********
e=1.000267 P=********* T= 2002 January 22.6837
Magnitudes calculated from m= 8.1+5.0*Log(d)+ 8.4*Log(r)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
November 2001																
1/ 2	4 25.0	48.53	4 28.8	48.60	9.6	0.82	1.69	1.44	17.52 to 5.35	138	38	100	5	226	-11	-6
6/ 7	4 8.6	47.05	4 12.2	47.13	9.1	0.70	1.61	1.07	17.44 to 5.43	145	50	67	6	216	-14	-9
11/12	3 46.5	44.04	3 50.0	44.13	8.5	0.59	1.53	0.25	17.37 to 5.51	152	116	13	6	201	-19	-15
16/17	3 18.2	39.03	3 21.5	39.13	7.9	0.49	1.46	23.37	17.31 to 5.59	160	152	3	7	175	-27	-25
21/22	2 43.6	30.46	2 46.6	30.59	7.3	0.40	1.38	22.43	17.26 to 6.06	162	90	41	9	124	-37	-41
26/27	2 4.2	17.59	2 6.9	18.13	6.7	0.34	1.29	21.43	17.22 to 4.35	151	19	85	20	79	-46	-63
December 2001																
1/ 2	1 22.6	1.09	1 25.2	1.25	6.3	0.32	1.21	20.42	17.19 to 2.06	130	65	99	40	62	-51	-84
6/ 7	0 42.1	-15.57	0 44.6	-15.41	6.2	0.33	1.13	19.41	17.17 to 23.26	108	148	60	60	59	-48	-85
11/12	0 5.0	-29.30	0 7.5	-29.13	6.2	0.38	1.05	18.45	17.31 to 19.58	89	122	9	70	64	-40	-67
16/17	23 31.8	-38.54	23 34.5	-38.38	6.2	0.45	0.97	17.52	Not Observable	75	53	4	74	72	-32	-47
21/22	23 2.0	-45.15	23 4.9	-44.58	6.3	0.53	0.89	17.02	Not Observable	64	37	42	78	82	-26	-31

26/27	22 34.3	-49.33	22 37.3	-49.17	6.3	0.61	0.81	16.15	Not Observable	55	90	87	82	94	-22	-21
31/32	22 7.2	-52.26	22 10.5	-52.11	6.2	0.69	0.74	15.29	Not Observable	49	144	97	89	107	-20	-14
January	2002															
5/ 6	21 39.9	-54.10	21 43.3	-53.56	6.1	0.78	0.67	14.42	Not Observable	43	112	52	98	121	-20	-8
10/11	21 12.0	-54.49	21 15.6	-54.37	6.0	0.85	0.62	13.54	Not Observable	38	54	6	106	138	-20	-3
15/16	20 44.7	-54.20	20 48.4	-54.09	5.9	0.93	0.58	13.07	Not Observable	35	38	5	111	156	-19	2
20/21	20 19.9	-52.41	20 23.6	-52.31	6.0	1.00	0.56	12.23	Not Observable	33	86	43	108	175	-18	8
25/26	19 59.6	-49.60	20 3.3	-49.51	6.1	1.06	0.56	11.43	Not Observable	32	143	89	97	193	-16	13
30/31	19 44.7	-46.33	19 48.3	-46.25	6.4	1.11	0.59	11.08	Not Observable	32	128	94	81	210	-12	17
February	2002															
4/ 5	19 34.8	-42.38	19 38.3	-42.31	6.7	1.15	0.63	10.39	Not Observable	33	61	46	64	225	-9	19
9/10	19 28.6	-38.32	19 32.0	-38.25	7.1	1.18	0.69	10.13	Not Observable	36	16	5	50	237	-6	20
14/15	19 25.0	-34.22	19 28.3	-34.15	7.5	1.20	0.76	9.49	Not Observable	39	67	6	39	246	-3	20
19/20	19 22.9	-30.13	19 26.1	-30.06	7.9	1.22	0.84	9.27	Not Observable	43	126	45	31	253	-2	20
24/25	19 21.7	-26.06	19 24.8	-25.60	8.2	1.23	0.92	9.06	Not Observable	47	166	92	25	258	-1	20
March	2002															
1/ 2	19 20.9	-22.01	19 23.9	-21.55	8.5	1.23	1.00	8.46	Not Observable	52	90	90	20	262	0	20
6/ 7	19 20.1	-17.59	19 23.0	-17.53	8.8	1.24	1.08	8.25	Not Observable	57	22	40	17	265	0	20
11/12	19 19.2	-13.57	19 22.0	-13.51	9.1	1.24	1.16	8.04	4.58 to 5.02	61	41	3	14	266	-1	20
16/17	19 17.8	-9.56	19 20.5	-9.50	9.3	1.24	1.24	7.43	4.13 to 4.49	66	99	7	12	267	-1	20
21/22	19 15.8	-5.55	19 18.4	-5.49	9.6	1.24	1.32	7.21	3.29 to 4.37	72	154	49	10	268	-2	20
26/27	19 13.0	-1.55	19 15.6	-1.49	9.8	1.24	1.40	6.59	2.47 to 4.24	77	124	96	9	267	-3	20
31/32	19 9.5	2.04	19 12.0	2.10	10.0	1.24	1.48	6.35	2.05 to 4.10	82	56	86	7	266	-4	19
April	2002															
5/ 6	19 5.1	6.01	19 7.5	6.06	10.2	1.25	1.56	6.11	1.24 to 3.57	87	34	37	6	264	-5	19
10/11	18 59.6	9.53	19 1.9	9.58	10.4	1.25	1.64	5.46	0.42 to 3.43	92	79	3	5	261	-6	19
15/16	18 53.0	13.39	18 55.3	13.43	10.6	1.27	1.71	5.20	0.01 to 3.29	97	126	9	4	258	-7	18
20/21	18 45.4	17.15	18 47.6	17.18	10.8	1.29	1.79	4.52	23.20 to 3.14	102	131	55	4	254	-9	17
25/26	18 36.6	20.38	18 38.8	20.41	11.0	1.31	1.87	4.24	22.40 to 3.00	106	81	99	3	248	-10	16
30/31	18 26.9	23.45	18 28.9	23.47	11.2	1.34	1.94	3.54	21.60 to 2.46	110	49	82	3	242	-11	15

Format for electronic submission of observations

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

TA format (examples)

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T     fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R     18 290                        Shanklin
970328.89 S   9.5  NP  20   T     10  75  2.5   2                Shanklin
961214.70 S   3.8  AA   8   B         20  6     7/  0.50    40   Baroni
```

ICQ format (examples)

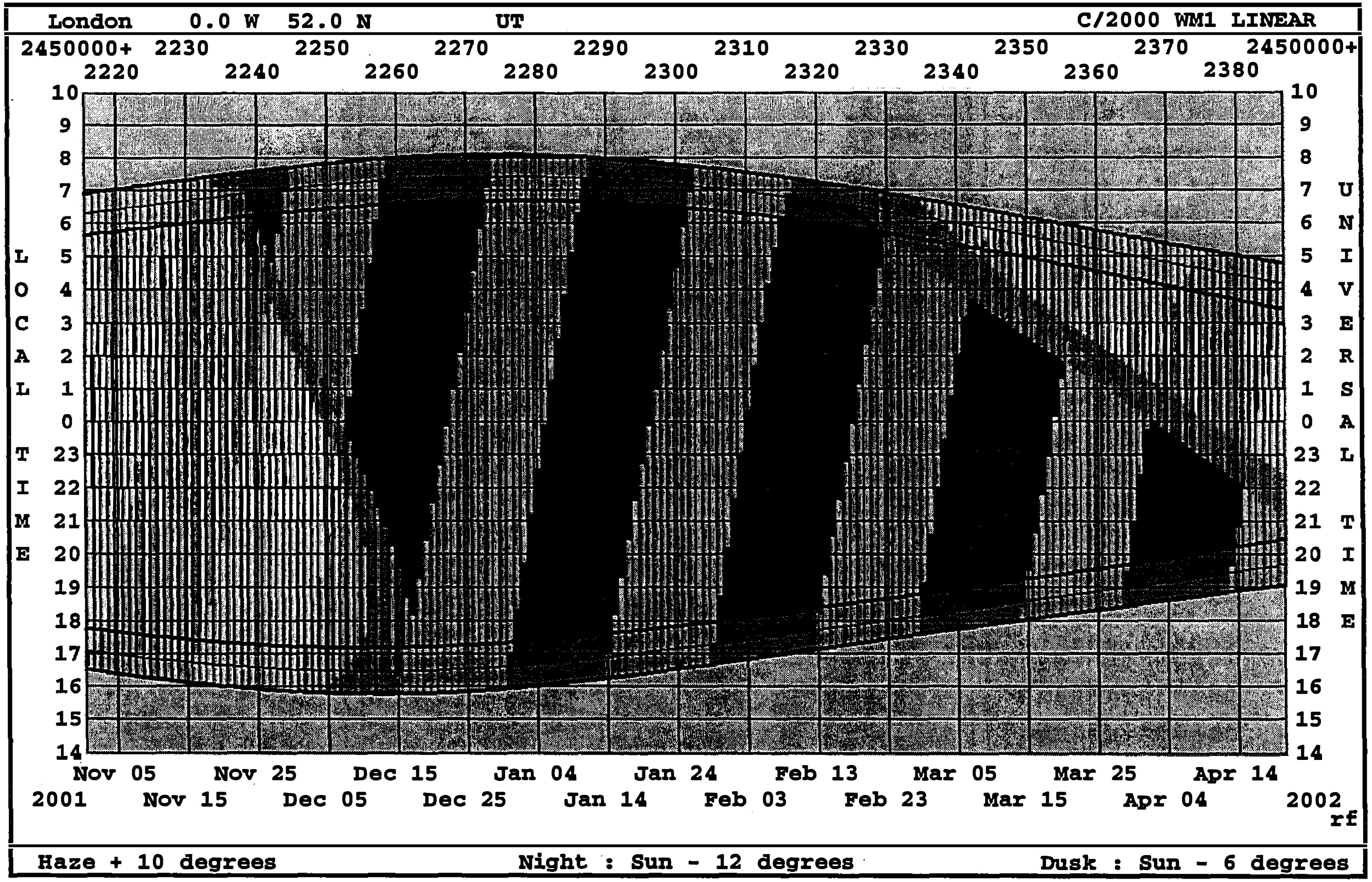
```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
   1992F1  1992  5 18.94  S  9.3 AA  7.5R     50    6    4          135 ICQ XX BEA
  1        1985 11 16.04  S  6.9 AA 20  R14   40    6    s7    0.12 130 ICQ 59 SHA02
   1999T2  2001  1 28.25 Comet possibly seen at mag 13.6 (S, HS) in 20cm f10 T x120, with
coma 1.0' DC 1.
   1999T1  2001  1 28.25 Possible tail 5' long in pa 345.
```

Charts

The visibility diagram shows when the moon interferes with observations of 2000 WM1 (LINEAR) and was produced using software written by Richard Fleet. There is no moon in the dark regions and the moon will interfere in the light regions. 2000 WM1 is visible virtually all night until the end of November but is rapidly moving south and becomes a Southern Hemisphere object, reappearing in the morning sky in early March. Although the comet is lost to UK observers between mid December and early March it will be visible from the Southern Hemisphere during this period.

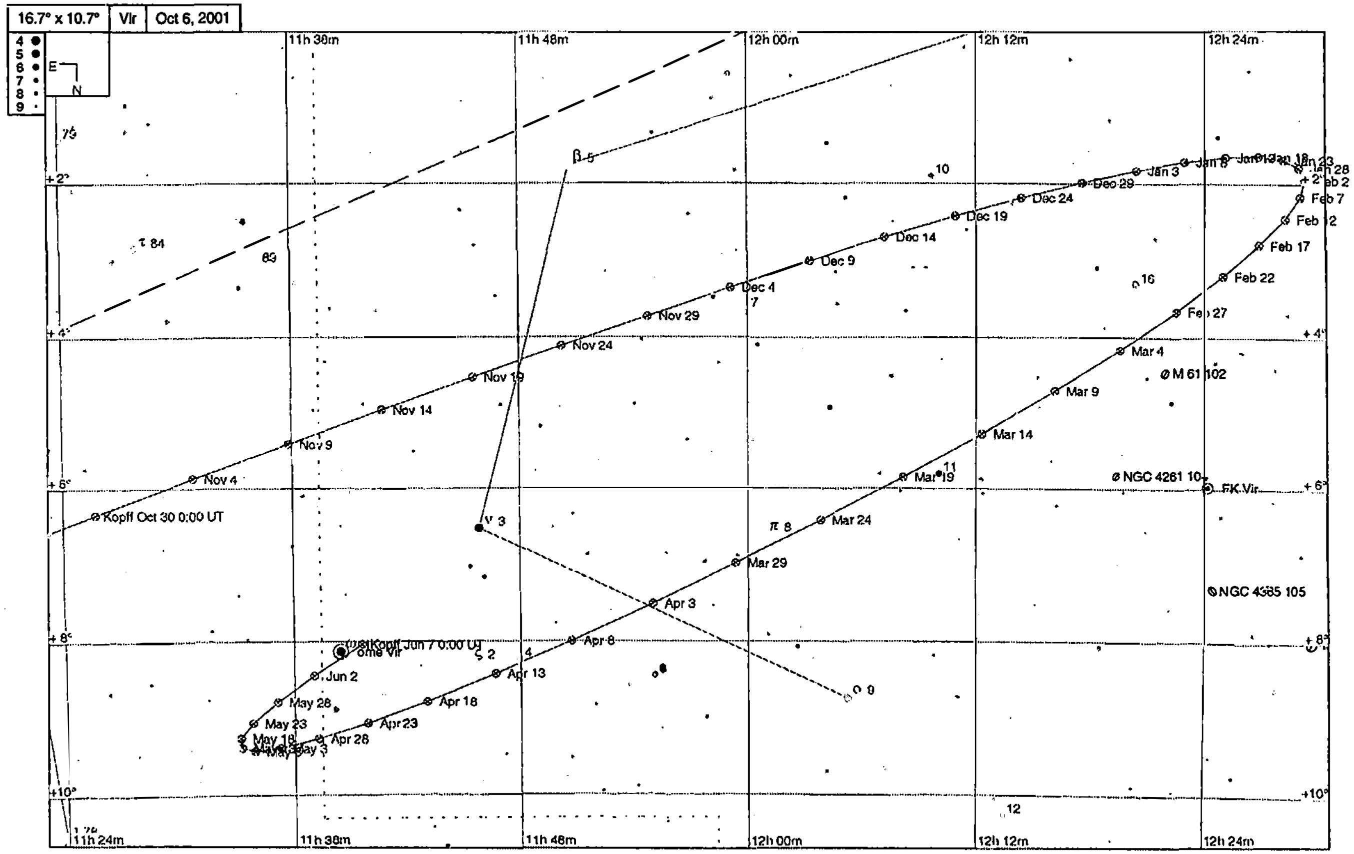
If you would like your own copy of Richard's software it is available at http://www.naas.btinternet.co.uk

The finder chart shows the location of 22P/Kopff and was produced using the Beta version of Megastar 8.



London 0.0 W 52.0 N UT C/2000 WM1 LINEAR
2450000+ 2230 2250 2270 2290 2310 2330 2350 2370 2450000+
2220 2240 2260 2280 2300 2320 2340 2360 2380
10 9 8 7 6 5 4 3 2 1 0 23 22 21 20 19 18 17 16 15 14
LOCAL TIME
UNIVERSAL TIME
Nov 05 Nov 25 Dec 15 Jan 04 Jan 24 Feb 13 Mar 05 Mar 25 Apr 14
2001 Nov 15 Dec 05 Dec 25 Jan 14 Feb 03 Feb 23 Mar 15 Apr 04 2002
rf
Haze + 10 degrees
Night : Sun - 12 degrees
Dusk : Sun - 6 degrees

Finder chart for 22P/Kopff



22P/Kopff

Name	Number	T	q	e	w	W	i	H1	K1	Epoch	Source
d'Arrest	6P	2002 02 03.5971	1.352733	0.612835	178.1158	138.9450	19.4969	7.5	40.0	2000	MPC 34422
Pons-Winnecke	7P	2002 05 15.7313	1.258199	0.633992	172.2926	93.4504	22.2848	10.0	15.0	2000	MPC 34422
Finlay	15P	2002 02 07.1654	1.034089	0.710564	323.6361	41.9657	3.6745	12.0	10.0	2000	CCO 13
Brooks 2	16P	2001 07 19.8513	1.834918	0.492014	198.1163	176.9121	5.5480	7.5	25.0	2000	MPC 43333
Borrelly	19P	2001 09 14.7312	1.358196	0.623919	353.3741	75.4248	30.3244	4.5	25.0	2000	MPC 31664
Kopff	22P	2002 12 12.1441	1.583831	0.543080	162.7627	120.9288	4.7184	3.0	26.0	2000	MPC 34423
Schaumasse	24P	2001 05 02.6646	1.205045	0.704845	57.8789	79.8310	11.7515	6.5	35.0	2000	MPC 31663
Grigg-Skjellerup	26P	2002 11 29.6212	1.116627	0.633137	1.5863	211.8172	22.3679	12.0	40.0	2000	MPC 34423
Neujmin 1	28P	2002 12 27.3886	1.551339	0.775641	346.9368	347.0476	14.1866	8.5	15.0	2000	MPC 34424
Schwassmann-Wachmann 1	29P	2004 07 18.2922	5.721089	0.045241	49.5313	312.7271	9.3921	4.0	10.0	2000	MPC 42666
Schwassmann-Wachmann 2	31P	2002 01 18.5037	3.408558	0.195937	18.4049	114.1929	4.5489	5.0	20.0	2000	MPC 41899
Wirtanen	46P	2002 08 26.9517	1.058985	0.657900	356.3805	82.1770	11.7384	9.0	15.0	2000	MPC 34423
du Toit-Neujmin-Delporte	57P	2002 07 31.2085	1.729253	0.499033	115.2591	188.9377	2.8444	12.5	15.0	2000	MPC 34422
Shajn-Schaldach	61P	2001 05 09.0671	2.330136	0.389939	216.6544	166.8650	6.0837	6.0	25.0	2000	MPC 31664
Gunn	65P	2003 05 11.9367	2.447093	0.318170	196.3455	68.4203	10.3846	5.0	15.0	2000	MPC 40670
Churyumov-Gerasimenko	67P	2002 08 18.2855	1.292507	0.631586	11.4283	50.9754	7.1205	11.0	10.0	2000	MPC 34423
Schwassmann-Wachmann 3-E	73P	2001 01 28.4379	0.937653	0.693908	198.7722	69.9216	11.4064	12.0	15.0	2000	MPC 41717
Smirnova-Chernykh	74P	2001 01 16.1678	3.545932	0.148699	86.7324	77.1581	6.6523	5.0	15.0	2000	MPC 31662
Kohoutek	75P	2001 02 27.2924	1.787238	0.495966	175.6699	269.6831	5.9102	10.5	10.0	2000	MPC 31663
Longmore	77P	2002 09 04.5370	2.310137	0.358263	196.3713	14.9880	24.3999	7.0	20.0	2000	CCO 13
Gehrels 3	82P	2001 09 02.5754	3.626592	0.125219	227.8844	239.6797	1.1270	5.0	20.0	2000	MPC 31664
Wild 3	86P	2001 06 18.5634	2.310239	0.364463	179.1494	72.6126	15.4385	11.0	15.0	2000	MPC 31664
Russell 2	89P	2002 03 22.9529	2.289992	0.397903	249.2286	42.4871	12.0286	11.5	15.0	2000	CCO 13
Gehrels 1	90P	2002 06 22.9177	2.965713	0.509007	28.1729	13.5290	9.6156	8.5	15.0	2000	MPC 34422
Sanguin	92P	2002 09 23.0571	1.807102	0.663490	163.0524	182.3609	18.7646	12.0	15.0	2000	MPC 34423
Chiron	95P	1996 02 04.2835	8.433400	0.380160	339.0073	209.3696	6.9393	6.5	5.0	2000	CCO 13
Machholz 1	96P	2002 01 08.6326	0.124123	0.959166	14.5637	94.6087	60.1868	13.0	12.0	2000	MPC 34422
Metcalf-Brewington	97P	2001 04 14.8196	2.610501	0.456851	229.7125	186.3855	17.9824	5.5	15.0	2000	MPC 41159
Wilson-Harrington	107P	2001 03 26.6454	1.000502	0.621582	91.0805	270.8269	2.7842	15.5	5.0	2000	CCO 13
Hartley 3	110P	2001 03 21.2280	2.478198	0.314151	167.8895	287.7538	11.6907	1.0	30.0	2000	MPC 31663
Maury	115P	2002 12 23.9860	2.041167	0.520608	119.9122	176.7635	11.6841	10.5	15.0	2000	MPC 34424
Mrkos	124P	2002 07 27.0302	1.466814	0.542757	181.2348	1.4137	31.3516	13.5	7.0	2000	MPC 34422
Spacewatch	125P	2002 01 28.0555	1.528595	0.511463	87.3019	153.2378	9.9816	13.0	15.0	2000	MPC 34422
Elst-Pizarro	133P	2001 11 23.7099	2.635391	0.165379	133.0071	160.2315	1.3855	9.0	10.0	2000	unp
Kushida	144P	2001 06 27.6881	1.431277	0.628911	216.0195	245.6233	4.1187	8.5	20.0	2000	MPC 41159
Kushida-Muramatsu	147P	2001 04 28.9267	2.751925	0.277022	347.3615	93.7526	2.3678	14.0	10.0	2000	MPC 41527
Anderson-LINEAR	148P	2001 05 01.9455	1.693675	0.539315	6.7131	89.8003	3.6824	16.0	5.0	2000	MPC 41899
Mueller 4	149P	2001 02 07.9298	2.646719	0.388817	43.6312	145.3622	29.7481	8.0	20.0	2000	MPC 42109
LONEOS	150P	2001 03 23.3493	1.761764	0.546712	245.5108	272.5514	18.5201	13.5	10.0	2000	MPC 42548
Helin	151P	2001 09 23.7223	2.530771	0.565560	215.4229	143.5369	4.7171	10.0	15.0	2000	MPC 43021
Shoemaker 3	P/1986 A1	2002 12 15.0515	1.814165	0.726474	14.9349	97.2711	6.3865	10.0	12.0	2000	MPC 34423
Helin-Lawrence	P/1993 K2	2002 12 22.7463	3.109916	0.307223	163.7452	92.0130	9.8717	10.0	8.0	2000	MPC 34423
Skiff	C/1999 J2	2000 04 05.7375	7.109068	1.002678	127.1111	50.0479	86.4015	2.0	10.0	2000	MPC 41897
LINEAR	C/1999 K5	2000 07 04.4232	3.256508	1.001160	241.5143	106.3835	89.4754	6.0	10.0	2000	MPC 41897
LINEAR	C/1999 K8	2000 04 24.6446	4.202324	1.001194	164.7001	195.3832	52.7025	5.0	10.0	2000	MPC 41524
LINEAR	C/1999 L3	2000 01 04.7782	1.985973	0.974240	353.5151	140.4736	166.1080	10.0	10.0	2000	MPC 37478
LINEAR	C/1999 N4	2000 05 23.2432	5.503664	1.003941	90.4015	345.9276	156.9177	6.0	10.0	2000	MPC 42547
LINEAR	C/1999 S4	2000 07 26.1457	0.764565	0.999522	151.0084	83.1940	149.3907	9.0	10.0	2000	MPC 40988
McNaught-Hartley	C/1999 T1	2000 12 13.4567	1.171601	0.999688	344.7461	182.4743	79.9740	5.0	10.0	2000	MPC 42106
LINEAR	C/1999 T2	2000 11 24.4525	3.037284	1.002132	104.6666	14.8859	110.9941	6.0	10.0	2000	MPC 41525
LINEAR	C/1999 T3	2000 09 01.9895	5.366535	0.996711	211.3710	223.5153	104.7553	6.0	10.0	2000	MPC 41897
Catalina-Skiff	C/1999 U4	2001 10 28.4591	4.915310	1.007678	77.5125	32.2886	51.9258	4.5	10.0	2000	MPC 43603
Korlevic	P/1999 WJ7	2000 02 16.1365	3.168874	0.315953	154.6302	290.5257	2.9797	14.5	5.0	2000	MPC 41716
LINEAR	P/1999 XB69	2000 02 17.1848	1.639732	0.632298	220.2324	256.1632	11.3366	17.5	5.0	2000	MPC 39023
Catalina	P/1999 XN120	2000 05 01.7146	3.287168	0.212344	161.8785	285.4540	5.0322	13.5	5.0	2000	MPC 39023
LINEAR	C/1999 Y1	2001 03 24.1525	3.091281	1.000754	184.2971	188.8867	134.7890	5.5	10.0	2000	MPC 41525
Montani	C/2000 A1	2000 07 15.4506	9.744357	1.005603	14.3759	111.8278	24.5348	3.5	10.0	2000	MPC 41716
LINEAR	P/2000 B3	2000 02 14.3195	1.700483	0.575541	130.5759	352.1196	11.1235	16.0	10.0	2000	MPC 40668

LINEAR	C/2000 B4	2000 06	15.9223	6.830824	0.621791	126.2118	0.6411	15.9040	11.5	5.0	2000 MPC 41897
Hergenrother	P/2000 C1	2000 03	19.9036	2.094434	0.406799	51.1406	127.0337	6.1067	14.0	10.0	2000 MPC 40669
LINEAR	C/2000 CT54	2001 06	19.5010	3.156012	0.998510	272.6522	18.9616	49.2072	11.0	5.0	2000 MPC 43018
LINEAR	C/2000 D2	2000 03	08.6123	2.297627	0.867110	117.6825	235.8874	156.9918	15.0	5.0	2000 MPC 40669
LINEAR	P/2000 G1	2000 03	09.8919	1.001753	0.672320	343.2800	191.0028	10.3797	19.5	5.0	2000 MPC 41159
LINEAR	C/2000 G2	2000 02	06.1533	2.716730	0.809007	101.7505	328.3872	170.4791	11.5	10.0	2000 MPC 40669
LINEAR	C/2000 H1	2000 01	28.8754	3.636630	1.000000	78.7991	356.4441	118.2393	9.5	10.0	2000 MPC 40823
Ferris	C/2000 J1	2000 05	11.2734	2.542012	0.954614	147.2079	28.4294	98.7830	15.5	5.0	2000 MPC 40823
LINEAR	C/2000 K2	2000 10	11.3398	2.437372	0.995135	106.8292	195.2600	25.6340	11.0	10.0	2000 MPC 41898
Koehn	C/2000 O1	2000 01	28.5320	5.923848	1.000444	55.2398	88.8837	148.1050	6.0	10.0	2000 MPC 41159
Spacewatch	C/2000 OF8	2001 08	04.7711	2.173131	1.001717	256.0663	117.0932	152.4364	9.5	10.0	2000 MPC 43018
LINEAR	P/2000 R2	2000 09	12.9973	1.387775	0.584849	147.2446	187.3061	3.2157	18.0	10.0	2000 MPC 41716
Skiff	P/2000 S1	2000 07	15.1875	2.516595	0.619413	308.6533	29.0888	20.9768	10.0	10.0	2000 MPC 41716
LONEOS	C/2000 S3	2000 07	16.7266	2.665078	0.773413	298.4228	41.1331	25.1322	12.0	10.0	2000 MPC 41898
LINEAR-Spacewatch	P/2000 S4	2000 10	19.1028	2.265372	0.681903	172.3258	174.6453	28.3258	17.5	5.0	2000 MPC 41526
LINEAR	C/2000 SV74	2002 04	30.4225	3.541328	1.004924	76.2236	24.1850	75.2367	5.5	10.0	2000 MPC 43018
LINEAR	C/2000 U5	2000 03	13.3946	3.481439	1.007519	298.9186	65.2874	93.4155	7.0	10.0	2000 MPC 42547
Tichy	P/2000 U6	2000 10	04.3024	2.153680	0.431281	11.7760	24.3898	19.3648	13.5	10.0	2000 MPC 42106
Utsunomiya-Jones	C/2000 W1	2000 12	26.5593	0.321180	1.000000	51.5091	10.7661	160.1654	10.5	10.0	2000 MPC 42106
LINEAR	C/2000 WM1	2002 01	22.6837	0.555391	1.000267	276.7703	237.8971	72.5508	6.5	10.0	2000 MPC 43018
Tubbiolo	C/2000 Y1	2001 02	03.2051	7.974145	1.000135	181.7987	239.3940	137.9609	11.0	5.0	2000 MPC 42547
Skiff	C/2000 Y2	2001 03	21.8602	2.768816	0.994548	326.8332	185.8477	12.0868	11.0	10.0	2000 MPC 43018
Scotti	P/2000 Y3	2000 10	29.6031	4.046586	0.196538	88.4361	354.9575	2.2502	9.0	10.0	2000 MPC 42547
LINEAR	C/2001 A1	2000 09	17.6000	2.406608	0.990665	107.8905	339.5956	59.9339	10.5	10.0	2000 MPC 42547
LINEAR	C/2001 A2	2001 05	24.5173	0.778956	0.999252	295.3207	295.1255	36.4767	7.0	10.0	2000 MPC 43603
LINEAR	C/2001 B1	2000 09	19.4021	2.928651	1.001333	284.8519	49.8430	104.0996	9.0	10.0	2000 MPC 43332
NEAT	C/2001 B2	2000 09	01.7669	5.306545	1.001625	304.7578	145.0969	150.6003	4.0	10.0	2000 MPC 42665
LINEAR-NEAT	P/2001 BB50	2001 01	30.4420	2.346787	0.587127	189.3511	355.8094	10.6167	13.0	10.0	2000 MPC 42665
LINEAR	C/2001 C1	2002 03	28.3425	5.104658	0.999758	219.9391	33.7150	68.9573	6.0	10.0	2000 MPC 42665
LINEAR	P/2001 CV8	2001 02	12.3486	2.152189	0.445276	151.4526	359.9505	9.0419	13.0	10.0	2000 MPC 42665
NEAT	P/2001 F1	2000 11	22.0873	4.152674	0.356377	80.7305	92.8352	19.0872	8.5	10.0	2000 MPC 43160
LONEOS	C/2001 G1	2001 10	02.0132	8.242835	1.000000	342.8590	203.8703	45.3969	3.5	10.0	2000 MPC 42856
NEAT	P/2001 H5	2001 01	28.7086	2.396554	0.600325	224.8828	329.5566	8.3994	12.0	10.0	2000 MPC 43019
LINEAR-NEAT	C/2001 HT50	2003 07	08.7975	2.804298	1.000000	323.8007	42.8812	163.2401	4.5	10.0	2000 MPC 42856
NEAT	P/2001 J1	2001 03	14.1116	0.937161	0.758345	271.0356	200.7934	10.1590	16.0	10.0	2000 MPC 42856
NEAT	P/2001 K1	2000 11	06.9508	2.470447	0.357681	94.6565	84.8371	16.9129	11.0	10.0	2000 MPC 43160
Skiff	C/2001 K3	2001 04	22.8483	3.059995	0.998727	3.4453	289.8505	52.0267	8.5	10.0	2000 MPC 43332
LINEAR	C/2001 K5	2002 10	11.9576	5.182734	0.999689	47.0881	237.4687	72.5976	4.0	10.0	2000 MPC 43333
LINEAR	P/2001 MD7	2001 11	30.1329	1.254292	0.684102	244.8465	129.1686	13.5242	12.0	10.0	2000 MPC 43603
NEAT	C/2001 M10	2001 06	20.7549	5.297901	0.801654	5.4367	293.9021	28.0348	8.0	10.0	2000 MPC 43333
LINEAR	C/2001 N2	2002 08	19.6760	2.668650	1.001063	151.8926	52.7998	138.5435	7.5	10.0	2000 MPC 43603
NEAT	C/2001 O2	1999 10	17.4738	4.831881	0.997494	281.0660	328.7027	90.9942	6.0	10.0	2000 MPC 43603
NEAT	C/2001 Q1	2001 09	20.9829	5.834051	0.966105	175.4726	139.2614	66.9497	7.0	10.0	2000 MPC 43603
Petriew	P/2001 Q2	2001 09	01.9219	0.945714	0.696333	181.9007	214.1102	13.9451	11.0	10.0	2000 MPC 43604
NEAT	C/2001 Q4	2005 08	25.340	4.09424	1.00000	325.884	218.402	108.688	3.5	10.0	2000 MPC 43333
NEAT	C/2001 Q4	2004 05	16.1305	0.957628	1.000000	1.3161	210.1286	99.4745	3.5	10.0	2000 MPC 43604
LINEAR-NEAT	P/2001 Q5	2001 06	11.6026	2.042768	0.416655	6.3857	336.2611	10.9435	12.0	10.0	2000 MPC 43604
NEAT	P/2001 Q6	2001 11	09.4615	1.408224	0.824146	43.3267	22.1380	56.8593	13.5	10.0	2000 MPC 43604
LONEOS	P/2001 R1	2002 02	17.5576	1.360379	0.608828	24.7459	35.4848	7.0415	14.0	10.0	2000 MPC 43604
LINEAR-Skiff	P/2001 R6	2001 10	26.6685	2.115233	0.485675	305.9956	70.3547	17.3387	13.0	10.0	2000 MPC 43604
Skiff	C/2001 S1	2001 05	22.970	3.73250	1.00000	282.301	329.478	139.399	9.0	10.0	2000 MPC 43604

Source: CBAT web pages. H1 and K1 are also from the CBAT; alternative values are given in the main section and on the Section web pages.

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you use the correct format.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TK (Tycho 2), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA. Do not report tail details unless you are certain of their reality.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

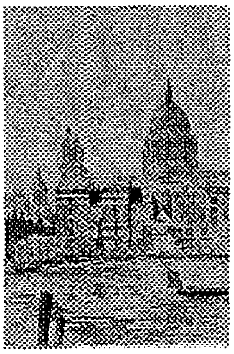
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	[illegible]	[illegible]	[illegible]	[illegible]	Comments



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 9, No 1 (Issue 17), 2002 April

JOEL HASTINGS METCALF MINISTER, HUMANITARIAN, ASTRONOMER

Richard R Didick

Joel Hastings Metcalf was born in Meadville, Pennsylvania, on January 4th, 1866, the son of Lewis Herbert and Anna (Hicks) Metcalf. Lewis was a Civil War Veteran, a soldier who lost a leg at the first battle of "Bull Run" and was held at Libby prison until exchanged and discharged.

At the approximate age of 14, Joel Metcalf borrowed Richard Proctor's book, *Other Worlds Than Ours*, from his Sunday school library which led him to an interest in astronomy. This interest was further inspired by the conjunction of Jupiter and Mars on May 7th, 1879, when the planets were slightly over one degree apart, and/or July 22nd, 1881, when the two planets were separated by only seven minutes of arc.

It is said that he made his first telescope at the age of 14. Though he does not give his age, this version of his experience in making a telescope is taken from his own article written in "Popular Astronomy" magazine 1906, vol. XIV, 'An Amateur's Observatory'. *"The writer's first instrument consisted of a two-inch spy-glass, by a French maker, which glass he mounted equatorially. He obtained a high power (100) negative eye-piece from Alvan Clark and Sons, which showed enough planetary detail to keep up his interest. A few years after this he was fortunate enough to get a three and five eighths inch glass by Henry Fitz; this he also mounted equatorially and enjoyed for many years"*.

The following account, taken from a newspaper article about him when he lived in Taunton, is somewhat dubious since he actually bought the 7-inch refractor. "*When but 14 years old he built a telescope and ground out a lens with which he was able to observe with success all the principal heavenly bodies. This was a small two-inch lens. His next attempt was a three-inch lens and he later made one of three and a half inches, which he subsequently sold to Harvard College. He followed up these two with a seven-inch visual instrument.*" (This refractor was purchased at an auction in Keesvile, New York, as mentioned below).

In his 1906 Popular Astronomy article the Reverend also provides a very informative account of the transportation of his 7 inch Alvin Clark across the ice of Lake Champlain. This is that account in his words: "*In 1901 he was fortunate enough to come into possession of a seven-inch equatorial manufactured by Alvan Clark and Sons in 1885. It had been the property of Elisha Arnold, a wealthy amateur astronomer of Keesville, N.Y., and after his death his executors sold it at a nominal sum. The telescope had been little used and was practically as good as new with all the excellence which one expects from the Clark glasses. In addition to the equatorial, which was the best for the size the Clarks make, the outfit contained a small transit instrument, a four-inch telescope with an altazimuth mounting, a fine micrometer, and a spectroscope which could be used with either a single prism or a grating, both of which were provided.*

In the observatory at Keesville, the instrument was mounted in a very substantial dome, being fastened to a fine cut granite base weighting about a ton. In a February when Lake Champlain had frozen over, the whole outfit was loaded on sleds and started across the Lake on the ice. The ice was thick enough - but there are always long cracks in the Lake due to expansion and contraction! These cracks will sometimes run out as far as four miles from the islands. The moving went well until off Juniper Island, when the large sled having the dome and the cut granite pier fell into a crack, and would have gone to the bottom but for the projected sides of the dome which reached out to the solid ice! There the load stuck with the water within a foot of the top of the dome until after three days when, by laying timbers on the ice, and rigging derricks, the whole was secured with the exception of the four-inch telescope, which now lies buried peacefully in the bottom of the Lake!

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which has been loosely connected with biological material." Buratti said. "This suggests that comets might be a transport mechanism for bringing the building blocks of life to Earth." Comets may have played an important role in supplying organic materials that are required for life to originate.

Soderblom points out that Borrelly's old, mottled terrain with dark and very dark spots -- different shades of black -- are apparently inactive. Ground-based observations estimated that 90 percent of Borrelly's surface might be inactive, and the observations taken by Deep Space 1 show that this is indeed true.

"It's remarkable how much information Deep Space 1 was able to gather at the comet, particularly given that this was a bonus assignment for the probe," said Dr. Marc Rayman, project manager of the mission. Deep Space 1 completed its original goal to test 12 new space technologies and then earned extra credit by achieving additional goals, such as the risky Borrelly flyby. "It's quite exciting now as scientists working with this rich scientific harvest turn data into knowledge."

Contour spacecraft on its way to prelaunch testing. The Johns Hopkins University Applied Physics Laboratory, Office of Communications and Public Affairs

The CONTOUR spacecraft has been shipped to Goddard SFC for prelaunch testing; on its way to a July 2002 launch.

After launch, the solar-powered CONTOUR will visit at least two comets as they travel through the inner solar system. From as close as 100 kilometres, the spacecraft will take the most detailed pictures ever of a comet's nucleus; map the types of rock and ice on the nucleus; and analyze the composition of the surrounding gas and dust. CONTOUR's targets include comet 2P/Encke in November 2003 and 73P/Schwassmann-Wachmann in June 2006, though the spacecraft can also be sent toward an as-yet-undiscovered comet. The data will provide clues into the similarities and differences between comets.

From Kuiper belt object to cometary nucleus: The missing ultrared matter. Jewitt DC: Astronomical Journal 123 (2): 1039-1049 Feb 2002

We combine new and published data to show that the optical color distributions of cometary nuclei and Kuiper belt objects (KBOs) are significantly different. The nuclei are, as a group, bluer than the KBOs, indicating that the surface chemical and/or physical properties of the two types of bodies are different. Objects in the dynamically intermediate Centaur class have optical colors like those of KBOs, while the color distribution of candidate dead comets is indistinguishable from that of the cometary nuclei. We infer that the surfaces of KBOs are modified upon entry to the inner solar system. We consider several mechanisms and conclude that the color change is most likely caused by the rapid burial of ancient surface materials exposed in the Kuiper belt. The distinctive, ultrared material that is present on the surfaces of some KBOs is absent on the cometary nuclei.

Cometary Outbursts - search of probable mechanisms - case of 29P/Schwassmann-Wachmann
P Gronkowski: AN 323 (2002) 1

This paper comes up with another theory of cometary outbursts. The author suggests that an outburst is triggered by polymerisation of HCN (either by uv light or solar wind electrons), which heats the nucleus and triggers a transformation of amorphous water ice into cubic ice. This gives rise to further heating and leads to the release of trapped CO or CO_2 and dust. However, the author admits that the mechanism cannot explain outbursts at small heliocentric distances.

Section Meeting Report, 2002 February 23

Members of the Comet Section and other comet enthusiasts met at the Scientific Societies Lecture Theatre in Saville Row on the morning of February 23. This was a new venture for the BAA, with the hope that a morning Section Meeting would tempt more people to attend the afternoon main BAA Meeting. The doors opened by 10:30 and a steady stream of people arrived for coffee and biscuits and a chance to chat. In total 33 people signed the register, though perhaps there were a few more than that present.

The Director, Jonathan Shanklin, opened the formal meeting at 11:00 and immediately apologised for the lack of comet guides, which were locked up in the BAA Office. The new edition of the Guide was a greatly expanded version of the first edition and he particularly drew attention to the section on formatting observations sent by email. Badly formatted observations took up hours of his and Guy Hurst's time every week. Once formatted correctly he was able to produce light curves from the observations and showed those for 2000 WM1, 2001 OG108 and 2002 C1, which should be readily observable in the coming months. He concluded by mentioning the recently discovered Marsden and Meyer groups of SOHO comets, of which the former were potential NEOs, with 1999 J6 approaching to within 0.03 AU of the Earth.

Guy Hurst then introduced a practical experiment in observing comet tails. He showed an overhead of 1996 B2 (Hyakutake), and asked us to estimate the length in 'daylight' and 'dark' conditions. The estimated length varied from 3.5 to 8°, with longer tails in dark conditions. He has provided the following report:

Estimating tail lengths of comets

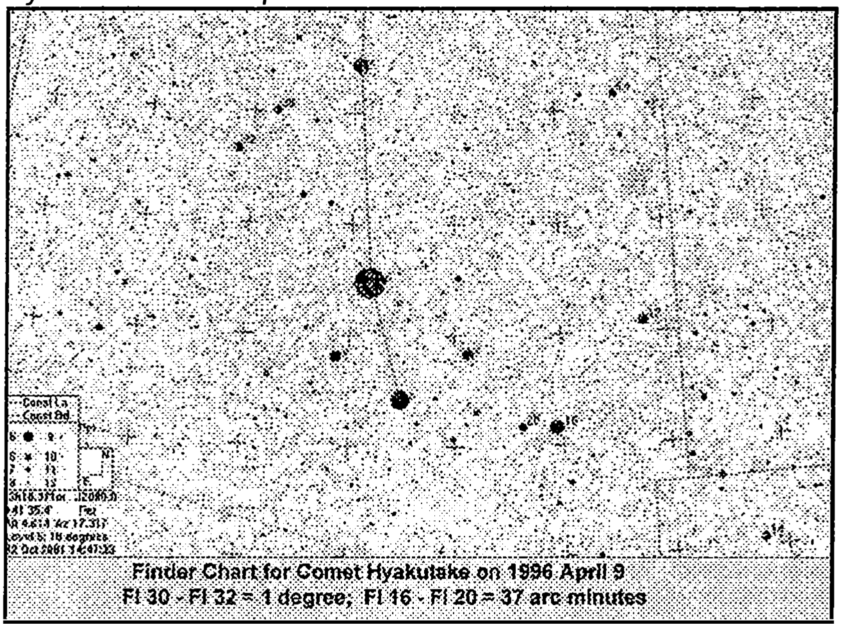
Guy M Hurst, Assistant Director, BAA Comet Section

The Ordinary BAA meeting held in London on Saturday February 23, was preceded, as an experiment, by a Comet Section meeting in the morning and this was very well attended.

With Jonathan's agreement, I conducted a practical experiment on the estimation of the tail length of Comet Hyakutake from studying a photograph secured by Arto Oksanen (Finland) of 1996 April 9 and which was shown on screen. At that time the comet was situated in Perseus near beta, probably better known to most of us as Algol.

Audience members were supplied with a map of the same area of sky, but without the comet depicted (figure 1), which had been derived from CD ROM software, *Guide 7.0* by Bill Gray of Project Pluto.

Figure 1: Field of Comet Hyakutake on 1996 April 9



In reality, this experiment had been conducted for the first time with students attending my evening class in Basingstoke back on 2001 November 5. We anticipated that fireworks might prevent direct viewing of the night sky so an in-class practical exercise was devised as a substitute!

Estimating tail lengths is quite difficult but the simplest technique is to select a gap between two nearby stars which is slightly longer than the tail and record a proportion of the star separation. Figure 1 shows the map supplied and two star gaps with approximate values were quoted:

Fl 30 to Fl 32 = 1 degree
Fl 16 to Fl 20 = 37 arc minutes

Leaving the lights on in the lecture theatre, 'votes' were cast which ranged from 4.0 to 6.5 degrees. Thirty people were brave enough to participate and the average tail length derived was 4.9 degrees. When they dimmed the lights, although leaving them on sufficiently to still see the map, this time the average was 5.9 degrees.

For comparison, 12 of my students, in a brightly light classroom on 2001 November 5, had an average of only 4.02 degrees. Five **visual** observers agreed use of their data for the classroom experiment and estimates recorded on that date from Mauro Zanotta, Bjorn Granslo, Melvyn Taylor, James Fraser and David Storey gave an average of 5.13 degrees.

It is obvious that if one observer is making estimates in strong light pollution and another from a dark country site, that the latter will usually record a much longer tail. However another effect, which may actually bias the observer, can occur when the tail is aligned with a pattern of bright stars, which was the case here with Fl 32 and Fl 30. The brain seems to automatically form a 'tidy' image of the tail just reaching the gap. Similar problems can occur with a comet in a densely populated portion of the Milky Way where mere star asterisms, if arranged in 'lines', can tempt observers to believe the tail is extended much further than is really the case.

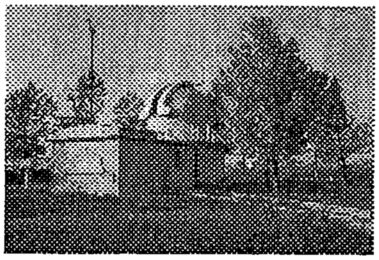
The message from the BAA meeting was that comet observing is not quite as difficult as many people attending, who were new to the subject, might have supposed. However a careful technique is needed and for tail lengths making estimates against two pairs of stars and averaging the results might assist. To signify the conditions, it is also helpful to note the limiting magnitude in the field of the comet.

Thank you to all who participated in the experiment!

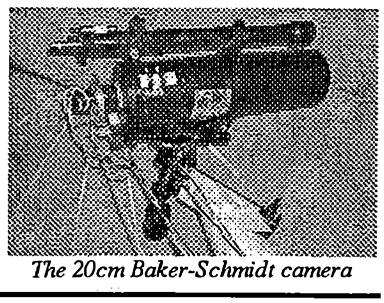
The next speaker was Giovanni Sostero, who observes from Remanzacco, Italy. The site suffers from severe light pollution but has 90 useable nights per year. He uses a Baker-Schmidt camera and a Newtonian-Cassegrain telescope with a local group of observers. He has provided the following summary of his talk.

CCD imaging of comets

Giovanni Sostero (Remanzacco Observatory, Italy)

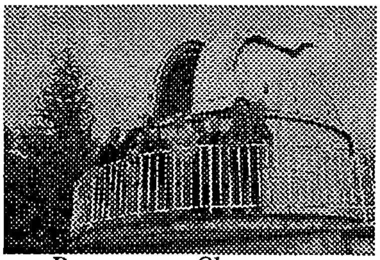


The rapid development of optoelectronic technologies has also proved to be very helpful for amateurs astronomers. A classic 20cm Newtonian scope, fitted with a CCD camera, can normally reach down to magnitude 17 in few minutes of exposure time, even from moderately light polluted backyards. In cometary astronomy this is a real help, and by means of CCDs, amateurs can provide additional valuable data with at reasonable expense.



The 20cm Baker-Schmidt camera

We can distinguish among two very broad fields of applications: cometary head photometry and morphological studies. In the first instance it is almost mandatory to provide the CCD camera with an appropriate filter set. Sometimes unfiltered CCD photometry can be helpful without the adoption of standard filters (e.g., in the monitoring of faint comets) but if a serious observing program is to be undertaken, then a Johnson V filter and a Cousin I filter are the right choice. With the first one we would be able to measure the gaseous emissions of cometary comae (mainly due to the so called ***Swan-band*** emissions) while the second is helpful for the monitoring of dusty emissions. Professional astronomers are routinely using interference filters with very narrow bandpasses, in order to detect the light contribution from single molecular species. But unfortunately these filters suppress most of the incident light and for the amateurs very few comets will be bright enough to be a suitable target with their instrumentation. Normally the measurement of cometary magnitudes through a CCD camera is performed by means of the "aperture photometry" method. In this way, after the appropriate pre-processing, the net amount of ADU is counted within a selected window centred on the coma. Similarly we are measuring the net ADU values produced by a reference star of known magnitude within the same field. Then through Pogson's formula we are able to calculate the magnitude difference between the comet and the standard and, finally, the comet's brightness. Great care should be taken to eliminate the contribution of background stars within the coma and in the selection of the standard stars: their spectral class should preferably be similar to that of the Sun in order to minimise the systematic errors due to the non-linearity of a CCD's spectral sensitivity. It's very helpful to standardise this observing method, adopting an aperture size equivalent to some given amount at the comet distance (e.g. a "window" spanning 100,000 Km). Extended over a range of different apertures, this procedure will also give us some helpful hints about the degree of condensation of the coma. Great care should be taken when a comet is showing a dusty tail: in this instance we risk including in our aperture part of the tail, and this will produce an offset in the total brightness of the coma. An amateur, measuring a comet throughout its apparition by means of a CCD and a couple of standard filters, could provide some meaningful information on the gas/dust production rates of the given object, just taking regular brightness measurements with backyard instrumentation. Also the development of jets, hoods, halos and similar structures within the coma would be recognisable with CCD imaging, as well as the fine details sometime developing in the tails. In this kind of application, as well, the adoption of some standard filters will be helpful, because in this way we will be frequently able to distinguish among gassy or dusty features. For the monitoring of fine details within the central condensation, a scale of the order of 2 arcsec/px and a good seeing are mandatory. For relatively bright comets, this kind of observation is also possible from a heavily light polluted observing site. Some software packages are provided with rotational gradient algorithms that would enhance the subtle details within cometary heads. Anyway, they should be treated with great caution, because without some experience this kind of image processing could dangerously enhance the noise, creating some appealing (but non existant) artefacts! In conclusion, CCD technology is a powerful tool for comet observations. In my opinion, what is missing now in this field is a basic standardisation method, and some guidelines provided (hopefully) by professional astronomers, about which particular kind of observation is most valuable. Sometimes the amateurs are just wondering if it's better to obtain total magnitude estimations or high resolution imaging of fine details within the coma and/or the tail. Frequently we have no time to do both of them... Anyway digital astronomy would not be able to substitute for all visual observations: they are just complementing one another. And, at the end, the target is the same: to understand and enjoy those fuzzy spots of light that we like so much...



Remanzacco Observatory

The author would like to thank very much Guy Hurst and Jon Shanklin for their invitation and kind hospitality.

Alan Fitzsimmons, was our next speaker on 'Big Comets and Little Comets - How many of each ?', which he subtitled as a programme to get the most boring images of comets possible. At 0.5 AU a 1 km comet nucleus spans 0.003" - not even NGST will see it. It is also hidden by dust - a 2km nucleus will be hidden by 10^{18} particles, but this amount only weighs 1000 kg and emission is at 1kg/sec. Most comets produce more. Comets formed beyond Saturn and now reside in the Kuiper Belt. It needs a 30 metre or larger aperture telescope to study the smaller members. Comets are lost by collision or switching off, they also shrink, vaporise, split and fragment. There are usually more little ones than big ones of anything, or mathematically $N(D) \sim D^{\alpha} \Rightarrow \log_{10} N(<H_{10}) \propto H_{10}$ which implies there are more faint comets. If the slope is > 0.5 it implies that most of the mass is in small comets and vice-versa. Collisional processes generate a slope of exactly 0.5.

Only two spacecraft have imaged comets, and spacecraft are expensive. HST can image a few comets per year and so a ground based programme is needed. Alan's programme is to measure Jupiter family comets to measure their size and to monitor activity beyond 3 AU. For 4% albedo, a 5 km nucleus at 3 AU is mag 19.5, whilst a 2 km nucleus at 5 AU is mag 24.1, so big telescopes are needed. Alan had used the 1-m JKT in 1995 and 1999 and the 4.2-m WHT in 1998.

48P was active at 3.4 AU, with a nucleus ≤7km D, cf 7P at 5.6 AU ≤5.2 km and 9P at 3.4 AU ≤4.8 km. Sometimes nothing is seen at all, eg 87P was >24.4 m_r at 4.3

AU, implying it was smaller than 1.2 km. 74P doesn't switch off at all and is <25km. Plotting N vs R_{10}, for D > 3km the slope is 0.32 implying for every comet bigger than 3 km there are 40 bigger than 1 km. This implies there are around 400 active comets in the inner solar system. The slope for NEOs, JFCs and MBAs is around 0.3, which is not collisional, however that for TNOs is 0.69 for D >50 km, but this can't go to small sizes or we would see the Kuiper Belt. The mass must be concentrated in large comets, and some have <0.7% albedo. [This report is based on my notes and subject to error, a full report from Alan will appear in the October Tale.]

At the conclusion of Alan's talk the meeting broke for a splendid lunch cooked by chef 'Louis'. There was plenty of chance for further discussion during the meal, which was served with a glass of wine. By the time we had finished eating, other astronomers were arriving for the main BAA meeting, which commenced at 14:30. There were lots of comments that the meeting had gone well, so we are planning another one for next year. The intention will be to have a morning session devoted to technical issues for the comet Section, with popular talks on comets in the afternoon as the topic of the main BAA meeting. This may include the George Alcock Memorial Lecture, which we hope will be given by a well-known professional expert on comets.

Joel Metcalf (Continued)

Continued from page 1

The observatory was installed in Burlington, Vermont, until 1905, when the writer moved to Taunton, Mass., and then presented the house and dome to the University of Vermont, his previous experience in moving it not being an encouragement to experiment".

The 13-inch triplet

As a telescope maker he has graced the astronomical world with an 8-inch f/80 inch ("broken-backed") comet hunter kept at South Hero, Vermont for use during his summer vacations, a 10- inch photographic triplet now newly restored and in the possession of the Boyden Observatory, University of the Orange Free State, Bloemfontein, South Africa, a 12-inch doublet (which he used in Taunton, Mass.) now located at Oak Ridge Observatory, Harvard, Massachusetts, and a 16-inch f/5.25 doublet, also located at Oak Ridge Observatory. He was in the process of making the 13-inch triplet used in the discovery of the planet Pluto when he died in 1925 (it was completed by C. A. Robert Lundin of Alvan Clark and Sons).

He graduated from Meadville Theological Seminary in 1890, then continued his education at Harvard Divinity School and obtained his degree of Ph.D. at Allegheny College in 1892. He married Elizabeth S. Lockman, of Cambridge, Massachusetts in September of 1891. They had two children, a son, Dr. Herbert E. Metcalf of San Leandro, California, and a daughter, Rachel Metcalf Stoneham. She later wrote a wonderful article about her life with "father", titled "A Nice night For Comets" in the January, 1939 issue of "Popular Astronomy," which was later republished in the September, 1979 issue of "Yankee" magazine. He served in Burlington, Vermont (1893-1903) where it appears his interest in grinding lenses began extensively. He corresponded with Prof. J. M. Schaeberle at Ann Arbour, MI.

Being at risk of a nervous breakdown, he interrupted his ministry for a year in 1902 to attend Oxford University where he is said to have attended an average of twenty-five lectures weekly on philosophy and religion. He was also given the keys to the observatory by Professor Turner, spending much time on astronomical problems. After Oxford, he took a year off to rest before returning to the ministry at the First Congregational (Unitarian) church in Taunton, Massachusetts (1904/5-1910). Taunton at that time was one of, if not the largest, manufacturer of silver products in the United States. It's streets are still lined with the many Victorian style homes, with long and extended porches where the residents would sit and pass away the day conversing with the passers-by.

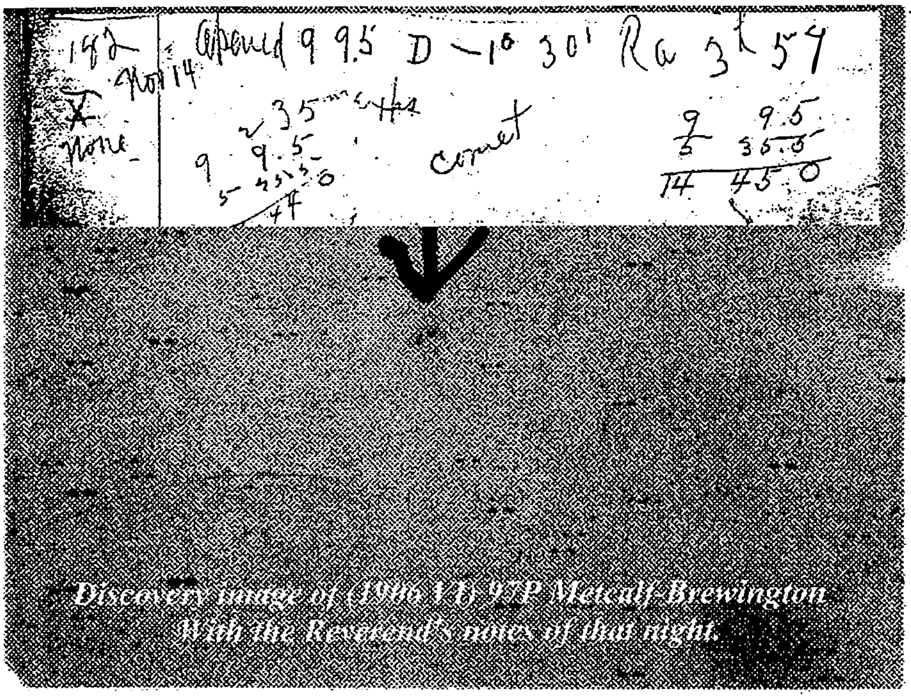
It was from Taunton that most of his asteroids were discovered and where his relationship with Harvard Observatory appears to have begun. He was also a member of the Visiting Committee of Harvard's Observatory. Reverend Metcalf enjoyed a lasting friendship and professional relationship with Dr. Pickering. He also became a member of the Visiting Committee for Brown University's Ladd Observatory, in Providence, Rhode Island.

One of the problems that he sought to follow up on from his time at Oxford was that of comparing and recording measurements from photographic plates take by "Schurs" of the "Praesepe Cluster in Cancer" with new photographs taken from Lick Observatory. He proposed this to Prof. Campbell, at Lick Observatory in a letter dated August of 1904.

His First Comet, 1906 VI, a Record Breaking Photograph

He and his family resided at 54 Summer Street where 38 of his 41 asteroids were discovered. The last four were discovered from Winchester, Mass. Taunton was also where he discovered the first of his 5 comets, 1906VI using his homemade 12-inch doublet, refracting telescope.

This comet was discovered in Eridanus on November 15th, 1906. (Metcalf states in his franticly written observing records that the comet was photographed on November 14th, at 3h 59m -1°). With a discovery magnitude of 11.5, having a round, 2 arcminute coma and a distinct central condensation. It had passed perihelion on October 10, 1906. After discovery the comet slowly faded as it continued on its path away from the sun. By December 10th the comet had reached 12th magnitude. It was last seen on January 16th, 1907 at 13th magnitude. Mr. Kronk goes on to say that it is worth mentioning that; M.E. Esclangon of Bordeaux Observatory observed two



Discovery image of (1906 VI) 97P Metcalf-Brewington With the Reverend's notes of that night.

nebulous objects near the comet on November 22nd which he described as easily visible. One was said to be elongated with a length of 30 arcseconds, the other was circular, with a diameter of 20 arcseconds. The objects were not detected the next evening, so he concluded that water was between the objective lenses. A periodic orbit was computed, but the comet was not recovered.

In early January, 1991, from Cloudcroft, New Mexico Howard Brewington walked out to his 16 inch reflector and began his search efforts for another new comet. (He had just discovered one on November 16, 1989.) It was during this search that he discovered another comet. After receiving the report at the Smithsonian Astrophysical Observatory in Cambridge, Mass., Dr. Brian Marsden noticed that the orbits to date matched those of the lost Comet Metcalf 1906VI. Therefore, although Brewington hadn't discovered a new comet, he did succeed where so many had failed, in the recovery of the Reverend's only short period comet, now designated 97P/Metcalf-Brewington. Also in reference to M.E. Esclangon of Bordeaux Observatory, observing "two nebulas objects" (mentioned above), it's an interesting note that when this author conversed with Dr. Marsden, after reading about the recovery of this comet, Dr. Marsden proposed that the comet may have divided at one time and that because of it's possible rotational period may only go through periods of flair ups when these areas of fresh material are exposed.

One of the greater surprises during my research of the Reverend's life was to learn that he held the record for amateur astro-photographical accomplishments. This he did from Taunton, Massachusetts, according to the unidentified newspaper account from the "Old colony historical society," Taunton, Mass. *"The most expert amateur astronomer in the country. This is the tribute paid by Professor Pickering of Harvard College to a young Bay State Minster. With a telescope which he himself invented and built, the Rev. Joel H. Metcalf of Taunton, a young Unitarian clergyman, has recently startled the scientific world by photographs he made of Phebe, one of the satellites of the planet Saturn, breaking all records for astronomical camera work. The smallest telescope to reflect the image of the ninth satellite has been until now the huge 24-inch instrument at the Harvard Observatory at Arequipa, Peru, but the Rev. Mr. Metcalf, with a 12-inch glass of his own make and a little observatory erected in his backyard, has accomplished the feat which for years has been regarded by scientists as impossible*".

Called To Winchester, Massachusetts. Some more Comets and a War!

He was next called to Winchester, Massachusetts (1910-1920), located just north of Boston, where many of his sermons and editorials were more than occasionally published in the "Winchester Star," the local newspaper.

His other four comets were visually discovered from South Hero, Vermont, where the Unitarian church had a summer camp. It was at this camp where he did most, if not all, of his lens grinding and comet hunting. He even expressed in an interview that he searched for comets "in Vermont, only when he was on vacation"!

His next comet, 1910IV was discovered on August 9th, at magnitude 8.5 and having a diameter of about 2 arcminutes. He used his trusty "broken-backed" comet seeker to discover this long period comet. This comet was discovered in Hercules. The comet's brightness was estimated as being between 9.5 -10th magnitude. The appearance of the comet depended on the instrument used through the month of August, ranging from 8th to 11th magnitude, with a nuclear region ranging from stellar to extremely diffuse. However, observations of its tail length remained constant as having a length of 1.5 arcminutes through the 11th. The comet reached perihelion on September 16th, at 10th magnitude. The coma remained at 2 minutes of arc. During the month of October the tail was reported to have a length of 18 minutes of arc, sustaining a magnitude of 10. The comet remained as such through November and December. January 29th brought on an outburst, bringing the magnitude to 9.5, and 9.3 by February 2nd. At that time the coma diameter was estimated at 1.5 minutes of arc, having a tail length of 5 minutes of arc. By late March the comet's magnitude was estimated at 11, by mid-April, 11.3 and by late May, 13th magnitude. It was last seen on June 23rd, close to magnitude 14.

Back on vacation again in South Hero, Vermont, on September 2nd, 1913 the reverend observed through his comet-seeker and discovered 1913 IV in Lynx, at magnitude 9.5. The comet was moving slowly northward, and at first was thought to be Comet Westphal. By September 9th, the comet's diameter was estimated between 5-6 minutes of arc. On the 14th of September the comet passed perihelion at 1.36 AU. As the comet approached the earth its diameter grew to 10 minutes of arc with a magnitude of 7.5, passing within 13 degrees of the north celestial pole. After perigee, (0.62 AU) on October 8th, the comet quickly faded as it continued along its retrograde orbit. By October 17th this comet faded to magnitude 9.5 and by early November it had faded to 10th magnitude. On the 21st of November its magnitude was estimated at 11.5. 1913 IV was last seen on November 30th.

In 1918, Reverend Joel Metcalf volunteered to go to France "*Rev. Joel H. Metcalf of the Unitarian Church will sail for France the week of March 4th. Mr. Metcalf will enter the Y.M.C.A. as a secretary and his duties in the war zone will include, besides the regular routine work, hut work and giving illustrated travel talks to the troops ...*" (Winchester Star, February 22nd, 1918)

Rev Joel Metcalf at the front

During the War much of his time was spent at the front lines. He was known to have sung songs while marching in front of the men along marches that were sometimes 25 miles in length! He was also known to have carried some of the wounded and their backpacks as well. Here is part of a letter from Rev. Metcalf while in France, published in "The Calendar", the Unitarian newsletter. Extracts from Mr. Metcalf's Letters of July 25th and 28th:

"When we broke the rush of Germans over the Metz to Paris road and French were in full retreat and when our boys came along they shouted, "La guerre est finis. Paris est perdu. Allez vite, etc." Instead of retreating, we advanced and fought the battle which centered around Belleau Woods. We relieved the marines for six days, so you can see I was right in it. In the day time I carried supplies into the woods, alone and with runners, and at night we sold supplies in the "Y." This place got several hundred 8-inch shells every day. They simply peppered the "Y." It got so every time I walked out, I made up my mind just what hole or depression in the ground I would drop into when I heard a shell (you can hear them 5 or 6 seconds).

The second battle of the Marne, that is, the German offensive beginning on the night of July 14, was a tremendous effort on their part. For two nights previous, I had carried chocolate to the men on the bank of the river, and for weeks they had not fired a shot and their trenches in plain sight of where I was seemed deserted. We shelled them all the time with a strafing that must have done some damage. At 12:15 Monday night without an instant's warning they opened with a crash on a 50 mile front. It was the most terrible thing imaginable. Like a thunderstorm and a sudden fall of rain, the heavens seemed to drop steel everywhere for 10 miles back of our lines. I was in bed (that is on the floor) with my shoes off when the first shells fell. By the time I got my coat on and shoes and got to the door, the court yard was raining shells, so I rushed through the chateau, smashed open a window on the lee side of the shells and tumbled into a dugout with about 25 others who were there. The air reeked with gas, high explosive and mustard. Imagine me, the tears running out of my eyes from gas, crouching in a corner sitting on a nail (two nails in fact) gasping for breath, the mask cutting my ears and forehead till they ached. We sat thus for 9 mortal hours, like Paul praying for the day and the end of the bombardment, while the wild roar of the shrieking death continued outside.

At twelve o'clock the worst was over and we came out of our holes in the ground, to find the chateau, except the lower stories, in ruins and many of our company dead and wounded. I helped in first aid all that day. The only things to eat were the Y.M.C.A. stuff which we gave them, the wounded and unwounded, without money and without price, chocolate crackers, etc.- all that we had."

Rev. Metcalf was later offered and refused a position as an officer in the Army out of a desire to continue along with "his boys" at the front.

Coming Home, a Couple More Comets and Off He Goes Again....

Brorsen of Altona Observatory, Germany discovered a comet on July 20th, 1847 at magnitude 9.5, in the constellation Aries. He observed it as vary faint and very diffuse without any nucleus. By mid-August, as the comet approached the sun and earth it reached a magnitude of 6.5, having a tail length of about 15 minutes of arc. During that period the comet faded slowly as it continued toward the sun and was last seen on September 13th at magnitude 9.5.

This was the first comet that the Reverend found, on August 21st, 1919, after his arrival home from his duty in France on the evening of January 24th. His home was in Winchester, Massachusetts at the time. This comet was also independently discovered by 5 other observers at the time. By September 5th, the comet came within 0.19 AU of the earth, having a magnitude of 5.3 and a coma 15 minutes of arc in diameter. As the comet increased its distance from the sun its magnitude increased as well. It's tail reached a length of 1.5 degrees in late September. However, its coma diameter decreased. Two days later, on August 23rd, the Reverend was again out searching and came across Comet 1919 V in the constellation Bootes, at 8th magnitude. Borrelly independently discovered the comet from Marseilles, France. Although the discovery magnitude was estimated to be about 8^{th}, most observers reported estimates of 9th magnitude, having a coma diameter of 2 minutes of arc. During September, as the comet approached the sun and earth, it brightness increased to 8 or 8.5. A coma diameter was estimated at 4 minutes of arc. It reached 7th magnitude by November. The comet was lost to northern observers during late November as it entered the sun's glare after the 23rd, reaching perihelion on December 7th (1.12 AU). The comet was recovered on the 19th by observers in the Southern Hemisphere remaining visible until February 3rd, 1920.

A short time later, he volunteered to go back to Europe to assist in rebuilding the churches in Hungary. "*Boston's most eminent amateur astronomer, Rev. Joel H. Metcalf, has deserted his astronomical station on the top of the apartment house in which he lives in Winchester, and has gone to Hungary on a mission to the one hundred Unitarian churches in Transylvania. He is one of a commission of three appointed by the American Unitarian Association and has resigned from the pastorate of the Unitarian church of Winchester to fill his mission.*" (Old Colony Historical Society, Taunton, Mass. Unknown (Boston?) newspaper, circa ~ 1919.)

He visited many remote parts of the area, travelling by automobile, making one remarkable journey between Cluj and Bucharest, returning not without peril, with about $10,000 in currency. He made a journey out from Transylvania to England, returning with supplies. He was so loved by the people there that when two other commissions were sent back to the area in 1922 and 1924, they were continually asked when Dr. Metcalf would ever return.

Home Again, a Few More Discoveries and Time To Rest...

It more than appears that the war and his extensive travelling throughout the region of Hungary had taken a toll on this man's relentless body and spirit. Because this time, on returning home to the United States, he moved to Portland, Maine, and with a last spark of discovery, he was able to add at least three new variable stars to his long list of accomplishments, RV Leonis (1919), SV Hydri (1921) and WZ Ophiuchi (1922). He died on February 23rd, 1925 at the age of 59.

The author wishes to acknowledge the help of: Martha Hazen, Harvard College Observatory; Dr. Brian Marsden, Harvard Smithsonian Astrophysical Observatory, Cambridge, Massachusetts; Dorothy Schauimberg, Mary Lea Shane Archives of the Lick Observatory; Mike Saladyga, AAVSO; Don Machholz, ALPO; Gary Kronk.

If you wish to read more of his sermons, and/or other articles by and about Reverend Metcalf you may visit the Joel H. Metcalf Memorial Homepage at http://personal.tmlp.com/richard/metcalf.htm.

Any additional information about this man will be greatly appreciated by Richard. Data on two areas of his life are very much needed: they are any records of his time spent at Oxford, and in Cluj, Romania. You may contact him personally at: richard@tmlp.com

Review of comet observations for 2001 October - 2002 April

The information in this report is a synopsis of material gleaned from IAU circulars 7740 – 7880 and The Astronomer (2001 October – 2002 March). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course. I have used the convention of designating interesting asteroids by A/Designation (Discoverer) to clearly differentiate them from comets, though this is not the IAU convention.

SOHO Kreutz group comets

1996 V1 SOHO (IAUC 7760, 2001 November 23)
1996 Y2 SOHO (IAUC 7807, 2002 January 24)
1998 H5 SOHO (IAUC 7842, 2002 March 5)
1998 H6 SOHO (IAUC 7842, 2002 March 5)
1999 H8 SOHO (IAUC 7839, 2002 March 1)
1999 H9 SOHO (IAUC 7839, 2002 March 1)
1999 J13 SOHO (IAUC 7839, 2002 March 1)
1999 K17 SOHO (IAUC 7842, 2002 March 5)
2001 T6 SOHO (IAUC 7750, 2001 November 10)
2001 T7 SOHO (IAUC 7750, 2001 November 10)
2001 U1 SOHO (IAUC 7746, 2001 November 6)
2001 U2 SOHO (IAUC 7746, 2001 November 6)
2001 U3 SOHO (IAUC 7746, 2001 November 6)
2001 U4 SOHO (IAUC 7746, 2001 November 6)
2001 U5 SOHO (IAUC 7746, 2001 November 6)
2001 U7 SOHO (IAUC 7750, 2001 November 10)
2001 U8 SOHO (IAUC 7759, 2001 November 21)
2001 U9 SOHO (IAUC 7759, 2001 November 21)
2001 U10 SOHO (IAUC 7759, 2001 November 21)
2001 V1 SOHO (IAUC 7759, 2001 November 21)
2001 V2 SOHO (IAUC 7759, 2001 November 21)
2001 V3 SOHO (IAUC 7764, 2001 December 3)
2001 V4 SOHO (IAUC 7764, 2001 December 3)
2001 V5 SOHO (IAUC 7764, 2001 December 3)
2001 W3 SOHO (IAUC 7764, 2001 December 3)
2001 W4 SOHO (IAUC 7764, 2001 December 3)
2001 X4 SOHO (IAUC 7797, 2002 January 19)
2001 X5 SOHO (IAUC 7797, 2002 January 19)
2001 X6 SOHO (IAUC 7797, 2002 January 19)
2001 X7 SOHO (IAUC 7797, 2002 January 19)
2001 X9 SOHO (IAUC 7797, 2002 January 19)
2001 Y2 SOHO (IAUC 7797, 2002 January 19)
2001 Y3 SOHO (IAUC 7797, 2002 January 19)
2001 Y4 SOHO (IAUC 7797, 2002 January 19)
2001 Y5 SOHO (IAUC 7797, 2002 January 19)
2002 C3 SOHO (IAUC 7839, 2002 March 1)
2002 C4 SOHO (IAUC 7839, 2002 March 1)
2002 D1 SOHO (IAUC 7839, 2002 March 1)
2002 E1 SOHO (IAUC 7850, 2002 March 12)
2002 E3 SOHO (IAUC 7862, 2002 March 28)
2002 F2 SOHO (IAUC 7862, 2002 March 28)
2002 F3 SOHO (IAUC 7862, 2002 March 28)
2002 G2 SOHO (IAUC 7873, 2002 April 10)
2002 G4 SOHO (IAUC, 2002)
2002 G5 SOHO (IAUC, 2002)
2002 H1 SOHO (IAUC, 2002)

were discovered with the SOHO LASCO coronographs and have not been observed elsewhere. They were sungrazing comets of the Kreutz group and were not expected to survive perihelion. Some of these comets show no tail at all and it is possible that some supposed observations of Vulcan were actually tiny Kreutz group comets.

Meyer group comets

Brian Marsden notes on MPEC 2002-C28 that: While 2002 C3, like some 95 percent of the comets discovered by SOHO, is clearly a member of the Kreutz sungrazing group, it is rather less appreciated that as many as 11 of the two dozen or so non-Kreutz comets discovered by SOHO also seem to be interconnected. The close temporal pairs C/2000 C2-2000 C5, C/2000 C3-2000 C4 and C/2000 Y6-2000 Y7 were remarked on when these comets were announced (cf. MPEC 2000-

C52, 2000-C53 and 2001-B08). There is also the pair C/1999 J6 (MPEC 2000-F30) and C/1999 U2 (MPEC 1999-U29), comets with i = 27 deg separated by more than five months. M. Meyer was the first to point out the similarity between the orbits of C/1997 L2 (MPEC 1997-M06, MPC 35205) and C/2001 X8 (MPEC 2002-B01, MPC 44505), comets with i = 72 deg separated by 4.5 years; it also appears that the poorly observed comet C/2001 E1 can be associated with this pair, if the orbit with i = 107 deg on MPEC 2001-F52 is replaced by the one with i = 73 deg on MPC 44505.

1997 G7 (SOHO) This comet, discovered by Rainer Kracht on February 8, is clearly a seventh member of the Meyer group (cf. IAUC 7832), as already suggested by M. Meyer on Feb. 10 on the basis of preliminary measurements. [MPEC 2002-D16, 2002 February 21, IAUC 7841, 2002 March 4]

1997 H4 (SOHO) & 1997 H5 (SOHO) These comets, discovered by Rainer Kracht on February 11 and 12 in SOHO C2 images, appear to be the eighth and ninth members of the Meyer group (cf. IAUC 7832, MPEC 2002-D16). [MPEC 2002-D41, 2002 February 27, IAUC 7841, 2002 March 4]

1999 K16 (SOHO) & 1999 L9 (SOHO) These comets, discovered by Rainer Kracht on February 22 and 25 in SOHO C2 images, are the tenth and eleventh members of the Meyer group [MPEC 2002-E05, 2002 March 1]

1999 F3 (SOHO) Another Meyer group comet, discovered by Rainer Kracht on 2002 April 14 in C2 images from 1999 March 17.

1998 A2 (SOHO), 1998 A3 (SOHO) & 2000 B8 (SOHO) Meyer's discovery C/2000 B8 (in C2 on 2002 March 4) is a member of the Meyer group. C/1998 A2 (discovered in C2 on 2002 March 3) and A3 (discovered in C2 on 2002 March 8), detected by Kracht, are members of the Marsden group, objects that could in fact have orbits differing significantly from the assumed parabolas. Nevertheless, the objects clearly have orbits that pass rather close to that of the earth (postperihelion), and D. A. J. Seargent has remarked on the similarity to that of the Daytime Arietid meteor stream, with q = 0.09 AU and L = 104, B = +10 (degrees, J2000.0; cf. MPEC 2002-E18). Although q is still larger, and there are substantial differences in the other orbital elements, the L and B values are also similar to those of both comet 96P/Machholz 1 and the Quadrantid meteor stream. [MPEC 2002-E25, 2002 March 9] I pointed out to Brian Marsden that members of this group are NEOs and can potentially come very close to the Earth post perihelion. Indeed the published orbit for 1999 J6 gives a miss distance of 0.03 AU, making it the fourth on the list of comet close approaches, although the orbit is rather uncertain.

1999 M3 (SOHO) A possible member of the Marsden group of comets was discovered by Rainer Kracht in archival SOHO imagery from 1999 June 30 on 2002 February 27.

Marsden group comets

1999 N5 (SOHO) & 1999 N6 (SOHO) The longitudes and latitudes of perihelion (deg, J2000.0) of the orbits for these comets, which were discovered by Rainer Kracht in SOHO C2 images on 2002 March 12, are L = 107.1, B = +12.0 and L = 96.0, B = +10.9, respectively. C/1999 N5 is a clear member of the Marsden group and C/1999 N6 a likely member of the more extended population (cf. MPEC 2002-E18, 2002-E25). Possibly C/1999 N6 is quite closely associated with C/1999 M3 (though not so much with C/2000 O3), but the orbit solution is not unique. [MPEC 2002-F03, 2002 March 16]

Kracht group comets

In a communication to the Minor Planet Center on Mar. 3, R. Kracht suggested that, on the basis of the apparent motion, there was some loose association between C/1999 M3 and C/2000 O3 (cf. MPEC 2000-Q09), despite the evident difference in the usual orbital elements. Nevertheless, it can be noted that the perihelion directions are L = 103.9, B = +11.4 (degrees, J2000.0) for C/1999 M3 and L = 100.6, B = +10.8 for C/2000 O3. On Mar. 4, Kracht wrote that, again despite differences in the usual orbital elements, the perihelion direction for C/2000 O3 is close to the average value, L = 102.6, B = +9.7, for the four clear members of the Marsden group (cf. IAUC 4832). A more extended relationship among these comets is therefore suggested. [MPEC 2002-E18, 2002 March 7]

1999 P6 (SOHO), 1999 P7 (SOHO), 1999 P8 (SOHO) & 1999 P9 (SOHO) These comets were discovered by Rainer Kracht on March 17 (P6) and March 19 in SOHO C2 images. C/1999 P6, 1999 P8 and 1999 P9 belong to the Marsden group, and C/1999 P7 to the Meyer group.

R. Kracht points out that, like C/1999 N6 (cf. MPEC 2002-F03), C/2001 Q7 (cf. MPEC 2001-R36) does not have a unique orbit solution, an alternative low-i solution being:

T = 2001 Aug. 21.80, q = 0.0445, e = 1.0, Peri = 54.77, Node = 43.95, Incl = 13.28

He suggests that, with C/1999 M3 and perhaps C/2000 O3, these comets form part of the extended Marsden population (i.e., having the same longitude and latitude of perihelion). Indeed, we could say that these four comets belong to the Kracht group. [MPEC 2002-F43, 2002 March 22]

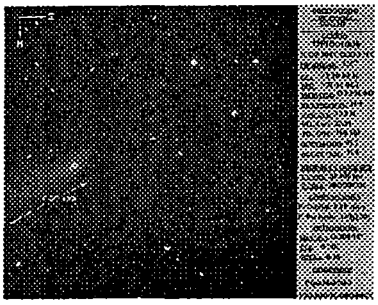
2002 A4 (SOHO) A Meyer group comet discovered in archival C2 images from January 1 by Rainer

7P/Pons-Winnecke was discovered by Jean Louis Pons with a 0.12-m refractor at Marseilles in 1819, but was then lost until rediscovered by Friedrich August Theodor Winnecke with a 0.11-m refractor in Bonn in 1858. He demonstrated the identity and recovered the comet in 1869. The perihelion distance has slowly been increasing since the early 1800s. It can make close approaches to the Earth and did so in 1927 (0.04 AU), 1939 (0.11), 1892 (0.12), 1819 (0.13) and 1921 (0.14). An outburst of the meteor shower associated with the comet, the June Bootids, occurred on 1998 June 27.6.

It has proved fainter than expect and no confirmed visual observations have so far been received. It is a morning object, and was predicted to reach 11th magnitude in May after which it is unfavourably placed for observation from the UK.

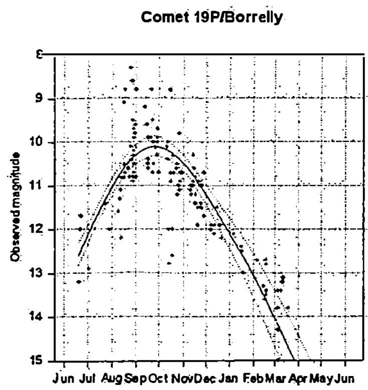
Observers at lower latitudes will be able to follow it until September. It moves eastwards, being in Aquila in April and Aquarius in May.

19P/Borrelly appears to have peaked in brightness in late September at around 10th magnitude according to the light curve, however observations by a couple of observers put it brighter than 9th magnitude. When brightest it was a morning object, which discouraged observation. After perihelion it steadily faded, becoming more diffuse, although it initially approached closer to the Earth.



2002 December 21, Pepe Manteca

The uncorrected preliminary light curve from 120 observations is m = 6.8 + 5 log d + 18.4 log r



22P/Kopff was discovered photographically by A Kopff at Konigstuhl Observatory in 1906, when it was around 11^m. The next return was unfavourable, but it has been seen at every return since then. Following an encounter with Jupiter in 1942/43 its period was reduced and the perihelion distance decreased to 1.5 AU. The following return was one of its best and it reached 8^m. The next return was unusual, in that it was 3^m fainter than predicted until perihelion, when it brightened by 2^m. It suffered another encounter with Jupiter in 1954, but this made significant changes only to the angular elements. 1964 was another good return and the comet reached 9^m.

UK observers may follow it until May, but the comet is likely to be only 15th magnitude. Although it continues to brighten, the solar elongation decreases and it is poorly placed when at its brightest (11^m) at the end of the year.

29P/Schwassmann-Wachmann is an annual comet which has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. It spends the year in Capricornus reaching opposition in early August, fairly close to Neptune. The comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. Unfortunately opportunities for UK observers are limited, as its altitude will not exceed 20° from this country.

Carl A Wirtanen discovered **46P/Wirtanen** at Lick in 1948. It is in a chaotic orbit, and its perihelion distance was much reduced due to approaches to Jupiter in 1972 and 1984. It has been reported to outburst, but BAA data suggests that it was just rejuvenated after the perihelion distance was reduced. It is a target for the Rosetta mission. A December perihelion would give a close approach to the Earth, however the present period is exactly 5.5 years so that perihelia alternate between March and September.

The comet is a morning object. More southerly placed observers may pick it up in June, but UK observers will probably not find it until August, when it is fading from its best magnitude of 11. The solar elongation only increases from around 40° to 60° by the end of the year, so it is never very well placed. In June it is in Cetus, moving into Taurus in July, Gemini in August and Virgo in November.

65P/Gunn was discovered in 1970 after a perturbation by Jupiter in 1965 had reduced the perihelion distance from 3.39 to 2.44 AU. In 1980 two prediscovery images were found on Palomar plates taken in 1954. The comet can be followed all round the orbit as it has a relatively low eccentricity of 0.32.

The comet doesn't reach perihelion until next year, but already a few observers have picked it up at between 14th and 15th magnitude. The solar elongation is now decreasing, but it should remain visible throughout the summer.

The uncorrected preliminary light curve from 11 visual and CCD observations is m = 4.8 + 5 log d + [15] log r

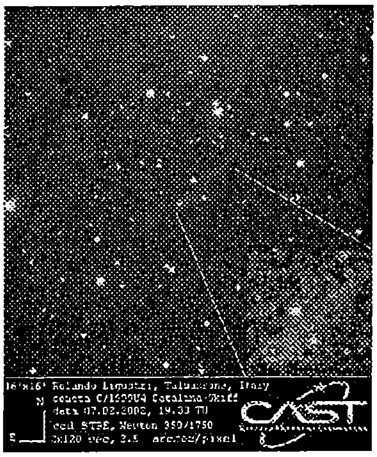
67P/Churyumov-Gerasimenko was discovered in 1969 September, by Klim Churyumov and Svetlana Gerasimenko on a plate taken for 32P/Comas Sola at Alma Ata observatory. It reached its present orbit after a very close encounter (0.05 AU) with Jupiter in 1959, which reduced the perihelion distance from 2.74 to 1.28 AU. At a good apparition, such as in 1982, when it approached the Earth to 0.4 AU and was well observed by the comet section, it can reach 9^m.

The comet is another morning object, and even at best it probably won't exceed 12th magnitude. Southern observers may pick it up around the solstice, but from the UK we won't pick it up before August, when it will be fading. Again the elongation is not good, increasing from around 50° to 100° at the end of the year. The comet's track closely parallels that of 46P/Wirtanen, entering Gemini in August and ending the year on the border of Leo and Virgo.

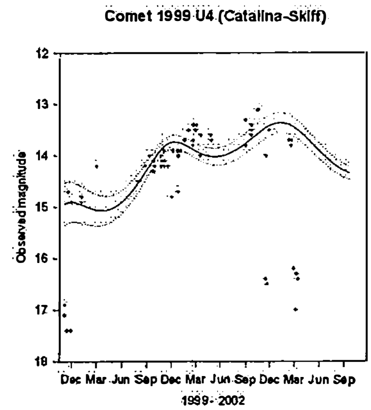
95P/Chiron is an unusual comet in that it is also asteroid 2060. It reaches 17^m when at opposition in June in Sagittarius. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically. It was at perihelion in 1996 when it was 8.5 AU from the Sun and will be nearly 19 AU from the Sun at aphelion in around 50 years time.

96P/Machholz The orbit of 96P/Machholz is very unusual, with the smallest perihelion distance of any short period comet (0.13 AU), which is decreasing further with time, a high eccentricity (0.96) and a high inclination (60°). Studies by Sekanina suggest it has only one active area, which is situated close to the rotation pole and becomes active close to perihelion. The comet may be the parent of the Quadrantid meteor shower. It is rarely sufficiently well placed to see visually and the 2002 return is no exception. However, at perihelion on 2002 January 8 it was only a few degrees from the Sun and was seen in the SOHO LASCO coronagraphs from January 6 to 11. On January 7 it was about 2nd magnitude with a 4 degree tail. It brightened to perhaps -2 just after perihelion on January 9.

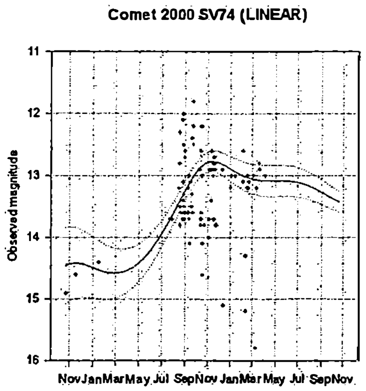
1999 U4 (Catalina-Skiff) The object is very distant, but the extrapolated visual light curve suggests that it should be visible until the autumn, fading from 14th magnitude. CCD observations suggest that the comet is much fainter than this, perhaps 17th magnitude. The uncorrected preliminary light curve from 55 observations is m = 6.9 + 5 log d + 4.6 log r



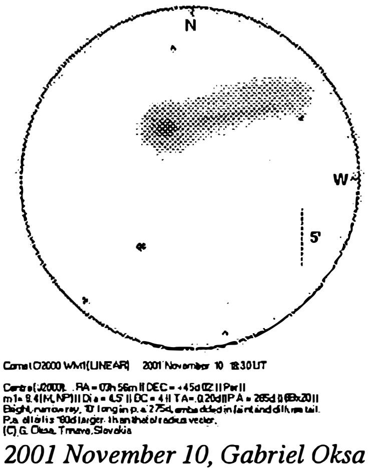
2002 February 7, Rolando Ligustri



2000 SV74 (LINEAR) The extrapolated light curve suggests that the comet will slowly fade from 13th magnitude. As with many comets the visual observations generally put the comet as being brighter than CCD observations. The uncorrected preliminary light curve from 82 observations is m = 8.0 + 5 log d + 3.9 log r.



2000 WM1 (LINEAR) Brian Marsden notes on MPEC 2001-U43 [2001 October 23], that 'The "original" and "future" barycentric values of 1/a are +0.000500 and -0.000266 (+/- 0.000002) AU**-1, respectively.' The original value is greater than 10^{-4}, hence the comet is probably not a new arrival from the Oort cloud and has made at least one previous visit to the inner solar system.

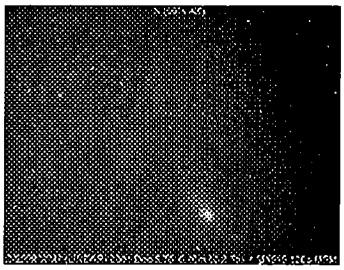


2001 November 10, Gabriel Oksa

J. Watanabe, National Astronomical Observatory (NAO) of Japan, reports the following antitail lengths and position angles for this comet from I-band CCD images taken by H Fukushima with the NAO 0.50-m f/12 reflector (noting the earth's passage through the orbital plane of the comet on Nov. 20.18 UT): Nov. 16.503, > 8'.5, 283 deg; 17.542, > 6'.5, 300 deg; 18.526, > 7'.9, 302 deg; 19.555, > 6'.2, 317 deg; 22.372, > 4'.7, 1 deg. Small scale jet-like structure near the nucleus was also recognized on these images. [IAUC 7762, 2001 November 29]

2001 November 25.91 Giovanni Sostero, Remanzacco Observatory

I observed it on October 9 under relatively poor conditions, using the Northumberland refractor x230. The comet was surprisingly easy to see and I estimated it at around 12th magnitude. An observation with the Thorrowgood refractor on October 23 put the comet at 10.3, generally diffuse but with a small star-like condensation.



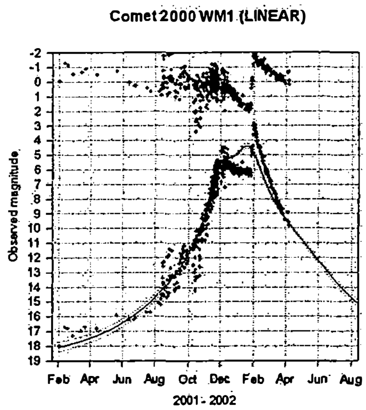
2001 December 5, Martin Mobberley

By the end of November 2001 the comet had reached 5th magnitude and was an easy object. It then slowly faded and observations by Southern Hemisphere observers in mid January put the comet at 6th magnitude, about a magnitude fainter than suggested by the preliminary light curve.

2002 March 23, Rolando Ligustri

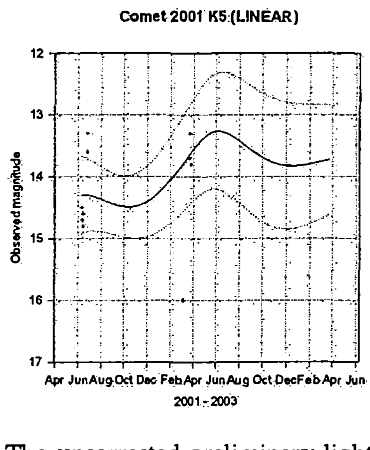
Andrew Pearce reported an outburst on 2002 Jan 27.85UT: m1=4.6, Dia=3.5', DC=8...20x80B...Andrew Pearce (Nedlands, Western Australia)[Comet has clearly undergone a significant brightness increase in the last 24 hours or so.

Surface brightness of the coma has increased significantly. Faintly visible to the naked eye even at only 10 deg altitude. Tail visible 0.5 deg long in PA 195 deg. Estimate made in 8x40B at the same time: m1=4.6, Dia=4', DC=8. I suspected something may be up the previous morning but the observation was hampered with the comet only 1' away from a 6th mag star. Quick examination of the comet through a 20cm reflector (90x) revealed an intense central condensation which appeared distinctly non stellar. No evidence of any split, however the telescope probably lacked the degree of resolution required to confirm this.]



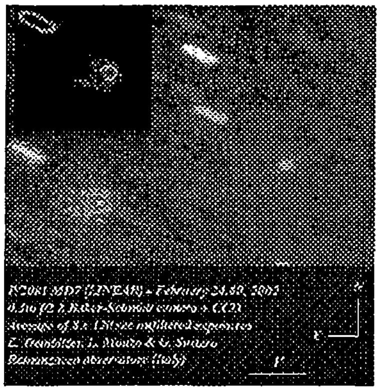
The uncorrected preliminary light curve from 715 visual observations is m = 7.1 + 5 log d + 10.6 log r, though this makes no allowance for the outburst. It will be visible until August 2002.

2001 K5 (LINEAR) The comet is distant and will remain at around 14th mag visually for some time. This is LINEARs 64th comet.

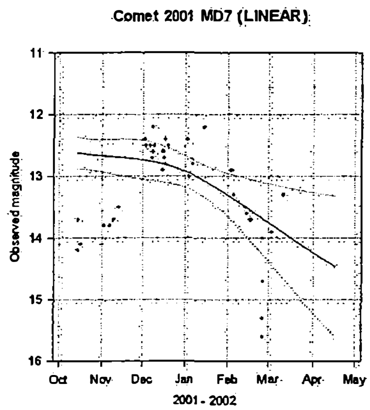


The uncorrected preliminary light curve from 11 visual observations is m = 4.9 + 5 log d + 7.1 log r

2001 MD7 (P/LINEAR). Michael Mattiazzo observed the comet on October 14 when it had brightened to 14.2 in his 0.27-m SCT x88. By December it had brightened to around 12.5. It moved north, but was not very well placed and few Northern Hemisphere observers reported observations. The visual light curve is not very well defined, but can be represented by m = 11.3 + 5 log d + [10] log r from 39 observations.

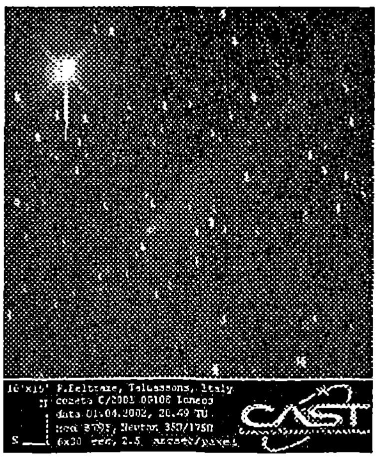


2002 February 24, Sostero et al



2001 N2 (LINEAR) may reach 13^{th} magnitude between May and August.

2001 OG108 (LONEOS) As the clue of a cometary type orbit suggested, this object did eventually show cometary activity and brightened rapidly

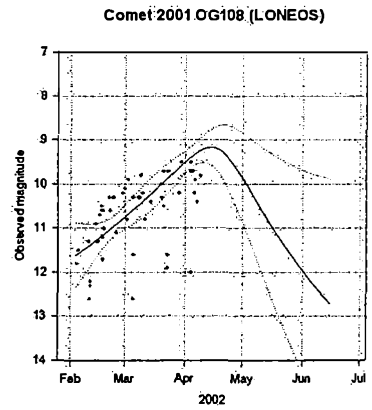


2002 April 1, Rolando Ligustri

An apparently asteroidal object reported by LONEOS was announced on MPEC 2001-P40 last Aug. 13. Numerous observers could not detect any cometary activity, despite the cometlike orbit. Now approaching perihelion, the object has finally shown cometary activity, detected by several observers as indicated by the following reported total magnitudes and coma/tail data from CCD images: Jan. 11.44 UT, 16.1, 0'.4 coma, 0'.5 tail in p.a. 230 deg (A. Nakamura, Kuma, Ehime, Japan, 0.60-m reflector); 22.39, 14.7, diffuse (S. Wakuda, Shizuoka, Japan, 0.25-m reflector); Feb. 1.40, 13.5, 0'.9 coma, broad tail toward west with the longest segment being 0'.9 long in p.a. 220 deg (Nakamura); 1.41, 12.8, fan-shaped coma spanning p.a. 200-345 deg (T. Oribe, Saji, Tottori, Japan, 1.03-m reflector). Recent astrometry and the orbital elements appear on MPEC 2002-C04. [IAUC 7814, 2002 February 2].

I observed it on February 9.81 and estimated it at 11.3: in the Thorrowgood refractor. The current light curve suggests that it will rapidly fade from around 10^{th} magnitude. It also suggests that the comet might have been observable to visual observers a month before the first reports were made.

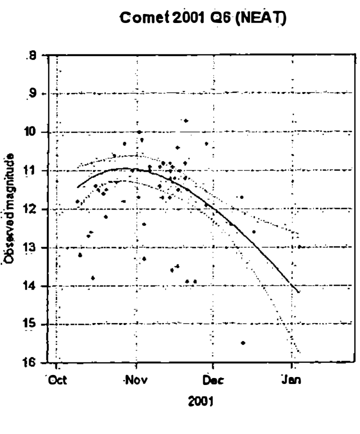
The uncorrected preliminary light curve from 46 visual observations is m = 10.2 + 5 log d + 5.9 log r, though this is a poor fit.



2001 Q4 (NEAT) The latest elements give T as 2004 May 16 with q at 0.96 AU. The value of 1/a is 0.000043, suggesting that this is a new visitor from the Oort cloud. [MPEC 2002-A87] The comet should be a bright object in

May 2004. Adopting a conservative magnitude law (7.5 log r), suggests a peak of around 3rd magnitude, whereas the standard 10 log r gives around 0 magnitude.

2001 Q6 (NEAT) Initial observations suggested that the comet could reach 14th mag at high northern declination in October, however it was unexpectedly a couple of magnitudes brighter. This is NEAT's 15th comet and their 13th this year.



The uncorrected preliminary light curve from 44 visual observations is m = 5.5 + 5 log d + 41.0 log r, but again this is a poor fit.

A/2001 SS107 (LINEAR) is an asteroid discovered by LINEAR on September 20, which has a perihelion distance of 1.51 AU and a period of 5.46 years in a typical Jupiter family comet orbit. Perihelion was on 2002 March 9.4.

2001 T5 (SOHO) A non Kreutz comet discovered by XingMing Zhou on October 17 in C3 images from October 14. [IAUC 7750, 2001 November 10]

2001 TU80 (LINEAR-NEAT) An 18th mag object independently discovered and reported as nebulous with a 3" coma by NEAT at Palomar on Nov. 16.53 UT has been identified by G. V. Williams, Minor Planet Center, with an apparently asteroidal object reported on Oct. 13.44 and 17 by LINEAR (m_2 = 19.8; discovery observations on MPS 39482) and on Oct. 19 by NEAT at Haleakala (MPS 40840), from which an apparently routine minor-planet orbit was computed (MPEC 2001-V35). Following posting on the NEO Confirmation Page, P. Kusnirak at Ondrejov found the comet to be moderately condensed with a 0'.3 coma on CCD images taken on Nov. 17.2 with a 0.65-m f/3.6 reflector. [IAUC 7753, 2001 November 17] The comet is in a short period orbit of 7.2 years, with perihelion of 1.94 AU in mid December and will fade.
The comet passed within about 0.1 AU of Jupiter in 1985, prior to which it was in a more distant, less eccentric orbit.

2001 U6 (LINEAR) An apparently asteroidal object of 19th mag discovered on Oct. 29.40 by LINEAR, posted on the NEO Confirmation Page due to its unusual motion, has been found to be cometary by J. Ticha and M. Tichy (Klet, diffuse with "a slight coma" on Nov. 3.8 UT) and by R. Trentman (Louisburg, KS, Nov. 6.3). [IAUC 7746, 2001 November 6] The comet is distant and will reach perihelion in August 2002. It will not come within visual range.
Brian Marsden notes on MPEC 2002-C55 that the "original" and "future" barycentric values of 1/a are +0.001080 and +0.001158 (+/- 0.000051) AU**-1, respectively. This suggests that it is not a new comet from the Oort cloud.

A/2001 UU92 (NEAT) is an asteroid, of 19th magnitude, discovered by NEAT on October 19.32. With a period of 5.63 years, the orbit is typical of a Jupiter family comet. It will be at perihelion at 1.05 AU at the end of December. [MPEC 2001-W34]

A/2001 VJ75 (LINEAR) is an asteroid, of 20th magnitude, discovered by LINEAR on November 12.45. With a period of 5.20 years, the orbit is typical of a Jupiter family comet. It was at perihelion at 1.07 AU at the beginning of November. [MPEC 2001-W05]

2001 W1 (LINEAR) A 19th mag object reported by LINEAR as apparently asteroidal but with unusual motion on November 17.43, and thus posted on the NEO Confirmation Page, has been found to appear cometary by other observers. CCD images taken by J. Nomen (Barcelona, Spain, 0.40-m f/2 Schmidt telescope) on Nov. 18.15 UT show the object to be slightly diffuse (m_1 = 18.0). CCD observations obtained by T. Spahr at the 1.2-m Mount Hopkins reflector on Nov. 18.33 show a very diffuse coma of diameter about 7" and a very faint tail about 15" long in p.a. 200 deg. [IAUC 7754, 2001 November 19]. The comet will brighten a little.

2001 W2 (BATTERS) S. Nakano, Sumoto, Japan, reports the discovery of a 14th mag comet on November 21.45 by A. Asami on CCD images taken with the Bisei Spaceguard Center 0.50-m f/2.0 reflector in the course of the "Bisei Asteroid Tracking Telescope for Rapid Survey" program. Additional observations were reported following posting on the NEO Confirmation Page. [IAUC 7758, 2001 November 21] A. Hale, Cloudcroft, NM, reports that this comet showed a 0'.8 coma and total visual magnitude 12.7 on Nov. 22.09 UT (0.41-m reflector). Additional astrometry and preliminary parabolic orbital elements appear on MPEC 2001-W53. [IAUC 7760, 2001 November 23] The comet reached perihelion in late December, at 1.05 AU, but did not become much brighter than at discovery. The latest elements show that it is in a Halley type orbit with period 76 years.

The comet was never well placed for observation, but a few observers reported it at around 11^{th} magnitude in December.

A/2001 WS1 (LINEAR) is an asteroid, of 17th magnitude, discovered by LINEAR on November 17.07. With a period of 4.92 years, the orbit is typical of a Jupiter family comet. It was at perihelion at 1.03 AU in late October. [MPEC 2001-W36]

A/2001 WU1=1979 WN8 (Palomar-LINEAR) is an asteroid, of 18th magnitude, rediscovered by LINEAR on November 18.22 and originally found at Palomar on 1979 November 24. With a period of 5.56 years, the orbit is typical of a Jupiter family comet. It will reach perihelion at 1.35 AU in early June 2002. [MPEC 2001-W38]

2001 WF2 (P/LONEOS) An apparently asteroidal object of 19th magnitude discovered by LONEOS on November 17.27 and designated 2001 WF_2 (cf. MPEC 2001-W42) was found to have a well-defined 45" tail in p.a. 320 deg on CCD images obtained on Feb. 13.5 UT by T. B. Spahr with the 1.2-m reflector at Mount Hopkins. Following notification by Spahr, C. W. Hergenrother also found a 27" tail in p.a. 320 deg and a stellar central condensation on a 1500-s co-added R-band image taken with the Catalina 1.54-m reflector. [IAUC 7827, 2002 February 13] The object was at perihelion in late January at 0.98 AU and has a period of 5.0 years. It is intrinsically very faint and will fade.

2001 X1 (LINEAR) R. Huber, Lincoln Laboratory, Massachusetts Institute of Technology, reports the discovery by LINEAR of a comet on images taken on Dec. 13.44 that show a bright core surrounded by a diffuse coma (comet's magnitude given as 16.5-17.0) and exhibiting a tail at least 95" long in p.a. 295 deg. CCD observations on Dec. 14.1 UT by R. Stoss and P. Geffert (Starkenburg Sternwarte, 0.45-m f/4.4 reflector) reveal a well- condensed coma with a thin tail 5' long in p.a. 300 deg (m_2 = 16.5). CCD images taken in twilight and poor seeing by A. C. Gilmore (Mount John, 1.0-m f/7.7 reflector) on Dec. 14.6 show the object as diffuse (m_1 = 14.6-15.1) with a broad, faint fan tail 1' long in p.a. about 315 deg. [IAUC 7774, 2001 December 14]. The comet was around 15th magnitude visually. Brian Marsden notes on MPEC 2002-F19 [2002 March 18] that the "original" and "future" barycentric values of 1/a are +0.02285 and +0.001659 (+/-0.000042) AU**-1, respectively. These values show that the comet is not a new one from the Oort cloud.

2001 X2 (P/Scotti) J. V. Scotti, Lunar and Planetary Laboratory, reports his discovery of a 19th mag comet on CCD images taken with the 0.9-m Spacewatch telescope on December 14.44, noting a coma diameter of 5" and a tail 0'.40 long in p.a. 283 deg (and m_2 = 22.7). Confirming observations were made at Klet by J. Ticha, M. Tichy, and P. Jelinek, who reported a 8" coma and a faint westward tail. [IAUC 7775, 2001 December 14]. The latest orbit shows that the comet is of short period (7.3 years), with perihelion at 2.5 AU in 2001 October. It will fade.

2001 X3 (11P/Tempel-Swift-LINEAR) R. Huber, Lincoln Laboratory, Massachusetts Institute of Technology, reports that a 20th mag object discovered by LINEAR on Dec. 7.08 was found to be diffuse on Dec. 17 (with prediscovery LINEAR data back to Sept. 10). G. Hug, Eskridge, KS, reports that the object is probably diffuse on CCD images taken on Dec. 19.1 UT (red mag 17.2-17.8). [IAUC 7778, 2001 December 19] The comet has a period of 6.4 years, with perihelion at 1.6 AU. It will fade.

C. Hergenrother, Lunar and Planetary Laboratory; and K. Muraoka, Kochi, Japan, suggested a link between comet 11D (last seen in 1908) and P/2001 X3 (cf. IAUC 7778) - a linkage confirmed at the Minor Planet Center and by S. Nakano (Sumoto, Japan). The orbital elements by Nakano (from 43 observations, 1908-2001, have mean residual 0".8; nongravitational parameters A_1 = +0.13 +/- 0.01, A_2 = -0.0134 +/- 0.0007). The comet was not found in 1963 despite a prediction by B. G. Marsden (IAUC 1838, 1839, 1840). More recent predictions were made by Marsden and Sekanina (1971, A.J. 76, 1142), by Nakano (Comet Handbooks for 1989, 1995, and 1996, Oriental Astronomical Association; and NK 686), and by Muraoka (Comet Handbook for 2001, OAA). The indicated correction to Nakano's 2001 prediction (1998, NK 686) is Delta(T) = +3.4 days. [IAUC 7779, 2001 December 20] The comet was listed amongst those due to return in my predictions for 2001 in the BAA Journal for December 2000.

2001 X8 (SOHO) A non Kreutz comet discovered by Alexander Mimeev on December 12 in real-time C2 images. [IAUC 7797, 2002 January 19] Studies by Maik Meyer show that it forms a triplet with 1997 L2 and 2001 E1.

A/2001 XQ (LINEAR) is an asteroid, of 15th magnitude, discovered by LINEAR on December 6.16. It was at perihelion at 1.04 AU in mid December. [MPEC 2001-X24] With a period of 6.87 years, the orbit is typical of a Jupiter family comet. It approached to 0.53 AU of Jupiter in 1983, which made small changes to the orbit.

A/2001 XU (NEAT) is an asteroid, of 18th magnitude, discovered by NEAT on December 7.45. With a period of 4.93 years, the orbit is typical of a Jupiter family comet. It will reach perihelion at 0.41 AU in early February. It is a PHA, possibly coming as close as 0.005 AU, but on this occasion only gets to within 0.22 AU. [MPEC 2001-X28]

A/2001 XL16 (Spacewatch) is an asteroid, of 21st magnitude, discovered by Spacewatch on December 10.13. With a period of 5.73 years, the orbit is typical of a Jupiter family comet. It will reach perihelion at 1.50 AU in mid January. [MPEC 2001-Y44]

2001 Y1 (152P/Helin-Lawrence) This periodic comet, first observed in 1993, has been recovered by T Oribe at the Saji observatory. It will reach perihelion at the end of 2002.
On 2001 Dec. 25, S. Nakano (Sumoto, Japan) reported that T. Oribe had apparently recovered comet P/1993 K2 (= 1993 XI = 1993l) the night before (December 24.86) with the 1.0-m reflector at the Saji Observatory. The position was within 2" of the prediction by B. G. Marsden on MPC 34423 (ephemeris on MPC 43696). No information was provided about the object's appearance other than m_1 = 19.5. The comet has now been independently reported by K. Sarneczky and Z. Heiner in 2002 Jan. 11 data obtained with the 0.6-m Schmidt at Piszkesteto, at m_1 = 20, but again with no information about the appearance. These observations confirm a tentative single-night detection by C. W. Hergenrother and D. Means

of an object of stellar appearance (in an 840-s co-added exposure) at the comet's expected position a year ago with the Steward Observatory's 2.3-m reflector at Kitt Peak. [IAUC 7790, 2002 January 14]

Further to IAUC 7790, K. Sarneczky reports that his 300-s unfiltered CCD images taken on Jan. 11.2 UT show a diffuse, 8" coma and a faint, narrow, 13" tail in p.a. 283 deg. [IAUC 7792, 2002 January 15] Further to IAUC 7790, T. Oribe reports that his CCD images taken on 2001 Dec. 24.86 UT show a 0'.15 coma and an 8" tail in p.a. 295 deg. [IAUC 7794, 2002 January 17]

2001 YX127 (P/LINEAR) An object previously reported as asteroidal by LINEAR has been shown to have cometary characteristics. It is distant and faint, and will fade from 20th magnitude.
An apparently asteroidal object of 20th mag discovered by LINEAR on December 17.32 and designated 2001 YX_127 (cf. MPS 47220, MPO 24028) has been found to have a broad, fan-shaped extension in p.a. 100 deg on CCD images obtained on Feb. 14.2 UT by T. B. Spahr with the 1.2-m reflector at Mount Hopkins. Co-added CCD R-band images taken at about the same time by C. W. Hergenrother with the Catalina 1.54-m reflector show a 7" coma and a broad tail 8" long in p.a. 100 deg. [IAUC 7828, 2002 February 14]

2002 A1 (LINEAR) and 2002 A2 (LINEAR) Two 19th mag objects of asteroidal appearance separated by <1 degree and having similar, somewhat unusual motion were reported by LINEAR on Jan. 8.32. Further observations were made following placement of the objects on the NEO Confirmation Page, and prediscovery observations in Nov.-Dec. 2001 were identified at the Minor Planet Center in LINEAR and NEAT data. Orbit computations for the two objects gave very similar results (basically differing only in T) and showed that the objects were only 0.7 AU from Jupiter at discovery. Observations by T. B. Spahr and P. Berlind with the 1.2-m reflector at the F. L. Whipple Observatory on 2002 Jan. 11.4 UT showed that the objects had faint, narrow tails around p.a. 250 deg. Independent observations by R. H. McNaught with the 1.0-m reflector at Siding Spring on Jan. 11.6 showed that the first object, now designated C/2002 A1, was slightly diffuse with a very faint 25" tail in p.a. 260 deg, and that the second object, C/2002 A2, was almost stellar with a very narrow 20" tail in p.a. 250 deg. The respective discovery observations and orbital elements are given in MPEC 2002-A62 (which also contains all the relevant astrometry and ephemerides). The 2001 Dec. 13 and 17 observations of C/2002 A1 originally appeared on MPS 45271 under the designation 2001 XG_115. The minimum distances from Jupiter were ><0.4 AU around 2001 July 9 and 18 for C/2002 A1 and C/2002 A2, respectively. [IAUC 7788, 2002 January 11] The latest orbits, on MPEC 2002-C58 and C69, gives them a periodic orbit of around 77 years, with perihelion distance of 4.7 AU in early December 2001.

2002 A3 (LINEAR) An 18th mag object reported as asteroidal by LINEAR on January 13.23 has been noted by several CCD observers to be cometary: Jan. 19.9 UT, slightly diffuse, m_1 = 17.3 (J. Nomen, Barcelona, Spain); 20.6, 10" coma, m_1 = 17.3 (J. Broughton, Reedy Creek, Qld.); 21.2, fuzzy coma of diameter about 10" (R. Dyvig, Quinn, SD); 21.2, m_1 = 17.0, 22" tail in p.a. 250 deg (R. Fredrick, R. Trentman, and R. Gruenke, Louisburg, KS). [IAUC 7799, 2002 January 21] It has a perihelion distance of 5 AU and reaching perihelion in May. It will fade.

2002 AR2 (P/LINEAR) An asteroid discovered by LINEAR on January 6.15 has been found to be a comet, initially suggested by its orbit, with follow up observations showing a coma. The object is in a 12.5 year orbit, with perihelion at 2.0 AU in mid January. It will fade from 18th magnitude.

A/2002 AZ1 (Spacewatch) is an asteroid, of 21st magnitude, discovered by Spacewatch on January 7.27. It will reach perihelion at 0.67 AU in late March. [MPEC 2002-A31] With a period of 4.86 years, the orbit is typical of a Jupiter family comet. It passed 0.72 AU from Jupiter in 1999, though this did not significantly affect the orbit.

A/2002 AR4 (LINEAR) is an asteroid, of 20th magnitude, discovered by LINEAR on January 8.23. It will reach perihelion at 1.13 AU in mid March. [MPEC 2002-A51] With a period of 5.17 years, the orbit is typical of a Jupiter family comet. It has made no recent close approaches to Jupiter.

A/2002 AO7 (LINEAR) is an asteroid, of 20th magnitude, discovered by LINEAR on January 8.16. It will reach perihelion at 1.10 AU in early April. [MPEC 2002-A63] With a period of 5.10 years, the orbit is typical of a Jupiter family comet. It has made no recent close approaches to Jupiter.

A/2002 AF29 (NEAT) is an asteroid, of 20th magnitude, discovered by NEAT on January 13.41. It will reach perihelion at 1.25 AU at the end of January. [MPEC 2002-A94] With a period of 5.97 years, the orbit is typical of a Jupiter family comet. It has made no recent close approaches to Jupiter.

A/2002 AO148 (LINEAR) is an asteroid, of 20th magnitude, discovered by LINEAR on January 11.36. It is in a 13.5 year orbit, with perihelion at 4.1 AU and an eccentricity of 0.27. [MPEC 2002-C107]

2002 B1 (LINEAR) An 18th mag object reported as asteroidal in appearance by LINEAR on January 26.09, and posted on the NEO Confirmation Page, has been found to be cometary on CCD images taken by M. Tichy and J. Ticha at Klet (coma diameter 7"-8", on Jan. 29.8 and Feb. 1.8 UT; coma diameter 9" with m_1 = 17.7-18.0 and a faint tail in p.a. 165 deg on Feb. 4.8) and by A. Galad and L. Kornos at Modra ('slightly diffuse' on Feb. 1 and 2). [IAUC 7817, 2002 February 4] It is intrinsically faint and will fade from 17th mag. The latest orbit (MPEC 2002-C70 gives it a periodic orbit, with period around 31 years.

2002 B2 (LINEAR) An apparently asteroidal 19th mag object reported by LINEAR on January 23.40 and posted on the NEO Confirmation Page has been found to be cometary by M. Tichy and J. Ticha at Klet (coma diameter 6", with ml = 17.2, and faint 9" tail in p.a. 90 deg on Feb. 3.05 UT) and by R. H. McNaught at Siding Spring (8" coma and 10" tail in p.a. 60 deg on Feb. 6.66). [IAUC 7821, 2002 February 6] It was quite distant and near peak brightness and will fade from 17th mag.

2002 B3 (LINEAR) F. Shelly, Lincoln Laboratory, Massachusetts Institute of Technology, reports that an apparently asteroidal object of 19th mag, discovered by LINEAR on Jan. 26.12 (and placed on the NEO Confirmation Page) was found to show a clear tail in p.a. about 330 deg on Feb. 11.09 UT. T. B. Spahr, Harvard-Smithsonian Center for Astrophysics, reports that CCD images taken with the 1.2-m reflector at Mt. Hopkins on Feb. 12.13 show the object to be very faintly diffuse with a faint extension in p.a. 315 deg. [IAUC 7826, 2002 February 12] It is very distant and near peak brightness and will fade from 19th mag.

2002 C1 (Ikeya-Zhang) Kaoru Ikeya and Daqing Zhang discovered a 9th magnitude comet on February 1. It reached perihelion on March 18 at 0.5 AU and brightened to 3rd magnitude. Kaoru Ikeya discovered 5 comets in the 1960s, including the spectacular sungrazer Ikeya-Seki (1965 S1).

Word has been received of the independent visual discovery of a comet by Kaoru Ikeya (Mori, Shuchi, Shizuoka, Japan; 0.25-m reflector, 39x; communicated by S. Nakano, Sumoto, Japan; coma diameter 2' with weak condensation; motion about 5' northeastward in 30 min) and by Daqing Zhang (near Kaifeng, Henan province, China; 0.2-m reflector; communicated by J. Zhu, Peking University; coma diameter 3').

2002 UT	R.A. (2000)	Decl.	m1	Observer
Feb. 1.408	0 08.9	-17 42	9.0	Ikeya
Feb. 1.47	0 09	-17 30	8.5	Zhang

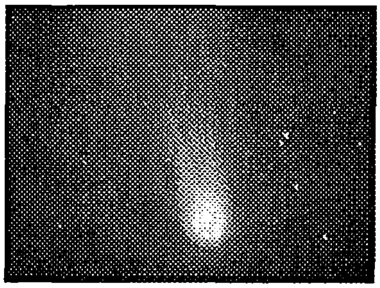
[IAUC 7812, 2002 February 1]

Precise astrometry (Feb. 1-2) and the preliminary parabolic orbital elements given below appear on MPEC 2002-C03. Visual m_1 and coma-diameter estimates: Feb. 1.910 UT, 7.5:, 5' (P. M. Raymundo, Salvador, Brazil, 0.25-m reflector; independent discovery); 2.081, 9.5:, 3' (A. Hale, Cloudcroft, NM, 0.41-m reflector; thin clouds); 2.43, 8.8, about 4' (K. Yoshimoto, Yamaguchi, Japan, 20x100 binoculars); 2.47, 8.8, 3' (D. Zhang, Kaifeng, Henan, China, 0.20-m f/4.4 reflector, 28x, as used for the discovery on Feb. 1.47; comet more condensed than on previous day); 2.53, 9.1, 3' (A. Pearce, Nedlands, W. Australia, 0.2-m reflector); 2.53, 8.5, 5' (N. Brown, Quinns Rocks, W. Australia, 0.15-m refractor). [IAUC 7813, 2002 February 2]

Nakano, Muraoka and Sato note that there is a possibility that the comet is identical with comet 1532 R1. Brian Marsden notes on MPEC 2002-C111 : A parabolic orbit no longer adequately fits the observations, and a revolution period of 400-500 years is likely. There is a possibility that the comet is identical with C/1532 R1, as first suggested by S. Nakano on the basis of observations through Feb. 10.4.

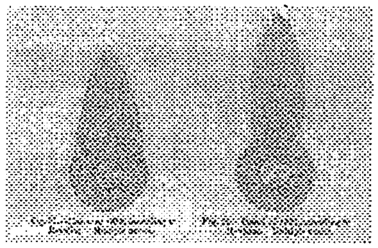
Further observations render this possibility unlikely, but make it more probable that the comet is a return of comet 1661 C1. Brian Marsden notes on MPEC 2002-D36 [2002 February 26] : Numerical integration backward of the perturbed equivalent of the above unperturbed orbit solution yields a previous perihelion date in March 1659. This suggests a likely identity with C/1661 C1, rather than with C/1532 R1 (cf. MPEC 2002-C111). If this identity is confirmed it will be the longest period comet so far known to return.

A new orbit is given on MPEC 2002-F21 [2002 March 18] and Brian Marsden notes that the orbital elements yield the year of the previous perihelion passage as T = 1660.9 +/- 0.4 (1 sigma), in very close agreement with the value T = 1661.1 for comet C/1661 C1. [See also Nakano's orbit, which links C/1661 C1 with C/2002 C1 and Kenji Muraoka 's orbit (in Japanese).



2002 April 1, Nigel Bryant

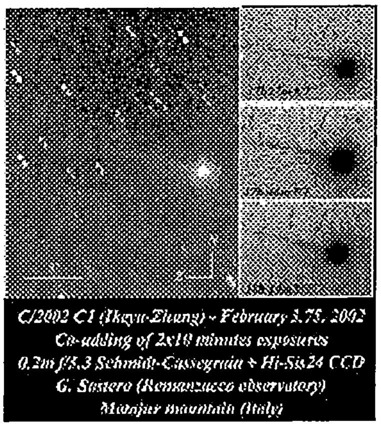
King Charles II was crowned in 1660 and had created the Royal Society in the same year. In 1661, Isaac Newton was 18, and went up to Cambridge in June of that year. It is unlikely that he observed the comet as his notebook suggest that the first comet that he observed was the one of December 1664. Halley would have been too young to record the comet (he was 5), but later he computed an orbit similar to that of the 1532 comet and suggested a possible link. Charles Messier noted this possible link, but that it had been refuted by Mechain.



Drawing of the 1661 comet (right) by Hevelius taken from Guillemin, 'The world of comets', 1877

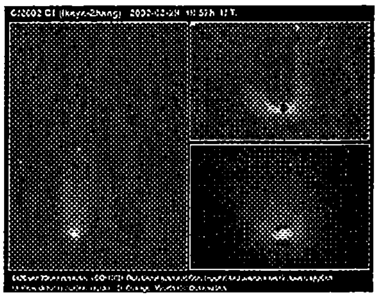
The comet was observed and drawn by Hevelius. The optical quality of his telescope was far inferior to those of today and the features drawn may be imaginary. The comet was thought to be a portent for 'Black Bartholomew's Day' when 900 non-conformist clergymen were ejected from their benefices following the Act of Uniformity of 1662. Succeeding bright comets were associated with the Plague and the Fire of London. The comet was illustrated by Johann Gabriel Doppelmayr in 1742.

The following excerpt about C/1661 C1 is from volume 1 of Cometography by Gary Kronk:



2002 February 3.75, Giovanni Sostero

Discovered: 1661 February 3.2 (D=0.62 AU, r=0.48 AU, Elong.=23 deg.) Last seen: 1661 March 28.1 (D=0.99 AU, r=1.39 AU, Elong.=88 deg.) Closest to the Earth: 1661 January 29 (0.6062 AU) Calculated path: DEL (Disc), AQL (Feb. 6), SER (Mar. 26)



2002 March 29, David Strange

The Polish astronomer Johannes Hevelius (1668) provided the most extensive set of observations of this comet. He discovered it on 1661 February 3.2, shortly after morning twilight had begun. Computations using the orbit below indicate the comet was then exiting the twilight after having passed only 17 degrees from the sun on January 28. Within a few days Hevelius estimated the tail length as 6 degrees and noted the comet appeared fainter than Alpha Aquilae. Hevelius noted a multiple structure of the nucleus on several occasions up to February 20. The comet was last detected on March 28.1 by Hevelius.

The observations of Eberhard Welper (Strasbourg, France) were included in the 1788 volume of the Berliner Astronomisches Jahrbuch. Welper first saw the comet on February 8 and said the tail extended 5 degrees and was perpendicular to the horizon. He noted the same orientation on the 9th. By the 10th Welper said the tail was basically extending perpendicular to the horizon, although he noted a slight tilt toward the west. Welper's observation of February 11 was his last, because of an extended period of bad weather.

In volume 46 of Travels and Explorations of the Jesuit Missionaries in New France (1899), Jerome Lalemant (superior of the Jesuit missions in New France, now Canada) wrote of this comet. He said, "the comet which was visible here, from the end of January to the beginning of March, was soon followed by the disasters of which those stars of evil omen are the forerunners." In describing its appearance, he said, "Its tail, extending westward, pointed toward us and seemed to threaten us with a flagellation, of which it was, to us, a brilliant but fatal portent." He continued, "it did indeed move from West to East, following the flight of the constellation of the Eagle, at whose head it appeared, although by another movement it tended a little Northward from us."

Marie de l'Incarnation (1671), superior of the convent at Quebec, Canada, wrote a letter to her son in 1661 September which also described this comet. She said, "A comet was seen, its rods pointed toward the earth. It appeared at about two or three o'clock in the morning and disappeared toward six or seven with the day. In the air was seen a man of fire, enveloped in fire. A canoe of fire was also seen and, towards Montreal, a great crown likewise of fire."

Edmond Halley (1705) and P. F. A. Mechain (1785) computed very similar parabolic orbits, with the former noting a similarity to the orbit of the comet of 1532. Mechain's orbit is given below. It indicates the comet reached a maximum declination of +6 degrees (apparent) on February 14. The orbits are as follows:

Computer	T		AOP	AN (2000.0)	i	q	e
Halley	1661 Jan. 27.4868	(UT)	33.552	87.169	32.596	0.448510	1.0
Mechain	1661 Jan. 27.381	(UT)	33.450	86.562	33.015	0.442722	1.0

Despite Halley's suggestion that C/1532 R1 and C/1661 C1 might be related, the idea was ignored until Nevil Maskelyne (1786) looked into the matter. Maskelyne took the elapsed time between the perihelion date of these two comets, added it to the 1661 perihelion date, and predicted the comet would arrive at perihelion around 1789 April 27. He added that assumed perturbations by Jupiter would probably cause the perihelion date to occur earlier, possibly as soon as late 1788. With an assumed perihelion date of 1789 January 1, he computed an ephemeris for the period of 1788 April 23 to 1789 January 1. Maskelyne said the comet could be recovered as early as 1788 September by observers near the equator or south of it, and added, "The Cape of Good Hope would be an excellent situation for this purpose." Early in 1788, both Johann Elert Bode and Capel Lofft made similar predictions for the probable return of this comet. However, despite the preparation and numerous searches, the comet was not found.

Full moon: February 14, March 15 Sources: J. Hevelius (1668), p. 483; Marie de l'Incarnation (1671), pp. 263-4; E. Halley, Philosophical Transactions of the Royal Society of London, 24 (1705), pp. 1882-99; A. G. Pingré, Cometographie (1784), p. 10; P. F. A. Méchain, Memoirs of the Pres. of Paris (1785), p. 395; Philosophical Transactions of the Royal Society of London, 76 (1786), pp. 426-31; N. Maskelyne, Gentleman's Magazine, 57 (1787), p. 59; Berliner Astronomisches Jahrbuch (1788), pp. 195-6; C. Lofft, Gentleman's Magazine, 58 (1788), pp. 1048-50; Berliner Astronomisches Jahrbuch (1790), pp. 184-6; The London and Edinburgh Philosophical Magazine and Journal of Science (Series 3), 7 (1835 Jul.), p. 37; Travels and Explorations of the Jesuit Missionaries in New France, Volume 46, edited by Reuben Gold Thwaites, Cleveland: The Burrows Brothers Company (1899), p. 205; S. K. Vsekhsvyatskij, Physical Characteristics of Comets (1964), p. 50; Journal of the Royal Astronomical of Canada, 70 (1976 Dec.), pp. 311-12.

Graeme Waddington provides the following information on orbital computations:

Nakano has a new linked solution forcing the identification of C/2002 C1 (Ikeya-Zhang) with C/1661 C1 (Hevelius). Nakano specifies the elements at epochs in 2002 and 1661. Integrating the 2002 set back to 1661 gives a difference of 0.12 days in the time of perihelion passage when compare to Nakano's 1661 set.

Integrating both sets backwards gives an estimate of the likely uncertainites involved and we now get the sequence

1661 Jan 28.9	(+- 0.1 d)
1273 Apr 25	(+- 1.5 d)
879 Jan 10	(+- 15 d)
426 May	(+- 500 d)

Integrations of Nakano's previous linked solution also gave a perihelion in 1273 Apr/May and Muraoka gave 1273 Mar 26 for his integration of Nakano's previous solution. [My own rough integration of Nakano's orbit suggested previous returns around 1273 May, 879 January and 425. Gary Kronk's Cometography lists a comet for 877, but not 879].

Ho Penk Yoke gives as #439 in his catalogue a comet of bluish-white colour and with the appearance of loose cotton that appeared in 1273 April. The details given (movement through Auriga towards U.Maj) mimic the expected appearance of the integrated object for 1273 - the agreement can be improved by having a periheilon passage ~ 20-30 days earlier than my integrations give (i.e. around 1273 April 1, near to Muraoka's result).

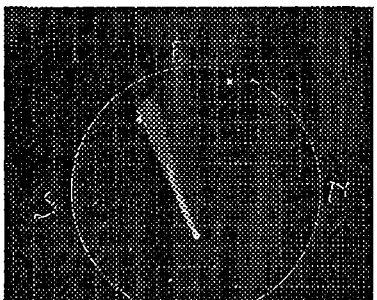
Thus is seems to me likely that the 1273 April comet mentioned in the Oriental annals can be equated with Ikeya-Zhang (2002) = Hevelius (1661) and as such could be used refine the long-term integration uncertainties.

The comet of 1273 April is also listed by Hasegawa (1980) and appears on page 223 of Gary Kronk's Cometography.

Hirohisa Sato provides the following information:

The comet of 11th February, 877 has a record in Japan. "On the 25th day in the first month of the first yaer of the Genkei reign-period a 'guest star' appeared to the west of the (Tung-) Pi (14th lunar mansion)."(Dainihonshi ch. 359; K; Hsi.) Ho Peng Yoke (1962)'s 'Ancient and Mediaeval Observations of Comets and Novae in Chinese Sources' p 176. Time is about 18:00?('Tori-no-koku').

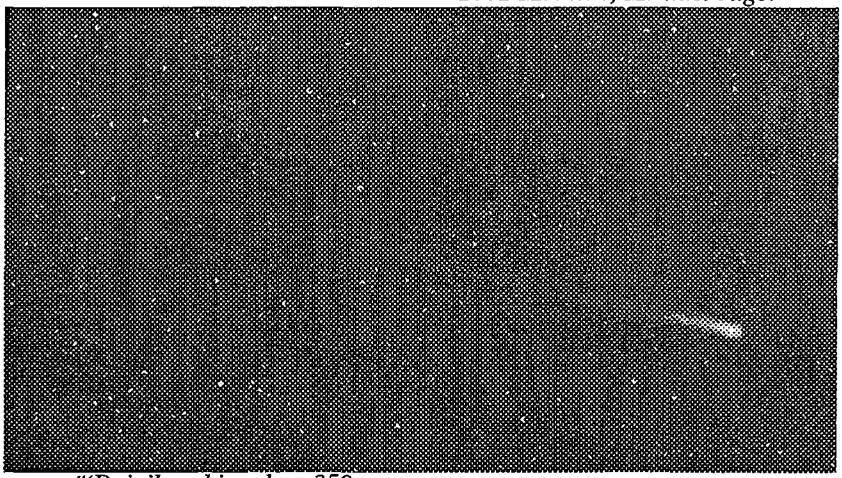
The comet of 5th February, 1273 has a record in Japan. "On the 16th day in the first month of the tenth yaer of the Bun-ei reign-period [5th February, 1273] a (hui) comet was seen....."(Dainihonshi ch. 359; K.). Ho (1962) p194. The observation on 11th April was a 'guest star' and is not this comet. (Sato)



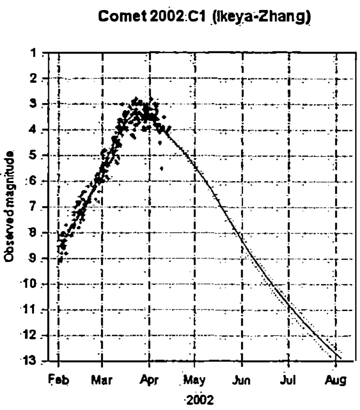
2002 March 11.77, Tony Scarmato

Early observations suggested that it was brightening quite rapidly. On February 5.77 I estimated it at 7.7 in the 20cm Thorrowgood refractor x40, however other observers made it a little fainter on the same evening. On February 9.77 I made it 8.1 in the same instrument x70, though this time other observers were indicating a brighter magnitude. The coma was well condensed, DC5 - 6, with a coma diameter of 4'. The comet was also easily visible in 14x100 and 20x80 binoculars. Observations on February 11 suggest a magnitude of about 7. Maciej Reszelski reports that the comet had reached 6.5 in 20x60B on February 15.72. On February 26.76 I observed the comet in rather bright twilight with 20x80B and estimated it at 5.9, with a 9' ion tail in pa 85. It was distinctly brighter on February 28.78 when I made it 5.6 with a 0.5 degree tail in pa 65.

2002 March 6, Michael Jager



By the end of February the comet had reached naked eye brightness and a steady stream of reports began to arrive. The comet had become very well condensed, with an almost stellar nucleus. At its brightest in late March, images show that the coma was distinctly green. From dark sky sites, the comet showed a prominent tail, with a maximum length reported by visual observers of around 6 degrees.



357 observations received February 2 - April 13 give a preliminary light curve of m = 7.1 + 5 log d + 10.6 log r

Stop press: The latest orbit for 2002 C1 on MPEC 2002-H23, which includes non-gravitational parameters gives the perihelion time for the last return as 1667.9±0.3.

2002 C2 (LINEAR) R. Huber and F. Shelley, Lincoln Laboratory, Massachusetts Institute of Technology, report the discovery by LINEAR of an 18th mag comet on February 1.09 with a tail 42"-47" long in p.a. 12.5 deg. Cometary activity has been confirmed via CCD observations by A. Galad and L. Komos at Modra on Feb. 1.8 (m_1 = 16.3, asymmetric coma extending 15" toward p.a. about 30 deg) and 2.7 UT (slightly diffuse with coma diameter about 10"), by J. Ticha and M. Tichy at Klet on Feb. 2.7 (coma diameter 10"), and by T. Payer at Duesseldorf, Germany, on Feb. 2.8 (coma visible, m_1 = 16.6). [IAUC 7815, 2002 February 2] It is a distant object and will fade.

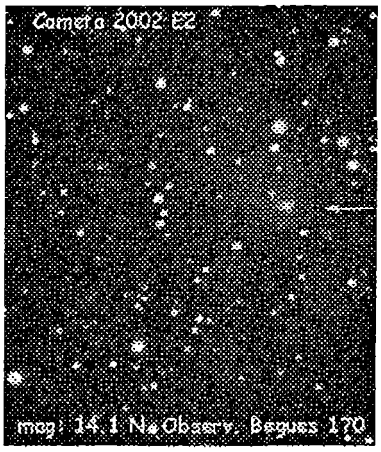
2002 CW134 (P/LINEAR) A 20th magnitude object, discovered by LINEAR on February 7.47 has been found to have a coma. It was near perihelion at 1.84 AU and has a period of 6.8 years.

A/2002 CE10 (LINEAR) This asteroid discovered by LINEAR is in a retrograde cometary type orbit with period of 25 years. It is still some 16 months from perihelion at 1.9 AU in June 2003, so it may begin to show cometary activity in the future. Discovered on February 6.32 at around 20th magnitude it is still 4.8 AU from the Sun. [MPEC 2002-C83, 2002 February 13]

2002 E2 (Snyder-Murakami) A new comet has been discovered by US astronomer Douglas Snyder and Japanese astronomer Shigeki Murakami. The comet is about 11th magnitude and moving northwards. It is just past perihelion and will slowly fade from around 11th magnitude. There is some similarity (pointed out by "Mitch") between the orbital elements and those of C/1998 H1 (Stonehouse).

Doug Snyder has provided the following information to the comet mail list: I was using a magnification of 149x, which was providing me with a field of 32' on my 20" f/5 Obsession. Occasionally, I would boost the magnification up to 212x to look at a particular object, but not for sweeping the skies. This was a deliberate search, although I am relatively new at comet searching. I had spent only about 70 hours up to the time of the finding. A real lucky find! I have been deep sky observing for about 20 years.

Not that I'm too much of a believer in the psychic side of things, but my wife and I had gone out to dinner with another couple very involved in amateur astronomy and we ate at a Chinese restaurant (this was on Sunday evening, the evening before the discovery). After the meal, we received our fortune cookies. Mine read "You will soon be the center of attention". On every other occasion where I get one of these fortunes, I just toss it away. Well, on this particular evening, I stuck it in my shirt pocket and took it home with me. Well, I stayted up the entire night and it was 8 hours later that I came across the comet. Now, for the time being, I guess I've been at the center of attention! My wife wants to frame it - but gee, its only 70 x 13 mm!



2002 April 17, Pepe Manteca

Stargazer finds comet by Lyn Southerland Sierra Vista Herald March 14, 2002

Palominas - With his eyes on the skies and the strains of "Some Enchanted Evening" playing in the background, Doug Snyder made the discovery of a lifetime early Monday morning.

The amateur stargazer discovered a new comet streaking through the Aquila Constellation in the heart of the Summer Milky Way galaxy.

At 3:40 on Monday morning, he happened across "a little gray smudge" nestled in the Aquila Constellation. He did some quick research using a sky atlas and numerous databases, but couldn't locate any references to his find.

Trying not to get his hopes too high, Snyder checked the comet's location again. "The comet had moved a bit, but not too much, and I found it again fairly easily. Dawn was coming, and my view of the comet was fading, but by now I was becoming more sure of my discovery," Snyder said.

He immediately e-mailed news of his discovery to the Central Bureau for Astronomical Telegrams, the Harvard-affiliated clearinghouse for new discoveries. It was 4 a.m. and the world was being told the latest space find had been made at a small observatory in Southeastern Arizona.

Several anxious hours later, he received a reply. CBAT has spent the interim time researching his find, verifying Snyder's experience and credentials, and locating the comet. CBAT asked for additional information, which Snyder provided, and then he waited.

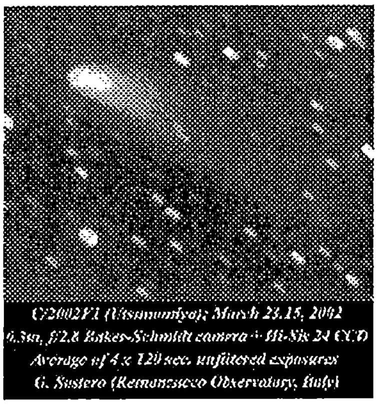
"It's been a whirlwind couple of days," Snyder said. "But yesterday (Tuesday), they finally let me know that I had really discovered a new comet."

Visual observers have put the comet at around magnitude 11 over the last month, with a 2' diameter, diffuse coma.

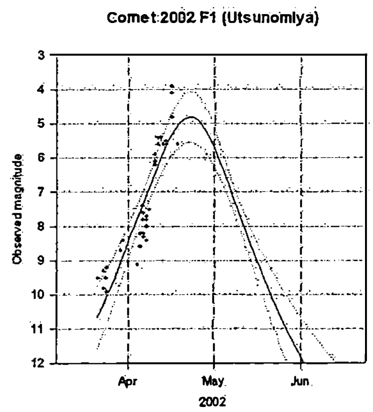
26 observations received March 13 - April 7 give a preliminary light curve of m = 8.0 + 5 log d + [10] log r

2002 F1 (Utsunomiya) Syogo Utsunomiya from Japan has discovered another comet. The object is diffuse, with a weak condensation and visible in the morning twilight. Images show a tail up to 90' long. The comet reached perihelion in April and will fade thereafter, though the solar elongation remains poor.

Syogo Utsunomiya



2002 March 23.15, Giovanni Sostero



The comet was highly condensed and showed a short tail when I observed it on April 6.14 and 7.15. The observations up to April 9 suggested that it was only brightening slowly and would reach mag 7 when brightest. Nicolas Biver, observing on April 10.16 noted a significant brightening, with the comet at magnitude 5.9, with a nearly stellar appearance, suggesting a recent outburst. The following morning he reported that the comet had brightened further, but had become more diffuse and showed jets. I was able to observe it in brightening skies on April 13.16 and estimated it at 5.6 in 20x80B. A further observation in misty conditions on April 14.15 put the comet at 3.9. Several observers in better skies were able to observe it and 2002 C1 with the naked eye, a rare opportunity to see two naked eye comets at the same time.

33 observations received March 21 - April 18 give a preliminary light curve of $m = 10.6 + 5 \log d + 17.0 \log r$

A/2002 FC (LONEOS) is an asteroid, of 19th magnitude, discovered by LONEOS on March 16.24. It will reach perihelion at 0.96 AU at the end of May. [MPEC 2002-F14] With a period of 4.85 years, the orbit is typical of a Jupiter family comet. It is a potentially hazardous asteroid, and can pass 0.022 AU from the Earth.
Kracht on April 8.

2002 G1 (SOHO) A non sungrazing group comet discovered in real-time C2 images by Rainer Kracht on April 2. It remains at small elongation from the sun and is not expected to be detected from the ground.

2002 G3 (SOHO) XingMing Zhou discovered a moderately bright comet on C3 frames on April 12.4, with Jonathan Shanklin making an independent discovery shortly afterwards. The bright, slow moving, object appeared at the bottom of the frames beginning at around 00:00 on April 12 and was moving up and to the left. It had no obvious tail, and was brightening quite rapidly. At its brightest, just before perihelion, it reached around 1st magnitude, and although it grew a short tail, began a dramatic fade, turning into a ghostly blur, last seen around April 19.0. Although potentially observable from the ground in late April, it seems very unlikely that the object will be recovered.

I made the independent discovery of the comet whilst at work. I had been configuring a number of computers with the Windows 2000 operating system and used the SOHO real time images to test the Internet connection and memory. In the process I discovered that Microsoft Internet Explorer seemed to give much better views of the SOHO real-time movies than did Netscape 4.7, which was my preferred web browser. Initially I put this down to the limited amount of software running on the new machines and the fact that they were higher performance than my office PC. One of the PCs had a faulty mother board, and whilst this had been replaced, I left the movie loop running and checked it intermittently to see if there were further problems. On April 12 I had checked the SOHO recent discoveries page from my office PC and seen no new reports, but didn't immediately check the latest images. After coffee I went to look at the loops on the test PC and immediately spotted the new object, which I reported to Doug Biesecker, but discovered that XingMing Zhou had reported it first. Subsequently I've found that Internet Explorer works better than Netscape on my office computer as well, so if you want to search for SOHO comets using the real-time images I would recommend using this browser.

A/2002 GJ8 (NEAT) is an asteroid, of 19th magnitude, discovered by NEAT on April 12.41. It will reach perihelion at 0.51 AU at the end of June. [MPEC 2002-G62] With a period of 4.45 years, the orbit is typical of a Jupiter family comet.

A/2002 GO9 (NEAT) is an asteroid, of 20th magnitude, discovered by NEAT on April 12.34. It reached perihelion at 10.45 AU (just outside the orbit of Saturn) at the end of December 1996. [MPEC 2002-H03] With a period of 399 years and aphelion at 98 AU, the orbit is typical of a long period comet.

I have begun to compile an archive of all the images that I receive and you can find this on the Section web pages. This includes all the images included here, at far better resolution. When submitting images **please** use the naming format that you see there as this makes it easy to catalogue the images.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

Produced by Jonathan Shanklin
E&OE

Introduction

This issue has ephemerides, for the UK or Southern Hemisphere, for the comets that are likely to be brighter than 12[th] magnitude:

- 22P/Kopff (Southern Hemisphere)
- 2000 WM1 (LINEAR)
- 2001 OG108 (P/LONEOS)
- 2001 RX14 (LINEAR)
- 2002 C1 (Ikeya-Zhang)
- 2002 E2 (Snyder-Murakami)

The actual magnitudes may differ from those given here by several magnitudes. Several other comets, including 7P/Pons-Winnecke, 46P/Wirtanen, 67P/Churymov-Gerasimenko, 2000 SV74 (LINEAR), 2001 HT50 (LINEAR-NEAT) and 2001 N2 (LINEAR) may be brighter than 14^m. 29P/Schwassmann-Wachmann has frequent outbursts and is currently best seen from the Southern Hemisphere. Many comets undergo outbursts and it is worth monitoring all periodic comets that are well placed for observation in case they are in outburst. Current ephemerides for the fainter comets, and for other locations, are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are for the UK at a latitude of 53° N, or the Southern Hemisphere at 40° S on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations may be used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for comet 2000 WM1 (LINEAR) (UK)

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Omega=276.7731 OMEGA=237.8958 i= 72.5520 q= 0.555330 a=**********
e=1.000262  P=*********  T= 2002 January   22.6734
Magnitudes calculated from m= 6.8+5.0*Log(d)+ 9.6*Log(r)
```

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
May 2002																
2/ 3	18 22.7	24.56	18 24.8	24.57	10.3	1.36	1.97	3.42	21.16 to 2.40	112	54	63	4	240	-11	15
7/ 8	18 11.7	27.36	18 13.7	27.37	10.5	1.40	2.04	3.11	21.28 to 2.25	115	90	17	4	232	-12	13
12/13	18 0.1	29.56	18 2.0	29.56	10.7	1.45	2.11	2.40	21.42 to 2.11	118	122	0	3	225	-12	11
17/18	17 48.0	31.53	17 49.9	31.52	10.9	1.50	2.19	2.08	21.56 to 1.57	120	113	30	3	216	-12	9
22/23	17 35.8	33.26	17 37.6	33.25	11.2	1.56	2.26	1.36	22.11 to 1.42	121	73	84	2	207	-12	7
27/28	17 23.8	34.38	17 25.6	34.36	11.4	1.63	2.33	1.04	22.26 to 1.29	122	59	98	2	198	-12	5
June 2002																
1/ 2	17 12.2	35.29	17 13.9	35.26	11.6	1.70	2.40	0.33	22.40 to 1.15	122	88	60	2	190	-11	4
6/ 7	17 1.2	36.02	17 3.0	35.57	11.8	1.78	2.46	0.02	22.54 to 1.03	121	118	15	1	181	-11	2
11/12	16 51.0	36.17	16 52.8	36.12	12.0	1.86	2.53	23.32	23.06 to 0.53	120	116	1	1	173	-10	1
16/17	16 41.9	36.18	16 43.7	36.13	12.2	1.95	2.60	23.03	23.15 to 0.46	119	79	38	1	165	-9	0
21/22	16 33.8	36.08	16 35.6	36.02	12.4	2.04	2.67	22.36	23.19 to 0.45	117	55	90	1	158	-8	0
26/27	16 26.7	35.47	16 28.5	35.41	12.6	2.14	2.73	22.09	23.16 to 0.49	115	80	96	1	151	-7	-1
July 2002																
1/ 2	16 20.7	35.19	16 22.5	35.12	12.8	2.24	2.80	21.43	23.09 to 0.59	113	115	57	1	145	-6	-2
6/ 7	16 15.7	34.45	16 17.6	34.38	13.0	2.34	2.86	21.18	22.58 to 1.12	110	126	13	1	139	-5	-2
11/12	16 11.6	34.06	16 13.5	33.59	13.2	2.45	2.93	20.55	22.46 to 1.25	108	93	3	1	134	-4	-3

Ephemeris for comet 2001 OG108 (LONEOS) (UK)

Omega=116.4178 OMEGA= 10.5554 i= 80.2456 q= 0.994084 a= 13.301452
e=0.925265 P= 48.512 T= 2002 March 15.2073
Magnitudes calculated from m=11.0+5.0*Log(d)+10.0*Log(r)

May 2002										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
2/ 3	9 29.4	27.46	9 32.3	27.32	11.3	0.70	1.27	18.49	21.14 to 1.00	94	160	63	3	110	5	-53
7/ 8	9 33.5	19.17	9 36.3	19.04	11.7	0.80	1.32	18.34	21.28 to 23.46	93	142	17	3	109	4	-42
12/13	9 37.4	12.37	9 40.1	12.23	12.1	0.90	1.37	18.18	21.42 to 22.39	91	84	0	2	109	4	-33
17/18	9 41.3	7.19	9 43.9	7.05	12.6	1.02	1.42	18.02	Not Observable	89	24	30	2	109	4	-26
22/23	9 45.2	3.00	9 47.8	2.46	13.0	1.14	1.48	17.46	Not Observable	87	49	84	1	110	4	-21
27/28	9 49.1	-0.33	9 51.7	-0.47	13.3	1.26	1.53	17.30	Not Observable	84	115	98	1	112	4	-17

Ephemeris for comet 22P/Kopff (Southern Hemisphere)

Omega=162.7627 OMEGA=120.9288 i= 4.7184 q= 1.583831 a= 3.466320
e=0.543080 P= 6.454 T= 2002 December 12.1441
Magnitudes calculated from m= 3.0+5.0*Log(d)+26.0*Log(r)

July 2002										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
18/19	12 19.3	2.42	12 21.8	2.25	13.2	2.27	2.11	16.35	18.05 to 19.50	68	46	70	1	112	8	-4
23/24	12 26.4	1.49	12 28.9	1.32	13.1	2.29	2.08	16.23	18.08 to 19.41	65	111	100	1	111	8	-4
28/29	12 33.9	0.54	12 36.4	0.37	12.9	2.31	2.05	16.11	18.12 to 19.33	63	171	81	1	111	9	-4
August 2002																
2/ 3	12 41.8	-0.04	12 44.3	-0.20	12.8	2.33	2.03	15.59	18.16 to 19.25	60	132	35	1	111	9	-4
7/ 8	12 50.0	-1.03	12 52.6	-1.19	12.7	2.35	2.00	15.47	18.20 to 19.23	57	67	0	1	110	10	-4
12/13	12 58.6	-2.03	13 1.2	-2.20	12.5	2.37	1.97	15.36	18.24 to 19.21	55	4	23	1	110	10	-5
17/18	13 7.6	-3.06	13 10.2	-3.22	12.4	2.38	1.94	15.26	18.28 to 19.19	53	71	77	1	109	11	-5
22/23	13 16.9	-4.09	13 19.5	-4.25	12.3	2.40	1.92	15.15	18.32 to 19.17	50	131	100	1	109	11	-5
27/28	13 26.6	-5.14	13 29.2	-5.30	12.1	2.41	1.89	15.05	18.36 to 19.15	48	172	79	1	108	12	-5
September 2002																
1/ 2	13 36.6	-6.20	13 39.2	-6.35	12.0	2.42	1.87	14.55	18.41 to 19.14	46	113	31	2	108	12	-5
6/ 7	13 47.0	-7.26	13 49.6	-7.41	11.8	2.43	1.84	14.46	18.45 to 19.12	44	45	0	2	107	12	-5
11/12	13 57.8	-8.33	14 0.4	-8.47	11.7	2.44	1.82	14.37	18.50 to 19.11	42	26	31	2	107	13	-5
16/17	14 8.9	-9.39	14 11.6	-9.54	11.6	2.44	1.80	14.29	18.55 to 19.09	40	89	82	2	106	13	-5
21/22	14 20.4	-10.46	14 23.1	-10.60	11.4	2.45	1.78	14.21	18.60 to 19.08	38	147	100	2	105	14	-5
26/27	14 32.3	-11.52	14 35.0	-12.05	11.3	2.45	1.75	14.13	19.05 to 19.07	37	157	76	2	104	14	-5
October 2002																
1/ 2	14 44.6	-12.57	14 47.3	-13.10	11.2	2.46	1.73	14.05	Not Observable	35	96	26	2	103	14	-5
6/ 7	14 57.2	-14.01	14 60.0	-14.13	11.0	2.46	1.71	13.58	Not Observable	33	25	0	2	102	15	-5
11/12	15 10.3	-15.03	15 13.1	-15.14	10.9	2.46	1.70	13.52	Not Observable	32	44	37	2	101	15	-5
16/17	15 23.7	-16.03	15 26.5	-16.13	10.8	2.47	1.68	13.45	Not Observable	30	104	85	2	100	16	-4
21/22	15 37.5	-16.60	15 40.4	-17.10	10.7	2.47	1.66	13.40	Not Observable	29	160	100	2	99	16	-4
26/27	15 51.7	-17.54	15 54.6	-18.03	10.6	2.47	1.65	13.34	Not Observable	27	143	73	3	98	16	-4
31/32	16 6.3	-18.45	16 9.2	-18.52	10.5	2.47	1.64	13.29	Not Observable	26	79	20	3	96	17	-4

Ephemeris for comet 2001 RX14 (LINEAR) (UK)

Omega=121.4875 OMEGA= 14.1849 i= 30.5807 q= 2.057649 a=**********
e=1.001066 P=********* T= 2003 January 18.8101 Equinox= 2000
Magnitudes calculated from m= 6.5+5.0*Log(d)+10.0*Log(r)

August 2002										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
25/26	6 26.9	47.08	6 30.7	47.06	13.2	3.03	2.67	8.15	1.15 to 3.27	60	90	92	1	288	11	2
30/31	6 40.5	47.38	6 44.2	47.34	13.1	2.95	2.64	8.08	1.05 to 3.38	62	39	51	1	289	11	2
September 2002																
4/ 5	6 54.3	48.05	6 58.1	48.00	12.9	2.87	2.60	8.03	0.57 to 3.49	64	38	6	1	289	11	2
9/10	7 8.5	48.29	7 12.2	48.24	12.8	2.80	2.57	7.57	0.48 to 3.59	67	102	11	1	290	11	2
14/15	7 22.9	48.51	7 26.6	48.45	12.7	2.72	2.53	7.52	0.35 to 4.09	69	155	64	1	291	11	1
19/20	7 37.5	49.09	7 41.2	49.02	12.6	2.64	2.50	7.47	0.21 to 4.19	71	126	98	1	291	11	1
24/25	7 52.4	49.25	7 56.1	49.17	12.5	2.57	2.47	7.42	0.07 to 4.28	73	75	90	1	292	12	1
29/30	8 7.4	49.38	8 11.1	49.29	12.4	2.50	2.44	7.37	23.53 to 4.37	75	29	47	1	293	12	1
October 2002																
4/ 5	8 22.5	49.47	8 26.1	49.37	12.2	2.42	2.41	7.32	23.40 to 4.46	77	57	3	1	293	12	0
9/10	8 37.7	49.53	8 41.3	49.42	12.1	2.35	2.38	7.28	23.28 to 4.55	79	121	17	2	294	12	0
14/15	8 52.9	49.56	8 56.4	49.44	12.0	2.29	2.35	7.23	23.16 to 5.04	81	152	68	2	294	12	0
19/20	9 8.0	49.55	9 11.5	49.43	11.9	2.22	2.32	7.19	23.04 to 5.13	83	110	99	2	295	12	0
24/25	9 23.0	49.52	9 26.4	49.38	11.8	2.15	2.30	7.14	22.53 to 5.21	85	60	88	2	295	12	0
29/30	9 37.8	49.45	9 41.2	49.31	11.7	2.09	2.27	7.09	22.43 to 5.29	87	29	42	2	295	11	0

Ephemeris for comet 2002 C1 (Ikeya-Zhang) (UK)

Omega= 34.6718 OMEGA= 93.3677 i= 28.1217 q= 0.507085 a= 50.845784
e=0.990027 P= 362.562 T= 2002 March 18.9833
Magnitudes calculated from m= 6.7+5.0*Log(d)+ 9.5*Log(r)

May 2002										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
2/ 3	18 38.3	56.50	18 39.2	56.53	5.2	0.41	1.10	3.56	21.14 to 2.40	92	83	63	128	236	-57	-19
7/ 8	17 36.6	50.25	17 37.8	50.23	5.5	0.42	1.19	2.35	21.28 to 2.25	104	98	17	92	219	-49	-32
12/13	16 54.2	43.02	16 55.8	42.58	6.0	0.45	1.27	1.34	21.42 to 2.11	115	117	0	64	205	-38	-36

17/18	16 25.1	35.47	16 26.9	35.41	6.4	0.50	1.35	0.45	21.56 to 1.57	124	98	30	43	194	-29	-36
22/23	16 4.7	29.12	16 6.7	29.04	6.9	0.55	1.43	0.05	22.11 to 1.42	130	54	84	29	183	-22	-32
27/28	15 50.1	23.27	15 52.3	23.18	7.4	0.62	1.51	23.31	22.26 to 1.29	135	55	98	20	171	-16	-28
June	2002															
1/ 2	15 39.6	18.31	15 41.9	18.22	7.8	0.69	1.59	23.01	22.40 to 1.15	137	104	60	14	160	-12	-24
6/ 7	15 32.0	14.19	15 34.4	14.09	8.3	0.78	1.67	22.34	22.54 to 1.03	138	148	15	11	150	-9	-21
11/12	15 26.7	10.43	15 29.1	10.33	8.7	0.86	1.75	22.09	23.06 to 0.53	137	126	1	9	141	-6	-17
16/17	15 23.0	7.38	15 25.5	7.27	9.1	0.96	1.82	21.45	23.15 to 0.46	135	64	38	7	134	-4	-15
21/22	15 20.8	4.57	15 23.3	4.47	9.5	1.06	1.90	21.23	23.19 to 0.45	132	21	90	6	128	-2	-13
26/27	15 19.6	2.37	15 22.1	2.27	9.8	1.17	1.97	21.03	23.16 to 0.49	129	76	96	5	123	-1	-11
July	2002															
1/ 2	15 19.4	0.34	15 21.9	0.23	10.2	1.28	2.05	20.43	23.09 to 0.58	126	134	57	4	119	0	-10
6/ 7	15 19.9	-1.16	15 22.5	-1.26	10.5	1.39	2.12	20.23	22.58 to 0.19	122	159	13	3	116	0	-9
11/12	15 21.1	-2.54	15 23.7	-3.04	10.8	1.51	2.19	20.05	22.46 to 23.40	119	97	3	3	113	1	-8
16/17	15 22.8	-4.22	15 25.5	-4.32	11.1	1.63	2.26	19.47	22.32 to 23.01	115	29	48	2	111	2	-7
21/22	15 25.1	-5.42	15 27.7	-5.53	11.4	1.76	2.33	19.30	22.18 to 22.22	112	42	94	2	110	2	-6
26/27	15 27.7	-6.56	15 30.4	-7.06	11.7	1.89	2.40	19.12	Not Observable	108	103	94	2	108	3	-6
31/32	15 30.7	-8.03	15 33.4	-8.13	12.0	2.02	2.47	18.56	Not Observable	104	160	54	2	107	3	-5
August	2002															
5/ 6	15 34.0	-9.05	15 36.7	-9.15	12.2	2.15	2.54	18.39	Not Observable	101	135	10	1	106	4	-5
10/11	15 37.6	-10.02	15 40.3	-10.12	12.4	2.28	2.60	18.23	Not Observable	97	66	6	1	104	4	-4
15/16	15 41.5	-10.56	15 44.2	-11.05	12.7	2.41	2.67	18.07	Not Observable	93	9	57	1	103	4	-4
20/21	15 45.6	-11.46	15 48.3	-11.55	12.9	2.55	2.74	17.52	Not Observable	90	70	97	1	103	4	-4

Ephemeris for comet 2002 E2 (Snyder-Murakami) (UK)

```
Omega=  9.0221 OMEGA=244.5788 i= 92.5454 q= 1.466287 a=**********
e=1.000000  P=*********  T= 2002 February  21.7774
Magnitudes calculated from m= 7.5+5.0*Log(d)+10.0*Log(r)
```

May 2002 Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
2/ 3	19 23.1	59.06	19 23.9	59.12	10.9	1.52	1.76	4.41	21.14 to 2.40	86	83	63	4	246	-1	25
7/ 8	19 19.3	63.40	19 19.7	63.46	11.1	1.58	1.80	4.17	21.28 to 2.25	85	86	17	3	241	-2	22
12/13	19 12.6	67.46	19 12.6	67.51	11.2	1.65	1.84	3.50	21.42 to 2.11	84	86	0	3	234	-3	20
17/18	19 2.0	71.24	19 1.4	71.28	11.4	1.72	1.88	3.19	21.56 to 1.57	83	84	30	3	227	-4	18
22/23	18 46.0	74.32	18 44.6	74.35	11.6	1.80	1.93	2.43	22.11 to 1.42	81	90	84	2	219	-5	15
27/28	18 22.9	77.10	18 20.6	77.11	11.8	1.88	1.97	1.59	22.26 to 1.29	80	101	98	2	209	-6	13
June	2002															
1/ 2	17 50.5	79.15	17 47.2	79.14	12.0	1.96	2.01	1.06	22.40 to 1.15	78	102	60	2	196	-7	10
6/ 7	17 7.9	80.44	17 3.8	80.40	12.2	2.04	2.06	0.03	22.54 to 1.03	77	89	15	2	182	-8	7
11/12	16 17.5	81.34	16 13.2	81.27	12.4	2.12	2.10	22.53	23.06 to 0.53	75	73	1	1	164	-9	4
16/17	15 25.9	81.47	15 22.5	81.37	12.5	2.20	2.15	21.42	23.15 to 0.46	74	75	38	1	147	-9	1
21/22	14 40.8	81.30	14 38.6	81.17	12.7	2.28	2.20	20.39	23.19 to 0.45	72	98	90	1	132	-8	-1
26/27	14 5.8	80.53	14 4.7	80.39	12.9	2.36	2.25	19.45	23.16 to 0.49	71	114	96	1	119	-6	-3

Format for electronic submission of observations

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

TA format (examples)

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T     fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R     18 290                        Shanklin
970328.89 S   9.5  NP  20   T     10  75  2.5   2                Shanklin
961214.70 S   3.8  AA   8   B         20  6     7/  0.50   40   Baroni
```

ICQ format (examples)

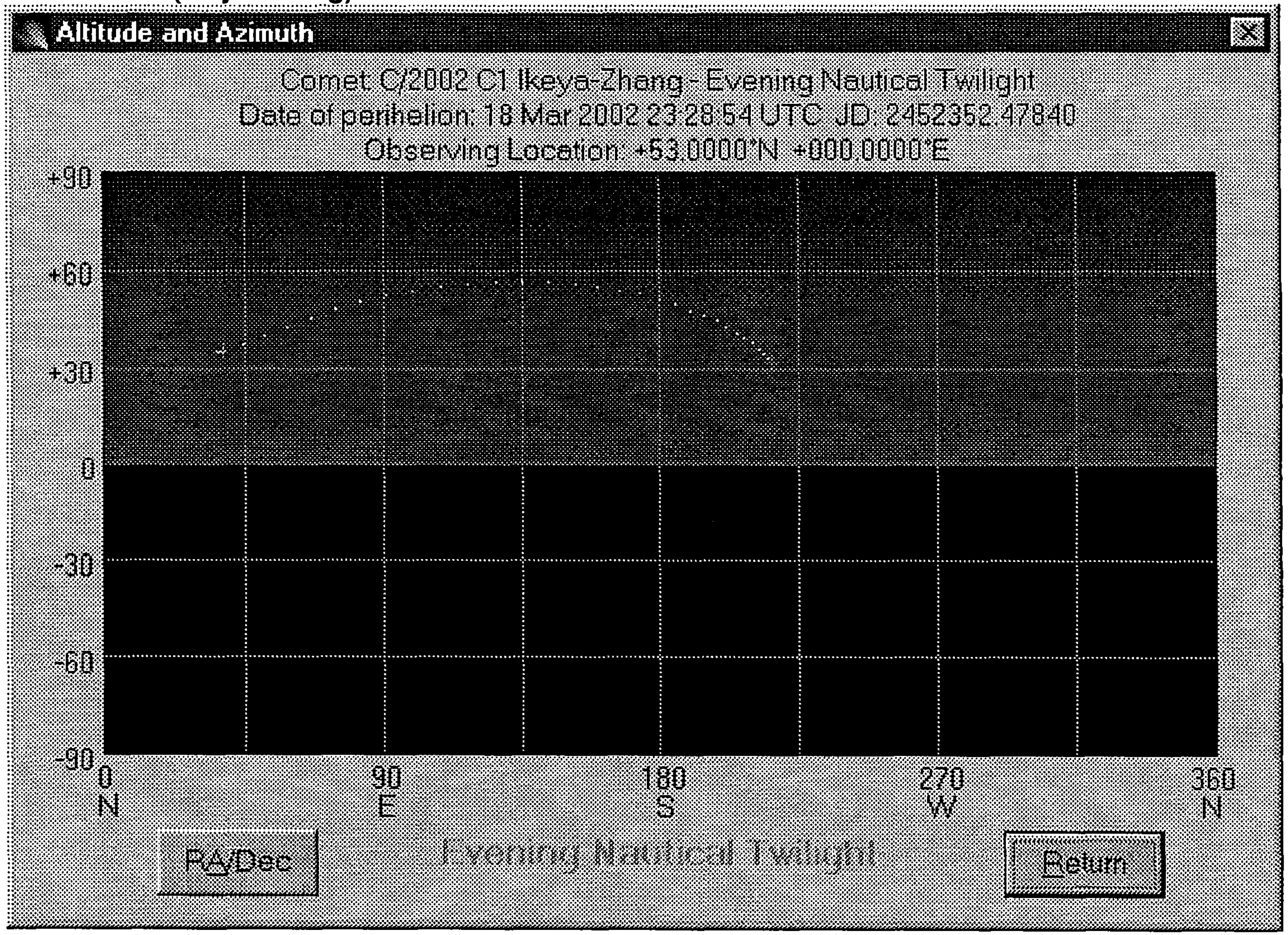
```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC        m
   1992F1   1992  5 18.94  S  9.3 AA  7.5R     50   6    4          135 ICQ XX BEA
  1         1985 11 16.04  S  6.9 AA 20  R14   40   6   s7    0.12 130 ICQ 59 SHA02
   1999T2   2001  1 28.25 Comet possibly seen at mag 13.6 (S, HS) in 20cm f10 T x120, with
coma 1.0' DC 1.
   1999T1   2001  1 28.25 Possible tail 5' long in pa 345.
```

Charts

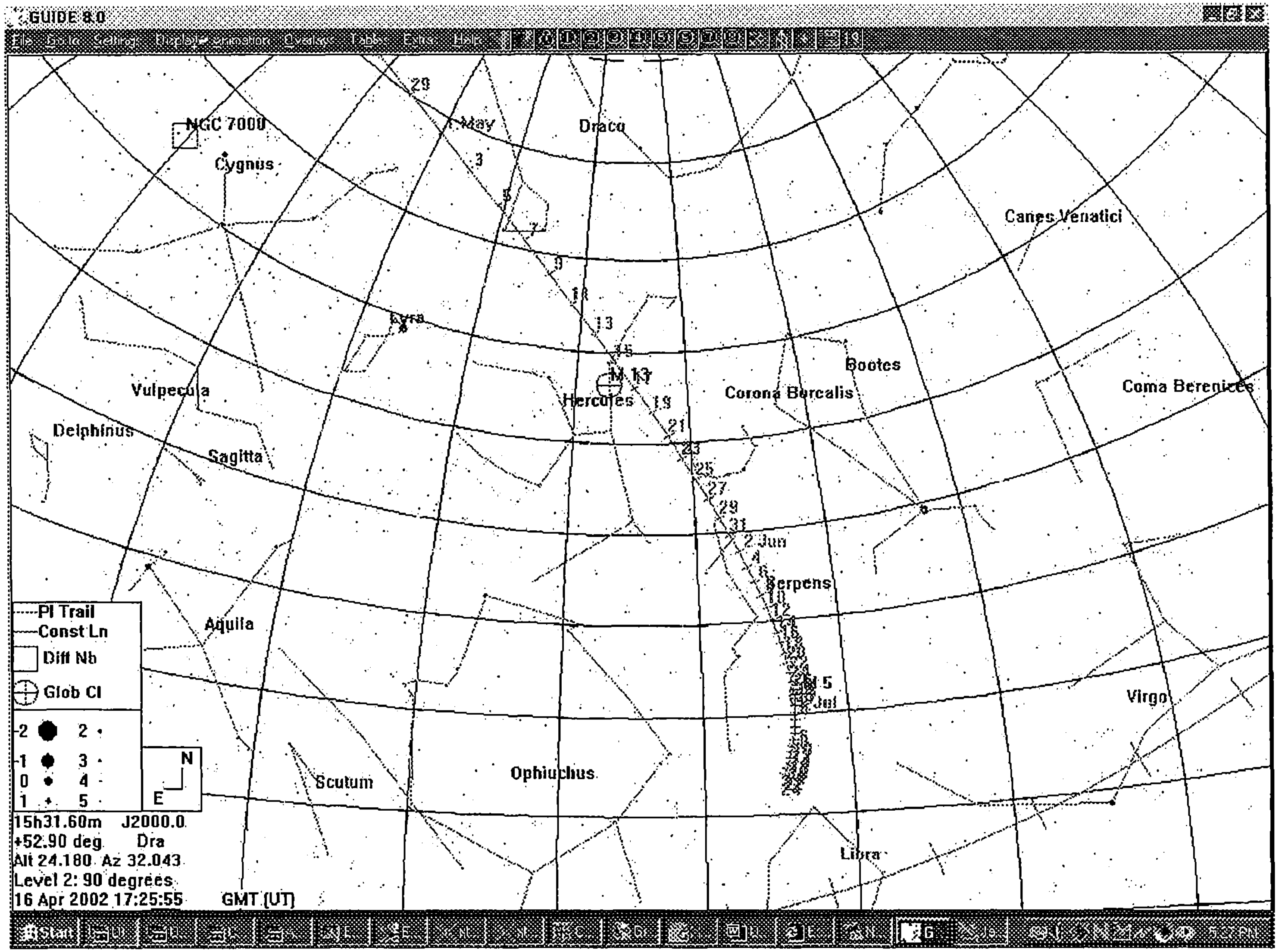
The visibility diagram shows the altitude of the comet at end of evening nautical twilight, when the Sun is 12° below the horizon. Positions are at two-day intervals, beginning on May 1 (left) and ending on June 30 (right). The chart was generated using William Schwittek's Cometwin software, which is downloadable from the Section web page.

The finder chart shows the location of 2002 C1 (Ikeya-Zhang) and was produced using Guide 8.

Visibility chart for comet 2002 C1 (Ikeya-Zhang)



Finder chart for 2002 C1 (Ikeya-Zhang)



Name	Number	T	q	e	ω	Ω	i	H1	K1	Epoch	Source
Pons-Winnecke	7P	2002 05 15.7313	1.258199	0.633992	172.2926	93.4504	22.2848	10.0	15.0	2000	MPC 34422
Brooks	16P	2001 07 19.8513	1.834918	0.492014	198.1163	176.9121	5.5480	7.5	25.0	2000	MPC 43333
Borrelly	19P	2001 09 14.7312	1.358196	0.623919	353.3741	75.4248	30.3244	4.5	25.0	2000	MPC 31664
Kopff	22P	2002 12 12.1441	1.583831	0.543080	162.7627	120.9288	4.7184	3.0	26.0	2000	MPC 34423
Schaumasse	24P	2001 05 02.6646	1.205045	0.704845	57.8789	79.8310	11.7515	6.5	35.0	2000	MPC 31663
Grigg-Skjellerup	26P	2002 11 29.6212	1.116627	0.633137	1.5863	211.8172	22.3679	12.0	40.0	2000	MPC 34423
Neujmin	28P	2002 12 27.3886	1.551339	0.775641	346.9368	347.0476	14.1866	8.5	15.0	2000	MPC 34424
Schwassmann-Wachmann	29P	2004 07 18.2922	5.721089	0.045241	49.5313	312.7271	9.3921	4.0	10.0	2000	MPC 42666
Schwassmann-Wachmann	31P	2002 01 18.5037	3.408558	0.195937	18.4049	114.1929	4.5489	5.0	20.0	2000	MPC 41899
Whipple	36P	2003 07 06.3201	3.088034	0.259686	202.1551	182.4160	9.9298	8.5	15.0	2000	MPC 40670
Van Biesbroeck	53P	2003 10 09.7206	2.415610	0.551329	134.1267	149.0073	6.6106	7.7	12.0	2000	MPC 40671
de Vico-Swift	54P	2002 08 07.4279	2.145958	0.430787	2.1284	358.9395	6.0920	10.0	15.0	2000	MPC 34423
du Toit-Neujmin-Delporte	57P	2002 07 31.2085	1.729253	0.499033	115.2591	188.9377	2.8444	12.5	15.0	2000	MPC 34422
Shajn-Schaldach	61P	2001 05 09.0671	2.330136	0.389939	216.6544	166.8650	6.0837	6.0	25.0	2000	MPC 31664
Gunn	65P	2003 05 11.9367	2.447093	0.318170	196.3455	68.4203	10.3846	5.0	15.0	2000	MPC 40670
Longmore	77P	2002 09 04.5370	2.310137	0.358263	196.3713	14.9880	24.3999	7.0	20.0	2000	CCO 13
Gehrels	82P	2001 09 02.5754	3.626592	0.125219	227.8844	239.6797	1.1270	5.0	20.0	2000	MPC 31664
Wild	86P	2001 06 18.5634	2.310239	0.364463	179.1494	72.6126	15.4385	11.0	15.0	2000	MPC 31664
Russell	89P	2002 03 22.9529	2.289992	0.397903	249.2286	42.4871	12.0286	11.5	15.0	2000	CCO 13
Sanguin	92P	2002 09 23.0571	1.807102	0.663490	163.0524	182.3609	18.7646	12.0	15.0	2000	MPC 34423
Russell	94P	2003 08 29.8437	2.229832	0.364519	93.0980	70.9625	6.1881	9.0	15.0	2000	MPC 40671
Machholz	96P	2002 01 08.6244	0.124123	0.959168	14.5643	94.6087	60.1870	13.0	12.0	2000	MPC 44505
Metcalf-Brewington	97P	2001 04 14.8196	2.610501	0.456851	229.7125	186.3855	17.9824	5.5	15.0	2000	MPC 41159
Hartley	110P	2001 03 21.2280	2.478198	0.314151	167.8895	287.7538	11.6907	1.0	30.0	2000	MPC 31663
Maury	115P	2002 12 23.9860	2.041167	0.520608	119.9122	176.7635	11.6841	10.5	15.0	2000	MPC 34424
Wild	116P	2003 01 21.2201	2.166531	0.377192	173.2447	21.2797	3.6183	2.5	25.0	2000	MPC 43760
Helin-Roman-Alu	117P	2005 12 31.4416	3.290595	0.227792	205.3536	70.1545	9.7111	2.5	20.0	2000	MPC 27080
Shoemaker-Levy	118P	2003 07 16.6647	2.012280	0.422148	302.0118	152.0387	8.4800	12.0	10.0	2000	MPC 40670
Mrkos	124P	2002 07 27.0302	1.466814	0.542757	181.2348	1.4137	31.3516	13.5	7.0	2000	MPC 34422
Spacewatch	125P	2002 01 28.0555	1.528595	0.511463	87.3019	153.2378	9.9816	13.0	15.0	2000	MPC 34422
Kushida	144P	2001 06 27.6881	1.431277	0.628911	216.0195	245.6233	4.1187	8.5	20.0	2000	MPC 41159
Kushida-Muramatsu	147P	2001 04 28.9267	2.751925	0.277022	347.3615	93.7526	2.3678	14.0	10.0	2000	MPC 41527
Anderson-LINEAR	148P	2001 05 01.9455	1.693675	0.539315	6.7131	89.8003	3.6824	16.0	5.0	2000	MPC 41899
LONEOS	150P	2001 03 23.3493	1.761764	0.546712	245.5108	272.5514	18.5201	13.5	10.0	2000	MPC 42548
Helin	151P	2001 09 23.7223	2.530771	0.565560	215.4229	143.5369	4.7171	10.0	15.0	2000	MPC 43021
Helin-Lawrence	152P	2002 12 22.7496	3.109917	0.307223	163.7452	92.0130	9.8718	11.5	10.0	2000	MPC 44505
Brewington	P/1992 Q1	2003 02 18.7696	1.590065	0.671925	47.9868	343.6587	18.0568	2.5	30.0	2000	MPC 40670
Hale-Bopp	C/1995 O1	1997 03 31.4659	0.919481	0.994953	130.6651	282.2159	89.4482	-2.0	10.0	2000	MPC 42547
Spacewatch	C/1997 BA6	1999 11 27.5321	3.435691	0.998725	285.9228	317.6584	72.7433	10.0	5.0	2000	MPC 43603
Catalina	C/1999 F1	2002 02 13.6993	5.786965	0.998914	255.1618	20.0177	92.0318	9.5	5.0	2000	MPC 44182
Skiff	C/1999 J2	2000 04 05.7375	7.109068	1.002678	127.1111	50.0479	86.4015	2.0	10.0	2000	MPC 41897
LINEAR	C/1999 K5	2000 07 04.4238	3.256503	1.001167	241.5145	106.3835	89.4754	6.0	10.0	2000	MPC 44503
LINEAR	C/1999 K8	2000 04 24.6419	4.202327	1.001195	164.6998	195.3831	52.7025	5.0	10.0	2000	MPC 43758
LINEAR	C/1999 N4	2000 05 23.2432	5.503664	1.003941	90.4015	345.9276	156.9177	6.0	10.0	2000	MPC 42547
LINEAR	C/1999 T2	2000 11 24.4504	3.037307	1.002135	104.6659	14.8858	110.9939	6.0	10.0	2000	MPC 44504
LINEAR	C/1999 T3	2000 09 01.9895	5.366535	0.996711	211.3710	223.5153	104.7553	6.0	10.0	2000	MPC 41897
Catalina-Skiff	C/1999 U4	2001 10 28.4591	4.915310	1.007678	77.5125	32.2886	51.9258	4.5	10.0	2000	MPC 43603
Korlevic	P/1999 WJ7	2000 02 16.1365	3.168874	0.315953	154.6302	290.5257	2.9797	14.5	5.0	2000	MPC 41716
Catalina	P/1999 XN120	2000 05 01.7146	3.287168	0.212344	161.8785	285.4540	5.0322	13.5	5.0	2000	MPC 39023
LINEAR	C/1999 Y1	2001 03 24.1520	3.091310	1.000735	184.2962	188.8864	134.7891	5.5	10.0	2000	MPC 43758
LINEAR	C/2000 B4	2000 06 16.1088	6.830830	0.621754	126.2250	0.6407	15.9040	11.5	5.0	2000	MPC 41897
Koehn	C/2000 O1	2000 01 28.5320	5.923848	1.000444	55.2398	88.8837	148.1050	6.0	10.0	2000	MPC 41159
Spacewatch	C/2000 OF8	2001 08 04.7711	2.173131	1.001717	256.0663	117.0932	152.4364	9.5	10.0	2000	MPC 43018
Skiff	P/2000 S1	2000 07 15.1875	2.516595	0.619413	308.6533	29.0888	20.9768	10.0	10.0	2000	MPC 41716
LINEAR	C/2000 SV74	2002 04 30.4440	3.541652	1.004727	76.2196	24.1850	75.2372	5.5	10.0	2000	MPC 44030
LINEAR	C/2000 U5	2000 03 13.3996	3.481487	1.007542	298.9200	65.2873	93.4160	7.0	10.0	2000	MPC 43758

LINEAR	C/2000 WM1	2002 01	22.6734	0.555330	1.000262	276.7731	237.8958	72.5520	7.5	10.0	2000 MPC 44182
Tubbiolo	C/2000 Y1	2001 02	02.5621	7.975145	1.001322	181.7591	239.3934	137.9689	11.0	5.0	2000 MPC 43758
Skiff	C/2000 Y2	2001 03	21.8602	2.768816	0.994548	326.8332	185.8477	12.0868	11.0	10.0	2000 MPC 43018
Scotti	P/2000 Y3	2000 10	30.2510	4.046689	0.196529	88.5154	354.9640	2.2502	9.0	10.0	2000 MPC 44030
LINEAR	C/2001 A2	2001 05	24.5174	0.778956	0.999257	295.3207	295.1255	36.4768	7.0	10.0	2000 MPC 44030
LINEAR	C/2001 B1	2000 09	19.3852	2.928485	1.001084	284.8467	49.8419	104.1020	9.0	10.0	2000 MPC 43758
NEAT	C/2001 B2	2000 09	01.7441	5.306569	1.001928	304.7525	145.0951	150.6015	4.0	10.0	2000 MPC 44182
LINEAR	C/2001 C1	2002 03	28.3425	5.104658	0.999758	219.9391	33.7150	68.9573	6.0	10.0	2000 MPC 42665
LINEAR	P/2001 CV8	2001 02	12.3486	2.152189	0.445276	151.4526	359.9505	9.0419	13.0	10.0	2000 MPC 42665
NEAT	P/2001 F1	2000 11	22.0873	4.152674	0.356377	80.7305	92.8352	19.0872	8.5	10.0	2000 MPC 43160
LONEOS	C/2001 G1	2001 10	08.9634	8.235558	1.002555	343.2681	203.8898	45.3684	3.5	10.0	2000 MPEC 2002-G37
LINEAR-NEAT	C/2001 HT50	2003 07	09.2780	2.791775	0.997287	324.0034	42.8056	163.2128	4.5	10.0	2000 MPC 44860
NEAT	P/2001 K1	2000 11	06.9508	2.470447	0.357681	94.6565	84.8371	16.9129	11.0	10.0	2000 MPC 43160
Skiff	C/2001 K3	2001 04	22.8483	3.059995	0.998727	3.4453	289.8505	52.0267	8.5	10.0	2000 MPC 43332
LINEAR	C/2001 K5	2002 10	11.8677	5.183969	0.999720	47.0674	237.4680	72.6052	4.0	10.0	2000 MPC 44860
LINEAR	P/2001 MD7	2001 11	30.1320	1.254282	0.684110	244.8465	129.1688	13.5240	12.0	10.0	2000 MPC 44182
NEAT	C/2001 M10	2001 06	20.9882	5.302877	0.801198	5.4544	293.9179	28.0850	8.0	10.0	2000 MPC 43759
LINEAR	C/2001 N2	2002 08	19.6792	2.668591	1.001046	151.8946	52.8002	138.5436	7.5	10.0	2000 MPC 43759
NEAT	C/2001 O2	1999 10	17.4738	4.831881	0.997494	281.0660	328.7027	90.9942	6.0	10.0	2000 MPC 43603
LONEOS	C/2001 OG108	2002 03	15.2073	0.994084	0.925265	116.4178	10.5554	80.2456	11.0	10.0	2000 MPC 44860
NEAT	C/2001 Q1	2001 09	21.0913	5.834341	0.966366	175.4834	139.2605	66.9553	7.0	10.0	2000 MPC 43759
Petriew	P/2001 Q2	2001 09	01.9225	0.945691	0.696274	181.9020	214.1067	13.9443	11.0	10.0	2000 MPC 44182
NEAT	C/2001 Q4	2004 05	16.0709	0.961626	1.000605	1.2075	210.2132	99.5808	3.5	10.0	2000 MPC 44504
LINEAR-NEAT	P/2001 Q5	2001 06	11.6269	2.043093	0.416647	6.3984	336.2674	10.9451	12.0	10.0	2000 MPC 44183
NEAT	P/2001 Q6	2001 11	09.4659	1.408178	0.823856	43.3291	22.1359	56.8553	13.5	10.0	2000 MPC 44183
LONEOS	P/2001 R1	2002 02	17.5917	1.360472	0.608539	24.7522	35.4866	7.0413	14.0	10.0	2000 MPC 44183
LINEAR-Skiff	P/2001 R6	2001 10	27.0791	2.115065	0.485925	306.1862	70.3233	17.3447	13.0	10.0	2000 MPC 44183
LINEAR	C/2001 RX14	2003 01	18.8101	2.057649	1.001066	121.4875	14.1849	30.5807	6.5	10.0	2000 MPC 44183
NEAT	P/2001 T3	2002 02	01.0939	2.505766	0.614871	356.2329	56.5385	19.1988	12.0	10.0	2000 MPC 44504
LINEAR-NEAT	P/2001 TU80	2001 12	10.0270	1.932489	0.472035	355.1475	109.1025	6.5865	14.0	10.0	2000 MPC 44504
LINEAR	C/2001 U6	2002 08	08.5356	4.406765	0.995982	85.6931	115.2261	107.2523	7.5	10.0	2000 MPC 44860
LINEAR	C/2001 W1	2001 12	24.8982	2.399475	1.000000	6.1613	91.9408	118.6530	13.0	10.0	2000 MPC 44504
BATTERS	C/2001 W2	2001 12	23.9302	1.050932	0.940896	142.0976	113.3546	115.9164	11.0	10.0	2000 MPC 44504
LONEOS	P/2001 WF2	2002 01	29.8545	0.976328	0.666611	51.3546	75.1371	16.9242	18.0	10.0	2000 MPC 44860
LINEAR	C/2001 X1	2002 01	08.0912	1.697964	0.997123	202.2003	336.0710	115.6263	11.0	10.0	2000 MPEC 2002-F19
Scotti	P/2001 X2	2001 10	14.7444	2.523862	0.331880	255.9233	194.6603	2.1843	13.5	10.0	2000 MPC 44861
LINEAR	P/2001 YX127	2003 03	14.8513	3.416207	0.180536	116.8709	31.5592	7.9187	14.5	5.0	2000 MPC 44861
LINEAR	C/2002 A1	2001 12	05.5688	4.710807	0.746059	19.4107	82.3005	14.3287	12.5	5.0	2000 MPC 44861
LINEAR	C/2002 A2	2001 12	12.2127	4.707854	0.743304	19.6319	82.3908	14.3409	11.0	5.0	2000 MPC 44861
LINEAR	P/2002 AR2	2002 01	16.5339	2.064463	0.615703	73.6733	7.8464	21.1092	12.0	10.0	2000 MPEC 2002-G30
LINEAR	C/2002 A3	2002 04	24.2146	5.150871	1.005748	329.4295	136.5909	48.0022	6.5	10.0	2000 MPEC 2002-E21
LINEAR	C/2002 B1	2002 04	20.0019	2.271086	0.771086	76.1555	58.1908	51.0286	11.5	10.0	2000 MPC 44861
LINEAR	C/2002 B2	2002 04	06.8538	3.842862	1.000000	257.0806	54.3206	152.8715	9.0	10.0	2000 MPEC 2002-F20
LINEAR	C/2002 B3	2002 01	25.017	6.05098	1.00000	123.897	289.470	73.625	7.0	10.0	2000 MPC 44861
Ikeya-Zhang	C/2002 C1	2002 03	18.9833	0.507085	0.990027	34.6718	93.3677	28.1217	7.0	10.0	2000 MPEC 2002-G38
LINEAR	C/2002 C2	2002 04	10.7764	3.253938	1.000000	159.9244	242.9541	104.8846	8.5	10.0	2000 MPEC 2002-F22
LINEAR	P/2002 CW134	2002 02	28.9470	1.839612	0.489434	190.1120	348.3179	15.2273	13.0	10.0	2000 MPEC 2002-G39
Snyder-Murakami	C/2002 E2	2002 02	21.7752	1.466275	1.000000	9.0203	244.5785	92.5450	7.5	10.0	2000 MPEC 2002-G40
Utsunomiya	C/2002 F1	2002 04	22.8955	0.438413	1.000000	125.8788	289.0293	80.8675	8.5	10.0	2000 MPEC 2002-G41
SOHO (Zhou-Shanklin)	C 2002 G3	2002 4	17.27	0.0825	1.0	1.94	150.17	41.66	13.0	10.0	2000 MPEC02G51

Source: CBAT web pages. H1 and K1 are also from the CBAT; alternative values are given in the main section and on the Section web pages.

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you get the format **EXACTLY** right. It is advisable to send the report as a text attachment as many mailers cut what they consider to be long lines.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TK (Tycho 2), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA. Do not report tail details unless you are certain of their reality.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

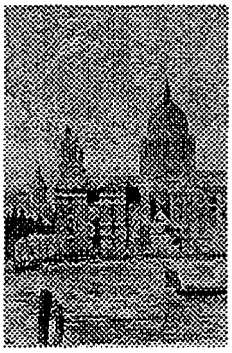
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	MM	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	DC	Tail len	Tail PA	Sky	Rel	Comments



THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 9, No 2 (Issue 18), 2002 October

ASTEROIDS, COMETS AND METEORS 2002

Astronomers from all over the world gathered together in Berlin at the end of July for the triennial Asteroids, Comets and Meteors conference. The ACM series began in 1983 in Uppsala, moving to the US in 1991 then alternating between the new and old world. This year, in total there were 452 astronomers from 34 countries, with 22 from the UK, ranking us in 7th place well behind the USA (105) and Germany (77). The majority were professionals, although there were a few amateurs as well.

Sebastian Hoenig, Maik Meyer and Brian Marsden discuss SOHO comets in the Stadthall of the Technical University of Berlin.

Many exciting developments were reported, including the discovery of comet 2002 O4 (Hoenig), which was discovered by Sebastian Hoenig from Heidelberg on July 22. Full moon intervened and it wasn't until July 29 that the discovery was finally confirmed. It was an accidental discovery, and although Sebastian has done some comet searching, on this occasion he was doing some casual star-gazing after a spell of bad weather. Fortunately he was able to recognise the interloper and report his find. This was the first comet discovery from Germany since 1946 and drew a generous round of applause.

Also discovered during the conference was comet 2002 O6, which was the first real-time discovery from the SOHO SWAN instrument, which scans the sky in the ultra-violet. Confirmation from ground based observers made this only the second SOHO discovered comet to be observed from the ground. This discovery perhaps sounds the death knell for amateur comet discoveries. Between the SOHO LASCO and SWAN instruments and LINEAR and future search programmes there is little sky left for the amateur to search. There is perhaps a small band running about 8° north of the ecliptic to around 50° from the Sun in the evening sky, which SWAN cannot see, and there is a chance of a comet brightening in this region.

Another development that was announced at the meeting is an exciting project called PanSTARRS, planned by the University of Hawaii. This will search virtually all the northern sky (except the pole) to magnitude 24 (getting this faint in less than a minute), three times a month. There may be four telescopes, each of 1.8-m aperture and capable of reaching the magnitude limit within a minute over a 3° field. Each frame will be around a billion pixels giving a huge flow of data at around 2 Tb a night. There will be a NEO (Near Earth Object) in every other frame and it may discover 100 comets a month, with the chance of seeing some interstellar ones. Comets will be confirmed in real time as the resolution is around 0.6", far better than existing programmes. It will discover around 10,000 KBOs (Kuiper Belt Objects) in the first year and 600,000 asteroids a night. It will put the supernova searchers out of business too, as it will detect new objects as well as moving objects and find perhaps 100,000 a year. The project is funded to the tune of $40M and is likely to be on line within a few years. The problem will be following up all the objects it discovers and providing linkages between the moving objects.

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way, for example by submitting observations or articles. **Renewals should be sent to the Director and cheques made payable to the BAA.** Those due to renew should receive a reminder with this mailing.

Section News from the Director

Dear Section member,

At the end of July I attended the Asteroids, Comets and Meteors meeting in Berlin. This event saw a large gathering of comet specialists and a large part of this issue is given over to my report of the meeting. One key message from the meeting is that there is likely to be a rapid growth in dedicated search telescopes. I fear that the day of the amateur visual comet discovery may have passed, unless SOHO fails before a replacement is in orbit. There is still however much useful work that the amateur can carry out. CCD observers can provide follow-up astrometry and confirmation of the cometary nature of newly discovered objects. Stephen Laurie recently made observations within 24 hours of an object being posted on the NEO confirmation page. Imagery also allows study of morphological changes in the coma and tail, and these are often used by professionals. Visual observers can continue traditional magnitude estimation as this allows long period comparison of returns of periodic comets. BAA observations show that the absolute magnitude of comet Encke has not changed significantly in the last 50 years.

There are a couple more comet meetings coming up. The Royal Astronomical Society has a meeting on December 13 devoted to "Cometary Science at the Launch of Rosetta". The meeting runs from 10:30 to 15:30 and takes place in the Geological Society Lecture Theatre in Burlington House. The organisers give this summary: *Recent years have seen marked advances in the study of comets, largely through ground-based observations of Hyakutake and Hale-Bopp, and in-situ measurements of Hyakutake and Borrelly. The imminent launch of the Rosetta mission is taken as an opportunity to review progress made in this field, and to discuss the questions and challenges to be addressed in the future. The meeting will cover all aspects of cometary science, from studies of the nucleus, dust, and coma, to comets' interactions with the solar wind."* Following this, there is a pro-am discussion meeting on 2003 May 10, provisionally in Liverpool. The meeting will include the first George Alcock memorial lecture and I am delighted to say that Brian Marsden has agreed to present the lecture. There will be further details about this meeting in the next issue, on the Section web page and in BAA Circulars.

I have been kept very busy over the summer with a variety of activities and still have some correspondence to catch up with. If you are waiting to hear from me, please accept my apologies and I hope to respond soon.

I will be visiting Antarctica again from mid February to early April, so the next issue of *The Comet's Tale* may be a little delayed from its nominal issue month of April. I will be in limited email contact (see address above - no pictures please), but will be unable to update the Section web pages. Whilst away I should be able to begin work on the Journal papers covering the comets of 1999 and 2000.

The visit is to set up our part of a big European project to investigate the ozone layer. Although we know the basic theory of how the ozone layer is destroyed, there is much fine detail still to discover. Several Antarctic stations are participating in the experiment, where balloons carrying ozone measuring sensors will be launched in carefully synchronised sequence to measure the same air mass as it passes over each station. We hope to discover which of several competing variations of the theory give the best match with observation.

Since the last newsletter observations or contributions have been received from the following BAA members: James Abbott, Sally Beaumont, Neil Bone, Owen Brazell, Denis Buczynski, Roger Dymock, Kenelm England, Len Entwisle, James Fraser, Mario Frassatti, Maurice Gavin, Massimo Giuntoli, Peter Grego, Werner Hasubick, Guy Hurst, Nick James, Geoffrey Johnstone, Gordon MacLeod, Brian Manning, Steve Martin, Cliff Meredith, Martin Mobberley, Gabriel Oksa, Roy Panther, Robin Scagell, Jonathan Shanklin, David Strange, Melvyn Taylor, John Vetterlein, Alex Vincent and Graeme Waddington and also from: Jose Aguiar, Alexandre Amorim, Alexander Baransky, Sandro Baroni, Nicolas Biver, Reinder Bouma, Nicholas Brown, Jose Carvajal, Tim Cooper, Matyas Csukas, Mike Feist, Rafael Ferrando, Sergio Foglia, Stephen Getliffe, Antonio Giambersio, Guus Gilein, Bjorn Granslo, Roberto Haver, Michael Jager, Andreas Kammerer, Heinz Kerner, Attila Kosa-Kiss, Gary Kronk, Martin Lehky, Rolando Ligustri, Pepe Manteca, Michael Mattiazzo, Maik Meyer, Antonio Milani, Andrew Pearce, Maciej Reszelski, Tony Scarmato, Hirita Sato, Carlos Segarro, Giovanni Sostero, Graham Wolf and Seiichi Yoshida (apologies for any errors or omissions). Without these contributions it would be impossible to produce the comprehensive light curves that appear in each issue of *The Comet's Tale*. I would welcome observations from any groups which currently do not send observations to the BAA.

Comets under observation were: 7P/Pons-Winnecke, 19P/Borrelly, 44P/Reinmuth, 46P/Wirtanen, 51P/Harrington, 65P/Gunn, 77P/Longmore, 1999 U4 (Catalina-Skiff), 1999 Y1 (LINEAR), 2000 SV74 (LINEAR), 2000 WM1 (LINEAR), 2001 A2 (LINEAR), 2001 B2 (NEAT), 2001 HT50 (LINEAR-NEAT), 2001 K5 (LINEAR), 2001 MD7 (LINEAR), 2001 N2 (LINEAR), 2001 OG108 (LONEOS), 2001 Q2 (Petriew), 2001 Q5 (LINEAR-NEAT), 2001 Q6 (NEAT), 2001 R1 (LONEOS), 2001 R6 (LINEAR-Skiff), 2001 TU80 (LINEAR-NEAT), 2001 X1 (LINEAR), 2002 C1 (Ikeya-Zhang) and 2002 E2 (Snyder-Murakami), 2002 O4 (Hoenig), 2002 O6 (SWAN).

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices and BAA Journals.

150 Years Ago: Professor Secchi discovered a small comet in Gemini on August 25, which was suspected to be one of the parts of Biela's comet, and on September 15 he discovered the other portion. It was very faint, without nucleus, and of a long oval shape, the point turned to the Sun. The larger and brighter portion had not the same shape as when seen on August 25: it was altogether irregular and with two very feeble brushes. The centre was more luminous than the edges, but there was no nucleus.

100 Years Ago: In April BAA Member William R Brooks wrote about his discovery of comet 1902 G1 (Brooks). This was his 23rd comet, and the 12th from Geneva, New York. The comet Section annual report for the year notes that there were now 15 Members of the Section. It includes a report from John Grigg, of Thames, New Zealand, of his discovery of a comet on July 22 (26P/Grigg-Skjellerup). As he was preparing to note its position a fire broke out in his neighbourhood and his work for the evening ceased! He confirmed the object the next evening, though was still doubtful, as the weather was cloudy and foggy. His observations continued until August 2. This was his first evening find after 15 years of searching and was made using a 90 mm Wray. *[I visited Thames on 1998 September 18 - 19 and whilst there observed comet 1998 P1. Skies were still very dark and clear, but must have been even better a hundred years earlier. At the time I hadn't even realised the connection with John Grigg!]*

50 Years Ago: The Section annual report notes that eight comets were observed during the session and lists 28 observers.

Professional Tales

SOHO Comet 500 Discovered
Paal Brekke, NASA/ESA Press release

A small object spotted by Rainer Kracht of Elmshorn in Germany, in an image from SOHO received via the Internet, has been officially confirmed as Comet 2002 P3 (SOHO). It is the 500th comet discovered with the ESA-NASA solar spacecraft and it made its closest approach to the Sun at 16:05 Universal Time on Monday, 12 August. Diane McElhiney of won a contest run by the SOHO science team for guessing that date and time for SOHO-500. Her prediction was too early by only 103 minutes.

The LASCO coronagraph on SOHO, designed for seeing outbursts from the Sun, uses a mask to block the bright rays from the visible surface. It monitors a large volume of surrounding space, and as a result it became the most prolific discoverer of comets in the history of astronomy. Most of them are small sungrazer comets that burn up completely in the Sun's hot atmosphere. More than 75% of the discoveries have come from amateur comet hunters around the world watching the freely available SOHO images on the web.

The biggest tallies have come from Mike Oates in England, Rainer Kracht in Germany and Xavier Leprette in France. They went back over pictures from 1996-99 and found dozens of comets that the professionals had overlooked. Kracht, a mathematics, physics, computer science and astronomy teacher at the Kooperative Gesamtschule

Elmshom in Elmshorn, Germany has discovered 63 comets since August 2001 with the help of SOHO data and images. Mike Oates from Manchester, England is the highest-scoring discoverer of comets ever, with 136 to his name, while Rainer Kracht has discovered 63.

Amateurs Win NEO Grants
Vanessa Thomas Astronomy.com

It seems we've been hearing a lot more reports of asteroids and comets zipping past our planet lately. Has Earth recently entered a more populated space, increasing the number of encounters with these smaller neighbors? Nope. It's just that we humans recently have become more aware of our immediate cosmic surroundings and have begun to pay more attention to these near-Earth objects (NEOs).

To improve our awareness and understanding of these frequent passers-by (and potential impactors), the Planetary Society established the Shoemaker Near-Earth Object Grant program in 1997. Named after the late planetary geologist Eugene Shoemaker (who studied asteroids, comets, and their impacts with the larger bodies of the solar system), the grant helps both amateur and professional astronomers enhance their own NEO projects.

This year, the Planetary Society is awarding a total of $28,290 to five deserving NEO programs on three continents.

John Broughton of Reedy Creek Observatory in Queensland, Australia, is an active observer of NEOs and has discovered several asteroids, including those named after the Beatles, Elvis Presley, Buddy Holly, the Beegees, and Brian Wilson. Broughton will receive $8,140 from the Planetary Society to buy an Apogee CCD camera to use on a new computer-controlled 18-inch (46-centimeter) telescope, which will conduct follow-up observations of fast-moving NEOs and those not visible from the Northern Hemisphere.

Amateur NEO observer Matt Dawson will also purchase a new Apogee CCD camera to use at the Roeser Observatory in Luxembourg and the Cote de Meuse Observatory in France. The camera will allow Dawson to observe objects as faint as 21st magnitude.

Richard Kowalski of Florida founded the Minor Planet Mailing List four years ago to provide an opportunity for minor-planet observers around the world to communicate with each other. In the past, Kowalski has spent his own money to maintain the list, and will receive a $900 grant to support the list and related websites for the next three years.

Amateur astronomer James McGaha of Tucson, Arizona, will use $10,000 to automate the 24-inch (62-centimeter) telescope at his Grasslands Observatory 55 miles from his home. This will improve the telescope's efficiency in the NEO observations it makes.

Roy Tucker, also of Tucson, currently has three telescope-camera systems observing NEOs, but the resulting data is more than he can handle. Tucker will receive $2,950 for software and computer equipment to distribute his observations to other local amateurs who can help reduce and analyze the data.

The five winners were selected by an international advisory group from 37 proposals received from 13 countries. "With so many highly qualified proposals, the selection committee's choice was a difficult one," states the Planetary Society's announcement of this year's winners.

The Planetary Society is not yet accepting applications for the next round of Shoemaker NEO Grants, but you can watch for updates or learn more about the grant program from the Society's website.

Comets break up far and near
NASA News

Some comets may break apart over and over again in the farthest reaches of the solar system, challenging a theory that comets break up only occasionally and not too far from the Sun, says a researcher from NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif.

A system of comets called "sungrazers," named for their orbit that closely brushes the Sun, reveals important clues about how these bodies break up. Most sungrazing comets are tiny -- the smallest could be less than 10 meters (30 feet) across -- and move in a highway-like formation of comets that pass near the Sun and disintegrate.

Dr. Zdenek Sekanina, senior research scientist at JPL, reports in the September 10 issue of the Astrophysical Journal that many sungrazer comets arrive at the Sun in clusters and on parallel paths. He emphasizes that such tiny fragments would have disintegrated if they had come so close to the Sun on an earlier trip. Therefore, the parents of these tiny sungrazers must have broken up after their previous encounter with the Sun and continued to break up far from the Sun on their journey through the solar system.

Sekanina's sungrazer studies challenge an earlier theory that the only place these comets break up is very close to the Sun, as the strong pull of its gravity cracked their loosely piled chunks of dust and ice. The gradual, continuing fragmentation gives birth to all the sungrazers, the most outstanding examples of splitting comets.

"Astronomers never before realized that there could be a fairly orderly pattern in breaking up, so that one comet cascades into large families of smaller comets, and that this process could be an important part of a comet's natural life cycle," Sekanina said.

Sungrazers are not the only comets that can break up far from the Sun. Sekanina points to new observations of comet 57P/du Toit-Neujmin-Delporte, whose fragmentation has led to the formation of a similar, though less prominent, highway of tiny comets. All fragments separated from the comet beyond the orbit of Mars.

Images taken by the European Space Agency's and NASA's Solar and Heliospheric Observatory have shown the many tiny sungrazing comets. Nearly seven years' worth of images from the solar observatory revealed more than 400 sungrazers in the Sun's immediate neighborhood. Sekanina estimates that currently there may be as many as 200,000 sungrazer comets the size of the ones the observatory detected. [*However a paper at the ACM suggested that the distribution of SOHO Kreutz group comets was essentially random, and they do not form clusters.*]

Asteroids, Comets and Meteors 2002

Continued from page 1

The following précis gives a flavour of the comet science discussed at the meeting. It is from my notes and reflects what I heard and have interpreted from speakers' talks and posters and may not be what they intended! Generally I have brought together themes and do not always credit specific speakers with the discoveries, nor should it be assumed that a named speaker made all the remarks in that section. In some cases I make comments, though I have avoided putting some that could be made, into print! Invited talks were normally 30 minutes, but other talks were only 10 minutes and speakers often spent most of the time introducing their paper and not presenting their conclusions. Abstracts of papers presented at the meeting are at http://berlinadmin.dlr.de/SGF/acm 2002/. In order to encourage participants to stay to the poster sessions the organisers laid on German beer, wine and snacks for us to sample!

Some 'elder statesmen' were often didactic in their views and unknowledgeable outside their own sphere, and were often given undue deference. The general scientific conference system tends to encourage mainstream views, with little chance for individualistic ideas. Another point is that professional astronomers often get only a few nights observing at widely spaced times and as a consequence appear to underestimate their observational errors. Compilations from several sources often showed variation outside the error bars, and many did not even give error bars. It was noticeable that many papers from eastern European or Russian authors used old data from the 1970s and 80s.

Berlin was a light airy city, with lots of trees, wide pavements and comparatively little traffic. The S-bahn (overground train) system was very efficient and cheap, with clean carriages and plenty of space. For most of the conference it was very hot (30°+), which made the lecture and hotel rooms very stuffy. There were many pleasant pavement restaurants. Sight-seeing highlights included the Tiergarten, Schloss Charlottenberg, the Pergamon Museum (particularly the Ishtar gate) and a river cruise, though the famed Brandenburg Gate was under wraps. The next meeting will be 2005 in Rio de Janeiro, followed by 2008 in Baltimore. In the meantime there is a meeting in London on December 13 to discuss comets prior to the Rossetta encounter and I am organising a pro-am meeting on comets and meteors for 2003 May 10. Brian Marsden has agreed to give the inaugural 'George Alcock Memorial Lecture' at this meeting.

Comets

David Jewitt (U of Hawaii) kicked off proceedings with a talk entitled 'From Kuiper Belt to Cometary Nucleus'. Comets are collisionally produced in the Kuiper Belt (KB) and are modified on the journey inward. They may reside in the KB for 10^9 - 10^{10} years and only spend 10^7 as a comet and perhaps 4×10^5 as a Jupiter Family Comet (JFC). The thermal conduction time scale, τ_c, is approximately r^2/κ and for bodies with r larger than 5 km this is longer than the inward diffusion time, and for bodies larger than 2 km it is longer than their lifetime as a JFC. This means that comets are out of thermal equilibrium and are therefore "ice bombs". The sublimation life time is about the dynamical life time for bodies with r around 40 km so JFCs must die by sublimating away or growing a mantle, so there must be dead comets.

Comets spin up much faster than their dynamical lifetime thanks to the Yarkovsky effect. This can modify minor body orbits and rotation rates through re-radiation of sunlight and was invoked by many theorists to explain the inward migration of some orbits and the spin up and disintegration of some nuclei. Duncan Steel suggested that comets could break up through Joule heating due to a current flowing through a conducting coma.

The Kuiper belt is becoming better understood, but there are roughly the same number of these objects as there were main belt asteroids in 1900. A plot of the distant objects clearly shows the classic KBOs, plutinos (and clearly Pluto is just a large one of these and therefore NOT the ninth planet), SDOs (scattered disc objects) and Centaurs. Smaller bodies a likely to predominate. KBOs tend to be neutral to red in colour whereas comets are significantly bluer and similar to Trojan asteroids. Comets have no "ultra-red" material because as soon as they pass Jupiter/Saturn mantling by ejecta is faster than the dynamical lifetime. KBOs and Centaurs are therefore more diverse than comets because of this mantling. Comet light curves are generally more extreme than KBOs and Centaurs, by up to 2 magnitudes and are perhaps more elongated than simple collisional fragments. Comets are very dark compared to asteroids, though probably 10% of NEOs are dead comets. Comets are less dense (at 500 gm/cc) compared to KBOs (1500) implying they are very porous, though even KBOs are pretty porous. Comets are probably weakly bonded collisional rubble piles, with perhaps more 50% pore space.

There are no KBOs with low e and with perihelion at 50 AU. This possibly marks the edge of the primordial solar nebula, or it could reflect stellar encounters or a trans-Neptunian planet. A stellar encounter with a 1/3 solar mass star, passing at 200 AU with an inclination of 30° provides the best fit and can explain the SDOs. 95P/Chiron started a new outburst in 2000/01, which might last until 2003. Since 1965 its absolute V magnitude has varied between 5.1 and 7.3 and is currently around 6.

The Space Telescope has been used to observe comet nuclei and when combined with data from ISO (infra-red satellite) it is possible to make deductions about their size and albedo. 10P/Tempel is quite a large object, whilst 45P/Honda-Mrkos-Pajdusakova is the smallest.

55P/Tempel-Tuttle has 5% albedo, whilst 19P/Borrelly is the most elongated. There are large numbers of small objects with radii less than a km. SPC (Short Period Comets) are not significantly bluer than KBOs. For small SPC cometary activity may cover 100% of the surface. The large diversity in colour reflects primordial variation. Colour studies provide the first evidence for a physical link from KBOs to dead comets, and there is a colour shift over dynamical evolution. Comments made after talks include that just because things are the same colour doesn't mean that they are the same. For example everything in a greengrocers that is green is not necessarily an apple. A rubble pile is what you get when you drop a load of rocks out of the back of a truck. This is not the same as a gravitational aggregate, which is what a dynamicist means by a rubble pile.

At the DS1 encounter with 19P/Borrelly the coma had less than 1% of the intensity of the nucleus. The physical properties are generally similar to asteroids. The overall albedo was 2.9%, which is within the error bars for that measured for 1P/Halley, but it varied between 1% and 5%, with two peaks in the distribution. A few asteroids have similarly low albedos, including NEOs but Iapetus or the rings of Uranus are the best match. The bond albedo is only 0.9%, so the surface is a good absorber of energy, which is why it is hot. There is evidence that the regolith is 'fluffier' than any other body. There are two terrains - roughly 50/50 'desiccated' and 'smooth', although the 'smooth' (or mottled) terrain is rougher at the pixel scale and perhaps reflects ponding of material. The surface is probably covered in 'native' particles, ie comet dust. Mottled terrain shows dark areas, which may be the sites of former jets, as the present jets map back to dark regions. There is some evidence that as the comet outgasses the surface gets darker, so these areas may be older. Geology includes dark spots, circular depressions, ridges and fractures, but no impact craters. Around 6- 8% of the surface was active. The upper layer of refractory material was hot at 300 K, with no sign of water ice. The rotation pole was located at 214° -5°, with the primary jet near the pole. This location implies that seasonal effects should be present, with peak sublimation from 2001 August to mid-September, followed by a rapid switch off. There may be a secondary jet in the opposite hemisphere. The mass of the comet is around 1.8 x 10^{13} Kg, with dimensions 4 x 4 x 8 km, giving a density of 0.27 that of water, although it could be higher in the range 0.29 - 0.83. It rotates with a period of 25±0.5 hours. There was a steep fall off in gas production (a factor of 20 - 30x) between 1.36 and 1.89 AU. A polar source is continuously in sunlight during September, but three months later is in darkness and will remain in darkness for the next six years. The source has a total area of around 3.5 km^2, about 4% of the total surface area. New features seen in DS1 images include hemispheric jet bases and loop features. Dust impacts were only detected near closest approach, with the nominal size of the particles 1.3μm. There were some double hits, implying a separation between particles of 2.5 - 25 metres. The dust is very red, implying large grains. There is evidence for fragmentation of icy particles (10 - 100 micron) near the nucleus. Modelling shows that the comet can form a stable crust, which is thicker at the poles.

The 2MASS survey has detected 265 comets of which 117 were periodic. It found prediscovery images of a couple of comets. Association is by position within a relatively wide window, which gives significant false detections for asteroids. It also implies that there may be undiscovered comets present in the data-set. The ISO survey data is also now publicly available and this may hold previously undiscovered observations of comets and asteroids. LONEOS/LINEAR/NEAT/Catalina don't search below -30° or above 80° or closer than 6 hours from the Sun, though occasional special searches go to 4 hours. LONEOS avoids the milky way and concentrates on the ecliptic.

Another possible space mission is NESS (Near-Earth Space Surveillance), which is being studied by the Canadian Space Agency. This is a small satellite in sun-synchronous earth orbit. It would scan ±20° from the ecliptic and 45 - 70° from the Sun to 20^m using a 15cm f6 Maksutov. It would have 2" astrometric precision. It would observe comets closer to the Sun than present search programmes and would search for Kreutz comets. In some eclipse geometries it could search even closer to the Sun.

The Stardust spacecraft encounter with comet 81P/Wild (the pros were not very good at using the correct identifications for comets) takes place on the same day as the launch of the Deep Impact spacecraft. Stardust is a dust return mission but will provide imagery at 10 - 20 metres resolution. Unfortunately the comet is at only 33° elongation at the time of the encounter, but all ground based observations will be of use. Contour will explore the evolutionary diversity of comets and has imaging better than 5 metres. Deep Impact will investigate the interior of the nucleus ("a crude experiment but interesting") and can image to around 1.5 metres; it will also benefit from ground based observations. They don't really know what sort of crater to expect. A strong surface gives a small crater with diameter to depth ratio of 3:1 and an ejecta cone that detaches. A porous surface fives a small deep crater and if the surface is weak it will excavate material to give a 60 - 240 m crater with a ratio of 4:1, which is what the team is working on. No missions will measure a comet's mass before Rossetta. There are no planned missions to an OCC (Oort Cloud Comet), though Contour could be targeted at one. An OCC is one that is making its first trip into the inner solar system and which has a Tisserand invariant less than 2; the Tisserand invariant is a measure of an object's gravitational interaction with Jupiter. There is a proposal for a comet surface sample return over the next decade, though cryogenic storage and return of a sample is a long way off.

Olivier Groussin and Philippe Lamy suggest that there is a rapid increase in water production in comet 46P/Wirtanen prior to perihelion, with the active fraction of the surface increasing from 10% to 85% in 10 days when the comet is at around 1.5 AU. The albedo is less than 10%. After perihelion the activity again reduces to 10%. They suggest that a one metre thick mantle blowing off causes the change. The paper is based on a few data points measured in 1997 and could equally be another example of under-estimation of observational errors. Another paper suggested that both 46P and Hale-Bopp need to have a low matrix heat conductivity and large active areas to explain the measured molecular fluxes.

A dust trail from 22P/Kopff has recently been detected. It comprises of large (cm sized), dark (1% albedo) particles similar to the parent comet KBOs and Centaurs.

The SOHO C3 LASCO coronagraph has a 77.6mm f9.3 lens, which allows a 1' resolution and can observe out to 15° from the Sun. Comet 96P/Machholz was observed over a phase angle from 160 - 114°, though incoming observations were overexposed. Klaus Jockers et al suggest that the comet shows a phase effect when very close to perihelion. The polarisation curve fits quite well to the expected curve, but appears to be a little higher. The tail is dominated by dust emission. Unfortunately the speaker ran out of time to present his conclusions.

Sebastian Hoenig, Maik Meyer and Brian Marsden at ACM2002

Brian Marsden reviewed orbit computations for the SOHO comets. Some comets were clearly not members of the Kreutz group, and as numbers increased close pairs began to appear, followed by members wider displaced in time. These become known as members of the Meyer, Marsden and Kracht groups, though all three groups have a similar longitude of perihelion (~100°), which is similar to that of the daytime Arietids, 96P/Machholz and the Quadrantids. This is odd! The Meyer group have a higher latitude of perihelion (50°) than the other two groups (10°) and the Marsden group has a greater inclination than the Kracht group. There may be a fourth group comprising of three members so far (2000 Q1, 2000 Y6, 2000 Y7), and clearly most SOHO comets are members of groups. In answer to a question on whether the groups are uniform in time, Brian replied that the objects look asteroidal and the search is perhaps not yet complete.

Michael Kueppers et al looked at the possibility of detecting cometary ions from Kreutz fragments as they pass the earth. The maximum size of the Kreutz fragments is ten to around 50 metres for a solid body sublimating completely. If tidal splitting occurs (such as seen in Ikeya-Seki) they could be as large as a few hundred metres. From a sample of 386 SOHO Kreutz comets there is no convincing evidence for the non-random distribution of perihelia times on small timescales, as proposed by Sekanina (ie comet pairs). The Earth could pass through a disrupted plasma tail in September/early October, but the chance is only around 2% a year given the observed comet frequency.

Hiroshi Kimura (Doug Biesecker was a co author) began his talk and by showing a nice painting of comet 1882 R1 by Ichigoro Ogawa and said that the tail was interpreted as an omen of a rich harvest. Dust grains include a major population of sub micron silicate grains, in aggregates containing more olivine than pyroxene. Pyroxene sublimes at around 5 solar radii, whereas olivine sublimes at around 10 solar radii. Kreutz group comets fade as they approach closer to the Sun, with two groups of light curves. One begins to fade at 11 - 12 solar radii, with perhaps another weaker group at 7 - 8 radii. There are perhaps sub-peaks at 11.2 and 12.3 radii, which reflect different dust properties - amorphous and crystalline olivine. There is no correlation with the comet orbits.

A poster by Teemu Makinen et al describing the discovery of comet 2000 S5 had a post-it note added during the meeting noting that Masayuki Suzuki had made a possible real-time discovery. Daily summary pages are on the web at http://sohowww/data/summary/swan/swan-images.html Magnitudes are accurate to around ±1 and positions to around 15'. Comets can be seen down to 11 - 12 magnitude. 2000 S5 was discovered during a second assessment of the Lyman alpha images using a neural net system to detect moving images. It might have disintegrated after perihelion and is best searched for on its inbound leg. There is a chance that an amateur astronomer may have recorded it on a photograph or image. The assessment suggested that search programmes were missing around 5% of the brightest comets. SWAN has observed comets 2P, 19P, 21P, 41P, 45P, 46P, 55P, 73P, 81P, 96P, 103P, 141P, 1995 O1, 1995 Y1, 1996 B1, 1996 B2, 1996 N1, 1996 Q1, 1997 J2, 1997 K2, 1997 N1, 1997 O1, 1997 Q1, 1997 T1, 1998 H1, 1998 J1, 1999 H1, 1999 J3, 1999 N2, 1999 S4, 1999 T1, 2000 S5, 2000 W1, 2000 WM1, 2001 A2 and 2001 Q2.

When comets with semi-major axes greater than 100 AU are sub-divided into groups of different dynamical age Fernandez found that there were significant differences in inclination between the afe groups. The ratio of prograde to retrograde orbits also varies with $1/a_{orig}$. A plot of $1/a_{orig}$ shows two peaks - one from the inner Oort Cloud and one from the outer Oort Cloud, which has a boundary at around 3×10^9 AU. Comets from the outer cloud are all new, but the inner ones have to traverse the Jupiter/Saturn region as Centaurs (because the change in energy is proportionately smaller), which is why there is an excess of retrograde orbits in this class. The excess of prograde orbits in the outer cloud could be due to too small a sample, or because the distribution reflects some memory of the original formation orbit. Another paper suggested that comet aphelia are aligned along a great circle, which implies an impulsive component to the flux. There is also a pattern of orbital element correlations. This is unlikely to be caused by observational bias (ie selection effects or bad data). The lack of comets along the galactic equator is due to galactic forces, but there are two peaks in longitude which are not expected from the galactic tide. Of 27 new orbits between the 11th and 14th catalogues 9 are in this distribution. The comets in the great circle distribution are more tightly bound. The most likely cause is a Jovian sized companion in the Oort Cloud.

Some recent research on cometary volatiles presented by Michael Mumma uses measurement of several parent species within a short space of time. Eight of nine comets studied have similar chemistry, though 1999 S4 is an exception. CO shows evidence for a distributed source in Hale-Bopp and varies by a factor of 20 between different comets. Compared to water most comets show about 2% methanol and 0.6% ethene. The studies show that the Oort cloud does contain comets that are chemically diverse, with 2/3 forming beyond 30 AU and the remaining third forming between 5 and 30 AU. Polarisation measurements help enhance dust features, eg shells in Hale-Bopp. There are three classes of comet: low polarisation, high polarisation and Hale-Bopp. What causes the difference is not known. Long term monitoring of Hale-Bopp from 7 AU on the way in, through perihelion and out to 14 AU shows significant short-term variation in molecular species, especially CO. The transition from a CO to H_2O dominated coma occurs between 3 and 4 AU. At large solar distances water production rates depend on a complex combination of seasons, spin state, r and the thermal properties of the nucleus. CO production rates depend only on r and it doesn't sublimate from great depths, so the nucleus may be very inhomogeneous. Generally production was higher after T, but it modelling suggests that it depends on seasonal effects. A lower limit for the nuclear radius is 13 km. The rotation axis was constant between 1995 and 2002. There were at least four active regions on Hale-Bopp, with a continuously active northern fan. Some outbursts were in a 'palm-tree' pattern and others included 'boulder spitting' as mini-comets. Small condensations were seen in the coma of 1996 B2 over a period of around 20 days, which were possibly mini comae around icy fragments between 5 and 100 metres in diameter. One effect of this spallation of fragments is that the nucleus remains extremely cold. The structure appears to be a thin layer of crystalline ice, over a mixed layer of amorphous and crystalline ice then a pristine nucleus. This structure is quite different to that of JFCs. LPCs experience strong thermal stress close to the surface.

A lot of species have been measured in high resolution spectra of 2000 WM1. These include C_2, NH_2, CN, C_3, CO, H_2O^+, CH^-, CO^+, CH^+ and C_2^-. The ratio of C^{12}/C^{13} is close to the terrestrial, but that of N^{14}/N^{15} is only half, though comparable to that in Hale-Bopp. The outbursts of 2001 A2, which is a gas rich comet of the Halley class (or possibly a water poor Borrelly type) *[note that chemists use a different naming convention to the dynamicists]*, were associated with fragmentation, except the one on July 12. CN, CH, CH^+, C_3, C_2, NH_2, and O[I] were detected in its spectra. P/2001 Q2 is also a Halley type comet. The ortho/para spin temperature for 1P, 1995 O1, 1999 S4 and 2001 A2 is around 28K, suggesting an origin in the Saturn/Uranus region, whilst that for 103P is around 35K. Complex chemicals ('pre-biotic') can form in comets. 19P is in the C_2 depleted class of comets. The source for C_2 may be C_2H_6 or ethane for comets depleted in C_2, whereas CH_3C_2H or CH_2CCH_2 may be the source for C_3, although another possibility is C_3H_8.

Many groups had observed 2002 C1. NH_3 had been detected for the first time in the infrared, at a few x 10^{26} in the month after perihelion. This was only 0.7% that of water. C_2H_4 (di-acetelyne), only observable in the infrared, was also detected at around 0.05% water, with HC_3N also detected. A sodium tail was seen. CO was much higher in 1999 T1 at 13% than in 2001 A2 or 2000 WM1 at <1%. The preliminary estimate for 2002 C1 was 8% of water. The presence of a hot component at 300 - 500 K suggests a CO_2 source.

Daniel Boice reviewed processes in the coma. At 1 AU the inner coma is dominated by collisions in a moderately active comet. The mean free path is around a metre, and an inner boundary layer exists several mean free paths above the nucleus. The outer boundary is the transition to free flow at 10^4 - 10^5 km. In between there is reactive fluid dynamics, but no solar wind or magnetic effects. Solar visible radiation initiates sublimation from the nucleus. To model what goes on a multi-fluid approach including neutrals, ions, electrons, H, H_2, dust etc is adopted and the continuity equations are solved separately. The most important terms are the inhomogenous ones, such as chemistry, mass {condensation, evaporation, etc}, momentum and energy that are related to sources and sinks and are particularly affected by He and H. The near nucleus region is very asymmetric, because of jets etc, but is approximately symmetric by 100 km. All this is solved and velocity & temperature profiles are derived that generally agree with the observations. Parent species generally follow a $1/r^2$ distribution, but daughter species have various patterns as the parents are broken down by solar ultra-violet radiation to give many daughters. There are differences between what happens when the sun is active and when it is quiet. Radiative transfer in the coma is complex, with factors such as optical depth and shadowing playing a part. Extreme UV penetrates into the innermost region. Water dominates at distances less than about 2 - 3 AU from the Sun, with carbon monoxide at greater distances. Gas phase reactions vary in importance with distance from the Sun and from the nucleus. Close to the nucleus electrons are coupled to water through inelastic collisions, but further out they decouple giving a steep rise in electron temperature to 10^4 K. Dust gives distributed gas sources and can lead to heating of gas through radiative heating. Generally even the best models don't give a brilliant fit to the observations and it seemed that the model was more important than reality, with one not even incorporating a dusty crust.

Water is difficult to observe from the ground, but the Odin satellite can measure it from space using emissions at around 550 GHz and has observed comets 1999 H1, 2001 A2, 2000 WM1, 2002 C1 and 19P. Comet 1999 H1 (Lee) produced 4 tonnes per second and generally production rates were 2 x 10^{28} - 2 x 10^{29} s^{-1}. 2001 A2 showed strong self absorption as it had a very strong emission line.

In 2002 C1 $H_2{}^{18}O$ was detected and the $^{16}O/^{18}O$ ratio was around 500, similar to the cosmic ratio. Nicolas Biver and his colleagues had used several millimetre wave telescopes to compare 25 comets. CH_3CN was quite variable. The HNC/HCN ratio varied with solar distance. The variation in CH_3OH was far greater than in HCN (<1% to 6%, around 2% in JFC). H_2CO was also variable, with a weak correlation with CH_3OH in LPC. Four CO rich comets were all HFC and CO was low in SPC. H_2S was quite variable at 0.1% - 1.5%. CS/HCN may also vary with solar distance, being about 0.8 at 1 AU. Generally NH_3 is around 0.5% of water.

The FUSE spacecraft has observed lots of UV emission lines, and around 50% remain unidentified. There is no evidence for argon in comets from the observations, so it must be at least 10 times less than solar. Comets can't therefore be the source of argon in Venus' atmosphere. FUSE has made the first detection of neutral nitrogen in comets, but can't account for the source. By looking at isotope ratios and relative concentrations they have showed that comet 1999 T1 was never warmer than 40 - 45 K and comets 2001 A2 and 2000 WM1 were never warmer than 60 K.

Some comets show no features in the coma. The features in those that do may be stationary or varying, and if varying may be periodic or one off. Jets are consistent with active areas. Projection effects are very important, eg a double jet feature may be explicable if we are looking directly at it. 1993 Y1 (McNaught-Russell) and 1996 Q1 (Tabur) only showed gas jets - there were no dust jets. 1P/Halley also showed some gas jets with no dust. They seem fairly common, so gas and dust jets may be formed in different ways.

The solar wind at solar minimum is very variable in equatorial regions, with speeds of 300 km s^{-1} and disconnection events in comet ion tails are observed. At polar latitudes (>30°) the wind is fast and constant at around 750 km s^{-1}. At solar maximum it is variable even in polar regions, with much less fast smooth wind conditions. John Brandt and others have used amateur photographs and images to investigate how the wind changes. 2001 A2 (LINEAR) showed a slender ion tail for most of December and January, with no disconnection events, implying a slow polar wind. 2002 C1 has shown lots of disconnection events, which are a good match to current sheet crossings. There is an equatorial type of solar wind north of the heliospheric current sheet (HCS) and polar south of it, though the polar wind was slower than 750 km s^{-1}. The location of the HCS may vary from that expected from the photospheric magnetic field measurements. 2002 Q4 (NEAT) will be a good probe of solar wind conditions.

A glitch in proton numbers measured by Ulysses was seen on 1996 May 1, with a coincident change in the magnetic field. If caused by an encounter with the tail of 1996 B2 (Hyakutake) this implied a tail 3.8 AU long and with a 740 km s^{-1} wind speed the particles would have been emitted 8 days earlier. The tail is a long curved structure, about twice the diameter of the Sun at the spacecraft distance. The orientation was not quite as expected. There is a question of how it lasted so long, and possibly magnetic field draping protected it. Images taken on April 23 will be important in understanding the observations. On March 1, the Earth was inside the tail, which was curved, though less so than in May. This could give a longer tail than predicted by geometrical considerations, however the feeling was that observers reporting very long tail lengths might have been confused by the geigenshine.

X-ray emissions from comets were now thought to be caused by charge exchange of highly ionised atoms, eg O^{6+}, in the solar wind picking up electrons from the coma. A clear emission line was seen in 1999 S4 prior to its breakup. C^{5+} and O^{7+} were seen in 1999 T1 (McNaught-Hartley).

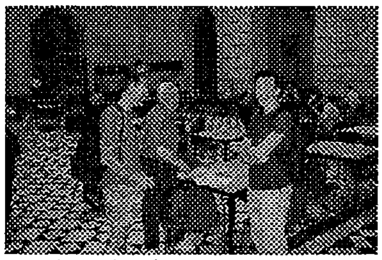
Paul Weissman reported on cometary nuclei. We have imaged 1P/Halley and 19P/Borrelly, but at best the resolution is 50 metres. There are various models of a nucleus: Classical Whipple, Fractal Aggregate, Rubble Pile and Icy Glue. The middle two are more likely as there is no heat source that could head the nucleus more than a few Kelvin and there is lots of evidence for the two models. 1999 S4 showed metre sized cometisimals and Kreutz sungrazers break up to metre to 10 metre sized objects. All the Kreutz fragments and comets seen so far would only sum to a body a few kilometres in size. 1993 F2 (D/Shoemaker-Levy) stretched at perijove, fragmented and then re-accreted into the objects seen. This concept explains lots of the features of the size distribution, with the biggest objects in the centre and the re-entry where there seems to be a greater surface area than can be explained by the mass. The regolith may hide any rubble structure. The maximum density is 1.65 for a tightly packed agregate, though actual estimates (for example from non-gravitational forces) suggest a value of 0.4. The breakup of 1993 F2 suggests a value about 1 and the same comes from IDPs (Interplanetary Dust Particles). However meteorites show a higher density than their parent bodies. The size distribution of nuclei varies as $N(r) > r \sim r^{-1.6}$; smaller objects are probably under-represented and the original distribution may be steeper. Perihelion distance has no effect on the derived slope parameter. 22P/Kopff has a rotational light curve of 12.3 hours and amplitude 0.5^m, which implies an axial ratio of more than 1.59. For 2P/Encke it is 7.26 hours and 0.3^m and the comet is probably smaller than 4 km. For 6P/d'Arrest it is 7.2 hours and 0.1^m, giving a size of 1.5 km. Generally the measured sizes are 1.5 to 2.5 km for an assumed albedo of 4%. The nuclei of 28P and 124P when far from the Sun are redder than the Sun.

Gonzalo Tancredi spoke about ways of measuring the nucleus diameter. It can either be visited, observed when very distant or the effect of the coma subtracted. For the latter two techniques a plot of the absolute magnitude against r should either show a constant value or reach a minimum. A phase coefficient and a geometric albedo of 4% is used to estimate the effective radius. There are good results for this technique with comets 1P and 19P, which have been visited. There is general agreement between ground based and HST measurements, except for 147P/Kushida-Muramatsu, where the HST value is clearly wrong. The survey of JFCs to q=2 is complete (ish) and suggests a magnitude index of -3.4 (or a cumulative index of -0.8). To measure more distant comets a telescope larger than 3 metres is needed. Of around 230 JFCs, 100 have had their nuclear magnitude determined, however there may be biases. The distribution is nearly linear up to a nuclear magnitude of 17, but then flattens with a cut-off at 20. Very few intrinsically faint comets with q < 2 have been found recently. Options are that break-up removes the small ones, mantling occurs, or they loose all their volatiles.

Hal Levison looked at fading in comets. There is a big inconsistency between models of delivery of OCCs into the inner solar system and the observations, so OCCs must disrupt. Two dormant external returning comets have been observed, but there should have been 200! There is a similar ratio for extinct HFCs, with 9 seen compared to a prediction of 1100. JFCs however don't disrupt at this rate, with some 20% being dormant; a typical example is 2000 QN_{130}. Dynamically new comets are often anomalously bright, however there is still a problem with the flux being much higher than observed. A full copy of this talk is at http://www.boulder.swri.edu/~hal/talks.html. Modelling suggests that the majority of new OCCs reach q at 30 - 40 AU, with roughly constant numbers reaching perihelion between 0 and 30 AU. The JFCs must come from a flattened Kuiper belt. Another modelling paper looked at the origin of JFC and HFCs from SDOs. There are a number of differences between theory and observation. The SD model produces more JFC than HFC as observed, but a thick disk cannot be the source for them.

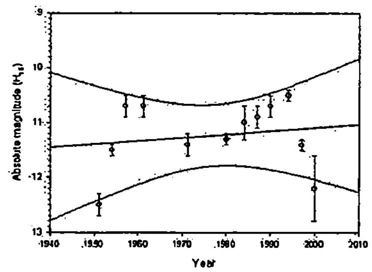
Carey Lisse et al looked at ageing in comets. Short period comets emit dust as large dark particles of high mass whilst LPCs emit small high albedo particles. They suggest that SPCs become extinct by mantle formation over a period of 10^3 - 10^4 years, disintegrate, or are ejected from the solar system or hit the Sun. 1999 S4 probably didn't break-up as a result of rotational splitting.

A replacement for a successful model must be able to predict, fit the observations and be physically realistic. The classical non-gravitational model of Marsden was invented years ago to improve orbital fits and includes radial and transverse forces linked to g(r). This can be modified to include a normal component and a delayed maximum. A newer model is the rotating jet model, averaged over one rotation. For 19P/Borrelly the classic model gives a poor fit to the observations. The modified model does better, with a ΔT of 51 days before perihelion, when the reported rotation pole was in the solar direction. If the jet is at the rotation pole the new model matches the observations. For 2P/Encke the modified model does no better than the classical model, and whilst the jet model does better, it gives a different rotation pole to that derived by Sekanina. Sekanina's pole doesn't match the light curve over the last twenty years, though the new pole position does match his precessed pole position. The model confirms Sekanina's two source regions, with 2° per apparition precession, with an obliquity pole of 35±15° and a rotation pole at 220° RA, 40° dec and the jet positions remaining constant.



Jonathan Shanklin, Brian Marsden and Sebastian Hoenig at the ACM.

I presented a paper on BAA comet observations and included an updated version of the estimated absolute magnitude of 2P/Encke over the last 50 years, which shows no significant change. I also showed that periodic comets tend to have a larger log r coefficient than do non-periodic comets. There is a general trend for comets with a brighter absolute magnitude to have a larger log r coefficient, though this does not apply to 'new' comets from the Oort cloud. There is no obvious correlation between absolute magnitude and perihelion distance. I've put a version of the poster on the web, including all the figures.



The absolute magnitude of 2P/Encke

The CLICC/A catalogue of comet magnitude estimates has been extended for 21 LPCs observed between 1959 and 1976. It can be found at http://www.ta3.sk/~astrsven

Comet 53P was in a Jovian moon like orbit some 600 - 1000 years ago. It is not a Trojan, though it is currently close to a 'horse-shoe' like orbit with respect to Jupiter. P/1997 V1 is in a 'horse-shoe' like orbit and may have been a Trojan in the past. In the future it will do 11 retrograde orbits about Jupiter. P/1998 U4 may undergo temporary capture in the future for around 500 - 2000 years. P/1999 WJ7 is at the end of a period of 'horse-shoe' like orbit and P/2000 Y3 is in a 'horse-shoe' orbit.

The radial profile of SDO 29981 (1999 TD10) measured from images is flatter than stellar images and it therefore shows evidence for a coma.

Asteroids

There are several asteroid missions planned. Dawn to Vesta and Ceres for orbital mapping and Muses C, which will launch at the end of this year, to 1998 SF36. Stardust is flying past Annefrank on November 2 and will test operations for 81P/Wild.

2002 NT7 had an impact probability of 1:70,000 up to July 23. Now an impact in 2019 is not possible, but one in 2060 is at 10^{-7} though negative on the Palermo scale. Several speakers on impact topics and orbital calculation were rather too wrapped up in the maths of their calculations, with little attention to the real world. It would need 30 Arianne launches to deflect it from a 2060 encounter. The Italian Spaceguard centre and JPL plan to create a database of each observing station so that a statistical distribution of errors and biases can be applied to each astrometric observation. In order to reach the Spaceguard target (all km sized NEOs within 10 years) searches would have to be complete to 21.5^m now - they aren't! LINEAR would take until around 2035, though PanSTARRS could do it in six years. Undiscovered NEOs are probably intrinsically harder to discover and all the search teams together will only get to 90% by 2014.

A solar concentrator gives quite an effective means of moving a small NEO over a five year or longer period. Several NEOs require a smaller ΔV to rendezvous with, than do Mars or Venus, and one has a smaller value than for the moon. A hit from a large object is likely every 400,000 years with a small one every 1000 years. Objects on imminent collision course with the Earth will be undetectable due to their lack of motion 3 - 4 weeks before impact.

Binary asteroids were a big theme of the meeting and William Merline gave an introductory talk. There are 7 TNOs (Trans Neptunian Objects) with known satellites, 8 MBAs (Main Belt Asteroids) and 14 NEOs, with a further 8 binary NEOs detected from light curves. They have densities between 1 and 3 (times water). There are a variety of formation mechanisms. The TNO satellites must have formed in situ, but the NEOs by fragmentation. The TNOs are mostly cubewanos, and are too wide to have formed by collisional breakup. Sizes range from 1:1 to 1:20. A small secondary is likely to arise from ejecta form an oblong object. Rotational fission will give rise to close equal components. Tidal disruption is likely to be common in NEOs. He showed an impressive animation showing the effects of adaptive optics. Dactyl was the first positive detection in 1993, with Eugenia/Petit Prince in 1998. Some light curves give convincing evidence of duplicity. Dactyl probably formed from a cratering event on Ida as its surface is only around 30 My old. Arecibo has 7.5 metre range resolution and gives clear views of NEO binaries. All NEO binaries are fast rotators and about 17% of NEOs are binary, suggesting that tidal disruption gives rise to rubble piles. 216 Kleopatra is an M type asteroid in the shape of a 'dog bone' and may be a residual metallic core frozen into shape.

The shortest measured rotation period of any asteroid is 76.8 seconds. Smaller objects rotate faster, but it is impossible to measure much faster periods with sub 2-m class telescopes. It is possible to get fast rotators from the break up of a rubble pile. Possibly 50% of the most easily accessible NEOs are fast rotators and therefore not easy to land on! Most asteroids with regolith will have ponds and cracks, which fill with fines if seismic shaking force is comparable to gravity. They show weak to moderate albedo features and even large bodies may show irregularities.

The binaries are important individually, as a population and because the NEO, MBA and TNOs are different. NEO 2000 DP107 is a pair of 800 and 300 m diameter separated by 2.6 km. Radar observations give very good, rich data. The secondary is always brighter in radar images, which can currently only view NEOs. About 16% are binary, with typical size ratios of 1:3, with the secondary orbiting at 5 times the primary radius, with a period of about a day. Densities are between 1 and 2.6 implying high porosity. Primaries are spherical and fast rotators. MBA can be detected with adaptive optics on large telescopes. There are observational selection effects and satellites that are faint or at small separations won't be seen. A few percent of MBAs are binary, with typical size ratios of 1:10, with the secondary orbiting at 10 times the primary radius, with a period of about four days. Densities are between 1.2 and 2.3, even for M type asteroids, which is an implausible porosity for them to be the source of iron meteorites. There are a few large contact binaries, eg Nysa, Daphne and Hector. TNO binaries can be seen with HST or medium sized ground based telescopes. No new binaries were seen in a sample of 200, however two and an already known one, were found in a set of 75 imaged with WFPC. About one percent of TNOs are binary (or possibly 4%), with typical size ratios of 1:1 to 1:3, with the secondary orbiting at 10 - 100 times the primary radius, with a period of 60 - 600 days. So far there is no information on density.

Formation of binaries could be by tidal splitting (NEOs only), rotational fission, impact or disruptive capture. The large separations of TNOs are not caused by tidal evolution and their formation mechanism is unknown. We would expect the secondaries of NEOs to be rotationally locked, like the moon. NEO binaries form by spin-up and mass shedding, most likely the result of disruption during close planetary encounters. MBA binaries form from impact ejecta. The low density implies either a high porosity or a high volatile content.

The rotational variant of the Yarkovsky effect called YORP can explain some of these rapid rotations. Asteroids can spin up and self destruct. These forces are as important as gravity and collisions in asteroid evolution. The Yarkovsky effect on bodies smaller than 20 km can transform MBAs into NEOs. The YORP effect is important for spin, obliquity and configuration of km sized asteroids. There is evidence for the Yarkovsky effect working in the orbits of members of the Eos family and modelling suggests an age of 2.1 Gy. Asteroid groups can be identified from their proper elements and another recently identified group is the Karin group, which from its compact grouping must be young. Integrating the orbits back in time gives a breakup age of 5.8 My, with the original body 25 km across. This means that members of the group should show fresh surfaces, perhaps with water ice, and they may be the source of some zodiacal dust bands. A satellite visit to members of the group could help measure the Yarkovsky effect, satellite formation and crater counts (though these are probably dominated by debris). The spin vectors for Koronis family members are bi-modal.

Al Harris (JPL) asked 'How many Tunguskas are there?'. One way of estimating how many NEOs there are is to look at the re-detection rates by search programmes of already known bodies. To estimate the size of craters we can look at lunar impacts, where the size of crater/size of body ratio increases for smaller bodies up to 1:50. Discovery statistics need to be corrected for 'missing' detections near the limit of the system, and at faint magnitudes the efficiency may be 10^{-5}. Up to a limit of H=18 (roughly equivalent to a kilometre) there are around 1100 objects. For smaller objects the statistics are poor. To make an estimate he took 1000 known NEOs, ran the elements for 100 years and found 5000+ passages at less than 0.3 AU. He then convolved this with the LINEAR coverage, though note that LINEAR can't detect objects moving at more than 12° per day (which is why they often don't see close approachers until after they pass). This gave an estimate of 10^6 Tunguska sized objects or 1 per 1000 years. A questioner however noted that acoustic monitoring suggests an object this size every 120 years.

Boris Ivanov and Jay Melosh had numerically modelled asteroid impacts and concluded that they do not induce volcanism. Oceanic crust is young, less than 250 My, and there are no major (> 300 km) crater remnants. Hot spots are small, and unlikely to be hit. Flood basalts link to tectonic activity. A large impact can create a hot spot, but this is created by shock heating and is not intrinsic to the Earth itself. Melting is 1 - 3 orders of magnitude less than associated with large igneous provinces. It would be unlucky to hit a young hot spot and therefore this is not a regular geological process. There are varying estimates of the ratio of long period comets to asteroid impacts ranging from 5 to 30%. We have some idea of the LPC flux now, but how can we tell the difference in impact structures? David Wallis suggested by possibly using the difference in azimuth of impact direction as the orbital distribution in the two groups is different. Measuring the crater bowl shape asymmetry gives the impact direction and crater rays may confirm this for some lunar and Martian craters. There has been no practical study so far, and questioners were sceptical if the technique would work.

IDPs are quite different to meteorites : they are small grains with a high carbon content and probably originate in a few discrete sources. The three main zodiacal dust bands may be associated with asteroid families or perhaps a recent break-up. Perhaps as many as 85% of IDPs come from one source, possibly Veritas, a C-type asteroid, which broke up around 50 My ago. Dust must have been more significant away from the present epoch, possibly giving a climate signal. The near 100 Ky periodicity in the Quaternary climate might be related to chaotic transport of NEOs through variation in the orbital eccentricity of Mars.

The Klet observatory has a new, specially designed 1m f3 telescope, with 1024 pixel CCD camera and a 33' field for the KLENOT project, which is designed to provide astrometry of NEOs, comets, Centaurs, TNOs etc and in particular to make follow up observations. They have provided confirmation for 48 NEOs, including a 21.9^m Amor object, 5 comets and the 'B' component of 57P. They have discovered an Apollo 2002 LK. It can be worth measuring the position of around three numbered minor planets during the course of astrometric work as this can help trace errors of measurement or systematic effects. Station 940 shows residuals of around 1" in RA and dec over the last few years, with 951 having 0.6" and 0.4" respectively.

There are no KBOs with low eccentricity orbits beyond 50 AU. Deep searches should have found them, unless they are located in a thin disk in the invariable plane of the solar system. Alternatively they could have been cleared by a recent stellar passage or a Mars like planetoid at 60 AU. There are many biases in the follow up of TNOs, for example if the object is assumed to be a plutino it is most likely to be recovered if it is one. To do good statistics it is necessary to use a well characterised survey and this shows that some 20 - 25% are SDOs and <3% plutinos, with a new class of Extended SDOs. Richard Donnison suggests that there should be a predominance of large bodies in the TNO distribution.

Meteors

There are over 100 years of observations of meteors from comet 1P/Halley. Sadly Anton Hajduk didn't use any BAA data in his talk. Ondrejov data shows multiple peaks in Orionid observations, with significant shifts from one year to the next. Both Orionids and eta Aquarids extend over 14 days and the link with comet Halley is established beyond doubt. The eta Aquarids last from L 37 - 51°, with enhanced activity between 42.5 and 47°, whilst the Orionids last from 202 - 216° with a double maximum between 208 and 210°. The mass index is 2.2 and 1.8 respectively.

Double station recording from Ondrejov suggests that brighter Orionid and perhaps Perseid meteors start higher in the atmosphere (120 Km). Slow meteors penetrate more deeply (to 80 Km). They do not see cometary (ie fragile) meteoroids on orbits with small perihelion distances. Generally light curves from the Perseids, Orionids and Leonids are symmetric with peak brightness near the middle. Pavel Koten has written meteor video processing software - the present version is for DOS, but a Windows version is being developed.

A Russian speaker suggested the existence of meteor micro-showers with activity of perhaps 1/10 that of major showers. He suggested that they might arise by gravitational separation from the major showers. Unfortunately he didn't see some of the major showers and I suspect that there may be noise in his data.

The North Taurids are active from October 16 - November 29, whilst the South Taurids are active from October 4 to November 24. Meteors generally associated with the Taurid complex are active from September 16 to December 29 (N) and September 25 to December 19 (S). It is important to take account of radiant motion as it moves through over 90° in RA. 1993 KA2, 1998 VD31, 1999 VK12 and 2002 MX are probably associated with the complex, but 2201 Oljato is probably not. Taurids generally have a higher critical mass than the Orionids (5 mg cf 0.8 mg). Ziolkowski suggests that 2P/Encke and 1966 T1 (Rudnicki) are both member of the Taurid complex. If so, integrating back the orbit of 2P until the longitude of perihelion agrees with that of 1966 T1 should give the time of separation. This gives 4.35 x 10^4 years, comparable to the period of 1966 T1, which is about 4.5 x 10^4 years.

There are two more Leonid storms expected in 2002 on November 19 at 03:58 - 04:15 and 10:36 - 11:15. The second peak is from the 1866 trail and may have a peak ZHR of 2850, with a 2 hour duration. There is a Lorentzian distribution of particles long each debris trail, and the trail is displaced from year to year. Bright Leonids (~-2) tend to be brightest at the end of their flight, and these probably have greater strength and are larger. The final flare of a fireball may be richer in CaAl. 0^m meteors tend to have a variety of light curves. There is no evidence for ageing in Leonid meteors from different trails, though there are significant differences. A network of video cameras in Japan recorded the 2001 shower. Significant variations in the rates from north to south reflect the structure of the trail. The population index was higher at 2.2 after the 1815 (4 revolution) peak compared to 1.9 before the 9 revolution peak. The Japanese also set up a network of school observers. The results are scattered but the mean of 171 groups (1800 students) agrees well with the IMO results. Australian image intensifier results from 2001 shows peaks at 18:02±3 (9 revolution, 1699) and 18:17±3 (4 revolution, 1866) but no evidence for an 18:30 peak reported by visual observers. Short lived enhancements of Leonid rates (> 15 within a few seconds) in a linear distribution (cf Shoemaker-Levy 9) cannot be explained by ejection from the comet as the ejection velocity would have to be around 0.003 mm/sec, much less than the expected 30 cm/sec. It probably occurred after the last perihelion of the debris, about 6 days before encountering the Earth. Peter Jenniskens suggests that there could be a further significant Leonid shower in 2006. The visibility of 'periodic' outbursts is governed by Jupiter pulling around the solar system barycentre.

A fireball recorded by the European Fireball Network on 2002 April 6 lead to the recovery of a 1.7 Kg meteorite by amateur astronomers in July and this was exhibited at the meeting. It was found a little to the east of the predicted fall ellipse. The orbit is clearly related to that of Pibram and implies the existence of a meteroid stream. Another fireball on 2001 November 17 was so bright (-18^m) that it was detected by a radiometer at night.

The Arecebo radar shows a clear peak in fast meteors between 04 and 08 LAT. An unusual fireball was photographed from Ondrejov, which showed an apparently 'strong' meteor in a retrograde orbit, with q 1.01, Q 6.0 and lacking in sodium. Sodium lacking meteors occur in two groups: those in sun approaching (q < 0.25) prograde orbits with low to moderate inclinations and an inner halo with q ~ 1 and in high inclination, often retrograde orbits. They could be related to the exinct HFC as proposed by Levison, however the non-chondritic structure argues against this. Inner halo meteoids are subject to significant hearing and this suggest there may be highly processed material in the Oort cloud.

Comets with aphelia less than 7 AU produce the bulk (90%) of meteoric material. HFC produce 5% and long period comets (P > 200 y) 5%. The model predicts the observed helion/anthelion distribution of sporadic meteors.

Conclusion

Richard Binzel summarised the meeting for the final talk. He thought that inter-relationships between the various bodies were amongst the most important aspects. We are getting some geophysics of asteroids, for example on Eros. Fundamental questions about comets remain. They have an aggregate structure. We are getting better nuclear magnitude distributions. 2/3 of OCC formed beyond 30 AU with rest forming between 5 and 30 AU. The Oort Cloud is the source of long and short period comets, with the Kuiper belt for JFC. TNOs are a growing field and we have discovered the same number as there were MBA in 1900. There are dynamically "hot" objects, which are blue/grey in colour, and "cool" objects (ie in stable orbits) that are red. Satellites are very important. Probably one size does not fit all. Highlights for meteors included the Leonids, recovery of the Neuschwanstein meteorite (only the 3rd European recovery) and the link of IDPs to showers. The Yarkovsky effect is important for meteorite delivery.

Review of comet observations for 2002 April - 2002 September

The information in this report is a synopsis of material gleaned from IAU circulars 7881 – 7979 and The Astronomer (2002 April–2002 September). Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course. I have used the convention of designating interesting asteroids by A/Designation (Discoverer) to clearly differentiate them from comets, though this is not the IAU convention.

7P/Pons-Winnecke Although few confirmed observations were received, reports circulating on the internet suggested that the comet entered visual range in April. It was several magnitudes fainter than expected and the majority of observations were made from the Southern Hemisphere.

22P/Kopff Although it continues to brighten, the solar elongation decreases and it is poorly placed when at its brightest (11^m) at the end of the year.

29P/Schwassmann-Wachmann This annual comet has frequent outbursts and over the past few years seems to be more often active than not, though it rarely gets brighter than 12^m. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. It spends 2002 in Capricornus and was at opposition in early August, fairly close to Neptune. Unfortunately opportunities for UK observers are limited, as its altitude will not exceed 20° from this country. The comet has undergone a series of outbursts over the summer.

This comet appears again to be in outburst, as indicated by the following total-magnitude estimates (visual unless otherwise noted): Mar. 20.83 UT, [16: (T. Kojima, Chiyoda, Japan, 0.25-m reflector + CCD); 27.80, 14.4 (Kojima); May 8.46, 13.5 (A. Hale, Cloudcroft, NM, 0.41-m reflector); 9.46, 13.3 (Hale); 21.45, 13.3 (Hale); June 8.39, 12.3 (Hale; near-stellar appearance); 9.75, 12.0 (A. Nakamura, Kuma, Ehime, Japan, 0.60-m reflector + CCD; strong condensation). [IAUC 7918, 2002 June 13]

46P/Wirtanen is a morning object in 2002, fading from its best magnitude of 11. The solar elongation only increases from around 45° to 60° by the end of the year, so it is never very well placed. The first visual observation was reported in early August when the comet was around mag 11.5. Observations reported around the equinox suggest that the comet has experienced an outburst and has brightened to magnitude 9. The comet is in Virgo in November and December.

Observations received prior to the outburst (7) give a preliminary light curve of 8.5 + 5 log d + [15] log r which is quite similar to that of 1997.

57P/du Toit-Neujmin-Delporte is currently too faint for visual observation. It was observed in outburst at the 1996 return and in July 2002, as it approached perihelion, NEAT discovered a secondary component. A further 18 components were discovered by Fernandez et al at the University of Hawaii.

A faint object reported as a possible NEO candidate on July 12.21 by S. Pravdo, Jet Propulsion Laboratory, on behalf of NEAT and described as appearing cometary was recognized at the Minor Planet Center as being on the line of variation and to have the motion of comet 57P, but to be displaced from that brighter comet (which was not included in the dataset) by more than 0.2 deg on the 1.2-m Palomar Schmidt frames. NEAT had reported the brighter comet on July 1 (see MPEC 2002-N14), but a check with Pravdo on July 12 did not reveal anything obvious at the July 1 expected position of the new object. Following a request by the Minor Planet Center, M. Tichy and J. Ticha (Klet, KLENOT 1.06-m reflector) located the new object, describing it as diffuse and having a coma of diameter 8"-10"; as did G. Masi and F. Mallia (Campo Catino, 0.8-m f/8 reflector), whose coaddition of five images (for a total integration of 20 min) showed a well-defined 12" coma and a delicate northeast-southwest elongation. The object was again included in the July 13 NEAT NEO-candidate report but with no remark about its appearance.

The positions are fully consistent with the orbital elements for comet 57P on MPC 45964 (ephemeris on MPC 44939) with T for this "component B" delayed by 0.19 day (i.e., to 2002 July 31.37 TT). It should be noted that comet 57P was anomalously bright at its unfavourable 1996 return (T = 1996 Mar. 5.7; m1 = 13.3 at the first postperihelic observation on July 24.8--see MPC 27482--some 5 mag brighter than expected). [IAUC 7934, 2002 July 13]

Y. R. Fernandez, D. C. Jewitt, and S. S. Sheppard, University of Hawaii, report the detection of an additional 18 components (C-T) of comet 57P (cf. IAUC 7934) in observations taken on July 17.5 and 18.4 UT with the University of Hawaii 2.2-m reflector. R-band magnitudes range from 20.0 to 23.5. The components range from well condensed to diffuse with little central condensation and have comae of diameter 1"-5". Components I, K, L, N, P, and T show a lack of central condensation. The components are delayed with respect to T = 2002 July 31.181 TT for component A by the following times (in days): C, +0.012; D, +0.037; E, +0.053; F, +0.078; G, +0.156; H, +0.164; I, +0.170; J, +0.180; (B, +0.188); K, +0.194; L, +0.194; M, +0.224; N, +0.226; O, +0.240; P, +0.271; Q, +0.309; R, +0.311; S, +0.313; and T, +0.354. [IAUC 7935, 2002 July 20]

Total magnitude estimates for the primary component (visual unless otherwise noted): June 5.71 UT, 15.6: (A. Nakamura, Kuma, Ehime, Japan, 0.60-m reflector + CCD); 9.68, 15.4 (Nakamura); 18.70, 15.7 (K. Kadota, Ageo, Saitama, Japan, 0.18-m reflector + CCD); July 5.27, 13.4 (A. Hale, Cloudcroft, NM, 0.41-m reflector); 10.24, 13.3 (Hale); 10.95, 14.1 (K. Sarneczky, Agasvar, Hungary, 0.38-m reflector); 11.59, 14.5 (Y. Ezaki, Toyonaka, Osaka, Japan, 0.30-m reflector + CCD). [IAUC 7937, 2002 July 24]

Z. Sekanina, Jet Propulsion Laboratory, writes: "Very preliminary analysis of the relative astrometry of the two brightest nuclei (cf. MPEC 2002-O10) has been completed, employing a new computer code recently developed by P. W. Chodas and myself. The parameters of the standard model for split comets are now determined with full account of the planetary perturbations and the nongravitational effects on the principal nucleus. The results suggest that nucleus B could have broken off from primary A near perihelion in 1996. If the event had occurred exactly at perihelion, plausible values for the nongravitational deceleration (4-8x10^-5 solar attraction, as B is obviously a persistent companion; cf. Sekanina 1982, Comets, ed. L. L. Wilkening, pp. 251-287) require that B separated from A with a reasonably low velocity, whose transverse component ranged from 0.5 to 1 m/s in the direction opposite the orbital motion and whose normal component was some 0.4-0.5 m/s toward the north orbital pole. These solutions are independent of the radial component of the separation velocity. Similar solutions are also found for separation times 100 days before and after perihelion, except that the deceleration then correlates with both the transverse and radial components. Because of the comet's extremely low orbital inclination, it is doubtful that the separation parameters can ever be determined with high accuracy. All examined solutions yield essentially the same ephemeris, which shows that the projected separation of B from A will diminish in the coming weeks. The offsets and position angles are as follows (0h UT): 2002 Aug. 4, 853", 259.1 deg; 14, 814", 259.1; 24, 758", 259.0; Sept. 3, 694", 258.7; 13, 631", 258.3; 23, 571", 257.7; Oct. 3, 516", 257.0.

It is unlikely that companions C-T (cf. IAUC 7935) are all products of the same event. In particular, C-F were probably released from A more recently than B was. Some of nuclei M-T may be fragments of B, but a more complex fragmentation hierarchy is also possible. Accurate astrometry on existing images and additional observations may allow one to make more, but not very, definite statements in the future." [IAUC 7946, 2002 August 3]

65P/Gunn was discovered in 1970 after a perturbation by Jupiter in 1965 had reduced the perihelion distance from 3.39 to 2.44 AU. In 1980 two prediscovery images were found on Palomar plates taken in 1954. The comet can be followed all round the orbit as it has a relatively low eccentricity of 0.32. It returns to perihelion in May next year.

The visual and CCD observations received so far (13) give an uncorrected preliminary light curve for the 2002 apparition of 4.8 + 5 log d + [15] log r

67P/Churyumov-Gerasimenko is a morning object in 2002. Again the elongation is not good, increasing from around 50° to 100° at the end of the year. The comet's track closely parallels that of 46P/Wirtanen ending the year on the border of Leo and Virgo. A few observations reported on the internet suggest that it was around 13th magnitude in September.

92P/Sanguin This comet was discovered in 1977, when it reached mag 13.5. The period is 12.4 years, which makes alternate returns unfavourable and in 1989 it only reached 18th mag in large aperture telescopes. Magnitude predictions for the present return, which is similar to the discovery return, were based on the 1989 return and made no allowance for the method of magnitude estimation. To the surprise of some, the comet was an easy object of 13th magnitude in early September. This is actually more or less exactly the brightness expected on the basis of the discovery return.

I observed it with the Northumberland refractor on September 1.88, estimating it at 13.3.

Kracht Group comets

2001 Q8 SOHO (IAUC 7952, 2002 August 10)
2001 R8 SOHO (IAUC 7952, 2002 August 10)
2001 R9 SOHO (IAUC 7952, 2002 August 10)
2001 N2 SOHO (IAUC 7956, 2002 August 19)
2002 Q8 SOHO (IAUC 7963, 2002 August 31)
2002 Q10 SOHO (IAUC 7969, 2002 September 13)
were discovered with the SOHO LASCO coronagraphs and have not been observed elsewhere.

Kreutz group comets

1998 V9 SOHO (IAUC 7916, 2002 June 7)
1998 X12 SOHO (IAUC 7916, 2002 June 7)
1999 W2 SOHO (IAUC 7898, 2002 May 13)
2000 C7 SOHO (IAUC 7919, 2002 June 14)
2000 F2 SOHO (IAUC 7913, 2002 May 30)
2000 F3 SOHO (IAUC 7913, 2002 May 30)
2000 H6 SOHO (IAUC 7899, 2002 May 13)
2000 H7 SOHO (IAUC 7899, 2002 May 13)
2000 T5 SOHO (IAUC 7919, 2002 June 14)
2000 T6 SOHO (IAUC 7919, 2002 June 14)
2001 H8 SOHO (IAUC 7918, 2002 June 13)
2001 J5 SOHO (IAUC 7931, 2002 July 2)
2001 K10 SOHO (IAUC 7931, 2002 July 2)
2001 L11 SOHO (IAUC 7952, 2002 August 10)
2002 G4 SOHO (IAUC 7882, 2002 April 22)
2002 G5 SOHO (IAUC 7882, 2002 April 22)
2002 H1 SOHO (IAUC 7882, 2002 April 22)
2002 H3 SOHO (IAUC 7886, 2002 April 29)
2002 H4 SOHO (IAUC 7886, 2002 April 29)
2002 H5 SOHO (IAUC 7886, 2002 April 29)
2002 H6 SOHO (IAUC 7886, 2002 April 29)
2002 H7 SOHO (IAUC 7948, 2002 August 3)
2002 J1 SOHO (IAUC 7897, 2002 May 9)
2002 J2 SOHO (IAUC 7897, 2002 May 9)
2002 J3 SOHO (IAUC 7899, 2002 May 13)
2002 J6 SOHO (IAUC 7909, 2002 May 28)
2002 J7 SOHO (IAUC 7909, 2002 May 28)
2002 J8 SOHO (IAUC 7913, 2002 May 30)
2002 K3 SOHO (IAUC 7909, 2002 May 28)
2002 K5 SOHO (IAUC 7913, 2002 May 30)
2002 K6 SOHO (IAUC 7913, 2002 May 30)
2002 K7 SOHO (IAUC 7913, 2002 May 30)
2002 K8 SOHO (IAUC 7951, 2002 August 10)
2002 K9 SOHO (IAUC 7951, 2002 August 10)
2002 K10 SOHO (IAUC 7951, 2002 August 10)
2002 L1 SOHO (IAUC 7916, 2002 June 7)
2002 L2 SOHO (IAUC 7916, 2002 June 7)
2002 L3 SOHO (IAUC 7918, 2002 June 13)
2002 L4 SOHO (IAUC 7918, 2002 June 13)
2002 L5 SOHO (IAUC 7919, 2002 June 14)
2002 L6 SOHO (IAUC 7922, 2002 June 17)
2002 L7 SOHO (IAUC 7930, 2002 July 2)
2002 L8 SOHO (IAUC 7930, 2002 July 2)
2002 M1 SOHO (IAUC 7930, 2002 July 2)
2002 M2 SOHO (IAUC 7930, 2002 July 2)
2002 M3 SOHO (IAUC 7935, 2002 July 20)
2002 M4 SOHO (IAUC 7935, 2002 July 20)
2002 M5 SOHO (IAUC 7935, 2002 July 20)
2002 M6 SOHO (IAUC 7935, 2002 July 20)
2002 M7 SOHO (IAUC 7935, 2002 July 20)
2002 M8 SOHO (IAUC 7948, 2002 August 3)
2002 N1 SOHO (IAUC 7936, 2002 July 22)
2002 O1 SOHO (IAUC 7936, 2002 July 22)
2002 O2 SOHO (IAUC 7936, 2002 July 22)
2002 O3 SOHO (IAUC 7936, 2002 July 22)
2002 P2 SOHO (IAUC 7956, 2002 August 19)
2002 Q7 SOHO (IAUC 7963, 2002 August 31)
2002 Q11 SOHO (IAUC 7969, 2002 September 13)
2002 Q12 SOHO (IAUC 7969, 2002 September 13)
2002 Q13 SOHO (IAUC 7969, 2002 September 13)
2002 Q14 SOHO (IAUC 7969, 2002 September 13)
2002 R6 SOHO (IAUC 79xx, 2002 September)
2002 R7 SOHO (IAUC 79xx, 2002 September)
2002 S2 SOHO (IAUC 79xx, 2002 September)
2002 S3 SOHO (IAUC 79xx, 2002 September)
were discovered with the SOHO LASCO coronagraphs and have not been observed elsewhere. They were were not expected to survive perihelion.

One of the brighter objects was 2002 J3, discovered by Kazimieras Cernis on May 13. I independently discovered it at 08:30 on May 14, however this was 18 hours after the discovery had been posted and by then the comet was very obvious. I should have spotted it the previous day as I had looked at the C3 images on Monday evening.

Marsden Group comets

2002 R1 SOHO (IAUC 7969, 2002 September 13)
2002 R4 SOHO (IAUC 79xx, 2002 September)
were discovered with the SOHO LASCO coronagraphs and have not been observed elsewhere.

Meyer Group comets

1997 O2 SOHO (IAUC 7931, 2002 July 2)
1997 U8 SOHO (IAUC 7931, 2002 July 2)
1997 U9 SOHO (IAUC 7931, 2002 July 2)
1998 V8 SOHO (IAUC 7916, 2002 June 7)
1998 W7 SOHO (IAUC 7916, 2002 June 7)
1999 F3 SOHO (IAUC 7898, 2002 May 13)
1999 K16 SOHO (IAUC 7842, 2002 March 5)
1999 L9 SOHO (IAUC 7842, 2002 March 5)
2000 J8 SOHO (IAUC 7899, 2002 May 13)
2000 N4 SOHO (IAUC 7899, 2002 May 13)
2000 X9 SOHO (IAUC 7919, 2002 June 14)
2001 C7 SOHO (IAUC 7936, 2002 July 22)
2001 K11 SOHO (IAUC 7952, 2002 August 10)
2001 L10 SOHO (IAUC 7952, 2002 August 10)
2001 R7 SOHO (IAUC 7952, 2002 August 10)
2001 V6 SOHO (IAUC 7952, 2002 August 10)
2001 X10 SOHO (IAUC 7952, 2002 August 10)
2002 A4 SOHO (IAUC 7875, 2002 April 12
2002 H8 SOHO (IAUC 7951, 2002 August 10)
2002 P3 SOHO (IAUC 7956, 2002 August 19)
2002 R8 SOHO (IAUC 79xx, 2002 September)
were discovered with the SOHO LASCO coronagraphs and have not been observed elsewhere. 2002 P3 was SOHO 500.

Other SOHO comets

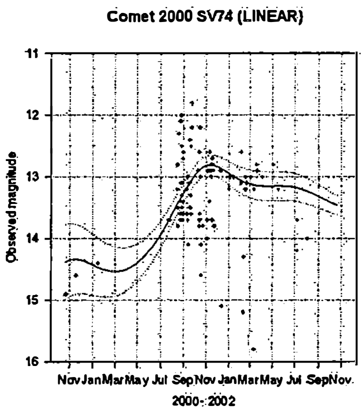
1997 S4 SOHO (IAUC 7931, 2002 July 2)
2001 D1 SOHO (IAUC 7936, 2002 July 22)
2002 Q6 SOHO (IAUC 7963, 2002 August 31)
2002 Q9 SOHO (IAUC 7969, 2002 September 13)
2002 R5 SOHO (IAUC 79xx, 2002 September)
were discovered with the SOHO LASCO coronagraphs and have not been observed elsewhere. C/2002 R5, discovered in C2 imagery on September 5 by Rob Matson, appears to be related to

C/1999 R1, a point first made by R. Kracht. [MPEC 2002-S35, 2002 September 22]

2000 S5 (SOHO) was an unusual SOHO discovery, found in SWAN imagery. Although having a perihelion distance of 0.60 AU, it remained outside the LASCO field of view and was too far south and/or in the twilight for Northern Hemisphere comet hunters. Nevertheless it might be dectable on images taken in November or December 2000. [MPEC 2002-H41, 2002 April 24]

T. Makinen, Finnish Meteorological Institute, Helsinki, reports the discovery of another apparent comet (cf. IAUC 7327) from the second systematic survey of hydrogen Lyman-alpha emission appearing on SWAN images (wavelength range 10-180 nm) taken from the SOHO spacecraft during September-November 2000 (discovery observation below). Makinen notes that all comets brighter than total visual mag approximately 11 can be seen on the SWAN full-sky maps. The stated uncertainty in the reported positions is 0.5 degree due to the resolution of the SWAN instrument.

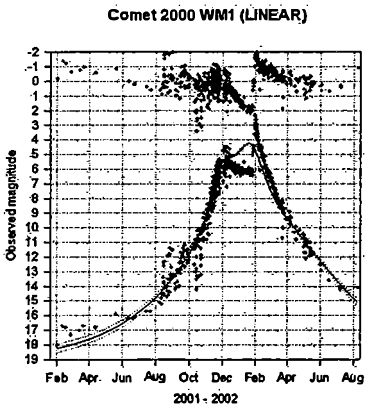
Further positional and orbital information, together with an ephemeris to encourage searches of archival optical images, are given on MPEC 2002-H41. Derived total visual magnitudes from the Lyman-alpha fluxes (using a formula by Jorda et al. 1992, Asteroids, Comets, Meteors 1991, 285): 2000 Sept. 21.77 UT, 10.8; Oct. 1.42, 10.0; 5.23, 9.4; 7.35, 8.4; 10.38, 7.7; 12.45, 7.3; 14.37, 7.5; 17.40, 7.8; 21.38, 7.9; Nov. 4.42, 8.2. [IAUC 7885, 2002 April 25]



2000 SV74 (LINEAR) This distant comet will slowly fade from 13th magnitude. The scatter in observations is largely due to differences between visual and CCD methods.

88 observations received give an uncorrected preliminary light curve of m = 9.0 + 5 log d + 2.1 log r.

2000 WM1 (LINEAR) became visible to UK observers again in April, but it quickly become large and diffuse and few observations were reported.



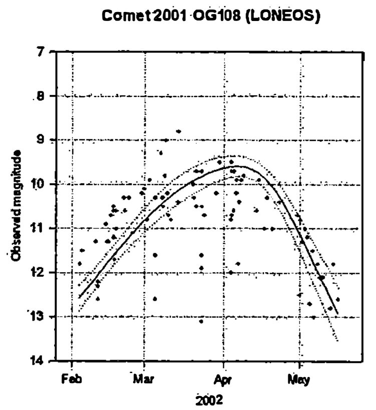
859 visual observations received give an preliminary light curve of m = 6.7 + 5 log d + 9.6 log r which does not take into account the outburst.

2001 HT50 (LINEAR-NEAT) The comet could reach 11th mag or brighter at its two oppositions in 2003. 5 observations give a preliminary light curve of 1.7 + 5 log d + [10] log r

2001 K5 (LINEAR) The comet is distant and will remain at around 14th mag visually for some time. 23 observations give a preliminary light curve of 1.9 + 5 log d + 9.0 log r

2001 OG108 (LONEOS). On March 28.84 I was able to see it in the Thorrowgood refractor, despite strong moonlight and observing through trees, estimating it at 10.2. The comet became quite a diffuse object making it difficult to locate.

82 visual observations give a preliminary uncorrected light curve of 9.3 + 5 log d + 17.2 log r. Moonlight and the rapid rate of brightening would probably have prevented visual observation before early February.



2001 Q4 (NEAT) The comet was discovered when still over 10 AU from the Sun. The latest elements give T as 2004 May 15.9 with q at 0.96 AU. Brian Marsden notes on MPEC 2002-R45 that the "original" and "future" barycentric values of 1/a are +0.000022 and -0.000723 (+/- 0.000022) AU**-1, respectively. [2002 September 11] The "original value of 1/a suggests that this is a new visitor from the Oort cloud.

The comet should be a bright object in May 2004. Adopting a conservative magnitude law (7.5 log r), suggests a peak of around 3rd magnitude, whereas the standard 10 log r gives around 0 magnitude.

2001 RX14 (LINEAR) Brian Marsden notes on MPEC 2002-R45 that the "original" and "future" barycentric values of 1/a are +0.000778 and +0.000259 (+/- 0.000003) AU**-1, respectively. [2002 September 11] The "original value of 1/a suggests that this is not a new visitor from the Oort cloud.

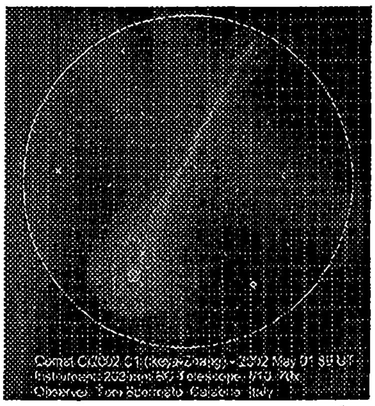
The comet reaches perihelion at 2.06 AU in January 2003 and could reach 10th mag. Visual observers were reporting it at around 13th magnitude in early September 2002.

2002 BV (P/Yeung) = 2001 CB_40 An asteroid reported to the MPC by William Kwong Yeung of Benson, Arizona who was taking CCD images from near Apache Peak with a 0.45-m reflector on January 21.49 was linked to asteroidal observations by Spacewatch and LINEAR, including 2001 CB40. This showed it to have a cometary orbit and Timothy Spahr was able to take images with the 1.2-m telescope on Mt Hopkins which showed it to be a comet. [IAUC

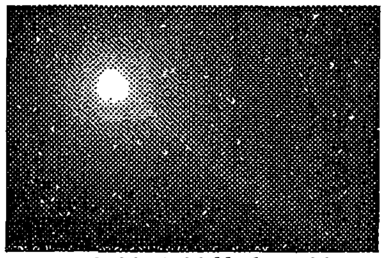
7896, 2002 May 9] The comet has a period of 6.6 years and was at perihelion at 2.24 AU in mid March. It will fade from 17th magnitude. It is a Jupiter family comet.

2002 C1 (Ikeya-Zhang)

H. E. Matthews, National Research Council, Victoria, British Columbia, and Joint Astronomy Centre, Hawaii (JAC); and T. B. Lowe, JAC, report pointed spectral-line observations of comet C/2002 C1 made at the James Clerk Maxwell Telescope, Mauna Kea, in the 1.3-mm and 0.8-mm bands: "The beamwidths to halfpower are about 21" and 13", respectively. We have detected the groundstate rotational transitions HCN 4-3 and 3-2, HNC 4-3 and 3-2 and CS 5-4. Observed integrated intensities (in mainbeam brightness K km/s) were: 3.65 and 0.71 (HCN 3-2, HNC 4-3, Mar. 23.95 UT), 4.10 (HCN 3-2, Mar. 28.82), 0.71 (HNC 3-2, Mar. 29.85), 18.4 (HCN 4-3, Mar. 30.98) and 4.47, 0.62 and 0.74 (HCN 3-2, HNC 3-2, CS 5-4, Apr. 7.93). CO has not been detected in two attempts (CO 3-2, Mar. 23.95 and CO 2-1, Apr. 7.93), the absolute upper limit to the peak signal being 0.1 K. The velocity width (km/s) to halfpower measured using the HCN lines was 2.6 (Mar. 23.93), 2.4 (Mar. 28.82), 2.2 (Mar. 30.98) and 2.2 (Apr. 7.87) and thus appears to show a decrease with increasing r." [IAUC 7876, 2002 April 13]



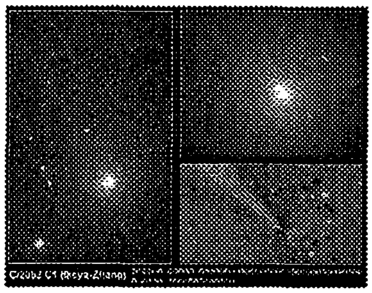
A. Lecacheux, Observatoire de Paris; and N. Biver, European Space Agency, ESTEC, on behalf of the Odin Solar System Topical Team and of the Odin Team, report: "The Odin submillimetric space telescope observed water lines in comet C/2002 C1 with a high spectral resolution (80 m/s) from Apr. 21.9 to 28.3 UT. The H_2O 110-101 line at 556.936 GHz was detected with a peak integrated line intensity of 21.6 K km s**-1 on Apr. 26.8 inside the 2' Odin beam. This corresponds to a preliminary water-production rate of 1.7 x 10**29 molecules/s, taking into account opacity effects. The 110-101 line at 547.676 GHz of the (^18)O isotopic variety of water was also detected. The average of Apr. 23.7-28.1 observations yields an integrated line intensity of 0.24 +/- 0.02 K km s**-1. Within model uncertainties, the inferred H_2^(18)O production rate is consistent with the terrestrial ^(16)O/^(18)O ratio." [IAUC 7910, 2002 May 28]



An image by Martin Mobberley on May 4

G. Cremonese, Istituto Nazionale di Astrofisica (INAF) and Osservatorio Astronomico, Padova; A. Boattini, M. T. Capria, M. C. De Sanctis, and G. D'Abramo, Istituto di Astrofisica Spaziale e Fisica Cosmica, CNR, Rome; and A. Buzzoni, INAF and Telescopio Nazionale Galileo (TNG), report observing the sodium distribution in the coma of comet C/2002 C1 on Apr. 20.17 UT, using the 3.5-m TNG reflector (+ high-resolution spectrograph SARG; resolving power 43000; spatial coverage 26") with a narrow-band filter to isolate the sodium-D lines. Two long-slit spectra (one parallel and the other perpendicular to the sun-comet vector) show cometary sodium emissions clearly visible due to the comet's geocentric velocity of -8.3 km/s. In the first spectrum, the sodium emissions are clearly asymmetric with respect to the slit center, corresponding to the nuclear region, extending to the edge of the slit in the tail direction (about 4000 km). Even in the second spectrum, a slight asymmetry is visible in the sodium emissions with stronger intensity toward the southwest, suggesting the presence of a sodium jet that is most likely related to a dust feature. [IAUC 7914, 2002 June 2]

J. E. Lyke, M. S. Kelley, D. C. Jackson, R. D. Gehrz, and C. E. Woodward, University of Minnesota (UM), report 1- to 12-micron photometry of this comet on May 22.37 UT at the Mt. Lemmon Observing Facility 1.52-m telescope (+ UM bolometer + IRTF narrowband 'silicate' filters). No evidence for strong silicate emission was observed at 11 microns; short-wavelength data were fit to a 5800-K reflected solar blackbody, while the observed spectral energy distribution at longer wavelengths yields a blackbody color temperature of 270 +/- 15 K. Observed magnitudes: [J] = 10.87 +/- 0.02, [H] = 10.42 +/- 0.01, [K] = 10.26 +/- 0.01, [L'] = 8.78 +/- 0.28, [M] = 6.49 +/- 0.29, [N] = 1.98 +/- 0.24, [8.81 microns] = 2.81 +/- 0.34, [10.27 microns] = 1.33 +/- 0.06, [11.70 microns] = 1.18 +/- 0.31, and [12.49 microns] = 0.34 +/- 0.31. [IAUC 7921, 2002 June 17]



An image taken by David Strange on May 1 showing jet structure in the coma.

The link with the comet of 1661 is confirmed, but it seems to have been intrinsically brighter at that return. An explanation is that the comet's intrinsic brightness is variable, and this is clearly seen in the current light curve, which shows a slow brightening over the course of the apparition. Some orbit computers suggest that the comet of 1532 is also associated with this comet and may be the primary component of a fragmentation which occurred over 1000 years ago, so it may be worth searching along the orbital track for further fragments.

A suggestion from Michael Mattiazzo is that the earth passed through the orbital plane of the comet around June 24-25 and this may have contributed to the apparent slow fade in brightness.

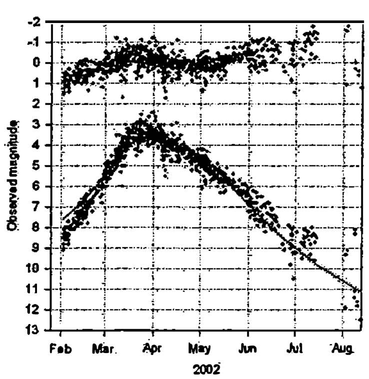
A naked eye observation on May 1.89 put it at around 4.5. An observation with 20x80B on May

22.91 put it at 6.1. An observation with 20x80B on May 31.94 put it at 6.4. Observations with 20x80 Vixen binoculars in Cornwall under very dark skies in mid July put the comet at around 9.5, but very diffuse. The diffuse nature of the comet made it hard to pick out in light polluted regions and few observations were received after mid August.

The comet has been very well observed and it has become the second most observed comet in the Section files, after Hale-Bopp.

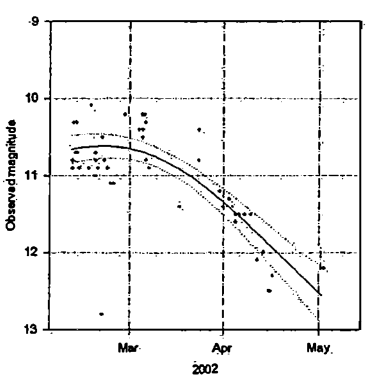
1158 observations give an aperture corrected preliminary light curve of m = 6.1 + 5 log d + 6.7 log r The comet's absolute magnitude has slowly varied by around two magnitudes over the course of the apparition, though interestingly most of the variation took place when the comet was outbound beyond 1 AU.

Comet 2002 C1 (Ikeya-Zhang)



2002 E2 (Snyder-Murakami) Brian Marsden notes on MPEC 2002-L42 [2002 June 10] that the "original" and "future" barycentric values of 1/a are +0.000289 and -0.000180 (+/- 0.000023) AU**-1, respectively. The original value implies that the comet is not a new visitor from the Oort cloud.

Comet 2002 E2 (Snyder-Murakami)

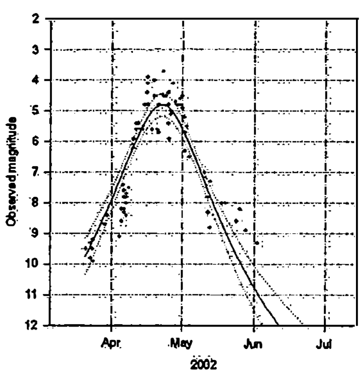


46 observations received give a preliminary light curve of m = 7.1 + 5 log d + 9.8 log r

2002 EJ57 (P/LINEAR) A 19th magnitude object discovered by LINEAR on March 13.20, and noted by the Minor Planet Centre to have an unusual orbit, has been found to be cometary. The object is in a 17 year periodic orbit. Perihelion was in mid December at 2.6 AU and the object will fade. [IAUC 7890, 2002 May 2] Its orbit is affected by both Jupiter and Saturn.

An apparently asteroidal object discovered by LINEAR was given the designation 2002 EJ_57 (observations on MPS 55777-55778). Additional observations of the object were located during routine processing at the Minor Planet Center, and these indicated that the orbit was unusual. The object was then placed on the NEO Confirmation Page, resulting in CCD observations by J. Ticha and M. Tichy at Klet (diffuse with coma diameter about 10" on May 1.8 UT) and by R. H. McNaught at Siding Spring (circular coma with diameter about 7" on May 2.5) showing cometary activity. [IAUC 7890, 2002 May 2]

Comet 2002 F1 (Utsunomiya)



2002 F1 (Utsunomiya) A photograph submitted by Alex Vincent shows the comet at around 3rd magnitude on April 18, significantly brighter than reported by visual observers. I glimpsed the comet in very hazy conditions on April 23.86, estimating it at 4.5, with a 0.4 degree long tail. On May 1.87 I estimated it at 6.3 in my new Vixen 20x80B, surprisingly easy, and with the Pleiades a beautiful sight just below the comet. Antonio Giambersio made it 5.2: on May 1.79 in 16x70B. Alexandre Amorim observed the comet with 20x80B on May 11.90 and estimated it at 8.3 and still very strongly condensed. Jose Aguiar observed it on May 17.89 and estimated it at 8.0 in 20x80B, with a very strongly condensed coma.

73 observations received give a preliminary light curve of m = 8.8 + 5 log d + 13.3 log r

2002 H2 (LINEAR) A rapidly moving object reported by LINEAR has been found to be cometary. It was at perihelion on March 23 at 1.63 AU and faded from around 13th magnitude.

Brian Marsden notes on MPEC 2002-L43 [2002 June 10] that the "original" and "future" barycentric values of 1/a are +0.004146 and +0.003921 (+/- 0.000098) AU**-1, respectively. The original value implies that the comet is not a new visitor from the Oort cloud.

2002 J4 (NEAT) S. Pravdo, E. Helin, and K. Lawrence, Jet Propulsion Laboratory, report the discovery by NEAT, on CCD images taken on May 13.45 UT with the Palomar 1.2-m Schmidt telescope, of a 18th mag comet with nebulosity extending about 5" toward the southwest. Following posting on the NEO Confirmation Page, additional observations obtained elsewhere on May 13.9 confirm the cometary nature: P. Kusnirak at Ondrejov (0.65-m reflector; m_1 = 18.3, faint 7" coma slightly elongated to the southwest); M. Tichy and M. Kocer at Klet (1.06-m KLENOT telescope; compact coma of diameter 16"); and L. Kornos at Modra (0.6-m reflector; m_1 = 16.6, coma diameter about 15"). Additional observations made by LONEOS and LINEAR on May 4, 7, and 8 were then identified by the Minor Planet Center staff. [IAUC 7899, 2002 May 13] The comet will not reach perihelion until October 2003, at 3.6 AU. It could reach 13th magnitude when brightest.

2002 J5 (LINEAR) An apparently asteroidal 18th mag object discovered by LINEAR on May 15.38 has been found to be slightly diffuse with a coma diameter of about 10" on CCD images taken by M. Tichy and M. Kocer with the 1.06-m reflector at Klet on May 16.0 UT. [IAUC 7904, 2002 May 18]

The comet is distant and will reach perihelion at 5.7 AU in September 2003.

Brian Marsden notes on MPEC 2002-L45 [2002 June 10] that the "original" and "future" barycentric values of 1/a are +0.000010 and -0.000036 (+/- 0.000028) AU**-1, respectively, suggesting that this is a "new" comet.

2002 JN16 (P/LINEAR) An apparently asteroidal object of 18th mag reported by LINEAR on May 9.28, designated 2002 JN_16, and having an unusual orbit (e.g., MPEC 2002-J42) has been found by C. A. Trujillo, California Institute of Technology, to be cometary (coma extended 10"-15" from the nuclear condensation in p.a. 270 deg) on images taken on May 17.2 UT as part of a program by M. Brown and himself with the 1.2-m Schmidt telescope at Palomar. At Trujillo's request, J. Tonry obtained images of 2002 JN_16 through clouds with the University of Hawaii 2.2-m reflector at Mauna Kea on May 22.35 that show a similar appearance and m_1 = 17.2. [IAUC 7907, 2002 May 22]

Perihelion is at the end of July at 1.8 AU and the object is in a 6.6 year periodic orbit. It will brighten a little, but is unlikely to exceed 17th mag. It is a Jupiter family comet.

A/2002 JE109 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 May 11.30. It is in a 6.1 year orbit, with perihelion at 1.68 AU and an eccentricity of 0.50. It is close to perihelion and will fade. [MPEC 2002-K11, 2002 May 17] The orbit is typical of a Jupiter family comet, though there have been no recent approaches to Jupiter. The perihelion distance has varied from 1.5 to 1.7 AU over the last few hundred years, but there have been no significant changes to the angular elements.

A/2002 JC68 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 May 7.32. It is in a 5.3 year orbit, with perihelion at 1.39 AU and an eccentricity of 0.54. It reaches perihelion in September and will fade. [MPEC 2002-L27, 2002 June 7] The orbit is typical of a Jupiter family comet, though there have been no recent approaches to Jupiter.

A/2002 JW115 (Spahr) is an asteroid, of 20th magnitude, discovered by Tim Spahr at the Whipple observatory on 2002 May 7.17. It is in a 5.5 year orbit, with perihelion at 1.83 AU and an eccentricity of 0.41. It is approaching perihelion and will remain of similar brightness. [MPEC 2002-K21, 2002 May 20] The orbit is typical of a Jupiter family comet, and the object was 0.6 AU from the planet in 1950.

2002 K1 (NEAT) K. Lawrence, E. Helin, and S. Pravdo, Jet Propulsion Laboratory, report the discovery of a comet with a tail about 8" long toward the southwest (and m_2 = 19.4-19.6) on images taken with the 1.2-m NEAT telescope at Haleakala on May 16.55. Confirming CCD images by E. S. Barker at McDonald Observatory (0.76-m reflector) show a 15" tail toward the southwest. [IAUC 7902, 2002 May 17]
The comet is distant and just past perihelion at 3.2 AU.

2002 K2 (LINEAR) Another apparently asteroidal LINEAR discovery of 18th mag, found on May 16.37, has also been found to be cometary on Klet CCD images that show a compact coma of diameter about 7"-8" on May 16.9 and 18.0 UT. [IAUC 7904, 2002 May 18]
The comet is faint and distant. It will reach perihelion at 5.2 AU and is just past perihelion. It will not brighten significantly

2002 K4 (NEAT) S. Pravdo, E. Helin, and K. Lawrence, Jet Propulsion Laboratory, report the discovery of a 19th mag comet (with nuclear condensation of diameter about 4" and tail extending about 10" to the southwest) on NEAT images taken at Haleakala on May 27.51 UT, with confirming NEAT images taken at Palomar on May 28. [IAUC 7909, 2002 May 28]
It will reach perihelion in July, at 2.8 AU. It is periodic, with a period of around 64 years. It will brighten a little.

A/2002 KK3 (LONEOS) is an asteroid, of 19th magnitude, discovered by LONEOS on 2002 May 18.28. It is in a 5.4 year orbit, with perihelion at 1.08 AU and an eccentricity of 0.65. It is close to perihelion and will remain at a similar brightness. [MPEC 2002-K24, 2002 May 20] The orbit is typical of a Jupiter family comet and the object was 0.7 AU from the planet in 1977. It approached to 0.15 AU of the Earth in 1986.

A/2002 KL6 (NEAT) is an asteroid, of 17th magnitude, discovered by NEAT on 2002 May 27.42. It is in a 4.7 year orbit, with perihelion at 1.04 AU and an eccentricity of 0.63. It is at perihelion in July and will brighten a little. [MPEC 2002-K70, 2002 May 29] The orbit is typical of a Jupiter family comet, though there have been no recent close approaches. The object can approach the earth to within 0.07 AU.

A/2002 KJ8 (NEAT) is an asteroid, of 20th magnitude, discovered by NEAT on 2002 May 18.23. It is in a 6.1 year orbit, with perihelion at 1.37 AU and an eccentricity of 0.59. It is at perihelion at the end of July and will brighten a little. [MPEC 2002-K74, 2002 May 31] The orbit is typical of a Jupiter family comet and it approached to 0.24 AU in 1871.

2002 L9 (NEAT) An object of 18th mag originally reported as asteroidal on NEAT CCD images taken at Palomar on June 13.41 was posted on the NEO Confirmation Page due to its unusual orbit. S. Pravdo later suggested the object was cometary, in particular on July 2 noting a central condensation of diameter 3" surrounded by a spherical nebulosity of diameter about 8". [IAUC 7931, 2002 July 2]
It will reach perihelion in 2004 at 7 AU and will brighten a little when nearer perihelion.

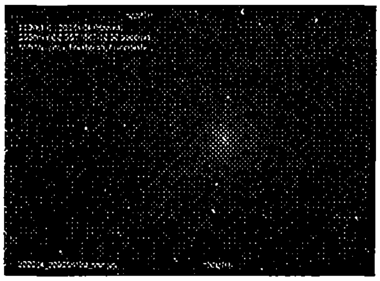
A/2002 LV (LINEAR) is an asteroid, of 18th magnitude, discovered by LINEAR on 2002 June 1.37. It is in a 5.1 year orbit, with perihelion at 0.92 AU and an eccentricity of 0.69. It is at perihelion in late August and will brighten to 15th magnitude. [MPEC 2002-L14, 2002 June 3] The orbit is typical of a Jupiter family comet, though the high inclination (31 degrees) keeps it relatively far from the planet. The more distant encounters are slowly changing the orbital elements and are currently tending to reduce the inclination. It is a potentially hazardous object and can approach to 0.027 AU of the Earth at the descending node. This year it approaches within 0.14 AU on July 29.

A/2002 LJ27 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 June 8.31. It is in a 6.0 year orbit, with perihelion at 1.67 AU and an eccentricity of 0.49. It is close to perihelion and will fade. [MPEC 2002-L62, 2002 June 13, 5-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent approaches.

A/2002 MS3 (NEAT) is an asteroid, of 19th magnitude, discovered by NEAT on 2002 June 30.24. It is in a 7.6 year orbit, with perihelion at 0.92 AU and an eccentricity of 0.76. It is at perihelion in early September and will brighten a little. [MPEC 2002-N05, 2002 July 1] The orbit is typical of a Jupiter family comet, though there have been no recent close approaches to the planet.
Further observations show that it is actually in an Apollo type orbit.

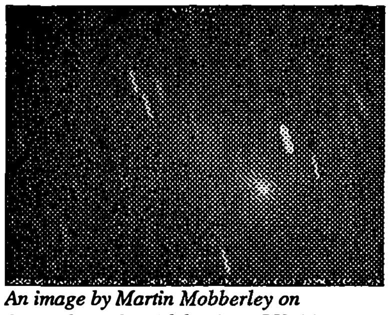
A/2002 MT3 (NEAT) is an asteroid, of 19th magnitude, discovered by NEAT on 2002 June 30.24. It is in a 4.5 year orbit, with perihelion at 0.89 AU and an eccentricity of 0.67. It was at perihelion in late April. It is a potentially hazardous object and can approach within 0.03 AU of the Earth [MPEC 2002-N06, 2002 July 1] The orbit is typical of a Jupiter family comet and it approached within 0.4 AU in 1928.

2002 O4 (Hoenig) The discovery of this was announced during the ACM meeting, which was particularly appropriate, as the discoverer is German. This was the first comet to be discovered from Germany since 1946 and it was an accident! Sebastian Hoenig is a keen amateur astronomer and after a long period of cloudy weather a clear spell drew him out to a dark sky location. Whilst scanning for globular clusters in the Andromeda region with his 25-cm LX200, an unexpected fuzz caught his eye. He knew that there wasn't supposed to be anything in the area, but hadn't come prepared for any serious observing. He took the approximate RA and Dec from his roughly set-up GoTo system and wrote the co-ordinates along with a rough sketch on the label of an empty water bottle. He reported the details to the CBAT, but it wasn't until five days later that he finally received confirmation of his find. In addition to this comet, Sebastian has discovered around a two dozen comets on SOHO LASCO images, but these all bear the name SOHO.



An image by Cliff Meredith on August 19

On July 22, a report of an apparent visual comet discovery of a 12th mag comet on July 22.00 was received from Sebastian Hoenig, Dossenhiem, Germany. The object clearly showed motion to the north. Due to poor initial positions and bright moon, attempts to recover the object visually by A. Hale (Cloudcroft, NM) and Hoenig were unsuccessful. On July 27, S. Nakano (Sumoto, Japan) reported that K. Kadota (Ageo, Saitama, Japan), following a request by A. Nakamura (Kuma, Ehime, Japan), successfully imaged a comet while searching for the object reported on July 22. Additional observations were received after the comet was posted on the NEO Confirmation Page. [IAUC 7939, 2002 July 27]

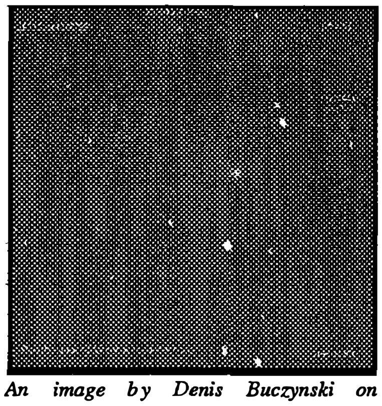


An image by Martin Mobberley on September 3.87 with his 0.3m LX200.

Sitko, Lynch, Russell, Hammel and Polomski report similar spectroscopy of comet C/2002 O4 on Aug. 1.54 UT: "The infrared flux peaked near 10 microns, suggesting a temperature of around 280 +/- 20 K (equilibrium blackbody temperature = 243 K). There was a silicate-emission feature between about 8.5 and 11.5 microns extending about 20 percent above the continuum. Narrow-band [M] and [N] magnitudes were 9.7 and 4.4, respectively, both +/- 0.1." [IAUC 7950, 2002 August 8]

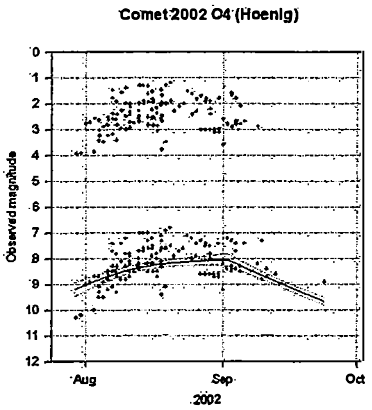
The latest orbit on MPEC 2002-R48 has a note from Brian Marsden that 'the "original" and "future" barycentric values of 1/a are -0.000694 and -0.000230 (+/- 0.000054) AU**-1, respectively.'[2002 September 11] It is somewhat unusual for a comet to have a negative "original" value for 1/a and this is one of the largest on record. It is possible that 'non gravitational' effects should be applied to the comet's orbit.

After my return from the ACM meeting in Berlin (where I met up with Sebastian and Maik Meyer) I was able to observe the comet on August 4.9. I estimated it at 9.5 in the Thorrowgood refractor x40, with a 3' coma and DC3. The early observations suggested that the comet was brightening quite rapidly as several reports on August 6 put the comet as bright as 8th magnitude. A photograph taken on August 8.83 by Toni Scarmato shows a green coma, characteristic of Swan band emissions. I observed it with 20x80 binoculars on August 10.91 and made it 7.8.



An image by Denis Buczynski on September 10

The comet's brightness then stalled and it did not significantly brighten any further. A suggestion from Michael Mattiazzo is that the earth passed through the orbital plane of the comet around August 13-14 and this may have given the apparent rapid rise in brightness. Observations up to the equinox suggested that the comet was fading slightly. Further observations reported on the internet towards the end of the month suggest a more dramatic fade and it seems unlikely that it will survive perihelion, unless it experiences an outburst comparable to 2000 WM1.

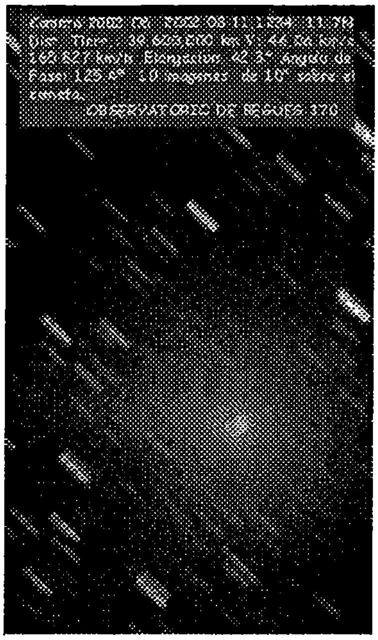


130 observations give a preliminary light curve of m = 8.4 + 5 log d + 5.4 log r Alternatively a slightly better fit is given by a linear type of light curve, peaking some 30 days before perihelion.

2002 O5 (P/NEAT) S. Pravdo and K. Lawrence, Jet Propulsion Laboratory, report the discovery of a 16th mag comet (with nuclear condensation of diameter about 6" and tail extending 12" to the southwest) on NEAT images taken at Haleakala on July 30.25 UT. After the object was placed on the NEO Confirmation Page, confirmation of cometary activity was reported by: R. Fredrick, K. Smalley, and R. Trentman, Louisburg, Kansas, with a 0.75-m reflector (tail 40" long in p.a. 130 deg); P. M. Kilmartin, Mt John Observatory, New Zealand, with a 0.6-m reflector (short tail in about p.a. 130 deg); and R. H. McNaught and G. J. Garradd, Siding Springs Observatory, Australia, with a 1.0-m reflector (tail 13" long in p.a. 125 deg). [IAUC 7942, 2002 July 31].

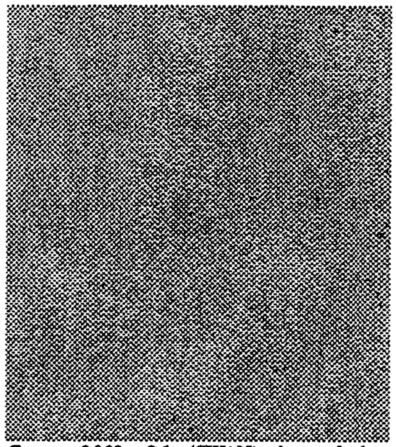
The preliminary orbit suggests that it is in a short period orbit with P around 5 years and is near perihelion. It is intrinsically very faint (H0=19) and will fade. The orbital period is the third shortest of current P/ comets. At a favourable return it can pass 0.2 AU from the Earth.

2002 O6 (SWAN) This interesting comet was discovered by Masayuki Suzuki using real-time SOHO-SWAN data and is the first SWAN discovery to be observed from the ground. The first orbit showed that the comet was passing close to the earth and would brighten. It had perihelion at 0.5 AU in early September.



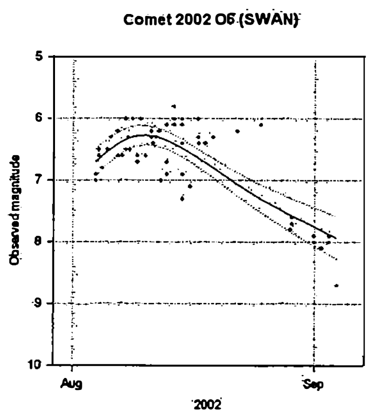
Akimasa Nakamura provides the following discovery report:
Masayuki Suzuki posted the discovery circumstances of C/2002 O6 to the comet-obs mailing list (in Japanese). According to that, although he is a frequent visitor to the SWAN webpage (and has checked images time to time since this spring), his discovery of O6 was accidental.
Inspired by Sebastian's discovery, he downloaded SWAN images taken on 25th and 27th of July, to see whether he could find C/2002 O4 or not. He found TWO moving objects: dimmer one was C/2002 O4, and the brighter one looked like C/2001 Q4 (NEAT). But, he noted the latter should have been much fainter because Q4 was around 16 mag.... it might be a new comet! He considered a possibility to observe it by himself on the night of his discovery (July 31th), but gave up due to bad weather and its position (way out of his observable sky). So, he sent his discovery report to the CBAT without confirmation. (He is an astrometrist at code 347, BTW.)
He also noted the comet was visible on the images taken on 13, 16, 18, 20th as well (faint, though), and later measured their positions and sent them to the CBAT in response to the request by Carl Hergenrother.

M. Suzuki, Utsunomiya, Tochigi, Japan, reports the discovery of a comet on publicly accessible images taken with the SWAN instrument on the SOHO spacecraft on July 25 and 27 UT. Prediscovery images were found on images taken as early as July 13. Visual confirmation has been reported by A. Hale, Cloudcroft, New Mexico, with a 0.20-m reflector (coma diameter 4'; magnitude measurement hampered by twilight, moon and clouds). CCD frames taken by J. Broughton, Reedy Creek, Australia, with a 0.25-m reflector also confirm the object's cometary nature. [IAUC 7944, 2002 August 1]



Comet 2002 O6 (SWAN) imaged by Michael Jager on September 13.125. The image is a composite of 6.5 and 5.5 min exposures on a 250/450 mm Schmidt camera using hypered TP2415. The faint cigar shaped coma is typical of a disintegrating comet.

Observations in early August showed that it was slowly brightening and it reached around mag 6. I observed it after a long meteor watch on August 12/13 and found it an easy object in 20x80B. Reports by Bjorn Granslo at the end of August show that it has faded significantly to around 7.5. Observations by myself in early September suggest that the fade is continuing, with the comet at mag 8



56 observations give a preliminary light curve of m = 9.2 + 5 log d + 4.1 log r

2002 O7 (LINEAR) An apparently asteroidal, 20th mag, object reported by LINEAR on July 29.17 UT has been found to be cometary by A. Boattini on CCD images taken with the 0.60-m Schmidt at Campo Imperatore on Aug. 2.9 and by J. Ticha and M. Tichy with the 0.57-m telescope at Klet on Aug. 4.9 (comet slightly diffuse with a coma of diameter 8"). [IAUC 7949, 2002 August 5]

The comet does not reach perihelion until September 2003, when it may reach 6th magnitude. At its brightest it will be a southern hemisphere object, but should be visible as a telescopic object from 2003 March to 2004 January. [MPEC 2002-P13, 2002 August 5]

2002 O8 (P/NEAT) K. Lawrence, Jet Propulsion Laboratory, reports the discovery of a 17th mag comet (with nuclear condensation of diameter about 6" and a tail extending about 10" to the west) on NEAT images obtained on July 29.32 UT (discovery observation appears below). Confirmation of cometary activity was reported by A. C. Gilmore and P. M. Kilmartin on CCD images taken with the 0.6-m reflector at Mt John University Observatory on Aug. 4.4 (faint tail 40" in p.a. 255 deg). Prediscovery observations have been identified in NEAT data from July 16.5, LINEAR data from July 5.4 and Spacewatch data from 2001 May 22.3 and June 11.2. [IAUC 7949, 2002 August 5]

It is in a periodic orbit of 8 years and perihelion at 3.2 AU and is a Jupiter family comet. It will fade.

2002 P1 (NEAT) S. Pravdo, K. Lawrence and E. Helin, Jet Propulsion Laboratory, report the NEAT team's discovery with the 1.2-m Schmidt telescope at Palomar of a 19th mag comet with a 7" tail in p.a. 235 deg on August 7.39. Confirmation of the object's diffuse appearance has been provided by G. Hug, Farpoint Observatory. [IAUC 7950, 2002 August 8]

The preliminary orbit suggests that it is a distant object past perihelion and will fade.

A/2002 PD43 (NEAT) is an asteroid, of 17th magnitude, discovered by NEAT at Paolomar on 2002 August 7.45. Prediscovery images were taken only hours earlier by W Yeung. It is in a 4.2 year orbit, with perihelion at 0.11 AU and aphelion at 5.07 AU and is classied as an Apollo type asteroid. It is a potentially hazardous object and can approach within 0.035 AU of the Earth. It was at perihelion in mid June. [MPEC 2002-P51, 2002 August 12]

2002 Q1 (P/Van Ness) Michael Van Ness of the LONEOS team discovered a 16th magnitude comet on 2002 August 17.44. It is periodic with a period of around 6.6 years and is past perihelion. It will fade.

2002 Q2 (LINEAR) and 2002 Q3 (LINEAR) LINEAR has found a pair of comets, moving on parallel tracks in the same field. The brighter (Q2) is about 17th mag and Q3 is a couple of mags fainter. The preliminary orbit suggests that they are just past perihelion in a high inclination orbit. BAA observer Stephen Laurie was able to provide confirming astrometry within 24 hours of the discovery. Maik Meyer points out that the preliminary elements are similar to those of 1994 N1 (Nakamura-Nishimura-Machholz). Some recent observations are putting Q2 at around 13th magnitude.

2002 Q4 (154P/Brewington) has been recovered at 17th mag by F. Artigue, H. Cucurullo, and G. Trancredi at the Observatorio Astronomico Los Molinos, Montevideo. The correction to the prediction on MPC 40670 is Delta(T) = +0.52 day.

The comet is making its first return in 2003 since its discovery in 1992. It was discovered by Howard J Brewington of Cloudcroft, New Mexico, as a small diffuse 10m object on August 28.41 using a 0.40-m reflector x55. This was his fourth discovery and his second periodic one. The comet is in a Jupiter crossing orbit, but has not approached the planet for several revolutions. At a favourable return it could reach 7m.

We may pick it up in November as it brightens to 10th magnitude and we will be able to follow it into the New Year as it continues to move north. It is an evening object, but its solar elongation decreases from 80° in November to 50° at the end of the year. It will not reach perihelion until 2003. By October it is moving north-eastwards in Capricornus and ends the year in Aquarius.

2002 Q5 (LINEAR) LINEAR has discovered another comet. It reaches perihelion in November, but unfortunately it is on the opposite side of the Sun to the Earth at the time and will not get brighter than 15th magnitude.

2002 R2 (155P/Shoemaker) (1986 A1) has been recovered by T Oribe and A Nakamura at 18th mag. The correction to the prediction on MPC 34423 is Delta(T) = -0.14 day. It is making its first return since discovery. It will be quite faint, around 14-13th magnitude in November and does not get much brighter by the time it reaches opposition in February 2003. It moves eastwards from Cancer into Leo at the end of the year.

2002 R3 (LONEOS) is a distant comet that will reach perihelion next year, however it will not brighten much from its present 17th magnitude.

A/2002 RC118 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 September 6.34. It is in a 5.2 year orbit, with perihelion at 1.28 AU and an eccentricity of 0.57. It is at perihelion in mid November and will brighten to 17th mag. [MPEC 2002-R40, 2002 September 8, 3-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent approaches.

A/2002 RP120 (LONEOS) is an asteroid, of 17th magnitude, discovered by LONEOS at Lowell Observatory on 2002 September 4.41. The orbit is retrograde, with a period of around 300 years and perihelion distance at 2.47 AU, with aphelion over 90 AU from the Sun. It reaches perihelion in early October, when it may brighten to 16th mag. [MPEC 2002-R43, 2002 September 10, 6-day orbit] The orbit is more typical of a long period comet, though so far there is no sign of cometary activity.

A/2002 RA126 (NEAT) is an asteroid, of 20th magnitude, discovered by NEAT at Palomar on 2002 September 11.14. It is in a 5.2 year orbit, with perihelion at 1.04 AU and an eccentricity of 0.65. It is past perihelion and will fade. [MPEC 2002-R61, 2002 September 12, 2-day orbit] The orbit is typical of a Jupiter family comet and can approach both Jupiter and the Earth.

2002 S1 (P/Skiff) was found by Brian Skiff during the course of LONEOS survey work. The 18th magnitude comet is past perihelion. It is in a periodic orbit of around 8.3 years, and will remain at its present brightness until the end of the year.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

2002 EDGAR WILSON AWARDS

The Smithsonian Astrophysical Observatory (SAO), part of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, has announced the recipients of the 2002 Edgar Wilson Award for the discovery of comets by amateurs during the calendar year ending June 10. The award was set aside as part of the will bequeathed by the late businessman Edgar Wilson of Lexington, Kentucky, and administered by the SAO. The following seven discoverers will receive plaques and a cash award:

Vance Avery Petriew of Regina, Saskatchewan, Canada, for his visual discovery of comet P/2001 Q2 on 2001 August 18.
Kaoru Ikeya of Mori, Shuchi, Shizuoka, Japan, and **Daqing Zhang**, Kaifeng, Henan province, China, for their independent visual discoveries of comet C/2002 C1 on 2002 February 1.
Douglas Snyder of Palominas, Arizona, and **Shigeki Murakami** of Matsunoyama, Niigata, Japan, for their independent visual discoveries of comet C/2002 E2 on 2002 March 11.
Syogo Utsunomiya of Minami-Oguni, Aso, Kumamoto, Japan, for his visual discovery of comet C/2002 F1 on 2002 March 18.
William Kwong Yu Yeung of Benson, Arizona for his charge-coupled-device (CCD) electronic-camera discovery of comet P/2002 BV.

Observers Ikeya and Utsunomiya have had their names attached to comets previously. Comet C/2002 F1 was Utsunomiya's third named comet; he also won the Edgar Wilson Award in 2001 for C/2000 W1 (Utsunomiya-Jones). Ikeya became world-famous in the 1960s for a string of five comet discoveries between 1963 and 1967, with comet C/1965 S1 (Ikeya-Seki) becoming the brightest comet of the last century -- visible in broad daylight to the unaided eye as it skimmed closely by the sun's surface in October 1965.

The six visual discoveries of this past year involved four different comets and represent the most new comets discovered by visual observers since 1994. Automated CCD searches with large professional telescopes have dominated comet discovery since 1998. Utsunomiya's discovery was made with large 25x150 binoculars. The other discoveries were all made with moderate-sized reflecting telescopes having mirrors with diameters ranging from 25 to 50 cm.

Yeung's discovery image was obtained on 2002 January 21, but he reported the object initially as stellar in appearance and it was given a minor-planet (rather than cometary) designation; CCD images taken by Timothy Spahr at the SAO station on Mount Hopkins in Arizona in early May showed that P/2002 BV was indeed cometary with a faint tail, and Yeung's object was announced as a comet on May 9 (IAU Circular 7896).

The brightest comet of the bunch, C/2002 C1 (Ikeya-Zhang), became a faint naked-eye object in March and April for northern-hemisphere observers. It is of special interest because it is the first return of this comet to the inner solar system in 341 years, since it was last observed in 1661. Carefully made observations in February and March 1661 by the Polish astronomer Johannes Hevelius have allowed astronomers to confirm that the two apparitions belong to the same comet, though for centuries it was speculated erroneously that the 1661 comet might be identical with a comet seen in 1532. Comet 2002 C1 is now the comet with the longest orbital period that has been definitely seen at two or more returns to perihelion (closest approach to the sun).

In 2001, there were only two recipients of the Award, for their independent visual discoveries of a single comet (Albert Jones of New Zealand and Syogo Utsunomiya). Of the 20 Award recipients in the first four years, twelve have been for visual discoveries, seven for discoveries from CCD images, and one for a discovery from a photograph. The countries with the most recipients so far are the United States (5), Japan (4), and Australia (4). In years when there are no eligible comet discoverers, the Award will be made instead to amateur astronomers judged by the Central Bureau for Astronomical Telegrams (CBAT) to have made important contributions toward observing comets or promoting an interest in the study of comets.

David A. Aguilar & Christine Lafon, Public Affairs, Harvard-Smithsonian Center for Astrophysics

Comet Prospects for 2003

2003 sees the return of 16 periodic comets. The brightest of the year is predicted to be 2P/Encke, which is making its 59th predicted return at the end of the year and may reach 6th magnitude. 2001 Q4 (NEAT) reaches perihelion in 2004 and may reach binocular visibility at the end of the year. Several other long-period comets discovered in previous years are still visible.

Theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. This would make a useful project for CCD observers. As an example 51P/Harrington was observed to fragment in 2001. Ephemerides for new and currently observable comets are published in the *Circulars*, Comet Section Newsletters and on the Section, CBAT and Seiichi Yoshida's web pages. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook; details of subscription to the ICQ are available from the comet section Director. The section booklet on comet observing is available from the BAA office or the Director.

This year sees comet **2P/Encke's** 59th observed return to perihelion since its discovery by Mechain in 1786. The orbit is quite stable, and with a period of 3.3 years apparitions repeat on a 10-year cycle. This year the comet is well seen from the Northern Hemisphere prior to perihelion, which is in late December. The comet tracks through Andromeda during October and early November, then accelerates southwards through Cygnus and begins December in Ophiuchus. The comet might be observable from October until early December, when it could be 6^{th} magnitude. This magnitude may however be optimistic as observations from the SOHO spacecraft in 2000 showed that it suddenly brightened after perihelion, by which time it will be at a poor elongation. A possible explanation of this behaviour is that Encke has two active regions, an old one with declining activity, which operates prior to perihelion and a recently activated one present after perihelion. There is, however, little evidence for a secular fading in the archive of BAA observations of the comet. The comet is the progenitor of the Taurid meteor complex and may be associated with several Apollo asteroids.

22P/Kopff reached perihelion at the end of 2002 and although it is near its brightest, the solar elongation is poor and it is unlikely to be seen this year.

29P/Schwassmann-Wachmann is an annual comet that has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. It begins the year in Capricornus, but spends most of the year in Aquarius, reaching opposition at the beginning of September. The comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. UK based observers should be able to follow it throughout the second half of the year.

30P/Reinmuth was at perihelion last year, and is a little brighter at the start of this year, although only 14^{th} magnitude. Best seen in the morning sky, it reaches opposition in March, but by then is fading quite rapidly. The comet was discovered during the course of a regular photographic asteroid survey by Karl Reinmuth at Heidelberg Observatory on a photograph exposed on 1928 February 22.96. If the comet gets as bright as predicted this could be the best return since the comet's discovery.

43P/Wolf-Harrington does not reach perihelion until 2004, but it gets to 14^{th} magnitude in September and should be 13^{th} magnitude at the end of the year. It is favourably placed in the evening sky and CCD observers should certainly have a go at following the comet. This will be its tenth observed return, which was discovered in 1924, then lost until 1951. The comet is in a chaotic orbit, and made a close approach to Jupiter in 1936 which reduced its perihelion distance from 2.4 to 1.6 AU. It made an exceptionally close (0.003 AU) approach to Jupiter in 1841, which switched its previous perihelion distance into the new aphelion distance.

53P/Van Biesbroeck is an interesting object. George van Biesbroeck discovered it at Yerkes observatory in September 1954. Stan Milbourn and George Lea calculated the best recovery orbit and the comet was duly recovered in May 1965. Back calculating the orbit shows that it made a moderately close approach to Jupiter in 1850, which reduced q from 2.7 to 2.4 AU and reversed the nodes. The pre 1850 orbit is very similar to that of 42P/Neujmin 3 and it is likely that they are fragments of the same parent. The comet has a relatively favourable return and just reaches 14^{th} magnitude, however it lies south of the equator and will be difficult to observe from the UK.

65P/Gunn was discovered in 1970 after a perturbation by Jupiter in 1965 had reduced the perihelion distance from 3.39 to 2.44 AU. In 1980 two pre-discovery images were found on Palomar plates taken in 1954. The comet can be followed all round the orbit as it has a relatively low eccentricity of 0.32. At the last return in 1996 it reached 13^{th} magnitude and it will do a little better this time, as it is at opposition when at perihelion. It will be at moderate southern declination throughout the apparition and is essentially unobservable from the UK.

66P/du Toit has only been observed at alternate returns and its last return in 1988 was about the worst possible. It was discovered by Daniel du Toit at the Boyden Observatory in South Africa on 1944 May 16. The discovery return was a good one, with the comet approaching to within 0.5 AU of the Earth, and the comet reached 10^{th} magnitude. It was not found at the 1959 return, nor was it initially found in 1974, however in January 1975 a further inspection of search plates taken ten months previously revealed a diffuse image of the comet. This return is moderately favourable, and the comet could reach 13^{th} magnitude, however, as at the discovery return, it will essentially be a Southern Hemisphere object.

81P/Wild is a new comet that made a very close (0.006 AU) approach to Jupiter in September 1974. Prior to this it was in a 40-year orbit that had perihelion at 5 AU and aphelion at 25 AU. The comet was discovered by Paul Wild with the 40/60-cm Schmidt at Zimmerwald on 1978 January 6. The Stardust spacecraft is due to visit the comet in 2004 and recover material for return to earth in 2006. The comet reaches perihelion in September, but unfortunately the elongation is very poor and the comet will be difficult to observe at this return.

95P/Chiron is an unusual comet in that it is also asteroid 2060. It reaches 17^m when at opposition in July in Sagittarius. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically. It was at perihelion in 1996 when it was 8.5 AU from the Sun and will be nearly 19 AU from the Sun at aphelion in around 50 years time.

116P/Wild was discovered on 1990 January 21.98 by Paul Wild with the 0.40-m Schmidt at the Zimmerwald station of the Berne Astronomical Institute at a photographic magnitude of 13.5. At its brightest the comet only reached 12^m, but it was surprisingly well observed. The comet was perturbed into its present orbit after a close approach to Jupiter in mid 1987. The comet is at perihelion in January, but is poorly placed for viewing from the UK. It brightens from 13^{th} magnitude at the beginning of the year to 12^{th} magnitude in April as it nears opposition but is a long way south. It remains brighter than 13^{th} magnitude until July.

123P/West-Hartley was discovered by Richard West on an ESO survey plate taken on March 14 and independently by Malcolm Hartley on a UK Schmidt plate taken on May 28. The comet has made no recent close approaches to Jupiter. It reached between 13^{th} and 14^{th} magnitude at the last return in 1996. It should achieve a similar brightness this time round, but is at its brightest early in the New Year after its December perihelion.

154P/Brewington makes its first return since its discovery in 1992. It was discovered by Howard J Brewington of Cloudcroft, New Mexico, as a small diffuse 10^m object on August 28.41 using a 0.40-m reflector x55. This was his fourth discovery and his second periodic one. The comet is in a Jupiter crossing orbit, but has not approached the planet for several revolutions. At a favourable return it could reach 7^m, but this return is not particularly favourable. It is an evening object, of around 10 - 11^{th} magnitude, but its solar elongation decreases from 50° at the beginning of the year and we will loose it in the March twilight.

Comets reaching perihelion in 2003

Comet	T	q	P	N	H1	K1
2001 RX14 (LINEAR)	Jan 18.8	2.06			6.5	10.0
116P/Wild	Jan 21.6	2.17	6.48	2	1.2	25.3
79P/du Toit-Hartley	Feb 15.3	1.23	5.27	3	14.0	15.0
154P/Brewington	Feb 19.4	1.59	10.66	1	8.5	13.5
P/Tritton	Mar 6.0	1.43	6.32	1	12.5	10.0
2001 YX127 (P/LINEAR)	Mar 6.9	3.42	8.54		12.5	10.0
65P/Gunn	May 11.9	2.45	6.80	6	5.0	15.0
25D/Neujmin	May 26.4	1.27	5.38	2	10.5	10.0
127P/Holt-Olmstead	Jun 12.5	2.16	6.34	2	14.0	10.0
2002 R3 (LONEOS)	Jun 14.9	3.86			8.5	10.0
36P/Whipple	Jul 6.7	3.09	8.51	10	8.5	15.0
2001 HT50 (LINEAR-NEAT)	Jul 8.8	2.80			4.5	10.0
118P/Shoemaker-Levy	Jul 16.8	2.01	6.49	2	8.7	10.0
100P/Hartely	Aug 18.0	1.98	6.29	3	8.9	15.0
66P/du Toit	Aug 28.2	1.27	14.70	2	12.0	9.5
94P/Russell	Aug 29.2	2.23	6.58	3	9.0	15.0
2002 J5 (LINEAR)	Sep 19.3	5.73			11.0	5.0
2002 O7 (LINEAR)	Sep 20.3	0.89			6.5	10.0
81P/Wild	Sep 25.9	1.59	6.40	4	6.9	11.4
2002 J4 (NEAT)	Oct 3.2	3.63			5.5	10.0
53P/Van Biesbroeck	Oct 9.4	2.42	12.52	4	8.0	15.0
123P/West-Hartley	Dec 9.1	2.13	7.58	2	11.5	10.0
2P/Encke	Dec 29.9	0.34	3.30	58	11.0	15.0

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N) and the magnitude parameters H1 and K1 are given for each comet.

Note: $m_1 = H1 + 5.0 * \log(d) + K1 * \log(r)$

155P/Shoemaker reaches perihelion in 2002 December, and is making its first return since discovery. It will be quite faint, around 14-13^{th} magnitude when it is at opposition in February. It moves northwards in the sickle of Leo.

Several recently discovered parabolic comets will be visible during 2003. 2001 HT50 (LINEAR) will be a morning object of around 12th magnitude at the start of the year, but it quickly moves towards opposition. It brightens a little, but becomes poorly placed for observation after April. It reaches perihelion whilst in solar conjunction, but re-emerges towards the end of August at around 11th magnitude. The earth continues to approach it until October, when it is fractionally brighter, and it then fades slowly to the end of the year. 2001 Q4 (NEAT) doesn't reach perihelion until 2004, but will be brightening into visual range at the end of 2003. It is however a Southern Hemisphere object and UK observers will have to wait until it heads north in 2004. 2001 RX14 (LINEAR) will be around 10th magnitude at the start of the year. It is a fraction brighter in February, just after perihelion, and only fades slowly, so we will be able to follow it until it sinks into the twilight in June. Initially it is well placed on the borders of Ursa Major and Canes Venatici, then tracks southwards passing through Leo in April and May. 2002 O7 (LINEAR) should come within reach of visual observers in March and UK observers will be able to follow it until mid year. It continues brightening, but is best placed for Southern Hemisphere observers. Brightest after its September perihelion, it should still be an easy binocular object when it passes within a few degrees of the South Pole in November.

Several other comets are at perihelion during 2003, however they are unlikely to become bright enough to observe visually or are poorly placed. 94P/Russell, 100P/Hartley, 118P/Shoemaker-Levy and 127P/Holt-Olmstead have unfavourable returns 2002 J4 (NEAT) is unfavourably placed for viewing from the UK, whilst 36P/Whipple, 79P/du Toit-Hartley, 2001 YX127 (LINEAR), 2002 J5 (LINEAR) and 2002 R3 (LONEOS) are intrinsically faint or distant comets. Ephemerides for these can be found on the CBAT WWW pages. 25D/Neujmin has not been seen since 1926 and P/Tritton has not been seen since 1978.

Looking ahead to 2004, the highlight will almost certainly be 2001 Q4, which may become brighter than 3rd magnitude at perihelion. Several periodic comets have favourable returns, but they will all be telescopic objects.

References and sources

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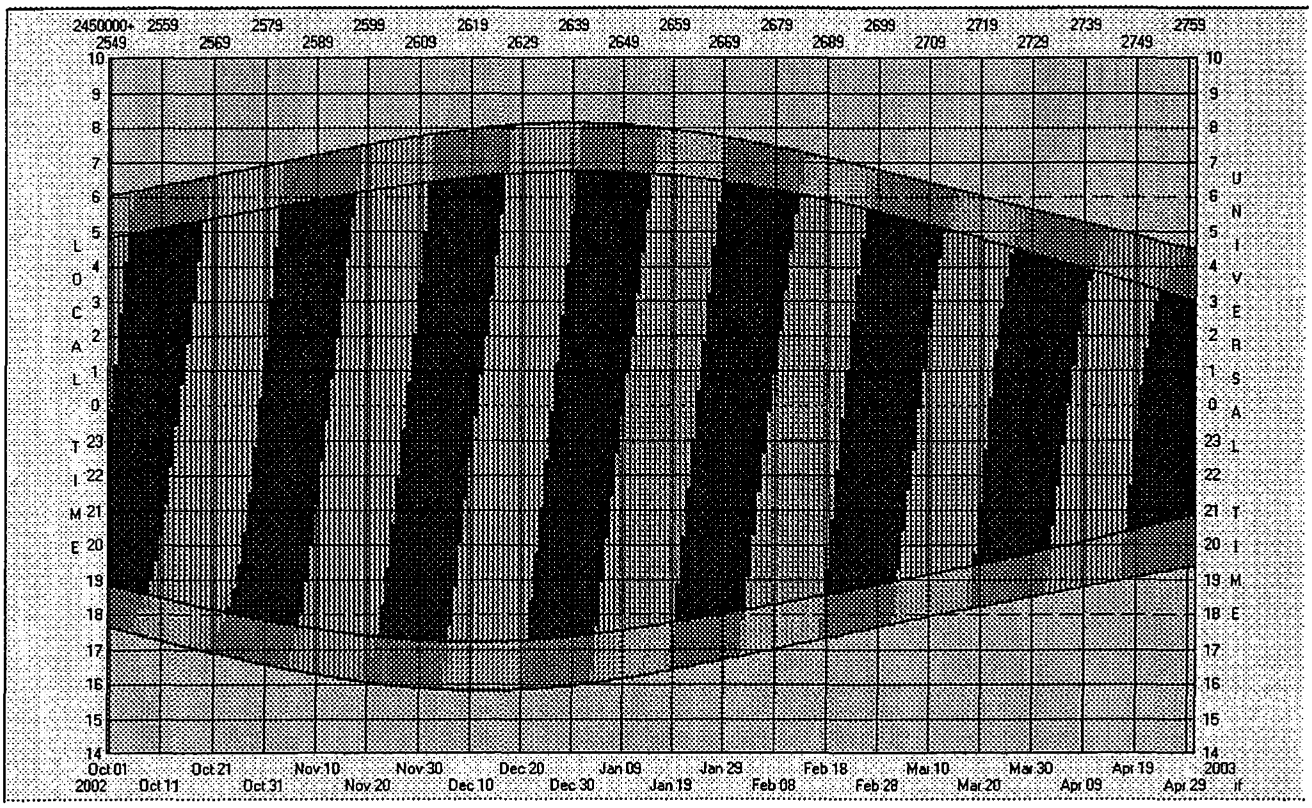
Jonathan Shanklin

The Comet's Tale is produced by Jonathan Shanklin, with thanks to the British Antarctic Survey and the Institute of Astronomy, Cambridge for the use of computing facilities. E&OE.

Lunar interference plot for the next six months, produced using GraphDark 2 by Richard Fleet.



Introduction

This issue has ephemerides, for the UK or Southern Hemisphere, for the comets that are likely to be brighter than 12th magnitude:

- 155P/Brewington
- 2001 HT50 (LINEAR-NEAT)
- 2001 RX14 (LINEAR)
- 2002 O4 (Hoenig)
- 2002 O7 (LINEAR)

The actual magnitudes may differ from those given here by several magnitudes. Several other comets, including 22P/Kopff, 46P/Wirtanen, 67P/Churymov-Gerasimenko, 2000 SV74 (LINEAR) and 2001 N2 (LINEAR) may be brighter than 14^m. 29P/Schwassmann-Wachmann has frequent outbursts and is currently best seen from the Southern Hemisphere. Many comets undergo outbursts and it is worth monitoring all periodic comets that are well placed for observation in case they are in outburst. Current ephemerides for the fainter comets, and for other locations, are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are for the UK at a latitude of 53° N, or the Southern Hemisphere at 40° S on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations may be used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc. I hope to include position angle in future.

Ephemerides follow

Ephemeris for comet 154P/Brewington (UK)

```
Omega= 48.0061 OMEGA=343.6441 i= 18.0595 q= 1.590347 a=  4.843524
e=0.671655  P=   10.660  T= 2003 February  19.3690    Equinox= 2000
Magnitudes calculated from m= 2.5+5.0*Log(d)+30.0*Log(r)
```

December 2002

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
1/ 2	21 9.1	-15.49	21 11.9	-15.37	11.7	1.97	1.81	16.29	Not Observable	66	97	7	2	73	11	7
6/ 7	21 18.5	-14.24	21 21.2	-14.11	11.6	1.99	1.79	16.19	17.18 to 17.19	64	28	9	2	72	11	7
11/12	21 28.2	-12.56	21 30.9	-12.43	11.4	2.01	1.76	16.09	17.17 to 17.50	61	34	53	3	70	11	7
16/17	21 38.2	-11.26	21 40.9	-11.12	11.3	2.03	1.74	15.59	17.18 to 18.08	59	90	93	3	69	12	7
21/22	21 48.6	-9.53	21 51.2	-9.39	11.1	2.05	1.72	15.50	17.20 to 18.22	57	149	95	3	68	12	7
26/27	21 59.1	-8.17	22 1.8	-8.02	11.0	2.07	1.70	15.41	17.23 to 18.33	55	143	50	3	67	13	8
31/32	22 10.0	-6.38	22 12.6	-6.23	10.9	2.08	1.68	15.32	17.27 to 18.42	53	76	4	4	66	13	8
January 2003																
5/ 6	22 21.1	-4.56	22 23.7	-4.41	10.8	2.10	1.67	15.23	17.32 to 18.50	51	15	11	4	65	13	8
10/11	22 32.4	-3.12	22 35.0	-2.57	10.6	2.11	1.65	15.15	17.38 to 18.57	49	47	54	4	63	14	8
15/16	22 44.0	-1.26	22 46.6	-1.10	10.6	2.13	1.64	15.07	17.44 to 19.03	48	104	94	4	62	14	8
20/21	22 55.8	0.22	22 58.3	0.38	10.5	2.15	1.62	14.59	17.51 to 19.08	46	163	93	4	61	14	9
25/26	23 7.8	2.12	23 10.4	2.28	10.4	2.16	1.61	14.51	17.59 to 19.13	44	124	43	4	60	15	9
30/31	23 20.1	4.03	23 22.6	4.19	10.4	2.18	1.60	14.44	18.07 to 19.17	43	60	2	4	58	15	9
February 2003																
4/ 5	23 32.6	5.55	23 35.1	6.12	10.3	2.19	1.60	14.36	18.15 to 19.22	42	13	12	4	57	15	9
9/10	23 45.3	7.48	23 47.8	8.04	10.3	2.21	1.59	14.29	18.24 to 19.25	40	57	55	4	56	15	9
14/15	23 58.3	9.40	24 0.8	9.57	10.3	2.23	1.59	14.23	18.33 to 19.29	39	115	96	4	55	15	9
19/20	0 11.5	11.33	0 14.0	11.49	10.3	2.25	1.59	14.16	18.41 to 19.32	38	166	88	4	54-	15	9
24/25	0 24.9	13.24	0 27.5	13.40	10.3	2.27	1.59	14.10	18.50 to 19.34	37	109	36	4	53	16	9
March 2003																

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you get the format **EXACTLY** right. It is advisable to send the report as a text attachment as many mailers cut what they consider to be long lines.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TK (Tycho 2), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA. Do not report tail details unless you are certain of their reality.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

The ICQ have recently produced detailed guidelines for submitting magnitude estimates made using CCD images and these are available on their web page at xxxxxxxxxx

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Ref	Comments

THE COMET'S TALE

Newsletter of the Comet Section of the British Astronomical Association

Volume 10, No 1 (Issue 19), 2002 April

Cometary Science at the Launch of Rosetta

.An RAS Discussion Meeting

In the event, the Rosetta launch did not take place as planned due to the failure of the Ariane V launch vehicle on its trial flight.

The Royal Astronomical Society organised a discussion meeting on cometary science, which was held at the Geological Society Lecture Theatre in Burlington House on 2002 December 13. The organisers gave this summary: *Recent years have seen marked advances in the study of comets, largely through ground-based observations of Hyakutake and Hale-Bopp, and in-situ measurements of Hyakutake and Borrelly. The imminent launch of the Rosetta mission is taken as an opportunity to review progress made in this field, and to discuss the questions and challenges to be addressed in the future. The meeting will cover all aspects of cometary science, from studies of the nucleus, dust, and coma, to comets' interactions with the solar wind."*

Rita Schulz (ESA) started the proceedings with a description of the Rosetta mission, entitled *Rosetta goes to comet Wirtanen.* If the launch goes ahead as planned, the spacecraft will rendezvous with the comet after aphelion and follow it through to perihelion. She described the scientific instruments on Rosetta, which include: a grain impact analyser, visual and infra-red thermal imaging spectrometer (which can measure the temperature of the surface and some of the coma), OSIRIS (optical, spectroscopic and ir imaging camera), which has 2 cm resolution, ALICE (uv imaging spectrometer, especially designed to look at water), CONSERT, MIDAS (imaging microscope for dust grains), COSIMA (composition of dust particles from an ion analyser), ROSINA (same for gas), MIRO (Sub-millimeter telescope looking at water, ammonia, carbon monoxide, methanol and subsurface), RPC, RSI (radio science, giving the gravity field and mass of the comet).

The spacecraft is 2.8 x 2.1 x 2.0m, with a 32m solar panel array and is designed to operate for 10.5 years. The Ariane 5 to be used to launch it is the basic version, which is different to the version that had failed a few days earlier. She said that there was no reason to delay the launch at the moment. The launch should take place on January 13, though the window is 1st - 29th, with a Mars flyby 1.5 years later, when the instruments will be activated. There are Earth gravity assists in 2005 and 2007, followed by asteroid flybys. First is Otawara, followed by Siva (a C type primitive asteroid 110 km across), which will be the largest asteroid yet encountered. The spacecraft will image the surface of 46P/Wirtanen from 4.6 to 3.0 AU, with the lander touching down at around 3 AU. It may detect a variation in the composition of the cometary output with solar distance and for the first time we will know what goes on in a cometary nucleus.

Jens Biele (German Aerospace Center, Cologne) spoke on *How to catch and land on a comet.* The nucleus of the comet is around 1km across, density 0.2 - 1.5 gcm^{-3}, albedo 3% and a rotation period of around 7 hours, possibly in an excited state, meaning that it is tumbling. The orbiter needs to get closer than 300 km (Hill's sphere of influence). The comet position as the comet approaches is uncertain by 20,000 km due to uncertain astrometry and non-gravitational forces. There are several phases to the encounter: it will take 158 days to close from 100,000 to 20,000 km, 120 days to 300 km and then 3 days to get within 60km before finally entering a 10 - 25 km orbit. This will not be easy due to continuous perturbations to the comet's orbit. In addition dust particles create false stars for the navigational camera, and orbit around a non-spherical body is unstable needing sufficient propellant reserves. There is a large variation in temperature between the day and night sides of the comet. The closest approach is 2km. The lander, which is 0.8 x 0.8 x 1.0m, will anchor itself with a harpoon and has ice screws in its feet. Its drill can sample down to 20cm.

Continued on page 5

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way, for example by submitting observations or articles. **Renewals should be sent to the Director and cheques made payable to the BAA.** Those due to renew should receive a reminder with this mailing.

Section News from the Director

Dear Section member,

It has been an eventful period since the last newsletter. I write this from on board the RRS Ernest Shackleton as we sail northwards towards the Falkland Islands across the Drake Passage. Renowned as one of the stormiest ocean passages in the world, it has been amazingly calm, albeit cloud has precluded any chance of observing. My stay at Rothera station in Antarctica went very well and the trial flights of our ozone balloons were completely successful. The weather there wasn't particularly good for observing either, indeed it was one of the cloudiest spells of Antarctic weather than I can remember. I did get a few glimpses of comet 2002 V1, the first on February 25, when it sported a short tail in the bright twilight. Although I had hoped to complete drafts of the papers on the comets of 1999 and 2000 whilst I was away, in the event, I was kept sufficiently busy that I only made a token start on them. My absence has also meant that this issue is rather thinner than usual. This is perhaps a benefit as I gather that the last issue was sufficiently close to the Post Office limit that some copies were surcharged. If this happened to you, please let me know and I will adjust your subscription accordingly.

Launching an ozonesonde at Rothera

In November we had a storm of meteors from comet 55P/Tempel-Tuttle. Not trusting the UK weather I decided to go overseas, and in the end made a last minute choice of destination based on weather information available on the Internet. I flew to Toulon and stayed at St Maximin, about 40km to the north. Here I had an excellent view of the meteors. It is now very easy, and cheap to fly to popular destinations and escape the vagaries of British weather and I can recommend this as an option should a really bright comet come along. A complete account of my trip appeared in the January issue of The Astronomer.

The Royal Astronomical Society had a meeting on December 13 devoted to "Cometary Science at the Launch of Rosetta". I gave a short talk on our activities and a full write up appears elsewhere in the newsletter. There are two events coming up in quick succession in May. First I am going to the Meeting on Asteroids, Comets, Europe, which this year is being held in Mallorca from May 2 - 5. The next weekend (May 10) is the pro-am discussion meeting at Milton Keynes and I hope that many of you will be able to attend. The star billing of the meeting is the first George Alcock memorial lecture and I am delighted to say that Brian Marsden has agreed to present the lecture, which is to be on 'Comets near the Sun'. Both John Alcock (George's brother) and Kay Williams (George's biographer) hope to be present. Other speakers include: Neil Bone, Andrew Elliot, Alan Fitzsimmons, Monica Grady, David Hughes, Nick James, Graeme Waddington and myself. There will be plenty of time for informal discussion during the lunch and tea breaks. Reports on both these meetings will appear in the next issue.

Space exploration of comets has encountered serious setbacks, with first the American Contour mission being lost, then the ESA mission to Wirtanen being postphoned due to problems with the Ariane launcher. Hopefully this spacecraft will now be launched towards 73P/Schwachmann-Wachmann, which will make a close pass by the Earth in 2006. There were also doubts about the Deep Impact mission, however this has only been slightly delayed and should provide the celebratory fireworks on schedule!

One of the few sunny days at Rothera during my stay – the instrument at right is a laser cloud base recorder.

I am pleased to announce that Cliff Meredith has been awarded the Keedy prize for 2002 for his enthusiastic observations over the last couple of years, using both visual and CCD techniques. The prize takes the form of a book and certificate and is awarded to BAA observers who make a significant contribution to the Section. David Keedy has supported the Section in this way for a good number of years, but has decided that the next award will be the final one. I would like to take this opportunity of thanking David for his considerable support, which has been much appreciated.

Nick James and Gerald North have just had a book called *Observing Comets* published by Springer as part of their 'Practical Astronomy' series (ISBN 1-85233-557-2). To quote from the advertising blurb: *Since comet Shoemaker-Levy collided with the planet Jupiter with stupendous force in 1994 there has been an upsurge of interest in comets. Most comets are first discovered by amateur astronomers, simply because there are so many amateurs looking for them. Techniques and instruments - not necessarily expensive - have improved dramatically in the past few years. Nick James and Gerald North describe comet hunting, photographing and imaging comets, and digital image processing.*

This comprehensive book is at once a "primer" for comet hunters and a reference text for more advanced amateur astronomers. The free CD-ROM that accompanies this book provides resources, comet images, and software. It can be used on almost any personal computer that is equipped with a CD-ROM drive and has an Internet browser.

Springer have generously made some copies available for competition prizes. BAA Members are also entitled to a 20% discount when ordering books from Springer - just quote your membership number when placing your order. For readers who are Members of the British Astronomical Association the competition is to submit a short essay of around 500 words on *'Why I observe comets'*. For any readers of these pages the competition is to submit a short essay of 500 - 1000 words on *'The importance of amateur comet observations'*. The winning essays will be published in the next issue of *The Comet's Tale*. The closing deadline for the competition was mid April, however as this is before the magazine will reach you, late entries will be accepted up to May 6. I hope to present the prizes at the meeting on May 10.

Since the last newsletter observations or contributions have been received from the following BAA and Section members:

RAS Discussion Meeting 2003 May 10

at

The Berrill Lecture Theatre, Open University, Milton Keynes

10:30 Doors open, registration, tea/coffee available

11:00 Welcome
11:05 **Monica Grady** (NHM), Meteorites
11:25 **Neil Bone** (BAA), BAA meteor observations
11:45 **Iwan Williams** (Queen Mary, London), Meteor streams
12:05 **Andrew Elliot** (BAA), Video meteors
12:25 Discussion

12:30 Lunch

14:00 **Jonathan Shanklin** (BAA), BAA visual comet observations
14:20 **David Hughes** (Sheffield), Cometary size distribution
14:40 **Alan Fitzsimmons** (Queen's, Belfast), Recent results in ground-based imaging of distant comets
15:00 **Nick James** (BAA), Amateur CCD observations of comets
15:20 Discussion

15:30 Tea

16:00 **Graeme Waddington** (BAA), Comet orbits and Ikeya-Zhang
16:20 **Brian Marsden** (SAO), *The George Alcock Memorial Lecture* "**Comets near the Sun**"

17:20 Discussion

17:30 Close

Refreshments will be available for purchase. **If you plan on coming to the meeting please let me know so that we can arrange adequate catering.** There is no registration fee. There will be plenty of opportunity for informal discussion during the breaks. Information on travel to Milton Keynes and maps of the location are available at http://www.open.ac.uk/maps/

James Abbott, Jose Aguiar, Alexandre Amorim, Alexander Baransky, Sandro Baroni, Sally Beaumont, Peter Birtwhistle, Nicolas Biver, Reinder Bouma, David Boyd, Nick Brown, Jose Carvajal, Julie Chignell, Emilio Colombo, Matyas Csukas, Alfons Diepvens, Kenelm England, Len Entwisle, Mike Feist, Rafael Ferrando, Sergio Foglia, Mike Foulkes, Martin Gaiger, Mike Gainsford, Stephen Getliffe, Guus Gilein, Juan Gonzalez, Bjorn Granslo, Mark Green, Werner Hasubick, Roberto Haver, Guy Hurst, Michael Jager, Andreas Kammerer, Manos Kardasis, Heinz Kerner, Attila Kosa-Kiss, Carlos Labordena, Martin Lehky, Rolando Ligustri, Mike Linnolt, Gordon MacLeod, Pepe Manteca, Michael Mattiazzo, Richard McKim, Cliff Meredith, Maik Meyer, Antonio Milani, Martin Mobberley, Alexandra Mormyl, Neil Morrison, Gabriel Oksa, Roy Panther, Andrew Pearce, Stuart Rae, Maciej Reszelski, Tony Rickwood, Hirohita Sato, Juan San Juan, Tony Scarmato, Carlos Segarro, Jonathan Shanklin, Oddleiv Skilbrei, Giovanni Sostero, Willian Souza, David Strange, Melvyn Taylor, John Vetterlein, Alex Vincent, Seiichi Yoshida and Mauro Zanotta (apologies for any errors or omissions). Without these contributions it would be impossible to produce the comprehensive light curves that appear in each issue of *The Comet's Tale.* I would welcome observations from any groups which currently do not send observations to the BAA.

Comets under observation were: 29P/Schwassmann-Wachmann, 30P/Reinmuth, 46P/Wirtanen, 67P/Churyumov-Gerasimenko, 81P/Wild, 92P/Sanguin, 116P/Wild, 2001 HT50 (LINEAR-NEAT), 2001 Q4 (NEAT), 2001 RX14 (LINEAR), 2002 O7 (LINEAR), 2002 Q4 (154P/Brewington), 2002 Q5 (LINEAR), 2002 R2 (155P/Shoemaker), 2002 T7 (LINEAR), 2002 V1 (NEAT), 2002 X1 (LINEAR), 2002 X5 (Kudo-Fujikawa), 2002 Y1 (Juels-Holvorcem), 2003 A1.

I look forward to meeting many of you on May 10.

Jonathan Shanklin

Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices and BAA Journals.

150 Years Ago: Professor Challis observed the following portion of Biela's comet from Cambridge in 1852 September. The publication of a new catalogue of "Cometic Orbits with copious Notes and Addenda" compiled and edited by Edward J Cooper was announced at the November meeting. He had arranged the orbits in tables and was induced to believe that to Sir John Herschell's hypothesis "that direct motion or a small inclination are favourable indications of a periodic comet" we may "a longitude of the perihelion and of the ascending node between 45° and 135°". January records the last observations of Westphal's comet, which had a period of around 60 years and just reached naked eye visibility. *[At its next return in 1913 it suddenly faded and has not been seen since].* In March Signor Secchi discovered a new comet from Rome, and it was independently found by Prof. Schweizer at Moscow, Dr Hartwig at Leipsic and by C W Tattle [sic] at Harvard. The discovery by Charles Tuttle was telegraphed from Boston to New York and transmitted to the Astronomer Royal by the steamer Arabia, which was just on the point of sailing when the message arrived. The March issue is dated March 11 and the telegram was sent on the 9th! At the April meeting Dr Lardner presented a paper on "The Classification of Comets and the Distribution of their Orbits in Space", based on 207 orbits. He identified three groups - those whose aphelia are within Saturn's orbit (eg Encke, Biela), those whose mean distances are nearly equal to Uranus' orbit (eg Halley, Westphal) and those whose mean distances exceed the extreme limits of the solar system.

100 Years Ago: Mr Maunder reported on two comets discovered during the recess. One had been discovered by John Griggs of New Zealand, who appeared to be the only observer. A paper by A C D Crommelin described a method of "the determination of Comets' places without micrometers'. In November Mr Maunder presented the report of the comet section and showed lantern slides of comet Perrine (1902 R1). Captain W Noble commented that on October 8 and 9 the head of the comet had appeared granular as if made of very fine luminous sand, though other observers thought it nebulous. The President (Mr Saunder) commented that the lantern slides in the RAS collection of Swift's comet showed a V-shaped tail and there was in one of the photographs a great mass almost as big as the head of the comet itself, which had been thrown off. There are notes on a paper in Ap J by Peter Lebedew on "The Physical causes of the deviations from Newton's Law of Gravitation", which looks at what causes the repulsion of a comet's tail from the Sun. He concludes that Kepler's original theory (1608), that it is due to the repulsive force of the solar radiation, again holds the field. The December Journal has a repport on comet 1902 R1 (Perrine) by E W Maunder. He comments that it proved to be a disappointing visitor. Sixteen members contributed observations and the report includes drawings and photographs. A few rough magnitude estimates are also included. *[This is perhaps the first report that does so, though no light curve is attempted.]* In January a note taken from MN quotes "Mr Innes has been hunting the records of the Cape Observatory and quotes six observations of comets between 1684 and 1689. In those days they seem usually to have been known as "stars with tails" and one of them is quaintly described as having appeared in "the 5th house of the heavens", which looks as if our friends at that period had not shaken themselves free from the charms of astrology." At the March meeting Mr Maunder described a technique for drawing comets and also commented on a technique used to copy some of the lantern slides, which had much deteriorated.

50 Years Ago:. The December Journal has a note from the Irish Astronomical Journal stating that the problem of cometary tails has been solved by Biermann. The theory suggests that protons and electrons impact on molecular ions in the tail and this explains the disturbances seen in tails after magnetic storms. January sees a review of the new book by J G Porter entitled 'Comets and Meteor Streams'. He includes Whipple's new theory and notes that Whipple himself admitted that the evidence for the theory was preliminary in character and subject to alternative explanations!

Cometary Science at the Launch of Rosetta

Continued from page 1

The next address, *In-situ Science on a comet - the Rosetta Lander,* was to have been given by Jean-Pierre Bibring (University of Paris Sud, Orsay) but was presented by Jens Biele. The lander has 11 instruments, looking at composition, physical properties, imaging and large scale structure, environment and evolution. CONSERT can measure the internal structure by sending radio waves through the nucleus to the orbit and achieve a 10m resolution. The lander has a five day lifetime on battery power alone, but should last three months on its solar panels. It is only designed to operate up to 2 AU (q is 1.06 AU).

Ian Wright (OU) spoke about *PTOLEMY.* This experiment is named after Ptolemy V, who is named on the Rosetta stone and is designed to measure the abundance and isotopic ratios in CHON. Comets (& meteorites) are the cosmogonical equivalent of the cosmic micro wave background - a relict from the birth of the solar system. The team wants to measure δD per mil to compare with SMOW (standard mean ocean water), meteorites etc to see if comets are a possible source of Earth's water. They use a stepped combustion principle to look at different components.

Iwan Williams (QMC, London) spoke about *CONSERT.* Rosetta should answer many questions on the nature of the cometary nucleus. CONSERT (COmet Nucleus Sounding Experiment by Radiowave Transmission) looks at the interior by using a 90 Mhz (3m) radio pulse emitted from the orbiter. The lander picks it up and sends a pulse back, thus acting as a probe of the structure by measuring the changes in transmission time due to path length and refractive index. They need to know exactly where the lander is, and also have a good map of the entire surface.

Chris Carr (Imperial College, London) described *The Rosetta Plasma Consortium.* The state of the art plasma experiments will look at the onset and development of cometary activity and its interaction with the solar wind. Imperial is a principal investigator, with the Mullard Space Sciences Laboratory as co-investigators. Andrew Coates (MSSL, UCL) followed up with *The cometary plasma environment: current knowledge and prospects for Rosetta.* Comets have a large interaction region with the solar wind. The size varies with cometary activity and there was a factor of 100 difference between comet Halley and Grigg-Skjellerup. Rosetta will see a factor of 1000 difference over the course of study. Gas pulls dust away from the comet nucleus, neutrals drift at a few ms^{-1} and escape at a few kms^{-1}. Production varies with solar distance and neutrals ionise in sunlight. The solar magnetic field is frozen into the flow of the solar wind, which slows as it picks up newly ionised particles. The tail of 1996 B2 (Hyakutake) was 3.8 AU long. 19P/Borelly had an asymmetric gas & dust emission into the coma. The relation of tail rays to in situ data is still not clear. Theory predicts a bowshock and ionopause. Many different boundaries are actually seen: a bow shock (Mach 1 - 2), a mystery boundary that shows as a change in the solar wind, a cometopause, where solar ions change to cometary ions, a magnetic field pile up, an ion pile up and finally an ionopause. There are many questions still to be answered by the plasma instruments on Rosetta, such as the permanence of the various boundaries, the structure of the inner coma, the structure of the tail formation region and tail rays, the magnetisation of the nucleus, and sputtering, charging and dust levitation on the nucleus.

The lunch break gave a chance for some informal chat to the various participants, though the sandwiches on offer do not give very good value for money, so many regular attendees at the venue had brought their own. After lunch, proceedings resumed with Alan Fitzsimmons (Queen's University, Belfast) on *Observing Distant Comets and the Nucleus Size Distribution.* Only four short period comets have well determined albedos (2, 19, 28 and 49). Ground based observations of distant comets may give no detection, which gives an upper limit for the nuclear magnitude and hence size. Alternatively they may give a strong detection, with lots of coma, which only gives a weak constraint on the size. Ideally he wants to see a point source, which gives a good measurement. Checks include comparison of the seeing disk with respect to stars, any rotational modulation and a consistent magnitude at different epochs. He showed the results of size distribution estimates by several authors: Fernandes et al (1999) gave $\alpha = 0.53$ for 64 short period comets (SPC), Hughes (2002) estimated $\alpha = 0.51$ from H_{10} magnitudes of 94 SPC with $H_{10} < 7.0$, Lowry et al (2002) found $\alpha = 0.32$ from 19 R band estimates of distant comets. HST observations of comets when close and therefore resolvable, combined with the best ground based estimates give $\alpha = 0.32$, but this might be biased by poor detection of small objects. The Kaplan-Meier statistic can be used to debias the estimate and confirms that $\alpha = 0.31$ for comets with radius > 1km, though it could still be biased as the data was selected from 94 numbered SPC. For smaller objects $\alpha = 0.03$, effectively implying that there are no very small comets. NEOs have a very similar value with α around 0.3.

David Hughes (University of Sheffield) followed this up with a talk on *The size Distribution of*

Nuclei and its Evolution with Time. In this context David equated SPC with Jupiter Family (JF) comets. He assumed that K = 10 in the magnitude equation and computed H_{10} values and then plotted this value against perihelion distance. There are four general regions. In region A (small q, bright H_{10}) the comets would be bright if they existed and in region D (large q, faint H_{10}) they would be too faint and small to easily detect. As SPC decay, comets with small q are quickly removed from the plot. For the relatively small set, α varies with q and at large q tends to $\alpha = 0.36$. From the change in current minimum magnitude versus q, it is possible to get some measure of the decay rate. Comets clearly do decay, for example 1P/Halley lost about 7m at its last return. This suggests that the average comet will last around 2500 years, and roughly a quarter of all comets inserted into the inner solar system are lost after 1500 years. We are currently finding about 1.6 SPC with q < 1.8 and 0.7 SPC with q > 1.8 per year and we need a greater discovery rate [*LINEAR and other search programmes have pushed this rate up recently*] There should be small comets to find beyond 3 AU.

Michael A'Hearn (University of Maryland, USA) then looked at *Diversity Among NASA's Cometary Missions.* There is a continuum in small bodies from the outer edge of the asteroid belt to the Oort cloud and interstellar comets. Space agencies have quite a few small body missions either planned or underway, including NEAR, DS1, Stardust, [Contour], Muses C, Rosetta, Deep Impact, Dawn and KBP. Deep Impact might go on to study P/Boethin. Small NASA missions have rigid cost caps (eg Deep Impact, Stardust). The resolution is steadily improving, for example Stardust has 10 - 20m, although imaging is a secondary component of the mission. Spectral resolution is also improving. The impactor on Deep Impact is made of copper because copper doesn't react quickly with water. Its target, 10P/Tempel, has a 2.6 km nucleus and an albedo of 7%. It will be targeted at the brightest nuclear region as the jets are much fainter than those of 1P/Halley and won't confuse the automatic system. It should form a crater, probably controlled by gravity, but it could be compressional. If it hits a snowdrift it will make a 2m diameter hole! Other possibilities were splitting the nucleus, shattering the nucleus or going straight through. The team needs Earth based observations, including those from amateurs. The encounter conditions for Stardust are not very favourable, with the comet at only 33° elongation, but for Deep Impact they are much better with the comet at 104°. To measure the comet's mass they would need a miss distance for the main probe of 2 km, however the comet's radius is 2.5km. Future US proposals include small discovery class missions for which an announcement of opportunity will be made soon. One will almost certainly be to a comet. A medium class mission will be the KBP, but a comet surface sample return has a less than 20% chance of being funded.

The final professional talk was by Mark Burchell (University of Kent) on *Laboratory Studies of what an impact in a porous ice target (eg comet nucleus) might look like.* The comet surface is likely to be eroded or resurfaced, but should have ice craters. Canterbury have a two stage gas gun that fires a 1mm projectile. Experiments started with slabs of solid ice, then went to porous packed ice flakes. They found craters with a deeper pit at slow impact speeds (1 km s^{-1}). It is possible to scale to larger sizes, but it is a long way to scale to values associated with typical real impact craters. The next stage was to go to spheres of ice, which required a lower energy to disrupt for a solid sphere, but formed craters or spallation from porous spheres. They are working on modelling the impacts.

I concluded the discussion meeting by describing *Amateur contributions to cometary science.* This talk demonstrated the work that many of you are undertaking, beginning with cometary discovery and ending with some of the detailed CCD work and visual magnitude estimation. One point that I made was that I thought that the days of amateur visual discovery were ended thanks to SOHO, LINEAR and other search programmes and that in the future PanSTARRS would remove all chances. Kudo and Fujikawa proved this speculation spectacularly wrong, almost as the meeting was taking place, with the discovery of 2002 X5!

Jonathan Shanklin

Professional Tales

COMET'S FEATURES LOOK A LOT LIKE SOME ON EARTH Diana Jong, Space.com, 21 October 2002 © Space.com

Venus has its volcanoes. Mars has a canyon grander than any on Earth. Eros the asteroid is pockmarked by impact craters and littered with boulders. Many Sun-orbiting objects have geologic features that are analogous to those here on Earth. New research reveals that even comets, the dirty balls of ice from the edge of the solar system, can remind us of home.

Last September, while on its last leg, the Deep Space 1 (DS1) spacecraft zipped by comet Borrelly, taking some of the most detailed images ever of a comet's core. Examining these images, scientists noticed mesas, ridges and hills, all resembling terrestrial surface features. The geologic features on Earth and Borrelly are formed through the same basic processes.

The new colour-enhanced composite of Borrelly images taken by DS1 was released earlier this month. It shows features of the comet's nucleus, dust jets escaping the nucleus and the cloud-like coma of dust and gases. On Earth, analogous structures are carved out largely through the erosive forces of wind and rain. On a ball of dust and ice (with perhaps some rock) hurtling through space, however, geology is formed when a material turns directly from a solid into a gaseous state, a process called sublimation. "It's basically all physics," says Dan Britt, a geologist from the University of Tennessee and a member of the DS1 science team.

The mesas on Borrelly are more than 100 meters tall and can be 20 times as wide. Britt says they resemble the mesas in the American Southwest, which are formed when a cap of hard rock overlies softer material that erodes faster. The cap acts as a type of shield. On Borrelly, the caps are made of the dust and rock left behind when volatiles, such as water and methane ice, sublimate. Sublimation continues from the sides of the mesa, and a resistant cap finally drops down when it is undermined, Britt said. During the course of Borrelly's seven-year orbit around the Sun, Britt adds, the mesas erode as much as 10 meters.

There are also regions on Borrelly that experience slower sublimation-related erosion, a fact Britt figures is responsible for making the hills and linear features on the comet. Overall, he says, sublimation removes about 1 meter of Borrelly every cycle. "That's actually pretty active erosion, even in geologic terms," Britt said in a telephone interview. "If your yard eroded one meter every seven years, you'd be upset."

Britt and his colleagues also observed ridges on Borrelly. These were formed, they believe, when one part of the comet broke off and was pushed back at an angle. "When you have two moveable objects pushing against each other, you make ridges," he said. "That's how you make mountains on Earth."

As simple as it may sound to draw a correlation between Earth and comets, these findings are somewhat surprising, Britt says. "Comets, up until now, have been really astronomical objects, sort of dots on a photographic plate, or blobs," he said. "I've never really thought that a ball of ice and dust would make interesting surfaces and have interesting processes and produce interesting pictures."

Britt and his colleagues compiled DS1's images of Borrelly to create 3-D composites. They then carefully examined and measured the features on the comet. They presented their findings earlier this month at a meeting of the Division of Planetary Sciences in Birmingham, Alabama.

Astronomers have been taking pictures of comets for more than a decade, but none have been as detailed as those of Borrelly, made when DS1 passed within 2,000 kilometers of the comet.

In 1986, the European Space Agency's Giotto mission took pictures of comet Halley. Those images, however, did not resolve the surface of the comet. In 2003, ESA will launch Rosetta, which will visit comet Wirtanen. It will be followed in 2004 by NASA's Deep Impact, designed to slam a probe into a comet while the mother ship monitors the event from afar, so as to learn more about comet insides.

DS1, launched in 1998, was designed primarily to test new technology, including an ion engine. Science was a secondary objective.

ROSETTA TO PLAY ORBITAL MECHANICS TO REACH COMET 67P/CHURYUMOV-GERASIMENKO by Bruce Moomaw, SpaceDaily, 23 March 2003 © SpaceDaily

"SpaceDaily" has now acquired additional information on the favoured new mission plan for Europe's Rosetta comet-rendezvous spacecraft, whose planned January launch to comet Wirtanen had to be cancelled due to the disastrous failure of the immediately preceding launch of its Ariane 5 booster.

While a delayed launch to Wirtanen next January cannot be completely ruled out, the most probably replacement mission for the craft is a launch next February. Since this comet's nucleus is thought to be considerably bigger than Wirtanen's, this will require considerable replanning of the landing procedure for its small ejectable comet-nucleus lander.

But simply getting to the comet also requires major redesign of its flight plan -- and part of this is trying to find new replacements for the two asteroids Rosetta was supposed to rapidly fly by for additional science observations during its circuitous 9-year trip to Wirtanen.

The first of those two asteroids was 4979 Otawara -- only a few kilometers wide, which may actually be a small chunk of the third-biggest asteroid Vesta broken loose by an ancient impact. (Vesta is the only big asteroid with actual flows of volcanic basalt on its surface; America's "Dawn" spacecraft is scheduled to visit it in 2010 and spend almost a year orbiting it for detailed study.)

The second would have been 140 Siwa -- a big "C-type" asteroid, thought to be made of the same darker "carbonaceous chondrite" rock that makes up most rocky bodies in the outer Solar System, which condensed out of the original solar-orbiting nebula out of which the Solar System formed at lower temperatures than the silicate rock bodies of the inner System, and so is much richer in water and even in organic compounds. (Siwa, at 110 km, would have been the biggest asteroid yet visited by a spacecraft.)

Those, however, are now out of reach. Rosetta's new flight plan calls for it to match orbits with comet 67P/ with an even more complex set of loops around the Sun than its original flight plan to Wirtanen did. It will still make a gravity-assist flyby of Mars -- but if the Feb. 2004 launch to 67P/ is chosen, it will also make three gravity-asist flybys of Earth instead of only two.

The new plan would involve Rosetta being initially launched into a near-Earth orbit with a period of exactly one year, allowing it to return to and fly by Earth at that time to get a boost into a more elongated orbit that will take it to Mars. (If it misses this launch window, it can be launched a year later directly from Earth to Mars -- but since Mars will be farther from the Sun in its mildly elliptical orbit than it would have been for a launch last January, such a direct flight to Mars will require a more powerful booster: either a Russian Proton, or the improved "Ariane 5 ECA" which failed so disastrously in December and might not be ready for this mission even by early 2005.)

However it gets to Mars, Rosetta will fly by that planet in Feb. 2007 (making some science observations as it does so) and getting a gravity-assist boost to further elongate its orbit. It will then return to Earth to make its second gravity-assist flyby of our home planet that November, putting itself into a still more elongated orbit with a period exactly two Earth years long -- so that it will return once again to make its third and last gravity-assist flyby of Earth in Nov. 2009, putting itself into a still more elongated orbit taking it almost as far from the Sun as Jupiter.

As it sails away from the Sun on that orbit, it will fire a burn on its main engine in mid-2011, moderately adjusting its path to help match orbits with 67P/. Then -- three years later, as it starts to approach the Sun again -- it will close in on the comet's nucleus and carry out a months-long string of finer manoeuvres to rendezvous with it after a total journey of about 10 1/2 years (two years longer than the originally planned flight).

Rosetta's planners have already carried out an extensive hunt for any asteroids it could fly past during this revised series of loops around the Sun, and have indeed found two. The first is 437 Rhodia, which it would fly past in Sept. 2008 at a speed of about 41,000 km/hour.

Rhodia -- only about 25 km wide -- may be a particularly unusual asteroid. It is thought to have an albedo higher than that of any other known asteroid, reflecting fully 56% of the light hitting it -- which would imply that it is made of some mineral as white as chalk (possibly a chance extrusion of some white rock like anorthosite, which formed on a bigger asteroid and was later broken loose by a collision).

The second asteroid target would be 21 Lutetia, a big asteroid about 100 km wide which Rosetta would fly past at about 55,000 km per hour in July 2010. While Lutetia is about the same size as Siwa, it is definitely odder -- it's one of the biggest of the so-called "M-class" asteroids, which until recently have been thought to be made largely of metallic nickel-iron alloy of the type that makes up many recovered meteorites.

M-class asteroids (tagged, like the other declared classes of asteroids, by the near-infrared spectra of their rocks as seen from Earth) are rather uncommon -- they make up only about 4 percent of asteroids. They have been thought to be pieces of the metal cores that formed at the centers of the dozen or so large "planetesimals", several hundred km wide, that orginally formed in the Asteroid Belt, before most of them were gradually shattered into smaller fragments by repeated collisions over the eons.

However, more detailed near-IR spectra recently show some signs that most of the bigger M-class asteroids -- including Lutetia -- may not be metallic at all. Instead, they may be made of silicate rocks that were exposed to some water during their early history. Many of the smaller M asteroids -- as well as 16 Psyche, the biggest of all -- don't seem to show such evidence, and may be the real thing. If Rosetta does visit Lutetia, its color photos, close-up IR spectra and magnetic field measurements will likely settle this question.

There, is, however, a catch. Matching orbits with 67P/ will require more manoeuvring fuel than Wirtanen would have. And so, in order to take the orbital paths needed to intercept the asteroids, Rosetta would have to rendezvous with its main comet target when the comet is closer to the Sun than Wirtanen would have been -- only 540 million km from the Sun, as opposed to the 600 million km planned for Wirtanen.

Since, as a comet approaches the Sun, the "coma" of gas and dust boiling off it dramatically increases, as 67P/ reaches its perihelion it will get much harder for the comet-orbiting spacecraft and its lander to make their observations. (Rosetta's design specifications only guarantee its full operation beyond doubt until the comet approaches within 490 million km of the Sun.) Scientists therefore would very much like to rendezvous with the comet when it's still 600 million km from the Sun as originally planned, to prolong their detailed observation time there. They will thus have to decide which they prefer: those two asteroid flybys, or as much as six extra months of time studying 67P/ itself in detail.

They have plenty of time to make that decision, however -- it can actually be delayed until after launch. At any rate, given the initial alarming indications immediately after the cancellation of last January's launch that they might be unable to find a workable replacement target for Rosetta at all, ESA scientists are quite happy even to have such a choice.

New Launch Date for Deep Impact Deep Impact Project April 1, 2003

A new launch window is announced for the Deep Impact project, the first mission to look deep inside a comet. Technical and management issues, including contamination in the propulsion system and late deliveries of key spacecraft components, resulted in delays in the pre-flight testing schedule. These concerns led Deep Impact Principal Investigator, Mike A'Hearn, to recommend to NASA a delay of launch. A launch window beginning December 30, 2004, previously identified as a back-up date, provides more thorough testing for the spacecraft systems before launch and allows the spacecraft to arrive at Comet Tempel 1 to impact it as originally scheduled on July, 4, 2005. NASA management approved the recommendation.

Deep Impact will be the first mission to make a spectacular, football-stadium-sized crater, seven to 15 stories deep, into the speeding comet. Dramatic images from both the flyby spacecraft and the impactor will be sent back to distant Earth as data in near-realtime. These first-ever views deep beneath a comet's surface, and additional scientific measurements will provide clues to the formation of the solar system. Amateur astronomers will combine efforts with astronomers at larger telescopes to offer the public an earth-based look at this incredible July 2005 encounter with a comet.

The following items are from Distant EKO news, the Kuiper Belt Electronic newsletter. You can find more items at http://www.boulder.swri.edu/ekonews/issues/

2060 Chiron - Chaotic Dynamical Evolution and its

Implications Ryszard Gabryszewski, Acta Astronomica, 52, 305 (2002 September)

Chiron--one of the Centaurs orbiting chaotically among the giant planets--is treated as an asteroid and a comet (95P/Chiron) as well. Since the day of the discovery many papers discussed its past and future fate.

This paper considers a possibility of Chiron's dynamical evolution to different cometary orbital types. An ensemble of orbital elements was used to describe Chiron's dynamics in terms of probability. The ensemble was generated using an unique scheme of elements creation. Dispersion of elements obtained by this method is much smaller comparing to ranges obtained by varying the original elements in the ellipsoid of their mean errors. The chaos in Chiron's dynamical evolution can be seen in 5 to 9 kyrs, although the dispersion of orbital elements is small. Halley type orbits are the rarest noticed orbital types but the number of these objects is 3 times greater than the number of apparent Halley type comets. The variations of probability of different cometary orbits as a function of time is also presented. The rate of HTC orbit production is only 4 times lower than the production rate of JFCs after the first 50 kyrs of integration. Some remarks on small body transportation mechanisms are also included.

143P/Kowal-Mrkos and the Shapes of Cometary Nuclei David Jewitt, Scott Sheppard, and Yanga Fernandez' To appear in: The Astronomical Journal

We add 143P/Kowal-Mrkos to the small but growing sample of well-observed cometary nuclei. Photometric observations from 3.4 to 4.0 AU heliocentric distance reveal a point-like object with no detectable outgassing. Periodic modulation of the scattered light ($\Delta m_R = 0.45 \pm 0.05$) is attributed to rotation of the bare nucleus with a double-peaked period 17.21 ± 0.10 hrs and a projected ratio of the shortest to longest axes of about 0.67/1. We also measured the phase coefficient (0.043±0.014 mag/deg), the *BVRI* colors ($V - R = 0.58 \pm 0.02$) and the absolute red magnitude ($m_R = 13.49 \pm 0.30$). The effective circular radius is 5.7 ± 0.6 km (geometric albedo 0.04 assumed).

We study the properties of 11 well-observed Jupiter Family Comet (JFC) nuclei. On average, the nuclei are systematically more elongated (average photometric range $\Delta m_R = 0.54 \pm 0.07$) than main belt asteroids of comparable size ($\Delta m_R = 0.32 \pm 0.05$), and more elongated than fragments produced in laboratory impact experiments. We attribute the elongation of the nuclei to an evolutionary effect, most likely driven by sublimation induced mass loss. However, we find no evidence for any relation between the nucleus shape and the sublimation timescale. This may be because the timescale for evolution of the nucleus shape is very short compared to the dynamical timescale for the JFCs, meaning that most nuclei in our sample are already highly physically evolved.

Review of comet observations for 2002 October - 2003 April

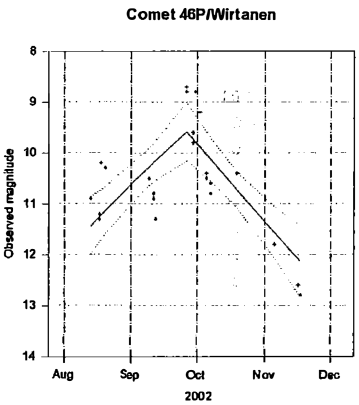
The information in this report is a synopsis of material gleaned from IAU circulars 7980 – 8116, The Astronomer (2002 October – 2002 April) and the Internet. Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course. I have used the convention of designating interesting asteroids by A/Designation (Discoverer) to clearly differentiate them from comets, though this is not the IAU convention.

Numbered periodic comets

29P/Schwassmann-Wachmann Carlos Labordena (Spain) reported the comet in outburst on November 1, at 12th magnitude with a well condensed coma. Michael Mattiazzo (Australia) also reported the comet bright, with the comet at around 14th magnitude through most of October, brightening at the end of the month. The degree of condensation was quite variable suggesting a series of outbursts, with perhaps one around October 27 and another around November 4. A further outburst may have taken place in early December.

30P/Reinmuth A couple of observations in the first quarter of the year put the comet at around 13.5.

46P/Wirtanen Observations suggest that the comet peaked at around 9th magnitude in late September. I observed it on October 19.18, estimating it at 10.4 in my 20cm LX200 x75. The observations are currently best fitted by a linear type light curve, with the comet brightest about a month after perihelion. The last observation was made in mid November when the comet was nearing 13[th] magnitude. Observations received (26) give a preliminary light curve of 7.7 + 5 log d + 0.0427*(t-T+30.4)



67P/Churyumov-Gerasimenko. A couple of observations made in December suggest that the comet was around 14[th] magnitude.

81P/Wild A couple of observations made in December suggest that the comet was around 14[th] magnitude.

92P/Sanguin. Observations by several observers suggest that the comet faded from 13[th] to 14[th] magnitude in the autumn.

116P/Wild was at perihelion in January 2003. Michael Mattiazzo estimated the comet at 12.5 in early February. It should brighten to 12th magnitude in April as it nears opposition but is a long way south and will be difficult to observe from the UK.

Comets discovered with the SOHO LASCO coronographs and not observed elsewhere.

1999 O4 (SOHO) D. Hammer reports measurements for a comet near the sun found by R. Kracht on October 20, on archival SOHO website C3 coronagraph images. The reduced astrometry and orbital elements (showing no known group identity) by B. G. Marsden appear on MPEC 2002-W34. [IAUC 8025, 2002 December 2]

2003 G3 (SOHO) is a non group comet that was discovered by John Sachs on April 4 on C3 and C2 coronagraph images. The preferred retrograde orbit suggests that it will be around 30° elongation from the Sun in late April and early May.

Meyer Group comets

2002 R8 (IAUC 7984, 2002 October 5)
2002 T2 (IAUC 7991, 2002 October 12)
2002 U6 (IAUC 8025, 2002 December 2)
2002 V4 (IAUC 8073, 2003 February 14)
2002 X6 (IAUC 8073, 2003 February 14)
2002 Y2 (IAUC 8073, 2003 February 14)
2003 B1 (IAUC 8065, 2003 February 4)

Kracht Group comets

2002 S4 (IAUC 7984, 2002 October 5)
2002 S5 (IAUC 7984, 2002 October 5)
2002 S7 (IAUC 7986, 2002 October 7)
2002 S11 (IAUC 7991, 2002 October 12)

Marsden Group comets

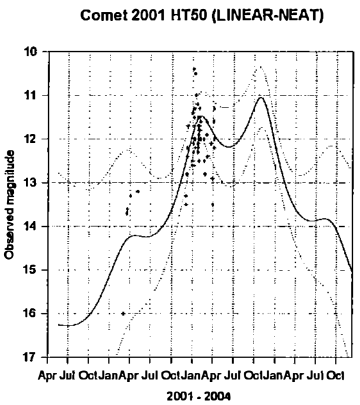
2002 V5 (IAUC 8073, 2003 February 14)

SOHO Kreutz group comets

1999 M4 (IAUC 8022, 2002 November 24)
2000 G3 (IAUC 8073, 2003 February 14)
2002 S6 (IAUC 7986, 2002 October 7)
2002 S8 (IAUC 7991, 2002 October 12)
2002 S9 (IAUC 7991, 2002 October 12)
2002 S10 (IAUC 7991, 2002 October 12)
2002 T3 (IAUC 7991, 2002 October 12)
2002 U1 (IAUC 8000, 2002 October 26)
2002 U3 (IAUC 8022, 2002 November 24)
2002 U4 (IAUC 8022, 2002 November 24)
2002 U5 (IAUC 8022, 2002 November 24)
2002 U6 (IAUC 8025, 2002 December 2)
2002 U7 (IAUC 8025, 2002 December 2)
2002 U8 (IAUC 8025, 2002 December 2)
2002 U9 (IAUC 8025, 2002 December 2)
2002 V3 (IAUC 8073, 2003 February 14)
2002 V6 (IAUC 8099, 2003 March 25)
2002 V7 (IAUC 8099, 2003 March 25)
2002 W1 (IAUC 8100, 2003 March 25)
2002 W2 (IAUC 8100, 2003 March 25)
2002 W3 (IAUC 8100, 2003 March 25)
2002 W4 (IAUC 8100, 2003 March 25)
2002 W5 (IAUC 8103, 2003 March 31)
2002 W6 (IAUC 8106, 2003 April 3)
2002 W7 (IAUC 8106, 2003 April 3)
2002 W8 (IAUC 8111, 2003 April 8)
2002 X3 (IAUC 8034, 2002 December 14)
2002 X4 (IAUC 8034, 2002 December 14)

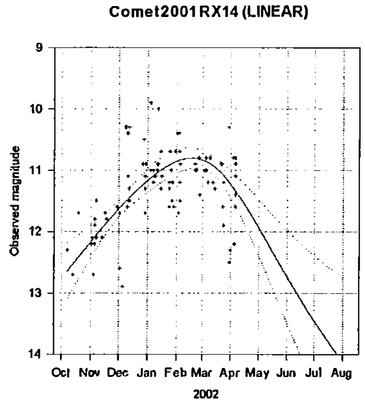
Comets with a preliminary designation

2001 HT50 (LINEAR-NEAT) This is a relatively distant comet, and has been quite tricky to see. Generally observers began to report it in December, when it was 13th magnitude according to Andrew Pearce and Michael Mattiazzo. It brightened a little, perhaps reaching 11.5 in the late winter. The comet is currently approaching conjunction, but will come to a second opposition later in the year, when it could reach a magnitude brighter. It should remain brighter than 13th magnitude throughout the year.



The 67 observations reported so far give a light curve of m = 6.4 + 5 log d + 6.5 log r

2001 RX14 (LINEAR) BAA observers first recorded the comet in early October, when it was around 13th magnitude with Nicolas Biver, Carlos Segarra and myself all making reports. It is a relatively distant comet and it slowly brightened, with some observers reporting it as bright as 10th magnitude over the winter months, though the majority suggest that it reached 11th magnitude. It was still quite an easy object in early April, but it is now past perihelion and will fade quickly.



The 94 observations reported so far give a light curve of m = 7.4 + 5 log d + 9.0 log r

2001Q4 (NEAT) A few observations over the winter suggest that the comet was near 15th magnitude. It should soon be coming into more general view, but remains a Southern Hemisphere object. It could become a naked eye object in May 2004.

2002 J4 (NEAT) The comet will not reach perihelion until October 2003, at 3.6 AU. It could reach 13th magnitude when brightest. It was around 16th magnitude according to CCD observations in early April.

Brian Marsden notes on MPEC 2003-G46 [2003 April 9] that the "original" and "future" barycentric values of 1/a are +0.000026 and -0.000278 (+/- 0.000007) AU**-1, respectively. The original value implies that the comet is a new visitor from the Oort cloud.

2002 O7 (LINEAR) Brian Marsden notes on MPEC 2003-A30 [2003 January 6] that the "original" and "future" barycentric values of 1/a are +0.000027 and -0.000307 (+/- 0.000024) AU**-1, respectively, suggesting that this is a "new" comet from the Oort cloud. It should soon come within visual range, but no observations have been reported so far.

2002 Q4 (154P/Brewington) A couple of observations in December suggest that the comet was around 13th magnitude.

2002 Q5 (LINEAR). Brian Marsden notes on MPEC 2003-C40 [2003 February 8] that the "original" and "future" barycentric values of 1/a are +0.000058 and -0.000885 (+/- 0.000006) AU**-1, respectively, suggesting that this is a "new" comet from the Oort cloud. A handful of observations suggest that the comet has been around 12th - 13th magnitude over the last six months.

2002 R2 (155P/Shoemaker) The observations suggest that the comet faded from 13th to 14th magnitude over the winter.

A/2002 RN38 is an asteroid, of 18th magnitude, discovered in 2002 September. It is in a 7.4 year orbit, with perihelion at 1.24 AU and an eccentricity of 0.67. It is at perihelion in mid December and will fade as its distance from earth increases. [MPEC 2002-T84, 2002 October 14, 34-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent encounters.

A/2002 SQ41 (NEAT) is an asteroid, of 20th magnitude, discovered by NEAT at Heleakala on 2002 September 29.41. The preliminary two day orbit puts it in a 5.6 year orbit, with perihelion at 0.50 AU and an eccentricity of 0.84. It will reach perihelion in early December, but unless it shows cometary activity will not brighten past 17th magnitude. It is a PHA, passing 0.006 AU from the Earth's orbit at the ascending node. On this occasion the closest approach is 0.09 AU. [MPEC 2002-T03, 2002 October 2, 2-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent approaches.

2002 T1 (P/LINEAR) M. Blythe and S. Partridge, Lincoln Laboratory, Massachusetts Institute of Technology, report the LINEAR discovery of a 16th mag comet showing a coma and a possible tail in p.a. about 260 deg on October 3.26. Following posting on the NEO Confirmation Page, other observers confirmed the cometary appearance, including P. Birtwhistle, Great Shefford, England (Oct. 4.11 UT, m_1 = 15.4, faint 1' tail in p.a. 231 deg), and J. McGaha, Tucson, AZ (Oct. 4.33, nuclear condensation of mag about 15.3 and diameter about 6", with a tail 45" long and about 12" wide in p.a. 235 deg curving toward the north). [IAUC 7983, 2002 October 4]

The comet is periodic and is near perihelion and will fade. The period is around 6.7 years and the perihelion distance 1.2 AU. BAA Member Peter Birtwhistle was amongst the first to confirm its cometary nature.

2002 T4 (54P/de Vico-Swift-NEAT) K. Lawrence, S. Pravdo, and E. Helin, Jet Propulsion Laboratory, report the discovery on Oct. 11.22 UT of a 19.3 mag comet (with a nuclear condensation of diameter about 4" and a tail about 20" long toward the south-southwest) on NEAT images taken at Palomar. M. Hicks reports that images taken by J. Young at Table Mountain on Oct. 12.3 (through cirrus clouds) show a diffuse coma and a faint 5" tail to the southwest. D. Balam, University of Victoria, reports that images taken by J. Clem with the 1.82-m Plaskett telescope (also on Oct. 12.3) also show the object to be cometary in appearance (3 pixels, or 3".3, larger than nearby stars). [IAUC 7991, 2002 October 12] The comet was named 2002 T4 (P/NEAT), but it was quickly realised that this was not a new comet: A. Nakamura, Kuma, Ehime, Japan, reports that K. Muraoka (Kochi, Japan) has identified comet P/2002 T4 (cf. IAUC 7991) with 54P, last seen in 1965. The indicated correction to the prediction on MPC 34423 (ephemeris on MPC 46016) is Delta(T) = -7.5 days. Calculations by B. G. Marsden, Smithsonian Astrophysical Observatory, indicate that the comet passed 0.16 AU from Jupiter on 1968 Oct. 18.[IAUC 7992, 2002 October 13]

2002 T5 (P/LINEAR) An apparently asteroidal object of mag 18.4 reported by LINEAR on October 5.39, posted on the NEO Confirmation Page due to unusual motion, has been found to be cometary in appearance. D. T. Durig and J. A. K. Blackwood, University of the South, Sewanee, TN, report that CCD images taken with a 0.30-m reflector on Oct. 18.4 UT show the object to be diffuse with a hint of a tail 12"-15" long in p.a. 330 deg and a soft coma of diameter 5"-8". Images taken by G. Hug, Eskridge, KS, also with a 0.30-m reflector at about the same time, show a nearly stellar coma with extension about 10"-15" long in p.a. about 280 deg. [IAUC 7998, 2002 October 22]

Although some 9 months from perihelion, it is a distant object and will only brighten a little. The period is around 18 years and the perihelion distance 3.9 AU. Observers contributing to the preliminary orbit include BAA Member Peter Birtwhistle.

2002 T6 (P/NEAT-LINEAR) An object reported as asteroidal independently by the NEAT (October 4.50, mag 20.1) and LINEAR surveys (October 7.26, mag 19.4), and later placed on the NEOCP, has been found cometary in appearance. P. Birtwhistle, Great Shefford, U.K., reports that CCD images taken with a 0.3-m reflector on Oct. 27.9 UT show two faint, thin, straight tails in p.a. 107 deg (36" long) and 310 deg (39" long) and a nuclear condensation with diameter about 8". T. B. Spahr reports that 5-min exposures taken with the Mt. Hopkins 1.2-m reflector on Oct. 29.2 show a small coma of diameter about 6" and an extremely faint tail about 10" long in p.a. 330 deg. [IAUC 8002, 2002 October 29]

Although some time from perihelion, it is a distant object in a periodic orbit and will initially fade. The period is around 21 years and the perihelion distance 3.4 AU. Observers contributing to the preliminary orbit include BAA Members Peter Birtwhistle and Stephen Laurie.

2002 T7 (LINEAR) Another object, of mag 17.5 found on October 14.42, and reported as asteroidal by the LINEAR survey has been found to be cometary in appearance. P. Birtwhistle, Great Shefford, U.K., writes that CCD images taken on Oct. 28.0 UT show the object to be slightly 'softer' than stars of similar brightness. T. B. Spahr reports that Mt. Hopkins images taken on Oct. 29.4 show the object to be very slightly diffuse, again with it being slightly larger than the FWHM of nearby stars. The available astrometry (some giving the comet's magnitude as bright as 16.5), including an Oct. 12 prediscovery observation, is given on MPEC 2002-U43. It is possible that this comet could reach naked-eye brightness around April--June 2004. [IAUC 8003, 2002 October 29] Observers contributing to the preliminary orbit include BAA Members Peter Birtwhistle and Stephen Laurie. Comet Section are +0.000447 and +0.000437 (+/- 0.000012) AU**-1, respectively, suggesting that this is not a "new" comet from the Oort cloud.

A/2002 VP94 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 November 5.31. It is in an 8.0 year orbit, with perihelion at 1.52 AU and an eccentricity of 0.62. It is at perihelion in January, and will brighten by about a magnitude. [MPEC 2002-V70, 2002 November 15, 10-day orbit] Brian Marsden notes that it is not clear if the object is in fact a comet. The orbit is typical of a Jupiter family comet and it can pass within 0.4 AU of the planet.

A/2002 VQ94 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 November 11.24. Brian Marsden notes that it is not clear if the object is in fact a comet. [MPEC 2002-V71, 2002 November 15] It is in a 3000 year orbit, with perihelion at 6.8 AU and an eccentricity of 0.97. Currently at 9.8 AU from the Sun it reaches perihelion in February 2006, when it may be mag 17.5 or brighter if it shows some cometary activity. [MPEC 2002-Y67, 2002 December 30]

A/2002 WW17 (NEAT) is an asteroid, of 19th magnitude, discovered by Heleakala NEAT on 2002 November 28.55. It is in a 5.1 year orbit, with perihelion at 1.04 AU and an eccentricity of 0.65. It is at perihelion in late March but will remain near its present magnitude. [MPEC 2002-X35, 2002 December 6, 8-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent passes close to the planet.

2002 X1 (LINEAR) An object of mag 18.0 reported as asteroidal by LINEAR on December 5.44, and placed on the NEO Confirmation Page due to its unusual motion, has been found to be cometary on CCD images taken around Dec. 7.4 UT by D. T. Durig (Sewanee, TN, 0.3-m reflector; 25" coma, m_1 = 15.5), by P. R. Holvorcem and M. Schwartz (Nogales, AZ, 0.81-m telescope; diffuse with coma diameter about 10" and a hint of tail at p.a. about 300 deg), and by G. Hug, R. Valentine, and B. Leifer (Eskridge, KS, 0.30-m reflector; diffuse). [IAUC 8028, 2002 December 7]

The preliminary low inclination, small perihelion distance orbit was quickly replaced by a retrograde, larger perihelion distance orbit after Sebastian Hoenig pointed out that no object had been detected in SOHO images. It is some 7 months from perihelion and will brighten by a couple of magnitudes and could reach 14th magnitude in February. Some CCD observations put the comet at 16th magnitude. Brian Marsden notes on MPEC 2003-C44 [2003 February 8] that the "original" and "future" barycentric values of 1/a are +0.000790 and +0.001222 (+/- 0.000011) AU**-1, respectively, suggesting that this is not a "new" comet from the Oort cloud. A single observation put the comet at around 14th magnitude in January.

2002 X2 (P/NEAT) K. J. Lawrence reports the discovery of a comet of mag 18.4 by the NEAT team (which now includes also R. Bambery, E. Helin, S. Pravdo, M. Hicks, and R. Thicksten) from CCD images taken with the 1.2-m Schmidt telescope at Palomar on December 7.17. Following posting on the NEO Confirmation Page, J. Ticha and M. Tichy found the comet to show a 7" coma and a 14" tail in p.a. 45 deg on Klet images taken on Dec. 8.8 UT. P. Holvorcem that the co-addition of three 120-s exposures taken with the Tenagra II telescope at Nogales, AZ, on Dec. 8.20 shows a coma with diameter about 7" and a tail about 14" long in p.a. about 55 deg. F. B. Zoltowski, Edgewood, NM, notes that CCD images taken with a 0.3-m reflector on Dec. 9.15 shows the comet as diffuse with a 15" coma diameter and a possible faint tail in p.a. 240 deg. [IAUC 8029, 2002 December 9] It is a moderately distant and intrinsically faint periodic comet of 18th magnitude. Although a few months from perihelion it will fade. It has a period of 8.1 years and a perihelion distance of 2.5 AU.

2002 X5 (Kudo-Fujikawa) S. Nakano, Sumoto, Japan, reports the visual discovery of a comet by Tetuo Kudo (Nishi Goshi-machi, Kikuchi-gun, Kumamoto-ken, Japan Nikon 20x120 binoculars. Coma diameter 2'; central condensation visible, but no tail detected). This was confirmed by K. Kadota (Ageo, Saitama, Japan). 0.25-m f/5.0 reflector + CCD. Coma diameter 5'.5; tail at least 18' long in p.a. 331 deg. [IAUC 8032, 2002 December 14]

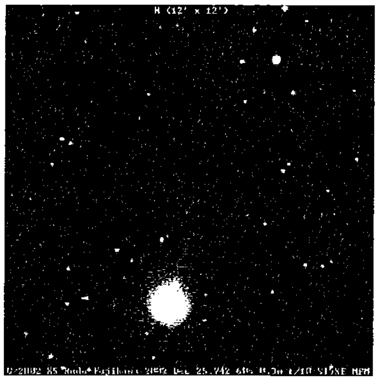


Image by Martin Mobberley, December 25

J. Watanabe, National Astronomical Observatory of Japan, reports the independent visual discovery of this comet by Shigehisa Fujikawa, Oonohara, Kagawa, Japan, (Dec. 14.858 UT, 9:, 4' 0.16-m reflector); report received by Watanabe prior to the issuance of IAUC 8032). T. Lovejoy, Thornlands, Qld., Australia, reports that C/2002 X5 appears faintly visible at mag approximately 10-11 (based on the appearance of other comets in SWAN images) on SWAN images that were taken on six dates, Nov. 6-13, and posted at the SOHO website. [IAUC 8033, 2002 December 16]

R. W. Russell, D. K. Lynch, and D. L. Kim, The Aerospace Corporation; M. L. Sitko, University of Cincinnati; and W. Golisch, NASA Infrared Telescope Facility (IRTF), report that spectroscopy of comet C/2002 X5 was obtained on Jan. 9.1 and 10.05-10.14 UT at 1.5-3.4 airmasses with the Aerospace Broadband Array Spectrograph System at the IRTF 3-m telescope. They observed a relatively smooth thermal-emission spectrum, over most of the spectral range covered (3-14 microns), whose shape resembled a blackbody near or slightly above the blackbody radiative equilibrium temperature of 340 K. A silicate emission feature, if present, would be no more than about 15 percent of the continuum. A 3.4-micron C-H feature may be present in emission. Narrowband magnitudes (each +/- 0.05) on Jan. 9.1 in a 3".5-diameter aperture were L [3.5 microns] = 8.3, M [4.5 microns] = 5.8, and N

[10.2 microns] = 1.7. The emission at 10.2 microns was extended at least 18" east-west and 10" north- south, using a 29" north-south chop. The beam only needed to be moved about 3" east-west to get to the half-power location, suggesting that the infrared emission was concentrated on the peak with an extended coma component. On Jan. 10, the spectrum was essentially unchanged, though perhaps 5 percent brighter. [IAUC 8062, 2003 January 30]

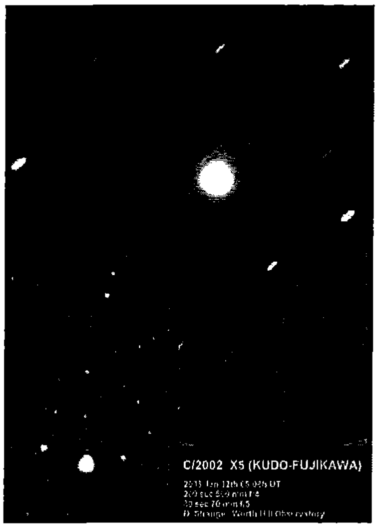


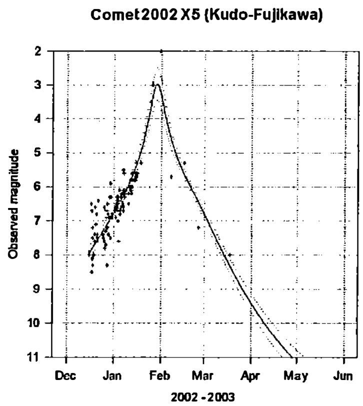
Image by David Strange on January 12

Initially reported as 9th magnitude, some observers report it as bright as 7th magnitude. It has a coma perhaps 5' in diameter and a faint tail. The preliminary orbit indicated that the comet could have been found a month earlier. Inspection of SOHO SWAN imagery by Terry Lovejoy and confirmed by Sebastian Hoenig found images that do show the comet and confirm the general form of the orbit and the absolute brightness of the comet.

This is Shigehisa Fujikawa's 6th comet, the others being C/1969 P1 (Fujikawa) C/1970 B1 (Daido-Fujikawa), C/1975 T1 (Mori-Sato-Fujikawa), 72P/Denning-Fujikawa (=1978 T2) and C/1983 J1 (Sugano-Saigusa-Fujikawa). He was also an independent discoverer of C/1968 H1 (Tago-Honda-Yamamoto), C/1968 N1 (Honda) and C/1988 P1 (Machholz). He used nearly the same telescope for these discoveries, but has replaced the original f5 primary mirror with a new f6 one.

After a long spell of overcast skies, it cleared for Cambridge as dusk fell on December 17 and I was able to observe the comet with my 0.15-m reflector x80, making it 8.5, DC3 and diameter 2.4' on December 17.73. This contrasts with observers using binoculars, for example Tony Scarmato, Calabria, Italy on December 17.70 made it 6.7, coma 5' in 7x50B and Guus Gilein from the Netherlands on December 18.21 made it 7.2, coma 5' in 10x50B. I observed it with 20x80B on December 18.73 making it 8.0 with a 5' coma. On December 28.74 I made it 6.9, DC5 in the same binoculars, and on January 1.80 approximately 6.6. Observing in poor conditions on January 10.27 I made it 6.6:, compared to 6.1 on January 7.74. During the second week of January the magnitude seems to have stalled. On January 12.26 under poor conditions I estimated the magnitude at 6.1 in 20x80B. On January 14.28 in brightening skies I found it at 5.8, DC7, diameter 2.3' in 20x80B.

The comet was visible in the SOHO C3 coronagraph from January 25 to 31. It reached perihelion at 0.19 AU on January 29.0, when it showed significant phase angle effects and faded significantly. After perihelion it appeared to brighten again, reaching around 1st magnitude. I compiled a movie loop of the images, which show the comet heading in towards the Sun, and as it heads out again, the tail swings round and it leaves tail first.



Michael Mattiazzo reported it at 5.7 on February 7.51 on 25x100B, low in the twilight. I had a good view of it from the Falkland Islands prior to heading further south, and at this time it appears to have been anomalously bright, as I made it 5.3 in 10x50B and could see a 15' tail in my 9cm Orion refractor x20. It returned to UK skies as a binocular object in mid March, but faded rapidly and was soon a couple of magnitudes fainter than the mean light curve.

149 observations received so far give a preliminary light curve, corrected for aperture and where possible for systematic observer differences of m = 7.2 + 5 log d + 6.9 log r

A/2002 XA (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 December 1.22. It is in a 5.1 year orbit, with perihelion at 1.04 AU and an eccentricity of 0.65. It is at perihelion in early February but and will brighten by at least a couple of magnitudes. [MPEC 2002-X08, 2002 December 2, 1-day orbit] The orbit is typical of a Jupiter family comet. It is also a potentially hazardous asteroid, passing 0.034 AU from the Earth's orbit at the ascending node. This February it will pass at 0.1 AU. It can also pass within 0.2 AU of Jupiter.

A/2002 XG36 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2002 December 5.31. It is in a 5.9 year orbit, with perihelion at 1.54 AU and an eccentricity of 0.53. It was at perihelion in early October and will fade. [MPEC 2003-A54, 2003 January 8, 33-day orbit] The orbit is typical of a Jupiter family comet, and it has approached within 0.8 AU during the last century.

A/2002 XE84 (LINEAR) is an asteroid, of 20th magnitude, discovered by LINEAR on 2002 December 13.44. It is in a 4.7 year orbit, with perihelion at 0.95 AU and an eccentricity of 0.66. It is at perihelion in mid January and will fade. [MPEC 2002-X85, 2002 December 15, 1-day orbit] There have been no recent approaches to Jupiter due to the high (30 degree) inclination orbit.

2002 Y1 (Juels-Holvorcem) Charles Juels and Paulo Holvorcem have discovered a 15th magnitude comet on CCD images taken with a 0.12-m f5 refractor on December 28.44. The preliminary orbit suggested that the comet will reach perihelion on April 15 at 0.75 AU. It is a morning object. The comet reached 6th magnitude in early April.

A comet has been found on CCD images (discovery observation below) taken with a 0.12-m f/5.0 refractor by Charles W. Juels (Fountain Hills, AZ) and Paulo R. Holvorcem (Campinas, Brazil). Holvercem reports that co-adding five 45-s and one 90-s exposures taken around Dec. 28.5 UT reveals a coma 1'.8 in diameter. Following posting on the NEO Confirmation Page, several other observers reported on the cometary appearance of the object, including D. T. Durig (Sewanee, TN), who noted that 300-s CCD exposures with a 0.3-m reflector show an inner coma of diameter 30" and a wider, diffuse glow of diameter 2'.5. [IAUC 8039, 2002 December 29]

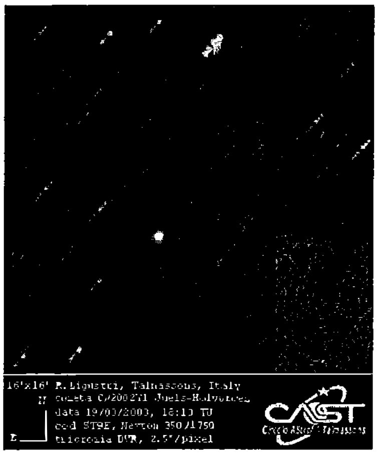


Image by Rolando Ligustri on March 19

D. K. Lynch, R. W. Russell, and D. L. Kim, The Aerospace Corporation; M. L. Sitko, University of Cincinnati; and R. B. Perry, Langley Research Center, NASA, report that 3-14-micron spectroscopy of comet C/2002 Y1, obtained on Feb. 20.6 UT with the NASA Infrared Telescope Facility 3-m telescope (+ Aerospace Broadband Array Spectrograph System), yielded a narrowband magnitude of N [10.2 microns] = 3.5 +/- 0.1. The spectrum shows a smooth featureless continuum with an 8-13-micron color temperature of about 280 +/- 20 K, roughly 12 times higher than the radiative equilibrium blackbody temperature. The comet was not detected between 3 and 8 microns, and an upper limit to the silicate emission feature was approximately 10 percent of the 8-13-micron continuum. [IAUC 8083, 2003 February 27]

Notes on the comet mail list suggest that the discoverers were using a 12cm f5 refractor, on a high-end mount and using a SITe CCD yielding a 2.35 x 2.35 degree field of view. The discovery was made on the very first night the equipment was commissioned! Paulo Holvorcem provided this background information:

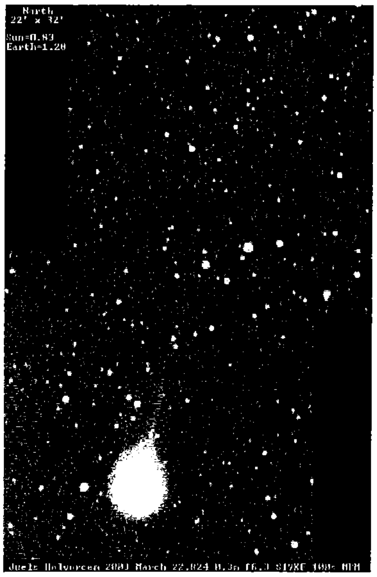


Image by Martin Mobberley on March 22

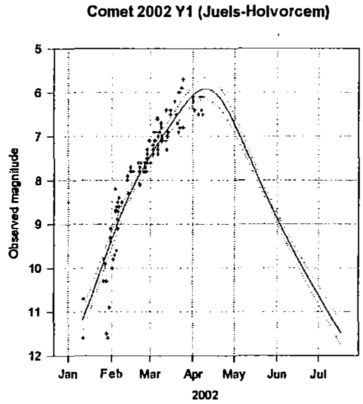
Charles Juels and myself collaborate over the internet, with the help of "fast" ADSL internet connections, which makes it easy to communicate and transfer images in near-real time between Fountain Hills (near Phoenix, Arizona) and my home in Campinas, Brazil. From here I can schedule search and follow-up runs at Fountain Hills using software I wrote for this purpose (or they can be planned by Charles), and we can split the tasks of data analysis by transferring images over the internet. The astrometric observations from codes 926, 848, and 860, which you see in MPECs are obtained in an analogous way. These days I hardly leave my house to observe! We were very lucky to find C/2002 Y1 on the first night with the new 0.12-m refractor on an automated mount. For some time we had considered the idea of doing wide-field searches for new "bright" objects, and this was our first experiment. The field of view is about 2.3 x 2.3 degrees. On that first night (Dec. 28) we searched some 300 square degrees and were surprised to find an object of apparently diffuse appearance. Co-adding the discovery images and a few others taken for follow-up on the same night suggested a coma about 1.8' in diameter, which we didn't immediately report (it seemed too much luck, maybe it was not real). But we reported the positions immediately to the MPC, which posted the object (then referred to as HJ0080) on the NEOCP. It was soon confirmed by others, so we were sure that it was real. And if it was real, then the co-addition of the images showed that it was a comet. We then reported the detection of the coma on Dec. 29, and soon afterwards the comet was announced on an IAUC and a MPEC.

Some observations in early January suggested that it might be around 13th mag. Seiichi Yoshida estimated the comet at mag 10.7 in his 0.32-m reflector on January 11.79 and I made a low reliability estimate of it at 11.6 in the Thorrowgood refractor on January 11.13. Observations later in January after the moon left the sky suggest that the comet had brightened to 10th magnitude. Observing on February 3.1 with 20x80B and 25x100B the comet was a large, diffuse object of approximately magnitude 8. By late February Gabriel Oksa reported it as 7.3 in 20x80B and he made it 6.5 by mid March. It rapidly moved out of the evening sky and was then visible in the early morning, which always reduces the number of observations, even for a bright comet. Observing from my bedroom window in Cambridge on April 2.17 I estimated the comet at 6.4 in 20x80B. It quickly sank into the morning twilight, but I made a final positive observation at 6.5 from my observing site outside Cambridge on April 8.16. Although we lose it from northern skies, it should continue to be visible from the Southern Hemisphere for several months.

Brian Marsden notes on MPEC 2003-G13 [2003 April 3] that the "original" and "future" barycentric values of 1/a are +0.004113 and +0.004506 (+/- 0.000020) AU**-1, respectively, suggesting that this is not a "new" comet from the Oort cloud. Such comets usually have consistent light curves, giving some hope that the comet will perform at perihelion.

107 observations received so far give a preliminary light curve, corrected for aperture and where

possible for systematic observer differences of m = 6.6 + 5 log d + 11.8 log r



A/2002 YK29 (LINEAR) is an asteroid, of 20th magnitude, discovered by LINEAR on 2002 December 31.30. It is in a 5.9 year orbit, with perihelion at 1.48 AU and an eccentricity of 0.55. It was at perihelion in mid October and will brighten a fraction towards opposition before fading. [MPEC 2003-A63, 2003 January 10, 9-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent approaches.

2003 A1 (????). LINEAR discovered a 19th mag comet on January 5.07. [IAUC 8044, 2003 January 8] Although parabolic orbital elements were published, Brian Marsden noted on MPEC 2003-A56 [2003 January 8] that the object was probably of short period, and that its orbit was rather similar to that of comet D/1783 W1 (Pigott). Further observations, published on MPEC 2003-A86 [2003 January 15] confirm the short period nature of the orbit, with perihelion at 1.91 AU, a high inclination of 46 degrees and a period of 7.1 years. The ephemeris suggests that it will fade. This is LINEAR's 100th comet.

Orbital calculations by Maik Meyer, Nakano and Muraoka tend to confirm the identity of the object with D/1783 W1, though no completely satsifactory linkage has so far been computed.

If the comet has made 33 revolutions from 1783 to 2003, this provides a good linkage between D/1783 W1 and P/2003 A1. Because the period of the comet is not certain, the number of revolutions of the comet could be between 37 and 29. Furthermore, in the case of 33 revolutions, the comet made close approaches to Jupiter: on 1923 9 16.0 to 0.35 AU, on 1864 6 1.5 to 0.57 AU, and on 1852 7 3.0 to 0.98 AU with an approach to 0.67 AU on 1793 4 7.5. The closest approach to the earth during this time was at the appearance of 1783.

An apparently asteroidal LINEAR object discovered on January 5.07 with m2 18.4), posted on the NEO Confirmation Page, has been found to be diffuse by CCD observers elsewhere, including at Haleakala (1.2-m reflector, with K. Lawrence reporting the object as slightly diffuse on NEAT images taken on Jan. 7.3 UT, and again somewhat diffuse on Jan. 8.3), at Klet (where M. Tichy found a coma diameter of 8" on images taken on Jan. 8.7 with the 1.06-m KLENOT reflector), and at Ondrejov (where P. Pravec found a faint, small coma that was "marginally apparent", on images taken close to the moon on Jan. 8.8 with the 0.65-m f/3.6 reflector). The object is likely of short period, with the angular orbital elements quite similar to those of D/1783 W1. [IAUC 8044, 2003 January 8]

2003 A2 (Gleason) A very distant, 20th magnitude object, first observed by Spacewatch II on January 10.39 has been found to show cometary activity. The preliminary orbit assumed that it was near perihelion, and was at 11.52 AU. Brian Marsden notes on MPEC 2003-A78 [2003 January 14] that the assumed perihelic parabolic orbit is very tentative. It seems likely that the object is a Centaur, showing cometary activity as (2060) = 95P/Chiron has shown near perihelion.

The latest orbit [MPEC 2003-C07, 2003 February 1] puts perihelion in 2004 January at 11.4 AU, with the comet currently 11.5 AU from the Sun. A revised orbit [MPEC 2003-C47, 2003 February 8], including prediscovery observations by Palomar/NEAT (found and measured in NEAT data by Sebastian Hoenig and R Stoss), confirms these perihelion circumstances. The perihelion distance is the largest on record.

Arianna E. Gleason, Lunar and Planetary Laboratory, reports her discovery of a slow-moving comet of 20th mag on Jan. 10.39 UT with the Spacewatch II telescope at Kitt Peak; J. V. Scotti adds that there was a more-or-less symmetrical coma about 20" across. On making follow-up observations on Jan. 11.3 (after placement on The NEO Confirmation Page), D. T. Durig and H. H. Fry (Sewanee, TN, 0.3-m f/5.75 Schmidt-Cassegrain reflector) confirmed a coma 15"-18" in diameter, and F. B. Zoltowski (Edgewood, NM, 0.3-m f/3.3 Schmidt-Cassegrain reflector) noted that the coma/tail structure had the appearance of a broad fan from p.a. 20 deg northward through p.a. 200 deg. On Jan. 12.0, J. Ticha and M. Tichy (Klet Observatory, 1.06-m KLENOT Telescope) indicated a coma diameter of 8"-10", with m_1 = 20.2 and m_2 = 21.0. The object's cometary nature was also noted by T. Gehrels (Spacewatch II) on Jan. 11-13 and by J. G. Ries (McDonald Observatory, 0.76-m reflector) on Jan. 14.3. [IAUC 8049, 2003 January 15]

Brian Marsden notes on MPEC 2003-E63 [2003 March 14] that the "original" and "future" barycentric values of 1/a are +0.000065 and +0.000158 (+/- 0.000017) AU**-1, respectively, suggesting that this is a "new" comet from the Oort cloud. The current orbit is now strongly hyperbolic.

A/2003 AC1 (LINEAR) is an asteroid, of 20th magnitude, discovered by LINEAR on 2003 January 1.43. It is in a 5.7 year orbit, with perihelion at 1.09 AU and an eccentricity of 0.66. It is at perihelion in mid February and will brighten a little. [MPEC 2003-A13, 2003 January 3, 2-day orbit] The orbit is typical of a Jupiter family comet and it can approach within 1 AU of Jupiter, though it has not done so over the last century. It approaches to 0.20 AU of the Earth at this return and this is one of its closest approaches.

A/2003 AK73 (NEAT) is an asteroid, of 19th magnitude, discovered by Palomar NEAT on 2003 January 11.22. It is in a 5.1 year orbit, with perihelion at 0.76 AU and an eccentricity of 0.74. It is past perihelion and will fade. [MPEC 2002-A73, 2003 January 13, 2-day orbit] The orbit is typical of a Jupiter family comet and it has made several encounters within 1 AU of Jupiter over the last century. It can also approach quite close to the Earth and was 0.11 AU away in December. It can approach within 0.07 AU of our planet.

A/2003 BM1 (NEAT) is an asteroid, of 20th magnitude, discovered by Palomar NEAT on 2003 January 24.32. It is in a 7.8 year orbit, with perihelion at 1.86 AU and an eccentricity of 0.53. Perihelion is in mid March, but the brightness will not change significantly. [MPEC 2003-B29, 2003 January 27, 3-day orbit] The orbit is typical of a Jupiter family comet. The object encounters Jupiter at both nodes and can approach within 0.35 AU.

A/2003 BD44 (LONEOS) is an asteroid, of 19th magnitude, discovered by LONEOS on 2003 January 30.31. It is in a 5.6 year orbit, with perihelion at 0.67 AU and an eccentricity of 0.79. Perihelion is at the beginning of July, but the brightness will not change significantly. [MPEC 2002-B54, 2003 January 31, 2-day orbit] The orbit is typical of a Jupiter family comet. It approached within 0.3 AU of Jupiter in October 2001 and will approach within 0.3 AU of the Earth in July. It is a potentially hazardous object, passing 0.011 AU from the Earth's orbit at the ascending node.

2003 CP7 (P/LINEAR-NEAT) A 18th magnitude comet discovered on NEAT Palomar images obtained on March 10.36, and posted on the NEO Confirmation Page, was reported by K. Lawrence as showing a nuclear condensation of diameter about 7" and a tail about 8" long toward the west. The cometary nature was confirmed by J. Young at Table Mountain on Mar. 12.4 UT. The Minor Planet Center has linked this object to an apparently asteroidal LINEAR object of mag 19.0 on Feb. 1.39 and 4 that was designated 2003 CP_7 (MPS 73383-73384, Feb. 16). [IAUC 8092, 2003 March 12] The comet is a distant one, with period of 8.05 years and will fade.

A/2003 CO1 (NEAT) is an asteroid, of 20th magnitude, discovered by Palomar NEAT on 2003 February 1.42. It is in a 96 year orbit, with perihelion at 10.94 AU and an eccentricity of 0.48. [MPEC 2003-F03, 2003 March 17, 1-year orbit] The orbit is typical of a Chiron like object. It is still approaching perihelion, which is in August 2006, so it may yet show cometary activity.

A/2003 CC11 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2003 February 4.16. It is in a 5.0 year orbit, with perihelion at 1.26 AU and an eccentricity of 0.57. It is at perihelion in mid February and will fade. [MPEC 2003-C31, 2003 February 5, 2-day orbit] The orbit is typical of a Jupiter family comet and it can approach within 0.6 AU of Jupiter and 0.30 AU of the Earth.

A/2003 CC22 (CFHT) is an asteroid, of 22nd magnitude, discovered by a team using the 3.6-m Canada-France- Hawaii and 2.2-m University of Hawaii telescopes on Mauna Kea on 2003 February 8.34. It is in a 21 year orbit, with perihelion at 4.20 AU and an eccentricity of 0.44. It is at perihelion this summer and will fade. [MPEC 2002-G16, 2003 April 3, 1-month orbit] The orbit is unusual, crossing that of Jupiter and Saturn.

2003 E1 (NEAT) S. Pravdo reports another NEAT comet discovery, found on March 9.51 at 20th magnitude, the object having a tail extending about 8" in p.a. 215 deg on Mar. 11. Young also found it cometary on Mar. 12. The available astrometry, very uncertain parabolic orbital elements [T = 2004 Mar. 13.3 TT, Peri. = 110.8 deg, Node = 141.9 deg, i = 37.6 deg (equinox 2000.0), q = 2.950 AU], and an ephemeris appear on MPEC 2003-E48. [IAUC 8092, 2003 March 12] Follow up observations show that comet is an intermediate period one, returning every 51 years and a month past perihelion at 3.2 AU. Its brightness will not change significantly over the next six months.

A/2003 EJ59 (LINEAR) is an asteroid, of 18th magnitude, discovered by LINEAR on 2003 March 12.24. It is in a 5.8 year orbit, with perihelion at 1.21 AU and an eccentricity of 0.62. It is at perihelion in mid March and will fade. [MPEC 2003-E55, 2003 March 14, 2-day orbit] The orbit is typical of a Jupiter family comet and it can approach within 0.2 AU of Jupiter and the Earth.

2003 F1 (LINEAR) was discovered by LINEAR on March 23.43. It has a perihelion distance of 4 AU and a period of 96 years. It will not brighten significantly from its current 16th magnitude.

2003 F2 (P/NEAT) is a distant periodic comet discovered by NEAT on March 27.20. It has a perihelion distance of 2.9 AU, a period of 16 years and will fade. Syuichi Nakano notes that the orbit of the comet is very similar to that of 2001 BB50 (P/LINEAR-NEAT) and that they were both at perihelion in late July 1987. Maik Meyer notes that the minimum separation of the two was only 0.016 AU in March 1989.

2003 G1 (LINEAR) was discovered by LINEAR on April 8.45. It has a perihelion distance of 4.9 AU. It is a couple of months past perihelion and will not brighten significantly from its current 16th magnitude.

2003 G2 (LINEAR) was discovered by LINEAR on April 8.38. It has a perihelion distance of 1.6 AU. It is near perihelion and will not brighten significantly from its current 17th magnitude.

A/2003 GS22 (Kitt Peak) is an asteroid, of 21st magnitude, discovered by R S McMillan with the 0.9-m telescope at the Steward Observatory, Kitt Peak on 2003 April 7.40. It is in a 5.1 year orbit, with perihelion at 1.15 AU and an eccentricity of 0.61. It was at perihelion in March and will fade. [MPEC 2003-G44, 2003 April 9, 2-day orbit] The orbit is typical of a Jupiter family comet. It can approach Jupiter to within 0.25 AU and approached within 0.18 AU of the Earth in February.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

The Comet's Tale is produced by Jonathan Shanklin, with thanks to the British Antarctic Survey and the Institute of Astronomy, Cambridge for the use of computing facilities. E&OE.

Introduction

This issue has ephemerides, for the UK or Southern Hemisphere, for the comets that are likely to be brighter than 12[th] magnitude:

- 2001 HT50 (LINEAR-NEAT)
- 2001 Q4 (NEAT) (Southern Hemisphere)
- 2002 O7 (LINEAR) (Southern Hemisphere)
- 2002 T7 (LINEAR)
- 2002 Y1 (Juels-Holvorcem) (Southern Hemisphere)

The actual magnitudes may differ from those given here by several magnitudes. Several other comets, including 2P/Encke, 65P/Gunn, 66P/du Toit, 81P/Wild, 116P/Wild, 2001 RX14 (LINEAR) and 2002 J4 (NEAT) may be brighter than 14^m. 29P/Schwassmann-Wachmann has frequent outbursts and is currently best seen from the Southern Hemisphere. Many comets undergo outbursts and it is worth monitoring all periodic comets that are well placed for observation in case they are in outburst. Current ephemerides for the fainter comets, and for other locations, are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are for the UK at a latitude of 53° N, or the Southern Hemisphere at 40° S on the Greenwich meridian and give the following:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula

Where the comet is invisible from the UK other locations may be used; these are either the Equator or latitude 40° S always at longitude 0°. The use of longitude 0° means that the times given can be used as local times.

- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemerides follow

Ephemeris for comet 2001 HT50 (LINEAR-NEAT) (UK)

```
Omega=324.0151 OMEGA= 42.8562 i=163.2148 q= 2.791821 a=**********
e=0.998323  P=67925.331  T= 2003 July     8.9847    Equinox= 2000
Magnitudes calculated from m= 4.5+5.0*Log(d)+10.0*Log(r)
```

August 2003 — Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
8/ 9	5 36.5	17.01	5 39.4	17.03	11.6	3.33	2.81	8.31	Not Observable	51	166	88	2	263	-1	0
13/14	5 35.0	17.10	5 37.9	17.12	11.6	3.25	2.82	8.10	Not Observable	56	100	97	2	264	-1	0
18/19	5 33.1	17.18	5 36.0	17.20	11.5	3.16	2.82	7.48	2.39 to 3.10	62	39	60	2	264	-2	0
23/24	5 30.5	17.26	5 33.5	17.28	11.5	3.07	2.83	7.26	2.14 to 3.21	67	24	15	2	265	-3	0
28/29	5 27.3	17.34	5 30.2	17.36	11.4	2.98	2.84	7.03	1.49 to 3.33	72	90	2	2	265	-3	0
September 2003																
2/ 3	5 23.4	17.41	5 26.3	17.44	11.3	2.88	2.85	6.40	1.22 to 3.44	78	161	44	2	266	-4	0
7/ 8	5 18.5	17.48	5 21.4	17.51	11.3	2.78	2.86	6.15	0.55 to 3.54	84	127	93	2	266	-5	0
12/13	5 12.7	17.54	5 15.6	17.57	11.2	2.68	2.87	5.50	0.28 to 4.05	90	62	95	2	266	-6	0
17/18	5 5.8	17.58	5 8.7	18.02	11.2	2.59	2.89	5.23	23.59 to 4.14	97	7	58	2	266	-8	0
22/23	4 57.6	18.02	5 0.5	18.06	11.1	2.49	2.90	4.55	23.29 to 4.24	104	64	12	2	265	-9	0
27/28	4 48.2	18.03	4 51.1	18.07	11.0	2.40	2.91	4.26	22.58 to 4.33	111	137	4	2	265	-11	0
October 2003																
2/ 3	4 37.4	18.01	4 40.3	18.06	11.0	2.32	2.93	3.55	22.25 to 4.42	118	147	53	2	264	-12	0
7/ 8	4 25.1	17.55	4 28.0	18.01	10.9	2.24	2.94	3.23	21.52 to 4.51	126	79	95	2	264	-14	0
12/13	4 11.4	17.44	4 14.3	17.52	10.9	2.18	2.96	2.50	21.19 to 4.60	134	16	94	2	263	-16	0
17/18	3 56.4	17.28	3 59.3	17.37	10.9	2.12	2.98	2.15	20.44 to 5.09	143	48	55	2	262	-17	-1
22/23	3 40.3	17.06	3 43.1	17.15	10.9	2.08	2.99	1.39	20.10 to 5.17	152	118	9	1	262	-19	-1
27/28	3 23.3	16.37	3 26.1	16.47	10.9	2.06	3.01	1.03	19.36 to 5.26	161	164	8	1	261	-20	-2

Ephemeris for comet 2001 Q4 (NEAT) (Southern Hemisphere)

Omega= 1.1942 OMEGA=210.2529 i= 99.6249 q= 0.962080 a=**********
e=1.000727 P=********* T= 2004 May 15.9427 Equinox= 2000
Magnitudes calculated from m= 3.5+5.0*Log(d)+10.0*Log(r)

May 2003 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
5/ 6	2 39.3	-32.21	2 41.4	-32.08	14.2	5.56	4.95	11.48	Not Observable	49	79	17	0	183	4	0
10/11	2 43.6	-32.22	2 45.7	-32.10	14.1	5.49	4.90	11.32	Not Observable	50	123	66	0	187	4	0
15/16	2 48.0	-32.26	2 50.1	-32.14	14.0	5.41	4.85	11.17	Not Observable	52	129	100	0	192	4	0
20/21	2 52.5	-32.33	2 54.6	-32.21	13.9	5.33	4.80	11.02	5.50 to 5.55	54	81	71	0	196	4	0
25/26	2 57.1	-32.44	2 59.2	-32.32	13.9	5.24	4.75	10.47	5.35 to 5.59	56	46	22	0	200	4	0
30/31	3 1.7	-32.57	3 3.8	-32.46	13.8	5.16	4.70	10.32	5.19 to 6.02	58	58	0	0	204	4	-1
June	2003															
4/ 5	3 6.4	-33.15	3 8.5	-33.03	13.7	5.07	4.65	10.17	5.03 to 6.05	61	99	21	0	207	4	-1
9/10	3 11.2	-33.36	3 13.2	-33.25	13.6	4.97	4.60	10.02	4.47 to 6.08	63	133	74	0	211	4	-1
14/15	3 16.0	-34.01	3 18.0	-33.50	13.5	4.88	4.55	9.47	4.31 to 6.10	65	108	100	0	214	4	-2
19/20	3 20.8	-34.30	3 22.8	-34.20	13.4	4.78	4.50	9.32	4.14 to 6.11	68	64	66	0	217	4	-2
24/25	3 25.7	-35.04	3 27.7	-34.54	13.3	4.69	4.45	9.17	3.58 to 6.12	70	50	20	0	220	4	-2
29/30	3 30.6	-35.42	3 32.5	-35.32	13.2	4.59	4.40	9.02	3.41 to 6.13	73	77	0	1	223	4	-3
July	2003															
4/ 5	3 35.5	-36.25	3 37.4	-36.15	13.1	4.49	4.35	8.47	3.24 to 6.12	75	116	27	1	226	4	-3
9/10	3 40.4	-37.12	3 42.2	-37.03	13.0	4.40	4.30	8.32	3.07 to 6.11	78	124	82	1	229	4	-3
14/15	3 45.2	-38.05	3 47.1	-37.56	12.9	4.30	4.24	8.17	2.50 to 6.10	80	87	99	1	232	4	-4
19/20	3 50.1	-39.03	3 51.9	-38.54	12.8	4.20	4.19	8.03	2.32 to 6.07	82	58	63	1	236	4	-4
24/25	3 54.9	-40.06	3 56.6	-39.57	12.7	4.11	4.14	7.48	2.11 to 6.04	85	65	17	1	239	4	-5
29/30	3 59.6	-41.14	4 1.3	-41.06	12.6	4.01	4.09	7.33	1.48 to 6.00	87	96	0	1	242	4	-5
August	2003															
3/ 4	4 4.3	-42.28	4 5.9	-42.20	12.5	3.92	4.03	7.17	1.25 to 5.56	89	120	35	1	245	4	-6
8/ 9	4 8.8	-43.47	4 10.4	-43.40	12.4	3.83	3.98	7.02	1.01 to 5.51	91	103	88	1	249	4	-6
13/14	4 13.2	-45.12	4 14.8	-45.05	12.3	3.74	3.93	6.47	0.37 to 5.45	93	73	97	1	252	3	-7
18/19	4 17.5	-46.43	4 19.0	-46.35	12.2	3.66	3.87	6.31	0.11 to 5.39	95	65	60	1	256	3	-7
23/24	4 21.5	-48.18	4 23.0	-48.11	12.1	3.58	3.82	6.16	23.45 to 5.32	96	83	15	1	260	3	-7
28/29	4 25.3	-49.59	4 26.7	-49.52	12.0	3.50	3.77	5.60	23.18 to 5.25	98	107	2	1	264	3	-8
September	2003															
2/ 3	4 28.9	-51.44	4 30.1	-51.38	11.9	3.42	3.71	5.43	22.49 to 5.18	99	106	44	1	268	2	-8
7/ 8	4 32.0	-53.34	4 33.2	-53.28	11.8	3.35	3.66	5.27	22.19 to 5.10	99	85	93	1	273	2	-9
12/13	4 34.8	-55.28	4 35.8	-55.22	11.7	3.29	3.60	5.10	21.46 to 5.02	100	73	95	1	277	1	-9
17/18	4 37.0	-57.25	4 37.9	-57.19	11.5	3.23	3.55	4.52	21.12 to 4.53	100	82	58	2	282	1	-9
22/23	4 38.5	-59.25	4 39.3	-59.19	11.4	3.17	3.49	4.34	20.33 to 4.45	100	99	12	2	287	1	-9
27/28	4 39.3	-61.26	4 40.0	-61.21	11.3	3.12	3.44	4.15	19.51 to 4.36	100	102	4	2	292	0	-10
October	2003															
2/ 3	4 39.2	-63.29	4 39.6	-63.23	11.2	3.08	3.38	3.55	19.11 to 4.28	99	86	53	2	298	0	-10
7/ 8	4 37.8	-65.31	4 38.1	-65.26	11.1	3.03	3.32	3.33	19.17 to 4.19	98	77	95	2	303	0	-10
12/13	4 35.0	-67.32	4 35.0	-67.26	11.0	3.00	3.27	3.10	19.23 to 4.10	97	86	94	2	309	-1	-10
17/18	4 30.3	-69.31	4 30.1	-69.25	10.9	2.96	3.21	2.46	19.29 to 4.02	95	101	55	3	315	-2	-9
22/23	4 23.3	-71.26	4 22.9	-71.19	10.8	2.93	3.15	2.19	19.35 to 3.54	94	102	9	3	322	-2	-9
27/28	4 13.4	-73.14	4 12.7	-73.07	10.7	2.91	3.10	1.49	19.42 to 3.46	92	83	8	3	330	-3	-9

Ephemeris for comet 2002 O7 (LINEAR) (Southern Hemisphere)

Omega=252.0689 OMEGA= 12.8000 i= 98.7461 q= 0.903338 a=**********
e=1.000242 P=********* T= 2003 September 22.5782 Equinox= 2000
Magnitudes calculated from m= 8.5+5.0*Log(d)+ 7.5*Log(r)

May 2003 Positions for 00:00 ET, Times in UT

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
5/ 6	13 14.4	42.35	13 16.6	42.19	12.5	1.74	2.38	22.23	Not Observable	117	82	17	1	155	-17	-3
10/11	12 55.6	41.31	12 57.9	41.14	12.4	1.72	2.32	21.45	Not Observable	114	39	66	1	146	-17	-5
15/16	12 37.8	40.04	12 40.2	39.47	12.3	1.71	2.26	21.07	Not Observable	109	69	100	1	138	-16	-7
20/21	12 21.5	38.17	12 24.0	38.01	12.2	1.71	2.19	20.31	Not Observable	105	130	71	1	131	-16	-8
25/26	12 6.7	36.15	12 9.3	35.59	12.1	1.71	2.13	19.57	Not Observable	100	144	22	2	125	-14	-10
30/31	11 53.8	34.01	11 56.3	33.45	12.1	1.72	2.07	19.24	Not Observable	95	95	0	2	120	-13	-11
June	2003															
4/ 5	11 42.5	31.38	11 45.1	31.22	12.0	1.74	2.00	18.53	Not Observable	89	39	21	2	116	-11	-11
9/10	11 32.9	29.10	11 35.5	28.53	11.9	1.76	1.94	18.24	Not Observable	84	40	74	2	113	-10	-12
14/15	11 24.7	26.38	11 27.4	26.22	11.8	1.78	1.88	17.56	17.51 to 18.43	79	110	100	2	111	-9	-12
19/20	11 17.9	24.05	11 20.6	23.49	11.7	1.81	1.81	17.30	17.51 to 19.06	74	167	66	2	109	-7	-12
24/25	11 12.3	21.32	11 14.9	21.16	11.6	1.83	1.75	17.04	17.53 to 19.12	69	120	20	2	108	-6	-12
29/30	11 7.6	18.59	11 10.3	18.43	11.5	1.86	1.68	16.40	17.54 to 19.12	64	60	0	3	107	-5	-12
July	2003															
4/ 5	11 3.9	16.28	11 6.5	16.11	11.4	1.88	1.62	16.16	17.56 to 19.09	59	7	27	3	107	-4	-12
9/10	11 0.8	13.57	11 3.5	13.41	11.3	1.91	1.56	15.54	17.59 to 19.04	55	75	82	3	108	-3	-12
14/15	10 58.4	11.27	11 1.0	11.11	11.2	1.93	1.49	15.31	18.02 to 18.58	50	146	99	3	109	-2	-12
19/20	10 56.5	8.58	10 59.1	8.42	11.1	1.94	1.43	15.10	18.05 to 18.52	46	149	63	3	111	-2	-12
24/25	10 55.0	6.29	10 57.6	6.13	11.0	1.95	1.37	14.49	18.09 to 18.45	42	91	17	3	113	-1	-12
29/30	10 53.9	3.59	10 56.4	3.43	10.8	1.96	1.31	14.28	18.13 to 18.37	38	29	0	4	116	-1	-12
August	2003															
3/ 4	10 53.0	1.28	10 55.5	1.12	10.7	1.96	1.25	14.07	18.16 to 18.30	34	41	35	4	120	-1	-12
8/ 9	10 52.3	-1.05	10 54.8	-1.21	10.5	1.96	1.20	13.47	18.20 to 18.22	30	109	88	4	126	0	-12
13/14	10 51.7	-3.41	10 54.2	-3.57	10.4	1.94	1.14	13.26	Not Observable	27	165	97	4	133	0	-12
18/19	10 51.2	-6.20	10 53.7	-6.36	10.2	1.92	1.09	13.06	Not Observable	25	121	60	4	142	0	-13
23/24	10 50.7	-9.05	10 53.2	-9.21	10.0	1.90	1.05	12.46	Not Observable	23	65	15	5	152	0	-13
28/29	10 50.2	-11.55	10 52.7	-12.11	9.9	1.86	1.01	12.26	Not Observable	23	22	2	5	164	0	-14
September	2003															
2/ 3	10 49.7	-14.54	10 52.2	-15.09	9.7	1.81	0.97	12.06	Not Observable	23	74	44	6	176	0	-14
7/ 8	10 49.2	-18.01	10 51.6	-18.17	9.5	1.76	0.94	11.45	Not Observable	24	133	93	7	188	0	-15

12/13	10 48.6	-21.20	10 51.0	-21.36	9.4	1.70	0.92	11.25	Not Observable	27	142	95	9	198	0	-16
17/18	10 47.9	-24.52	10 50.3	-25.08	9.2	1.63	0.91	11.05	4.46 to 4.53	30	98	58	10	206	0	-17
22/23	10 47.3	-28.43	10 49.7	-28.59	9.1	1.55	0.90	10.44	4.10 to 4.45	33	52	12	12	212	0	-19
27/28	10 46.7	-32.56	10 49.0	-33.12	9.0	1.47	0.91	10.24	3.32 to 4.36	37	49	4	14	218	0	-21
October	2003															
2/ 3	10 46.1	-37.36	10 48.4	-37.52	8.9	1.38	0.92	10.03	2.50 to 4.28	42	96	53	15	222	0	-23
7/ 8	10 45.6	-42.52	10 47.8	-43.08	8.9	1.29	0.95	9.43	2.02 to 4.19	46	127	95	17	225	0	-26
12/13	10 45.0	-48.52	10 47.2	-49.08	8.8	1.21	0.98	9.23	1.03 to 4.10	51	119	94	17	228	0	-29
17/18	10 44.3	-55.43	10 46.4	-55.59	8.8	1.13	1.01	9.02	23.36 to 4.02	56	93	55	18	231	0	-34
22/23	10 43.1	-63.33	10 44.9	-63.49	8.8	1.06	1.05	8.41	19.35 to 3.54	62	71	9	18	233	0	-39
27/28	10 39.8	-72.24	10 41.2	-72.40	8.8	1.01	1.10	8.18	19.42 to 3.46	67	67	8	17	236	-1	-44

Ephemeris for comet 2002 T7 (LINEAR) (UK)

Omega=157.7361 OMEGA= 94.8507 i=160.5760 q= 0.614686 a=**********
e=1.000391 P=********* T= 2004 April 23.1190 Equinox= 2000
Magnitudes calculated from m= 4.0+5.0*Log(d)+10.0*Log(r)

July 2003 Positions for 00:00 ET, Times in UT

										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
14/15	5 14.1	29.11	5 17.3	29.14	13.8	5.04	4.22	9.48	Not Observable	32	132	99	0	276	3	0
19/20	5 17.1	29.22	5 20.2	29.25	13.7	4.94	4.16	9.31	Not Observable	36	69	63	0	275	3	0
24/25	5 19.9	29.33	5 23.1	29.35	13.6	4.83	4.11	9.14	Not Observable	40	11	17	0	274	3	0
29/30	5 22.6	29.44	5 25.8	29.47	13.4	4.72	4.05	8.57	Not Observable	44	53	0	0	273	2	0
August	2003															
3/ 4	5 25.2	29.57	5 28.4	29.59	13.3	4.60	4.00	8.40	Not Observable	48	121	35	0	273	2	1
8/ 9	5 27.6	30.10	5 30.8	30.12	13.2	4.47	3.94	8.23	Not Observable	53	168	88	0	272	2	1
13/14	5 29.9	30.23	5 33.1	30.25	13.1	4.34	3.88	8.05	2.38 to 2.57	57	101	97	1	272	2	1
18/19	5 31.9	30.38	5 35.1	30.40	12.9	4.21	3.83	7.48	2.20 to 3.10	61	40	60	1	272	2	1
23/24	5 33.6	30.54	5 36.9	30.55	12.8	4.07	3.77	7.30	2.00 to 3.21	66	21	15	1	271	1	1
28/29	5 35.1	31.10	5 38.3	31.12	12.7	3.93	3.71	7.11	1.35 to 3.33	70	87	2	1	271	1	1
September	2003															
2/ 3	5 36.2	31.28	5 39.4	31.30	12.5	3.79	3.65	6.53	1.08 to 3.44	75	157	44	1	270	1	1
7/ 8	5 36.8	31.47	5 40.1	31.49	12.4	3.64	3.59	6.34	0.41 to 3.54	79	133	93	1	270	0	1
12/13	5 37.0	32.08	5 40.3	32.09	12.2	3.50	3.54	6.14	0.13 to 4.05	84	69	95	1	269	0	1
17/18	5 36.7	32.30	5 39.9	32.32	12.0	3.35	3.48	5.54	23.44 to 4.14	89	11	58	1	268	0	1
22/23	5 35.7	32.55	5 38.9	32.56	11.9	3.20	3.42	5.33	23.14 to 4.24	94	53	12	1	267	-1	2
27/28	5 33.9	33.21	5 37.2	33.22	11.7	3.05	3.36	5.12	22.43 to 4.33	99	125	4	2	266	-1	2
October	2003															
2/ 3	5 31.3	33.49	5 34.6	33.50	11.5	2.90	3.30	4.50	22.11 to 4.42	104	161	53	2	265	-2	2
7/ 8	5 27.6	34.18	5 31.0	34.20	11.3	2.76	3.24	4.26	21.38 to 4.51	110	96	95	2	263	-3	2
12/13	5 22.8	34.50	5 26.2	34.52	11.1	2.61	3.18	4.02	21.03 to 4.60	116	35	94	2	261	-4	2
17/18	5 16.7	35.22	5 20.0	35.25	10.9	2.47	3.11	3.36	20.27 to 5.09	122	28	55	2	258	-6	2
22/23	5 9.0	35.55	5 12.4	35.58	10.7	2.34	3.05	3.09	19.49 to 5.17	128	94	9	2	255	-7	2
27/28	4 59.6	36.27	5 2.9	36.31	10.5	2.21	2.99	2.39	19.09 to 5.26	134	165	8	2	251	-9	2

Ephemeris for comet 2002 Y1 (Juels-Holvorcem) (Southern Hemisphere)

Omega=128.8196 OMEGA=166.2178 i=103.7781 q= 0.713770 a=243.607509
e=0.997070 P= 3802.209 T= 2003 April 13.2500 Equinox= 2000
Magnitudes calculated from m= 6.5+5.0*Log(d)+10.0*Log(r)

May 2003 Positions for 00:00 ET, Times in UT

										Elong		Moon	Comet			
Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Sun	Moon	Phase	Tail	pA	d RA	dDec
5/ 6	1 3.9	9.15	1 6.5	9.31	6.8	1.63	0.85	10.13	5.25 to 5.43	26	76	17	41	252	10	-17
10/11	1 12.9	5.49	1 15.5	6.05	7.1	1.62	0.90	10.02	5.04 to 5.47	30	140	66	37	245	11	-17
15/16	1 22.1	2.22	1 24.6	2.38	7.4	1.61	0.96	9.52	4.44 to 5.51	35	147	100	34	240	11	-17
20/21	1 31.4	-1.09	1 34.0	-0.54	7.6	1.59	1.03	9.41	4.24 to 5.55	39	75	71	30	236	11	-17
25/26	1 41.0	-4.45	1 43.6	-4.30	7.9	1.57	1.09	9.31	4.04 to 5.59	44	17	22	27	233	11	-17
30/31	1 50.9	-8.27	1 53.3	-8.12	8.1	1.55	1.16	9.21	3.45 to 6.02	49	48	0	23	231	12	-18
June	2003															
4/ 5	2 0.9	-12.16	2 3.4	-12.02	8.3	1.53	1.23	9.11	3.25 to 6.05	53	106	21	21	230	12	-19
9/10	2 11.2	-16.13	2 13.6	-15.59	8.6	1.51	1.31	9.02	3.05 to 6.08	58	155	74	18	229	12	-19
14/15	2 21.8	-20.18	2 24.1	-20.05	8.8	1.50	1.38	8.53	2.45 to 6.10	63	109	100	16	229	12	-20
19/20	2 32.6	-24.31	2 34.8	-24.17	9.0	1.49	1.45	8.44	2.25 to 6.11	68	53	66	14	229	12	-21
24/25	2 43.7	-28.49	2 45.9	-28.36	9.2	1.49	1.52	8.35	2.04 to 6.12	72	42	20	12	229	12	-21
29/30	2 55.1	-33.10	2 57.2	-32.59	9.4	1.49	1.59	8.27	1.42 to 6.13	76	81	0	10	230	11	-21
July	2003															
4/ 5	3 6.9	-37.34	3 8.8	-37.22	9.6	1.50	1.66	8.19	1.20 to 6.12	80	121	27	9	231	11	-21
9/10	3 19.0	-41.55	3 20.8	-41.45	9.8	1.52	1.74	8.11	0.57 to 6.11	84	119	82	8	233	11	-21
14/15	3 31.5	-46.12	3 33.1	-46.02	10.0	1.55	1.81	8.03	0.34 to 6.10	87	81	99	6	234	10	-21
19/20	3 44.4	-50.21	3 45.9	-50.12	10.2	1.58	1.88	7.57	0.09 to 6.07	90	64	63	6	236	10	-20
24/25	3 57.9	-54.20	3 59.1	-54.12	10.4	1.62	1.94	7.50	23.43 to 6.04	92	78	17	5	238	9	-19
29/30	4 11.8	-58.07	4 12.8	-57.59	10.7	1.68	2.01	7.44	23.16 to 6.00	94	101	0	4	240	9	-18
August	2003															
3/ 4	4 26.4	-61.39	4 27.0	-61.33	10.9	1.73	2.08	7.38	22.46 to 5.56	95	104	35	3	242	8	-17
8/ 9	4 41.6	-64.57	4 41.9	-64.52	11.1	1.80	2.15	7.34	22.12 to 5.51	96	87	88	3	244	8	-16
13/14	4 57.6	-67.60	4 57.5	-67.55	11.3	1.87	2.22	7.29	21.32 to 5.45	96	79	97	3	245	7	-15
18/19	5 14.6	-70.48	5 14.0	-70.44	11.5	1.95	2.28	7.26	20.34 to 5.39	96	90	60	2	246	6	-13
23/24	5 32.6	-73.21	5 31.5	-73.19	11.8	2.03	2.35	7.24	18.33 to 5.32	95	101	15	2	247	6	-12
28/29	5 52.1	-75.40	5 50.3	-75.39	12.0	2.12	2.42	7.23	18.37 to 5.25	94	96	2	2	248	6	-11

Format for electronic submission of observations

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

TA format (examples)

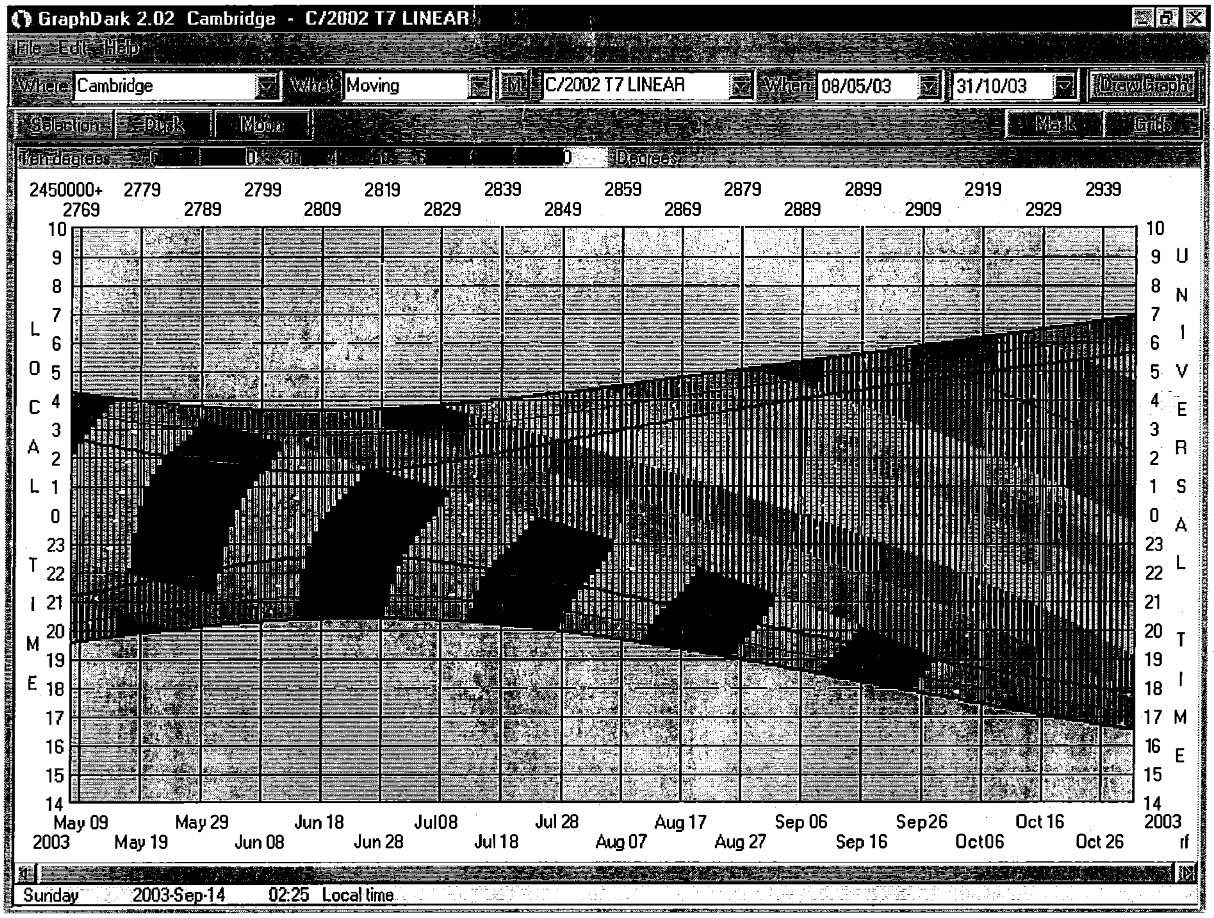
```
          1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c   DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                        Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5   2               Shanklin
961214.70 S   3.8  AA   8   B        20  6     7/  0.50   40   Baroni
```

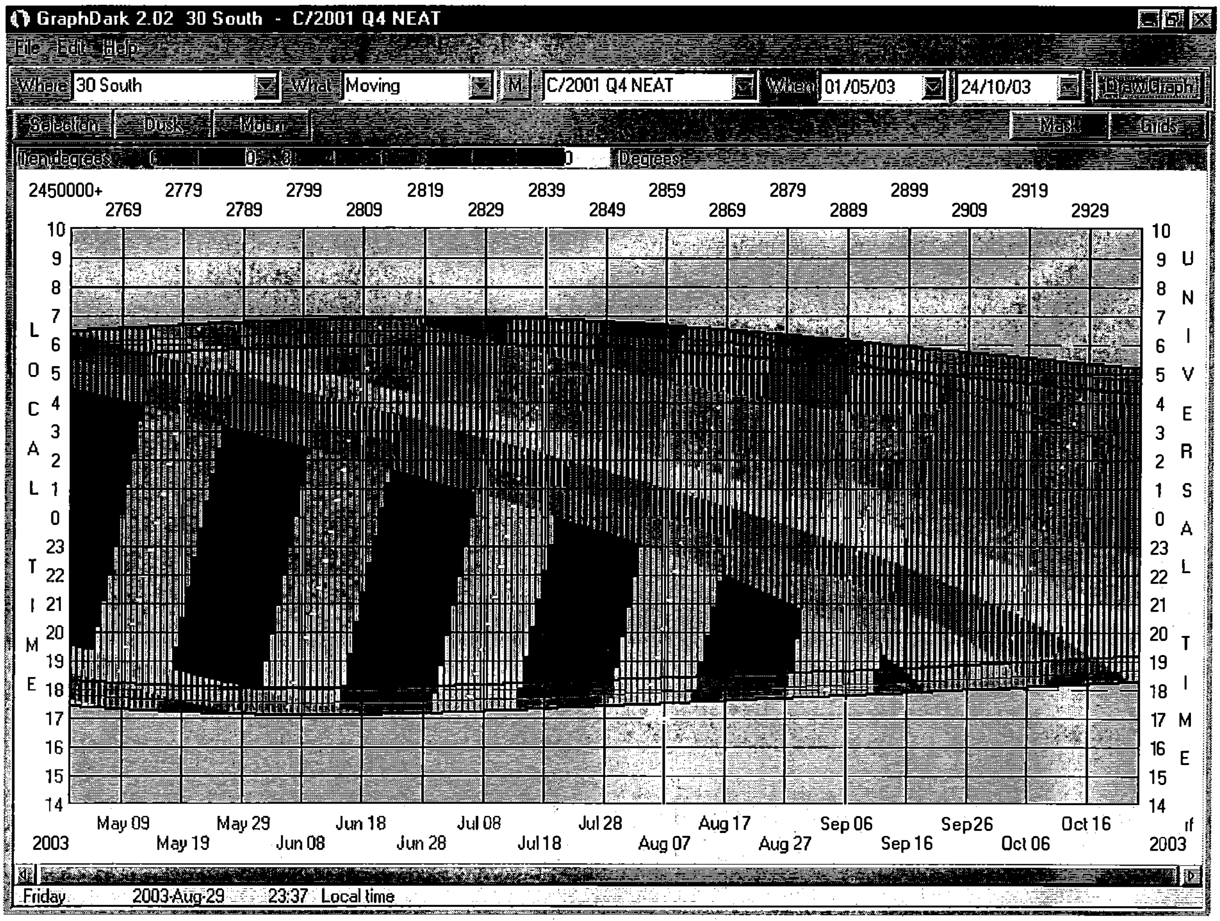
ICQ format (examples)

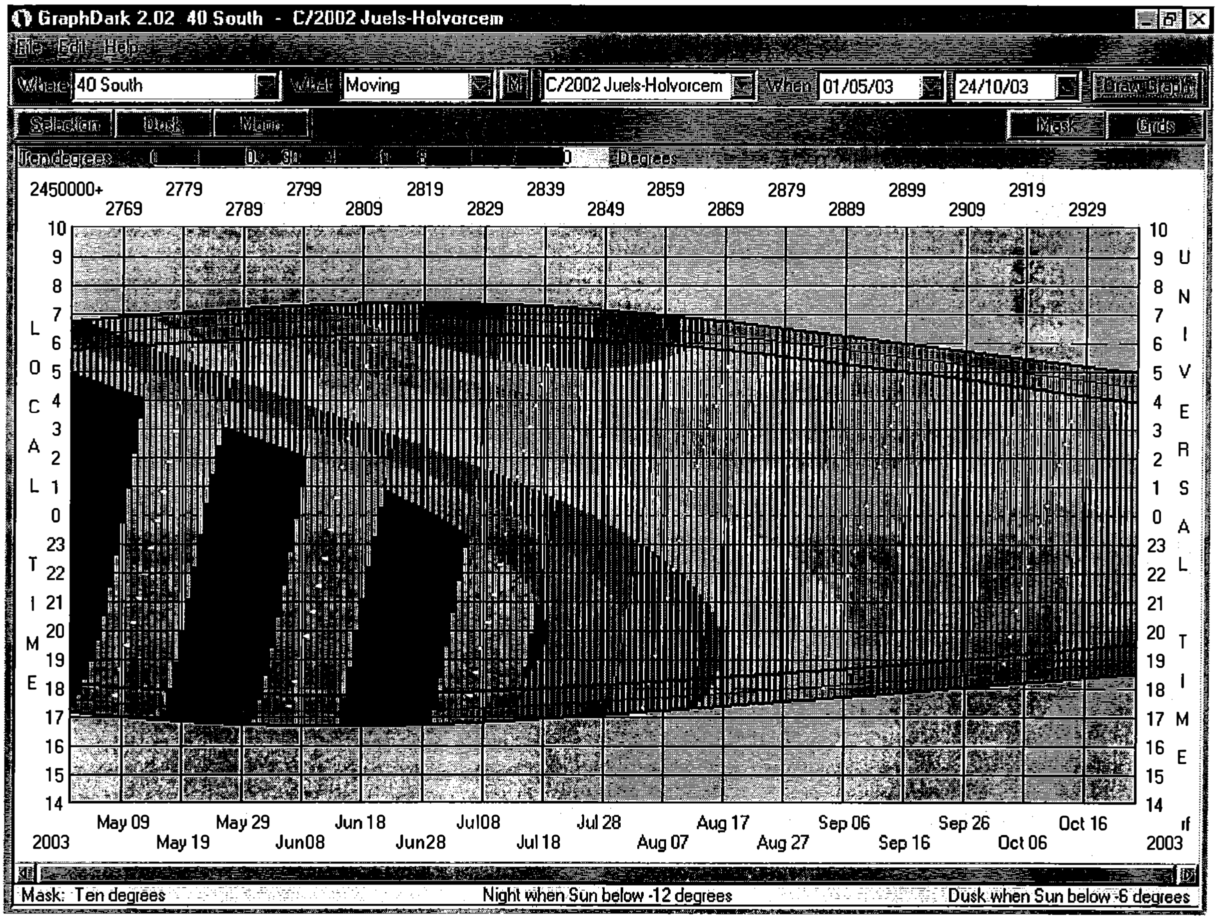
```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC      m
   1992F1  1992  5 18.94  S  9.3 AA  7.5R    50   6   4        135 ICQ XX BEA
  1        1985 11 16.04  S  6.9 AA 20  R14  40   6   s7   0.12 130 ICQ 59 SHA02
   1999T2  2001  1 28.25 Comet possibly seen at mag 13.6 (S, HS) in 20cm f10 T x120, with
coma 1.0' DC 1.
   1999T1  2001  1 28.25 Possible tail 5' long in pa 345.
```

Charts

The lunar interference diagrams show the dark observing windows, after nautical twilight, when the Sun is 12° below the horizon for three comets and latitudes. The charts were generated using the latest version of Richard Fleet's GraphDark software, which is downloadable via the Section web page. The online version on the Section web page has them in colour.




GraphDark 2.02 30 South - C/2001 Q4 NEAT
File Edit Help
Where 30 South
What Moving
C/2001 Q4 NEAT
When 01/05/03
24/10/03
Draw Graph
Selection
Dusk
Moon
Mask
Grids
Ten degrees
Degrees
2450000+
LOCAL TIME
UNIVERSAL TIME
May 09 May 29 Jun 18 Jul 08 Jul 28 Aug 17 Sep 06 Sep26 Oct 16
2003 May 19 Jun 08 Jun 28 Jul 18 Aug 07 Aug 27 Sep 16 Oct 06 2003
Friday 2003-Aug-29 23:37 Local time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File Edit Help
Where 40 South
What Moving
C/2002 Juels-Holvorcem
When 01/05/03
24/10/03
Draw Graph
Selection
Dusk
Moon
Mask
Grids
Ten degrees
Degrees
2450000+
LOCAL TIME
UNIVERSAL TIME
May 09 May 29 Jun 18 Jul08 Jul 28 Aug 17 Sep 06 Sep 26 Oct 16
2003 May 19 Jun08 Jun28 Jul 18 Aug 07 Aug 27 Sep 16 Oct 06 2003
Mask: Ten degrees
Night when Sun below -12 degrees
Dusk when Sun below -6 degrees

Name	Number	T	q	e	ω	Ω	i	H1	K1	Epoch Source
Finlay	15P	2002 02 08.1195	1.028272	0.712554	324.1668	41.3643	3.6833	12.0	10.0	2000 MPC 44862
Grigg-Skjellerup	26P	2002 11 29.7275	1.117895	0.632782	1.6323	211.7362	22.3471	12.0	40.0	2000 MPC 34423
Schwassmann-Wachmann 1	29P	2004 07 16.7492	5.723075	0.044484	49.3869	312.7241	9.3938	4.0	10.0	2000 MPC 42666
Reinmuth 1	30P	2002 12 24.3503	1.877412	0.501897	13.2673	119.7557	8.1305	9.5	15.0	2000 MPC 34424
Schwassmann-Wachmann 2	31P	2002 01 18.0393	3.408921	0.193862	18.3423	114.1963	4.5500	5.0	20.0	2000 MPC 41899
Vaisala 1	40P	2004 01 22.9597	1.795578	0.633022	47.2230	134.7343	11.5393	5.5	30.0	2000 MPC 42666
Wolf-Harrington	43P	2004 03 17.8261	1.578708	0.544687	187.2570	254.7003	18.5199	8.0	15.0	2000 MPC 42666
Wirtanen	46P	2002 08 26.7256	1.058566	0.657810	356.3843	82.1682	11.7381	9.0	15.0	2000 MPC 45964
Van Biesbroeck	53P	2003 10 09.4487	2.415365	0.551876	134.0994	149.0052	6.6102	7.7	12.0	2000 MPC 40671
de Vico-Swift-NEAT	54P	2002 07 30.9813	2.145271	0.430578	2.0788	358.9621	6.0851	10.0	15.0	2000 MPC 46764
Gunn	65P	2003 05 11.8630	2.445946	0.318698	196.3754	68.4164	10.3838	5.0	15.0	2000 MPC 40670
du Toit	66P	2003 08 27.9809	1.274275	0.787643	257.2466	22.2148	18.7010	12.0	9.0	2000 MPC 48097
Churyumov-Gerasimenko	67P	2002 08 18.3000	1.291664	0.631665	11.4397	50.9433	7.1214	11.0	10.0	2000 MPC 34423
Longmore	77P	2002 09 04.8029	2.309660	0.358387	196.4749	14.9713	24.4021	7.0	20.0	2000 CCO 13
Gehrels 2	78P	2004 10 27.0781	2.007455	0.462767	192.9689	210.5642	6.2524	5.5	20.0	2000 MPC 42667
du Toit-Hartley	79P	2003 02 15.3851	1.230017	0.594151	253.0889	307.9626	2.8948	16.0	10.0	2000 MPC 48097
Wild 2	81P	2003 09 25.9544	1.590300	0.538847	41.7620	136.1415	3.2402	7.0	15.0	2000 MPC 40671
Howell	88P	2004 04 12.5326	1.368117	0.561150	235.7838	56.8411	4.3820	11.0	15.0	2000 MPC 42666
Gehrels 1	90P	2002 06 23.3507	2.966570	0.509471	28.3067	13.4972	9.6151	8.5	15.0	2000 MPC 44184
Sanguin	92P	2002 09 23.0458	1.807487	0.663224	163.0502	182.3491	18.7648	12.0	15.0	2000 MPC 34423
Russell 4	94P	2003 08 29.2929	2.231087	0.364916	92.9517	70.9490	6.1851	9.0	15.0	2000 MPC 40671
Hartley 1	100P	2003 08 18.0232	1.979746	0.419176	181.5291	37.8923	25.6632	9.0	20.0	2000 MPC 40670
Wild 4	116P	2003 01 21.6124	2.169799	0.375529	173.4183	21.0750	3.6159	2.5	25.0	2000 MPC 43760
Mueller 1	120P	2004 09 30.2077	2.746256	0.337035	30.2010	4.4638	8.7859	12.0	10.0	2000 MPC 42667
West-Hartley	123P	2003 12 09.2038	2.128593	0.448255	102.9320	46.6340	15.3474	4.0	25.0	2000 MPC 40671
Mrkos	124P	2002 07 27.0605	1.467229	0.542702	181.2680	1.3846	31.3525	13.5	7.0	2000 MPC 34422
McNaught-Hughes	130P	2004 10 23.3296	2.105067	0.405551	224.0924	89.8937	7.3069	10.0	15.0	2000 MPC 42667
Mueller 2	131P	2004 12 17.6774	2.423100	0.342451	179.8837	214.2471	7.3486	11.0	10.0	2000 MPC 42667
Helin-Lawrence	152P	2002 12 22.4559	3.110091	0.307951	163.6903	92.0157	9.8706	11.5	10.0	2000 MPC 44505
Ikeya-Zhang	153P	2002 03 18.9848	0.507483	0.990153	34.6906	93.3709	28.1104	7.0	10.0	2000 MPC 46101
Brewington	154P	2003 02 19.3765	1.590378	0.671669	48.0105	343.6435	18.0595	2.5	30.0	2000 MPC 46622
Shoemaker 3	155P	2002 12 14.8281	1.813341	0.726673	14.9102	97.2645	6.3859	10.0	12.0	2000 MPC 47729
Hale-Bopp	C/1995 O1	1997 03 30.7796	0.926981	0.994996	130.7870	282.2779	89.4322	-2.0	10.0	2000 MPC 42547
Lagerkvist	P/1996 R2	2004 06 07.4654	2.622650	0.308578	334.2792	40.2294	2.6022	11.5	10.0	2000 MPC 42666
Spacewatch	C/1997 BA6	1999 11 27.8272	3.431008	0.998907	285.8645	317.6672	72.7618	10.0	5.0	2000 MPC 45960
Catalina	C/1999 F1	2002 02 14.0030	5.787396	0.999042	255.1903	19.9922	92.0328	9.5	5.0	2000 MPC 44182
Skiff	C/1999 J2	2000 04 05.8003	7.108655	1.003079	127.1089	50.0468	86.3593	2.0	10.0	2000 MPC 45961
LINEAR	C/1999 K5	2000 07 03.7409	3.264827	1.000067	241.6151	106.3801	89.4866	6.0	10.0	2000 MPC 44503
LINEAR	C/1999 K8	2000 04 24.0282	4.202628	0.999868	164.6603	195.4039	52.7073	5.0	10.0	2000 MPC 43758
LINEAR	C/1999 N4	2000 05 22.3182	5.503488	1.002070	90.3678	345.9388	156.9089	6.0	10.0	2000 MPC 42547
McNaught-Hartley	C/1999 T1	2000 12 13.4283	1.172738	0.999752	344.7852	182.4122	80.0037	5.0	10.0	2000 MPC 42106
LINEAR	C/1999 T2	2000 11 24.1004	3.037770	1.001348	104.6455	14.8786	110.9687	6.0	10.0	2000 MPC 44504
LINEAR	C/1999 T3	2000 09 02.2075	5.367220	0.997081	211.4019	223.5540	104.7517	6.0	10.0	2000 MPC 41897
Catalina-Skiff	C/1999 U4	2001 10 28.7855	4.916986	1.006769	77.5766	32.2821	51.9270	4.5	10.0	2000 MPC 45961
Korlevic	P/1999 WJ7	2000 02 16.0426	3.174111	0.315293	154.7577	290.5323	2.9796	14.5	5.0	2000 MPC 45334
Catalina	P/1999 XN120	2000 05 01.8448	3.291650	0.211750	162.0212	285.4603	5.0319	13.5	5.0	2000 MPC 39023
LINEAR	C/1999 Y1	2001 03 24.1617	3.089676	1.000868	184.2934	188.9222	134.7904	5.5	10.0	2000 MPC 43758
Montani	C/2000 A1	2000 07 17.4529	9.750684	1.005851	14.4761	111.8302	24.5354	3.5	10.0	2000 MPC 44860
LINEAR	C/2000 B4	2000 06 17.7288	6.836558	0.621733	126.3612	0.6433	15.8974	11.5	5.0	2000 MPC 45182
Koehn	C/2000 O1	2000 01 29.3784	5.924105	1.002041	55.2941	88.9038	148.0970	6.0	10.0	2000 MPC 41159
LINEAR	C/2000 SV74	2002 04 30.5526	3.542097	1.004497	76.2516	24.1867	75.2372	5.5	10.0	2000 MPC 45961
LINEAR	C/2000 WM1	2002 01 22.6825	0.555243	1.000284	276.7769	237.8614	72.5277	7.5	10.0	2000 MPC 46619
Scotti	P/2000 Y3	2000 10 25.4800	4.043728	0.194740	87.9905	354.9327	2.2526	9.0	10.0	2000 MPC 44030
LINEAR	C/2001 A2	2001 05 24.6324	0.777130	0.999175	295.2732	295.1129	36.4756	7.0	10.0	2000 MPC 44030
NEAT	C/2001 B2	2000 09 01.4529	5.315658	0.999409	304.8667	145.1043	150.6237	4.0	10.0	2000 MPC 44182
LINEAR	C/2001 C1	2002 03 28.3384	5.104686	1.000114	219.9469	33.6932	68.9440	6.0	10.0	2000 MPC 45961
NEAT	P/2001 F1	2000 11 23.3148	4.154550	0.357162	80.8722	92.8399	19.0825	8.5	10.0	2000 MPC 43160
LONEOS	C/2001 G1	2001 10 09.8602	8.236720	1.004216	343.3163	203.8895	45.3420	3.5	10.0	2000 MPC 45334
LINEAR-NEAT	C/2001 HT50	2003 07 09.0015	2.792095	0.997694	324.0649	42.9128	163.2121	4.5	10.0	2000 MPC 47291

LINEAR	C/2001 K5	2002	10	11.7401	5.184268	0.999453	47.0551	237.4526	72.5885	4.0	10.0	2000	MPC 44860
LINEAR	C/2001 N2	2002	08	19.6362	2.668758	1.000761	151.8939	52.8072	138.5395	7.5	10.0	2000	MPC 45654
LONEOS	C/2001 OG108	2002	03	15.1636	0.994343	0.925151	116.4270	10.5463	80.2401	11.0	10.0	2000	MPC 45654
NEAT	C/2001 Q1	2001	09	20.1931	5.832373	0.965216	175.3953	139.2648	66.9624	7.0	10.0	2000	MPC 47727
Petriew	P/2001 Q2	2001	09	01.7960	0.945041	0.696230	181.8683	214.0879	13.9486	11.0	10.0	2000	MPC 44182
NEAT	C/2001 Q4	2004	05	15.9375	0.961999	1.000725	1.1993	210.2692	99.6385	3.5	10.0	2000	MPC 46619
LINEAR	C/2001 RX14	2003	01	18.6784	2.057546	1.001427	121.4797	14.1649	30.5779	6.5	10.0	2000	MPC 46619
NEAT	P/2001 T3	2002	02	01.1521	2.502844	0.616322	356.4108	56.2789	19.1792	12.0	10.0	2000	MPC 44504
LINEAR	C/2001 U6	2002	08	08.8164	4.406470	0.997011	85.7365	115.2336	107.2542	7.5	10.0	2000	MPC 46620
LINEAR	P/2001 YX127	2003	03	06.2809	3.426182	0.178782	115.7939	31.0915	7.9108	14.5	5.0	2000	MPC 47292
LINEAR	C/2002 A1	2001	11	23.8990	4.706706	0.716166	18.9413	81.4189	14.0004	12.5	5.0	2000	MPC 48096
LINEAR	C/2002 A2	2001	12	01.0854	4.701804	0.713899	19.2939	81.4368	13.9688	11.0	5.0	2000	MPC 48096
LINEAR	P/2002 AR2	2002	01	16.2782	2.063302	0.615284	73.6061	7.8191	21.1204	12.0	10.0	2000	MPC 45334
LINEAR	C/2002 A3	2002	04	22.2286	5.158984	0.978860	329.6114	136.4674	48.6127	6.5	10.0	2000	MPC 47292
Yeung	P/2002 BV	2002	03	11.1373	2.244256	0.361473	178.7932	40.1277	11.5142	13.0	10.0	2000	MPC 45654
LINEAR	C/2002 B1	2002	04	20.0305	2.271586	0.770765	76.1800	58.1834	51.0157	11.5	10.0	2000	MPC 45962
LINEAR	C/2002 B2	2002	04	06.7711	3.842966	1.000000	257.0670	54.3227	152.8720	9.0	10.0	2000	MPC 45334
LINEAR	C/2002 B3	2002	01	14.4151	6.052462	1.000000	122.9251	289.3856	73.6796	7.0	10.0	2000	MPC 45183
LINEAR	C/2002 C2	2002	04	10.8322	3.254206	0.999570	159.9454	242.9599	104.8793	8.5	10.0	2000	MPC 46620
Snyder-Murakami	C/2002 E2	2002	02	21.7373	1.466476	1.000360	9.0232	244.5739	92.5480	7.5	10.0	2000	MPC 46099
LINEAR	P/2002 EJ57	2001	12	19.2267	2.636598	0.593735	166.9429	330.3813	4.9695	12.5	10.0	2000	MPC 47727
Utsunomiya	C/2002 F1	2002	04	22.8985	0.438299	0.999541	125.9001	289.0294	80.8767	8.5	10.0	2000	MPC 45655
LINEAR	C/2002 H2	2002	03	23.3592	1.635445	0.993994	20.4351	269.0105	110.4966	10.5	10.0	2000	MPC 46100
NEAT	C/2002 J4	2003	10	03.1887	3.632555	1.000000	230.7324	70.8855	46.5297	5.5	10.0	2000	MPC 46100
LINEAR	C/2002 J5	2003	09	19.2786	5.726782	1.001661	74.8317	314.1107	117.2281	11.0	5.0	2000	MPC 46100
NEAT	C/2002 K1	2002	06	16.3518	3.229951	0.999408	4.4386	280.5441	89.7190	10.0	10.0	2000	MPC 46762
LINEAR	C/2002 K2	2002	01	06.2014	5.237779	1.000000	26.7135	294.5888	130.9163	12.0	5.0	2000	MPC 46100
NEAT	C/2002 K4	2002	07	12.9021	2.764391	0.841897	24.4166	308.0989	94.0635	10.5	10.0	2000	MPC 46620
NEAT	C/2002 L9	2004	04	06.3789	7.031380	0.999012	231.4641	110.4636	68.4444	8.5	5.0	2000	MPC 46762
Hoenig	C/2002 O4	2002	10	01.9793	0.775883	1.000775	105.9180	321.0421	73.1288	9.5	10.0	2000	MPC 46762
SWAN	C/2002 O6	2002	09	09.4491	0.494649	0.998608	78.7480	330.9520	58.6247	10.0	10.0	2000	MPC 46620
LINEAR	C/2002 O7	2003	09	22.5614	0.903275	1.000328	252.0675	12.8016	98.7456	6.5	10.0	2000	MPC 47292
NEAT	C/2002 P1	2001	11	22.9761	6.529319	0.983976	347.7487	310.6711	34.6023	6.0	10.0	2000	MPC 47049
Van Ness	P/2002 Q1	2002	07	15.9875	1.521342	0.569621	184.7494	174.1016	36.3675	13.0	10.0	2000	MPC 46762
LINEAR	C/2002 Q5	2002	11	19.2069	1.243112	1.001583	133.3223	33.7554	149.1679	9.0	10.0	2000	MPC 47727
Skiff	P/2002 S1	2002	03	25.6649	2.307183	0.429584	35.6035	347.3514	27.6970	11.0	10.0	2000	MPC 47049
LINEAR	P/2002 T5	2003	06	27.8086	3.934262	0.436666	326.7496	123.3317	30.9047	8.0	10.0	2000	MPC 47292
NEAT-LINEAR	P/2002 T6	2003	06	26.9057	3.387800	0.556891	217.5393	209.0459	11.0096	10.5	10.0	2000	MPC 47292
LINEAR	C/2002 T7	2004	04	23.0724	0.614454	1.000432	157.7429	94.8535	160.5794	4.0	10.0	2000	MPC 48096
LINEAR	C/2002 U2	2002	12	31.9830	1.208648	0.999920	95.8478	38.7754	59.1356	13.0	10.0	2000	MPC 47727
NEAT	C/2002 V1	2003	02	18.2947	0.099286	0.999179	152.1684	64.0879	81.7054	8.0	10.0	2000	MPC 48096
LINEAR	C/2002 V2	2003	05	13.6187	6.812117	0.998697	314.6748	20.2348	166.7761	6.0	10.0	2000	MPC 48096
LINEAR	C/2002 X1	2003	07	12.8870	2.486754	0.998141	207.3238	281.8869	164.0889	8.0	10.0	2000	MPC 47728
NEAT	P/2002 X2	2003	03	29.6150	2.528766	0.373367	356.0386	78.1545	25.3530	12.0	10.0	2000	MPC 48097
Kudo-Fujikawa	C/2002 X5	2003	01	29.0021	0.190034	1.000089	187.5870	119.0661	94.1462	8.5	10.0	2000	MPC 48097
Juels-Holvorcem	C/2002 Y1	2003	04	13.2508	0.713747	0.997058	128.8232	166.2194	103.7816	6.5	10.0	2000	MPEC 2003-G13
	P/2003 A1	2003	02	01.2415	1.915860	0.481063	357.0790	55.1909	46.2612	13.5	10.0	2000	MPEC 2003-F50
Gleason	C/2003 A2	2003	11	04.5421	11.427217	1.006986	346.6210	154.5446	8.0614	3.5	10.0	2000	MPC 48097
LINEAR-NEAT	P/2003 CP7	2003	04	29.5471	3.016935	0.248899	42.6617	133.1262	12.3397	14.5	5.0	2000	MPEC 2003-F51
NEAT	C/2003 E1	2004	02	12.7682	3.235341	0.768008	104.0421	136.9768	33.4711	12.5	5.0	2000	MPEC 2003-F52
LINEAR	C/2003 F1	2003	07	02.287	4.00485	0.80883	121.853	87.413	70.252	7.0	10.0	2000	MPEC 2003-G14
NEAT	P/2003 F2	2003	04	24.365	2.91198	0.54757	194.345	358.782	11.107	16.5	5.0	2000	MPEC 2003-G04

Source: CBAT web pages. H1 and K1 are also from the CBAT; alternative values are given in the main section and on the Section web pages.

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you get the format **EXACTLY** right. It is advisable to send the report as a text attachment as many mailers cut what they consider to be long lines.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TK (Tycho 2), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA. Do not report tail details unless you are certain of their reality.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz 2)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

The ICQ have recently produced detailed guidelines for submitting magnitude estimates made using CCD images and these are available on their web page at http://cfa-www.harvard.edu/cfa/ps/icq/ICQFormat.html

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

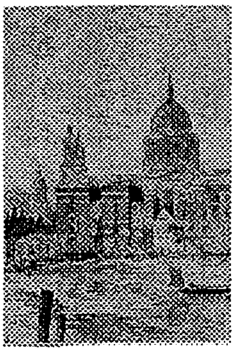
Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Rel	Comments



THE COMET'S TALE

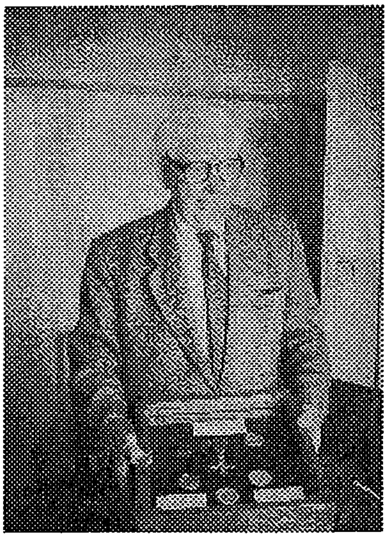
Newsletter of the Comet Section of the British Astronomical Association

Volume 10, No 2 (Issue 20), 2003 October

George Alcock Remembered

BAA-RAS Pro-am discussion meeting

Milton Keynes
2003 May 10



Around 80 astronomers gathered together on May 10 for a discussion meeting in the Open University Berrill Lecture Theatre in Milton Keynes. Although advertised as doors opening at 10:30, early arrivals had appeared by 9:30! Fortunately Tracey Moore from the OU was there ready to welcome visitors and the OU catering staff were already on hand to provide refreshments.

Several displays were available for inspection during the day, including comet drawings by George Alcock, samples of Libyan desert glass, cuttings from old journals and information on the Journal of the International Meteor Organisation.

Particular thanks are due to Tracey and the technical staff of the Open University for giving up their Saturday and interfacing all the various laptops to the display system, to Barrie Jones of the OU for arranging use of the facilities and to Simon Green and John Zarnecki for conducting the lunch time tours. Peter Hudson also supervised visits to the newly opened OU observatory.

The morning session was devoted to meteorites and meteors, with Monica Grady (Natural History Museum) having the unenviable task of setting the scene. The solar system formed in a region similar to the Orion Nebula, with asteroids being remnant fragments. Eros is an irregular object, well-battered over 4.6 billion years. Pieces of asteroids fall to earth as meteorites. Spectra of asteroids match those of meteorites and also the orbits of fireballs match those of asteroids. Meterorites are cool when the land, protected by a thin fusion crust. There are three types of meteorites - irons, stones and stoney-irons. Irons contain nickel and many other metals in trace amounts. Heat (from gravitational collapse and radioactive decay) allows reduction reactions similar to a blast furnace and metal accumulates in the centre of the asteroid. Iron meteorites tell us about core formation. Stoney-irons come from the boundary of core and mantle and are the most beautiful meteorites, with intermixed peridotite (olivine) and nickel-iron. Stones form the majority of meteorites. Their main components are chondrules and calcium-aluminium inclusions. The chondrules say something about asteroid formation. The CAIs formed 3 my before the chondrules, 4.568 by ago. Interstellar grains are also present as silicon carbide and diamonds. The silicon carbide has variable isotopic composition and therefore comes from different stars undergoing different reactions. At least 35 stars contributed material. Meteorites may also come from comets, the moon and mars. Deserts such as the Sahara and Antarctica are good places to hunt for meteorites. They come in various sizes - the Arizona meteorite crater was formed by an object 40 metres across and gave a 1 km diameter crater. The object that fell 65 my ago had significant effects on life on earth. On average one falls over the UK every 11 years. Falls are not predictable and the next one may be over Milton Keynes!

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Subscription to the Section newsletter costs £5 for two years, extended to three years for members who contribute to the work of the Section in any way, for example by submitting observations or articles. **Renewals should be sent to the Director and cheques made payable to the BAA.** Those due to renew should receive a reminder with this mailing.

Section News from the Director

Dear Section member,

The last six months have been heavily packed with meetings. First there was the Meeting on Asteroids and Comets in Europe in Mallorca quickly followed by the pro-am discussion meeting at Milton Keynes at the beginning of May. Next came the BAA Exhibition Meeting in June and at the close of the summer the observing workshop at the BAA Out of London meeting in York. Reports on the first two are elsewhere in this newsletter and reports on the latter two will appear in the Journal in due course. Next year there is another MACE meeting, however the main event is the International Workshop on Cometary Astronomy that will be held in Paris. Details of this are given in the box opposite and I would encourage all members to attend. The preliminary deadline for booking accommodation has already passed, however there is still plenty of time to book.

It is perhaps just as well that there have been few comets to observe as preparing for all the talks has taken up a lot of time. However things are beginning to change.

IWCA III

The third International Workshop on Cometary Astronomy will be held at Meudon and Paris Observatory, France from Friday 4th of June to Sunday 6th of June 2004. Its main objective is to promote cometary observations among amateur astronomers and optimise the benefit of these observations for the use by professional astronomers. It will be an opportunity for amateurs to meet professionals and exchange information about their techniques. It will be organized by the ICQ and Société Astronomique de France and sponsored by the Paris Observatory.

Topics to be discussed during the meeting include

- Cometary photometry (CCD, visual, light pollution effects, reference catalogs) and outgassing rates;
- Comet imaging with filters and Spectroscopy;
- Comet astrometry;
- Observation of trans-neptunians by amateurs;
- Comet discovery and automatic sky surveys;
- Space missions to comets;

Registration fee covering friday and saturday lunches, saturday reception, bus transportation, coffee breaks and welcoming package is 70 Euros per participant. Deadline: 31 December 2003 (80 Euros after).

Hotel room reservation fee for the 1st night is 52 Euros (Single) or 37 Euros each (shared double). The deadline was 20 September 2003 and the price is subject to change after this date. Full payment of the remainder can be made at the time of the meeting.

More details and registration forms are on the IWCA III web site. There is a link on the Comet Section web page.

Comet 2002 T7 (LINEAR) is brightening nicely and 2P/Encke should also reach binocular visibility in the autumn. The Section has observations of the latter comet going back over 50 years and I would like to encourage visual observers to continue the tradition as such long series can tell us much about the evolution of comets. Where possible try and use instrumentation that matches that of the past as this enhances their long term value. Next year several comets may attain naked eye brightness, however to see the rare spectacle of two naked eye comets at the same time you will have to head for the icy waters of the Southern Ocean in May. I will be visiting Antarctica yet again, however as last year I will be there in February and March, when they are still binocular objects. Hopefully the weather conditions will be somewhat more obliging than on my last visit, when the skies were unusually cloudy.

Whilst in Antarctica, I will be installing a new weather forecasting system at our Rothera station, though I suspect that the forecasts will be no more accurate than they are here! Colleagues will be installing a new permanent satellite link, so there is a chance that for once I will be able to maintain the web pages whilst I am away.

Conditions for comet observing in the UK are generally declining thanks to the widespread increase in light pollution. Maps on the Campaign for Dark Skies web site show that there is now nowhere in Cambridgeshire that has completely dark skies and such sites elsewhere in the country are rapidly declining. These maps are quite helpful in finding the best local sites and driving a short distance can make a significant difference to what you can see. Even in Antarctica light pollution is beginning to be a local problem, but it seems likely that regulation will be brought into the Antarctic Treaty system, thus combating light pollution on a whole continent. I hope that the report from the UK Select Committee due in early October will bring the promise of some regulation in this country.

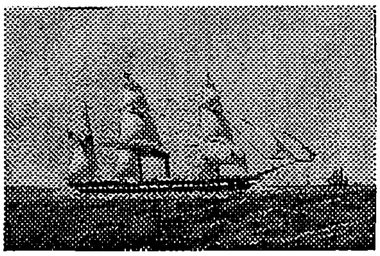
Since the last newsletter observations or contributions have been received from the following BAA members: Peter Birtwhistle, Werner Hasubick, Nick James, Gabriel Oksa, Jonathan Shanklin, and also from: Jose Aguiar, Alexandre Amorim, Alexander Baransky, Nicolas Biver, Jose Carvajal, Stephen Getliffe, JJ Gonzalez, Michael Jager, Andreas Kammerer, Heinz Kerner, Carlos Labordena, Martin Lehky, Rolando Ligustri, Michael Mattiazzo, Maciej Reszelski, Juan San Juan, Pepe Manteca, Jose Martinez, Stuart Rae, Tony Scarmato, and Seiichi Yoshida (apologies for any errors or omissions). Without these contributions it would be impossible to produce the comprehensive light curves that appear in each issue of *The Comet's Tale*. I would welcome observations from any groups which currently do not send observations to the BAA.

Comets under observation were: 29P/Schwassmann-Wachmann, 53P/Van Biesbroeck, 65P/Gunn, 66P/du Toit, 116P/Wild, 2000 SV74 (LINEAR), 2001 HT50 (LINEAR-NEAT), 2001 K5 (LINEAR), 2001 Q4 (NEAT), 2001 RX14 (LINEAR), 2002 O7 (LINEAR), 2002 T7 (LINEAR), 2002 Y1 (Juels-Holvorcem).

Jonathan Shanklin

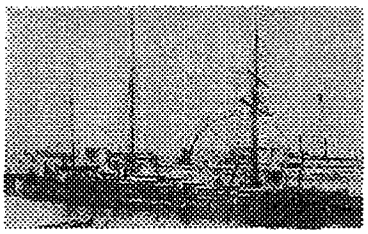
Tales from the Past

This section gives a few excerpts from past RAS Monthly Notices and BAA Journals.



The RMS Lady Joceyln

150 Years Ago: Observations of a comet [1853 G1] seen from HMS *Centaur* whilst at Buenos Ayres outer anchorage on 1853 April 30 and May 1 were reported in the June issue of Monthly Notices. The next month Lt Goodenough sent further observations and an apology for an error in the previous measurements, saying that he had 'worked out the degree of distance from Castor as 58° instead of 63°'. Other observations were reported from HM Sloop *Waterwitch* at Ascension Island, from the Cape and from the Royal Mail Steamer *Lady Jocelyn* on passage from the Cape to Mauritius.



HM Sloop Waterwitch

100 Years Ago: At a meeting Mr Crommelin said 'a paper had been received from Mr John Grigg recording observations of the comet Perrine [1902 R1] and this would be published in the Journal. Mr Grigg seemed to have re-discovered for himself what was very well known to observers, namely, the cross-bar micrometer. Although this, as he said, was well known, it was very creditable to Mr Grigg that he should have discovered it for himself in a place like New Zealand, where he was away from other observers. It was very satisfactory to know that he had now the power of recording accurately the place of any comet he might come across. Mr Grigg discovered a comet last July [26P/Grigg-Skjellerup], but his observations at that time were not sufficiently accurate for them to be able to get a reliable orbit, but now if he were fortunate enough to discover another they hoped his observations would be such that the comet's orbit would be fixed with accuracy.' The book reviews include one on "Comets and their Tails" by F G Shaw. The author advances the theory that comets' tails are merely optical appendages produced by refraction of light through the head, acting as a lens. The reviewer concludes 'while dissenting from many of his conclusions, we may welcome this evidence of increased zeal for cometary astronomy in our southern colonies'. The comet notes record the discovery of another comet [1903 H1] by 'Our energetic fellow member in New Zealand, Mr John Grigg'. It notes that Nature (May 7) stated that the comet was discovered from Mr Tebbutt's observatory in Windsor, NSW, when it was actually found from Thames, New Zealand. [*It seems clear that one hundred years ago the centre of the British Empire rather looked down on its far flung colonies!*] There was a paper in the June issue on "How I try to Realise a Comet's Orbit" by Edwin Holmes. In the annual report, the Director [E W Maunder] notes that the Section now numbers 18 Members, with 3 joining in the last year. He notes the half dozen comets that had been under observation during the year.

50 Years Ago:. The annual report notes that five comets had been observed by members of the Section during the sessional year. George Alcock had begun systematic comet searching in January and had so far logged a total of 34 hours in the five months to May.

Pro-am discussion meeting

Continued from page 1

Neil Bone, Director of the BAA Meteor Section introduced the work of the Section. The BAA is the largest UK organisation collecting amateur observations. Denning was an early Director and produced a catalogue of meteor shower radiants. Another Director, Prentice, was seconded to Jodrell Bank to correlate visual and radio observations. Harold Ridley and George Alcock both had long associations with the meteor section. Alcock in particular worked with Prentice on plotting tracks. Prentice was a solicitor and many of his observation reports have the wills of former clients on the reverse side! Today visual observers concentrate on rate information. A few observers using telescopes (or binoculars) still do plotting and there are also photographic surveys. Fireball reports come in at the rate of around one a week, mostly seen at 11pm whilst out walking the dog! Occasional bright events are seen widely, but the tracks often end over the sea. There may be possible fireball streams as there are some periods of enhanced activity, eg the end of June. Showers are listed in the BAA Handbook, however this year most showers are affected by moonlight. Neil has a portable observatory (a sun lounger), and showed his observing tools (several pencils and a red torch) and the standard observing form. A simple formula converts the observed rate into a zenithal hourly rate and for example Perseids observed at one a minute equates to a ZHR of 80. Observations give a profile of the ZHR and the Perseids showed an unexpected spike of activity in the early 1990s, which was still present as late as 1997. Such surprises show the value of visual observations. The profile of the Geminids has changed over the last couple of decades. Leonid storms have been observed over the last few years. Photography can be very pleasing and also scientifically useful. Trail photography and video work are very important. Spectra are being obtained by amateurs and could be analysed professionally. A few amateurs carry out radio work. Results are published in the Section newsletter and the BAA Journal.

Our next speaker was Iwan Williams of Queen Mary College, London, talking about meteor streams, their formation, evolution and observation. For a long time each aspect had been a separate discipline, for example comet specialists weren't interested in the bits once they had left the comet. We have known since the 1860s that a lot of meteor showers are associated with comets. Small ejected particles are blown away in the solar wind but large particles share the orbit with the comet. What happens next is highly mathematical, but results in the prediction of meteor storms etc. The sun vaporises ice in a comet and the resulting gas ejection speed is around 1 km/sec. Comets orbit the Sun at around 30 km/sec, so the particles must have a similar orbit to the comet as the difference in velocity is small, and it is possible to show possible changes in the orbital parameters. It is actually a 3-D problem, so the plane of the orbit can change, and with it the position of the nodes. The nodal position of a meteor is known very accurately (it is the time when it is seen), so the shift in nodal position between meteor and comet gives a measure of the out of plane ejection velocity. For the Leonids this amounts to around 20 m/s. Computer models can show the effect of differing ejection velocities, but it is also a function of where the ejection takes place, which makes the analysis more complex. Radar studies give us problems! They see very small meteors and lots of them - perhaps fragments of asteroids rather than comets. Recent TV results show evidence for hyperbolic orbits implying an interstellar origin if real. A third problem is that the density of meteors is generally quite high compared to that expected from comets, so there is either evolution of meteoroids or some of the theory is wrong!

Andrew Elliot concluded the morning session with a talk on how to video meteors. It is very easy if you have the right equipment. It can give good scientific results, with modern technology being a help. He had used an image intensifier system, with the intensifier being the most expensive item. A wide angle lens gives a 50° field and a similar limiting magnitude to the naked eye. The system needs an accurate time inserter and this can be manual, radio or GPS. Steve Evans does most of the analysis of the resulting videos, which form a permanent record. Single station work gives meteor rates, magnitude distributions, clustering information and radiant position. Two station work allows triangulation, particularly when combined with photography. It is possible to add spectroscopy, but this hasn't yet been done in the UK. Lunar impacts have also been recorded. A small number of cameras would cover the entire UK for a fireball survey. Photography gives 5" accuracy down to about 0^m, but video gives accuracy of a few minutes down to 5^{th} or 6^{th} magnitude. New software allows real time analysis of the data, whereas in the past it has often taken three times longer than the observations to reduce the data. Once an orbit is known software by Nick James can be used to visualise the orbit. Modern video cameras at prime focus on a 25-

cm telescope can reach 11^m stars, but are not yet quite as good for meteor work. Andrew then showed spectacular results from recent expeditions, including the 2001 Leonid storm over Arizona, the 2002 Leonid storm over Spain, and the 2003 Quadrantids.

Some of the speakers

Jonathan Shanklin started proceedings after lunch, giving a brief history of the BAA Comet Section and lamenting the fact that early observations had disappeared during World War II. Although George Alcock and Albert Jones had made visual discoveries of comets, but amateur visual comet discovery was probably now a thing of the past, thanks to asteroid search programmes such as LINEAR and spacecraft such as SOHO. However at the moment there was still a 'twilight zone' where amateurs stood a chance, particularly in the Southern Hemisphere. Visual observation of features in the coma and tail was also a thing of the past as CCDs now gave much more objective images. Amateurs could however make significant contributions by visual magnitude studies. Observations of 153P/Ikeya-Zhang showed variation across the course of the apparition, possibly reflecting the inhomogeneous comet nucleus loosing several metres as it rounded the Sun. Comet 2001 A2 (LINEAR) showed significant variation with a period of around a month, which might reflect precession of the nucleus. Comet 46P/Wirtanen had a relatively normal light curve, but by contrast 67P/Churyumov-Gerasimenko, the new Rosetta target, might be similar to 1999 K5 (LINEAR), which had a 'pathological' linear light curve, peaking some 73 days after perihelion. During questions David Hughes suggested that this might be due to a single active area becoming illuminated. Jonathan concluded by posing some questions: should observations be restricted to light pollution free areas (no, as this would eliminate most observations from the UK), do visual observers hallucinate (probably yes, as the brain often lets us see what we expect) and should light curves only be compiled from observations by experts (no, all observations are valuable).

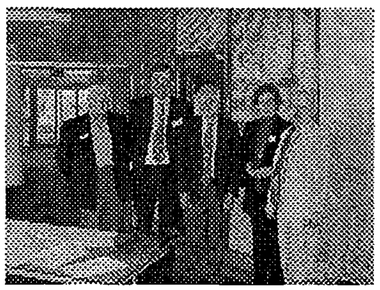
David Hughes (Sheffield University) demonstrated how he used magnitude parameters derived from amateur visual observations. Short period comets (those with period less than 20 years) are seriously affected by Jupiter. Their median period is 7.2 years, however when perihelion is at 1 AU the period is 5.46 years and when at 3 AU the period is 8.3 years. This means that the shorter period object goes round more frequently and there must be plenty of short period comets with larger q (1.5 - 3 AU) still waiting to be discovered. We can measure the size of a comet either directly with the HST or via a light curve as the log of the radius is theoretically proportional to 0.2 H_{10}. This absolute magnitude can either be derived by assuming that the comet brightens as 10 log r (=> H_{10}) or by fitting to the light curve (=> H). David said that it would be helpful if light curves were plotted as a function of log(r) rather than r or time. Different molecular emissions may have different slopes. When he first plotted values from selected periodic comets he didn't get a very good fit, however revised values did better. There is still a lot of scatter, which implies different surface activity. Around 2 metres is lost from 1P/Halley each revolution, implying that it will last for around 250,000 years. One might expect that size and perihelion distance are correlated, given that comets with shorter period will loose more material. A paper by Lamy shows no such correlation, however David's interpretation of the data is that it doesn't disagree with the hypothesis. The average Jupiter family comet starts with a radius of around 3 km and slowly shrinks. The gradient of size versus perihelion distance will give a clue on the average age. There are no bright comets passing close to the Sun. The average comet has a radius of 1.4 km and perihelion distance of 1.8 AU. Short period comets are literally disappearing in front of our eyes and after 400 orbits (2,500 years) half will have gone. If we are in a steady state Jupiter must be throwing in more objects to the inner solar system.

Alan Fitzsimmons (Queen's Belfast) told us about some of the interesting things that he is doing at the moment under the title of Recent results in the ground based imaging of distant comets. He concentrated on three aspects: why we should study nuclei, snapshot surveys and dedicated observations. Spacecraft show that 1P/Halley is quite a large nucleus about 17 km long. Sublimation is seen on the surface giving jets of dust and gas. 19P/Borrelly shows that the nucleus is complex and has real geology, quite different from the theoretical construct of ground based observations. Nuclei were formed in the outer solar system, which was a wild and dangerous place at the time, and are collisional ejecta from the Kuiper belt. They are a repository of organic matter and are important for studies on the origin of life. The nucleus is the source of the coma and tail. Alan had run a survey programme to study bare nuclei, which observed 56 objects to get a size distribution. The William Herschel Telescope has a new prime focus camera with 2048x4100 pixels giving a resolution of 0.25" per pixel. 43P/Wolf-Harrington at 4.43 AU was magnitude 21.6 but still showed a slight dust coma. 143P/Kowal-Mrkos at 4.74 AU was brighter at 20.5, but showed a bare nucleus. Such objects are possibly bright enough for amateurs to image, so they could contribute to these studies. 1998 U4 (P/Spahr) was the most distant object imaged at 6.14 AU (beyond Jupiter) when it was 23.3. His team is now moving on to dedicated observations, looking at size, colour and rotation. 22P/Kopff was observed for a total of 3.6 hours and showed a dust trail behind the comet. The individual frames show a light curve with a period of about 6.15 hours. 6P/d'Arrest has a period of 7.20 hours with an amplitude of around 0.1. New planned studies include monitoring activity all round the orbit and a search for comet ice as no water has yet been detected on a nucleus. A search for comets near the Sun is planned to come on line in a few months with SuperWASP1 (Wide Angle Survey for Planets), a fully robotic telescope which will have a 247 square degree field and image down to 16^m in 30 seconds. The primary task is to search for planets round other stars at the opposition point, but they hope to try and search for SOHO like comets at 45° - 60° elongation from the Sun.

The session concluded with Nick James (BAA) describing CCD imaging by amateurs. Automated searches such as LINEAR find practically everything, however amateurs can carry out rapid follow up, observe structure near the nucleus, do photometry and monitor faint objects. CCDs also give pretty picture. Is astrometry worth doing? Yes, once you have the images. Astrometrica (commercial software) is fast and catalogues are good. It is particularly important for objects on the NEOCP. Peter Birtwhistle is getting down to 19.8. Photography didn't have enough dynamic range to show structure in the coma, but CCD processing can be used to bring out details. For example Hale-Bopp had apparently stationary jets prior to perihelion. A rotational gradient filter enhances radial features such as seen in 153P/Ikeya-Zhang. Photometry is difficult. What aperture should be used ? What comparison stars ? Are filters needed ? [See my review of the MACE 2003 meeting - Ed] Overall photometry is now seen as the most difficult area for amateurs. Specific targets for amateurs include the potential Rosetta target 67P/Churyumov-Gerasimenko, comets which have outbursts such as 29P/Schwassmann-Wachmann. Nick wasn't sure if spectroscopy was valuable [again see the MACE notes], however Maurice Gavin had obtained spectra of 2002 C1 and 2002 V1. Finally the amateur could take pretty pictures and there is nothing wrong with this. In addition wide field images do contain lots of structure. New CCD chips such as Kodak KAF1600 at 14x9mm and KAF1000 at 25x25 mm are becoming comparable to film, but expensive. Alternatively it is possible to mosaic smaller fields and these show considerable tail structure. Another technique is to use an ordinary camera lens with a CCD. Some digital cameras can record comets and more expensive digital SLRs are comparable to CCDs. Nick emphasised the need to use the standard naming convention when submitting images. Brian Marsden confirmed that astrometry and imaging were important to check if objects on the NEOCP where comets and that it was very important to submit results as quickly as possible. When LINEAR reports an object they have no idea if it is cometary or not.

Alan Fitzsimmons and Paul Murdin briefed the gathering on possible grants for scientific projects. The RAS has a small grants program open to fellows for peer reviewed proposals. There is a six month cycle, with £18,000 per year available distributed in grants ranging from £500 to £5000. They are normally awarded for purposes not funded by PPARC, for example travel, to teachers etc. Pro-am work would come within this remit, but proposals must come from fellows. Full details are posted on the RAS web pages. The Faulkes and Liverpool telescopes will be operational this summer and welcome proposals from amateurs, which can either be live or via email. The BAA has Ridley grants which are open to all astronomers. There is also the Shoemaker grant in the US which has 35,000$ per year.

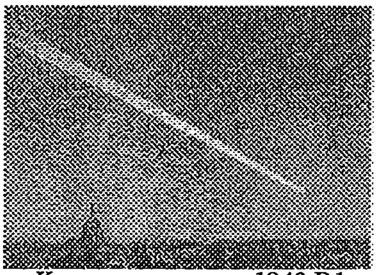
During the tea break speakers and audience were photographed, which meant that we reassembled to hear Graeme Waddington speak on Random Meanderings by Jove slightly later than planned. Nothing much happened for 13.7 billion years, then along came Kepler and Newton. For a few body problem we need to consider solar attraction, planetary perturbations and relativity (ignore). Solar heating (radiation pressure, Poynting-Robertson effect, Yarkovsky effect) on comets gives outgassing. The Marsden non gravitational forces are A_I = g(r), where A_1 is the radial, A_2 transverse and A_3 the force normal to the plane. They only apply when the comet is closer than about 3 AU of the Sun. The forces can change with time, for example in 7P/Pons-Winnecke. In the real world outgassing is asymmetric on a peanut shaped nucleus and peaks after perihelion. It is also from discrete sources, which may not be continuously active. Observations of the light curve and inner coma may help to distinguish between interpretations of A_i. Initial orbital solutions for comet Ikeya-Zhang showed that the orbits of the comets of 1661 and 1532 were similar, but the comet was soon securely linked to that of 1661. The non-gravitational forces appear to have been quite different between the apparitions. Further back in 1273 there are two possible comets, the best is one in April which was seen for 21 days. 877 has an object in February and March seen from Europe, though Chinese records suggest May. Linking 877, 1661 and 2002 gives a time for perihelion between February 5 and 12 in 1273. If we assume the perihelion time for 2002 and 1661 and change A_1 (which is a function of A_2) gives several possible results and a return around 455, but implies a close passage near Jupiter. Is there a link to the comet of 1532? A 1 m/s split at one return would give a four year separation at the next return, so one or other fragment could easily make an encounter with Jupiter whose radius of influence is around 0.35 AU. As a trial we can again assume the perihelion times in 2002 and 1661, but set $A_1 = 0$, then vary the perihelion time to get a return in 1532. 2013 May 1 is a possible solution for a split in 77, though his preferred solution is a perturbation in 451 that will return in 200 years time, though this requires a return in 956, which was possibly seen. Essentially the orbit is chaotic and so prediction is very difficult.



John, Guy, Brian, Kay and Nancy

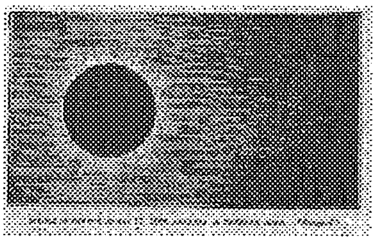
Guy Hurst introduced John Alcock, brother of George, and Kay Williams George's biographer, before asking Brian Marsden to present the George Alcock Memorial Lecture. Brian first met George on August 28 1959, the day following George's discovery of 1959f, though the IAU circular wasn't issued until

September 1. This was the first UK discovery since Denning had found 1894 F1 [though Candy accidentally found 1960 Y1 Ed] It was only observed for a week and was not seen after perihelion. 1983d, which made the closest approach to the Earth of any comet in the 20^{th} century was being observed exactly 20 years ago today. As well as making sketches on drawing card, George made copies on air letters. Brian had received a letter dated 1977 November 29, where George referred to a thin pencil like beam seen low in the sky on 1963 September 12, which may have been the comet discovered by Pereyra two days later. Ikeya-Seki was a great sungrazing comet as was the great September comet of 1882, when a fine drawing was made from Putney. The nucleus of this comet had fragmented and is possibly related to that of 1965, perhaps having split at a previous return early in the 12^{th} century - there was a comet in 1106 that may match. Sekanina & Chodas (AJ, 2002) suggest that the fragmentation occurred 18 days after perihelion on 1106 February 13.5. Spectra of Ikeya-Seki showed many lines of iron. Other bright comets in 1843 and 1880 appear to be related, with a period of a few hundred years, and to force a relation would require the period to be 360 - 380 years, with a split in the late 15^{th} century. The 1963 comet had a period of around 900 years and is perhaps another component of the 1106 breakup, although its orbit is clearly different. The exact orbit depends very much on where Jupiter is in its orbit; there are lots of possibilities, however Sekanina and Chodas suggest a link to the 1970 comet. In his original paper Brian had assumed a break-up at perihelion, however this is not necessarily the case. A comet seen on 1887 January 20 had a tail but no nuclear condensation and had perhaps passed through the Sun. A comet was seen in by du Toit (only) in 1945, then in 1970 came comet White-Ortiz-Bolelli. In 1981 the Central Bureau received reports from Solwind about a possible comet from 1979, which disappeared as it rounded the Sun. Since then SOHO has produced a multitude of objects. Eight Kreutz comets have been observed from the ground, 6 from Solwind, 10 from the Solar Maximum Mission and 465 from SOHO making a total of 489 as of May 1. There is quite a spread in the SOHO orbits, however they are only approximate and in many cases an orbit was only calculated because we know that the Kreutz group exists. For well known orbits L=282 and B=35. Brian wasn't sure if the spread in SOHO elements was real or not. Sekanina allows splitting well away from perihelion and finds pairs of comets coming in close together, which implies a separation velocity of mm/s, which doesn't match observed separation velocities [and often the elements of pairs appear different]. The problem is not solved yet. The comet of 371 BC is probably not connected with the Kreutz comets, but it makes a good story! We don't know the size of the progenitor. There should have been a bright comet in 1487, but no records have been found so far.



Kreutz group comet 1843 D1

Other SOHO comets also form a group. If they are periodic we have no idea what the period is. From the short arcs observed by SOHO it is impossible to tell the orientation of the orbit, and the groups were only recognised after further objects were found. A few comets pairs have been found in ground observed comets, but no groups. Why does only SOHO see them? The group is also associated with the Arietids, 96P/Machholz and the Quadrantids. The low inclination suggests that they might be short period objects. There are now 38 Meyer group objects, the Marsden group (similar to the Arietids) has 15 and the orbit passes close to the Earth today. The Kracht group has a further 16 members. Another group is 2000 Q1, Y6 and Y7. Excluding these groups leaves 35 comets that pass within 0.1 AU of the Sun of which 16 are from SOHO. Several of these did not survive perihelion, including all the SOHO objects. Those that survive did include 1680, 1962 Seki-Lines and 2002 V1 (NEAT).



Eclipse comet seen in 1882

A question asked about the boring names the majority of comets now received and would names be dropped? The new designation system introduced in 1995 is better than the old ones, but still has problems. On asked about whether interplanetary boulders might cause comet splitting, Brian thought it unlikely as comets were in any case so fragile.

Jonathan Shanklin

Professional Tales

The Populations of Comet-Like Bodies in the Solar system J. Horner (Oxford), N.W. Evans (Cambridge), M.E. Bailey (Armagh), D.J. Asher (Armagh), MNRAS

A new classification scheme is introduced for comet-like bodies in the Solar system. It covers the traditional comets as well as the Centaurs and Edgeworth-Kuiper belt objects. At low inclinations, close encounters with planets often result in near-constant perihelion or aphelion distances, or in perihelion-aphelion interchanges, so the minor bodies can be labelled according to the planets predominantly controlling them at perihelion and aphelion. For example, a JN object has a perihelion under the control of Jupiter and aphelion under the control of Neptune, and so on. This provides 20 dynamically distinct categories of outer Solar system objects in the Jovian and trans-Jovian regions. The Tisserand parameter with respect to the planet controlling perihelion is also often roughly constant under orbital evolution. So, each category can be further sub-divided according to the Tisserand parameter. The dynamical evolution of comets, however, is dominated not by the planets nearest at perihelion or aphelion, but by the more massive Jupiter. The comets are separated into four categories -- Encke-type, short-period, intermediate and long-period -- according to aphelion distance. The Tisserand parameter categories now roughly correspond to the well-known Jupiter-family comets, transition-types and Halley-types. In this way, the nomenclature for the Centaurs and Edgeworth-Kuiper belt objects is based on, and consistent with, that for comets.

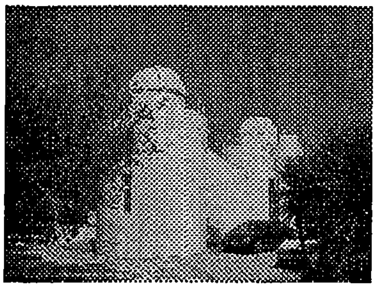
MACE 2003

The 2003 Meeting on Asteroids and Comets in Europe was held on the holiday island of Mallorca. The weather wasn't quite as sunny as shown in the holiday brochures and it soon became clear to me that the vast majority of tourists get no further than the beach. Inland at the north end of the island is a spectacular range of limestone mountains, with steep ravines leading down to the sea, yet on walks through them I rarely saw another traveller. Although we were staying in a beach front hotel, 20 minutes walk down the road was the internationally renowned nature reserve of Albufera, full of wildflowers and birds. The meeting was held at the Observatorio Astronomico de Mallorca at Costitx near the centre of the island, which necessitated an exciting bus ride through narrow village streets several times each day. Here there is a very well equipped observatory, with a planetarium, and a wide range of telescopes, some under robotic control through the internet and others available for school teaching.

Each dome houses an LX200!

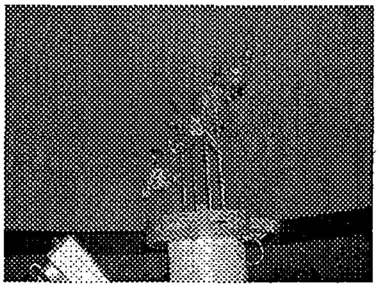
Here I generally describe only those talks relating to comets, however there was a good range of talks devoted to amateur studies of asteroids. These are summarised in a report in the BAA Journal and are also available as abstracts on the MACE web page at http://www.oam.es/oam/mace/abstracts2.htm. Many speakers used PowerPoint presentations, but only a few followed the best practice of using the pack and go option and the local laptop. Those that didn't often spent many minutes interfacing their own laptops to the host projector. This is a valuable lesson to learn if you plan on giving talks yourself.

Giovanni Valsecchi described close encounters between NEAs and the Earth. The mass distribution of these objects is approximately a power law. He described the keyhole theory where a close encounter at one return allows an even closer encounter at the following return. Each keyhole contains two collision possibilities. He estimates the error in calculations of future collisions done with the analytical theory of keyholes to be around 10%, mainly due to having disregarded various gravitational perturbations.



The dome of the robotic telescope

Mark Kidger updated us on the 2002/03 apparition of 67P/Churymov-Gerasimenko, the probable new target for the Rosetta spacecraft. It is a relatively new entrant to the inner solar system with the perihelion distance around 4 AU prior to 1840 and only going below 2.75 AU after 1959. The comet is fairly active, so it is a potentially risky encounter. The changes in perihelion distance drive the activity by increased sublimation blowing off crust. The Spanish language group "Observadores Cometas" have been observing it. 67P is much larger than 46P/Wirtanen at 2.5 km compared to 0.7 km radius. 67P/ apparently shows outbursts by about 1.5^m a few days before perihelion. 46P shows a consistent light curve, though a 3^m outburst reported in September 2002 and shown in a light curve from Seiichi Yoshida was not seen in his CCD data. Mark predicted another outburst for 67P in 2009 and is planning a campaign to observe it. His light curve suggests an outburst a few days before perihelion and a rapid change in slope at 1.85 AU on the way out, possibly related to H_2O sublimation switching off. A light curve by Seiichi Yoshida shows the same outburst, and also one at the previous apparition. [*Note that some sources use poorly calibrated CCD photometry, which frequently gives spurious effects* Ed.] He suggested that the coma became less condensed after perihelion. He showed examples of CCD images of the comet, which shows a prominent tail, even eight months after perihelion.



The planetarium projector

Jure Skvarc described astrovirtel and the search for trojans of the outer planets. The highlight of this talk was the Italian spaceguard representative who became very upset when it appeared that a possible NEO hadn't been reported to them.

Gerardo Avila reported on the spectra of comets. The Club of Amateurs in Optical Spectroscopy use a fibre optic linked spectrograph which has 1.5 Å resolution. They have obtained spectra of Hyakutake, Hale-Bopp and 1999 S4. They think that they recorded evolution in the Na-D lines in the spectra of Hyakutake that appeared during the apparition and also those in Hale-Bopp, which developed during March and April. Although raw spectra of 1999 S4 looked unpromising they do contain useful information. The group is developing an Echelle spectrograph which will have better resolution ($20,000\lambda/\Delta\lambda$) on the 0.6-m telescope, which will show spectra of a 6^m star with a 20 minute exposure.

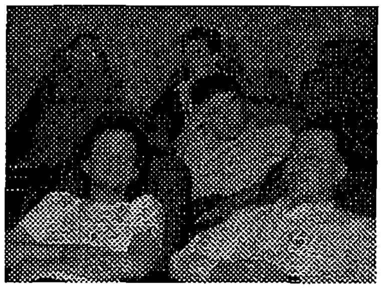
Andrea Boattini described NEO search efforts. US programmes are not complete, particularly in the north, south and near the Sun. A Schmidt camera (roughly equivalent to the IOA Schmidt in Cambridge) was refurbished with a CCD camera. It can point to within 8° of the horizon. The best strategy was to observe at 50°-55° elongation down to 20^m.

Marcos Voelzke reviewed comets and their origin and evolution. What are comets? - the word comes from cometes or long haired star. They are a mix of dust and ice - we know about the nucleus of 1P/Halley from Giotto. We study comets to understand solar system evolution and the possible cataclysmic effects they may have on the Earth etc. Spectra show their composition. It is possible to show morphological evolution by subtracting image pairs taken a few hours apart, and this was illustrated by images of 1P/Halley. We can explain disconnection events in the tail by the nucleus passing through a magnetic field change, which accounts for about 70% of cases. Another theory suggests that the solar wind pressure varies, but this only explains 22% of cases. He wants to extend the theories to other comets and to use 3-D imaging.

Mark Kidger gave another talk, this time on 153P/Ikeya-Zhang. The previous longest return period was 35P/Herschel-Rigollet, which was seen in 1788 and 1939. 153P was the first comet with a confirmed period longer than 200 years as the proposed link to 1661 is secure. Previous returns, in 877 and 1273, are less secure [See the talk by Graeme Waddington at the Proam meeting]. It was discovered on 1661 February 3 in the morning sky, with a 6° tail. Shortly after discovery Hevelius reported it fainter than Altair. It was last seen on March 28, presumably with the naked eye. A rapid decrease in the degree of condensation was reported. In 1273 a comet was seen on February 5 in the evening and 17 in the morning. One was also seen two months later as a blue-white guest star in Auriga, however this can't be 153P if the first comet is. Waddington suggests that the second object is 153P as the track fits and gives the perihelion as March 27.5±1 day. However the latest IAU orbit suggests a perihelion in 1272 December. The Japanese record a comet on 877 February 11 in Pegasus and a comet was seen in the west from Europe in March. Nakano links these with 153P, however the European comet was in Libra, whereas the Nakano orbit puts it in Cygnus. It would not have been seen from Europe at sunset unless it was very bright. The orbit of 1532 R1 is similar to that of 1661. If the 1661 comet had a similar light curve to the present apparition it would have been better placed for observation before perihelion, and brighter, but there are no reports either in late December or in mid January. Possible explanations are an outburst at perihelion or an asymmetric light curve, but neither is credible. A possible explanation of the 1273 reports is an incorrectly transcribed date. There is a problem linking the expected magnitude to the suggested orbital fits. The observational evidence tends to favour the Waddington linkage in 1273. The Chinese reports suggest that the comet was blue and therefore it must have been bright to see colour, however the light curve gives a magnitude of 1.5 and fading even if the 1661 light curve is used. Alternatively the comet may show strong secular fading. This could be explained if the 1532 and 1661 objects are two fragments of a comet that split in the first century, with the 1532 body being the principle component. A smaller fragment might be expected to show secular fading. The orbit of 153P permits close encounters with Jupiter at the descending node. A split in 58 AD, followed by a close encounter with Jupiter in 485 should separate the components. This implies that the bright component will return at the end of this century.

Maria Teresa (Maite) Merino described the transformation of an old Baker-Nunn Camera from a military base at San Fernando in southern Spain. It will feature a new large format CCD camera and will be used in a robotic mode. It will be installed at Tossa d'Alp in the Catalan Pyrenees by the end of 2004 and might get down to 21^m, theoretically covering the northern sky in four or five days when used in survey mode. It will also be used for discovery and follow-up work for solar system objects, as well as other astronomical survey work which requires a quick response time.

Jure Skvarc described the Fitsblink software developed at Crni Vrh, which has image processing and objection detection facilities. It can't detect trails yet. It uses the USNO SA, Tycho 2 and will use USNO B catalogues for astrometry. It uses Tycho 2 and LONEOS (by Skiff) for photometry and will use the Landolt catalogue in future. There is an option for comet photometry, with automatic star exclusion, background subtraction and tail exclusion. It will produce a report directly in ICQ format and is designed to help beginners.



Herbert Raab & Bill Yeung

Herbert Raab, producer of the widely used Astrometrica software, described some new star catalogues. GSC 2.2, USNO B 1.0 and UCAC (USNO CCD Astrograph Catalog) V2 and compared them with the USNO A 2.0. USNO A is based on the POSS at 0.25" accuracy for 1957 with no proper motions. USNO B has 10^9 stars, relative proper motions (relative to the mean sky, rather than the fixed background of quasars) and is complete to 21^m. Positions are accurate to 0.2" at the current epoch. GSC 2.2 is 455 x 10^6 stars and has a limiting magnitude of 18.5 (R) and 19.5 (B), there is no proper motion and the accuracy is 0.2" in 1993. Version 2.3 is due in 2003 and this will include proper motions. UCAC 2 is based on recent CCD observations. At 50 x 10^6 stars in size it includes proper motion, stars from 8^m to 16^m at -90° to +45° declination to an accuracy of better than 0.1". The new catalogues are significantly better than USNO A. The UCAC is available on 3 CDs from USNO at ad.usno.navy.mil/ucac. USNO B is available on line as is GSC 2.2. The UCAC is good for photometry (approximating to a yellow-red filter [579 - 642 nm]) to around 0.3^m.

Herman Mikuz, well known for his CCD work, described the new 0.6-m robotic telescope at Crni Vrh observatory, which will reach 20^m with a 5 minute exposure. They discovered an NEO 2003 EM1 whilst imaging comet 2001 RX14 and confirmed 2003 H1, which was essentially stellar, but the image profile was slightly broader than that of a star. 2003 H2 was fainter, but clearly diffuse. You need to be very systematic in calibrating and focussing the telescope in order to get good results.

Korado Korlevic commented that comet 1998 VS24 (LINEAR) was discovered as a one night stand at Visnjan, but as they couldn't follow it up they lost the credit for it.

Konrad Dennerl spoke about the recent discovery of X-rays from comets. ROSAT observed comet 1996 B2 and detected X-rays, which was a big surprise. The team obtained 9 images which show a factor of four variation in brightness over a few hours. The peak of X-ray flux is offset in the solar direction. The X-ray coma is much larger than the optical one, and elongated perpendicular to the solar direction. They then looked at the archive data from the satellite and found several comets showing X-ray emission, including one prediscovery image, down to a visual magnitude around 12. All comets inside 2 AU and brighter than 12^m were seen. The X-rays are generally low energy. The X-rays don't follow the optical morphology and in particular don't follow the dust. There is a correlation between the X-ray and optical flux, but the X-rays are some 10^{-4} the intensity. Gassy comets are brighter in X-rays. Protons, electrons and helium nuclei form 99.9% of the solar wind, but the 0.1% of 'heavy' ions (eg C^{6+}, O^{6+}) are responsible for the X-rays by exchanging electrons from neutral H_2O in the coma giving emission at discrete X-ray energies, in particular at 568eV. Therefore the X-ray emission is more from the solar wind and this explains the crescent shaped emission profile on the sunward side. Comet observations therefore make a good probe of the solar wind. At high ecliptic latitude the wind is fast and steady, whilst at low latitude it is highly variable at solar minimum but more variable all round at solar maximum. Chandra and XMM-Newton have both observed comets. XMM observed 1999 T1 (McNaught-Hartley) and 2000 WM1 (LINEAR). 2000 WM1 didn't have any emission above 1 keV, but they recorded 10^6 X-ray photons. The profile is a function of 1/r. XMM can also measure spectra, thus identifying electron transitions. Chandra observed 2002 C1 on two nights, finding completely different X-ray morphology. CCD images or photographs taken on 2002 April 15 between 01:54 and 05:09 would help understand the reasons. The X-ray coma would perhaps be comparable to the Lyman alpha cloud in size if sufficient sensitivity could be used.

Richard Miles showed that the Sony CCD HAD chip is actually quite a close match to Hipparcos and so can be used without a filter if a simple transform is used. This assumes that the stars used have a similar B-V to the asteroid.

In his third talk Mark Kidger looked at amateur CCD photometry. The advent of the CCD has been the biggest revolution in cometary observation in the last 50 years. It provides both astrometry and photometry, however the photometry is generally unreliable with a scatter of perhaps 4^m. There is a need to standardise in a way that is simple, quick and adequate for the purpose. We must accept unfiltered photometry, and the fact that comets are not point sources, which makes life harder. The MPC list an N ($\equiv m_2$) or T ($\equiv m_1$) magnitude, however the m_2 reports tend not to be a bare nuclear magnitude. The Spanish method is to assume that unfiltered magnitudes approximate to R, for everyone to make the reductions with one package (eg Astrometrica), to use a standard aperture of 10" for nuclear magnitudes and to calibrate using USNO A2.0 R magnitudes (this is widely available, has many stars and there is nothing better at the moment). The catalogue is from 1950 POSS plates (or more recent) and is not a photometric catalogue. The B mags are too bright above 13^m so that $20^m \equiv 19.2$ but is generally close to the truth at 14^m. R is within 0.2^m from 11 - 19 (18 USNO $\equiv$ 17.8) and the standard deviation is about 0.25^m. 60% of stars are within this and each field may have 100 stars, so outliers can be rejected (Astrometrica does this automatically). You should NEVER use single star calibrations. The error generally reduces as the square root of the number of stars used. The biggest single issue is actually sky subtraction. As an example using 2002 T7 the light curve scatter has ±0.2 mag. It is possible to improve things by using a range of fixed apertures, 10", 20" etc. They have developed a custom program (FASE3) to permit multi-aperture photometry and astrometry, and also give good sky subtraction.

Gyula Szabo introduced the idea of an Afrho database. It is difficult to do photometry on a diffuse comet coma. The observed length of tail or coma size depends on equipment and sky conditions. The coma brightness depends on aperture, the brightness of the nucleus depends on seeing, equipment, coma etc. Sunlight is scattered from dust in the coma towards the Earth, therefore the ratio of comet flux to solar flux is a measure of the dust in the coma. Dust is characterised by a function of the albedo and dust density (Afrho). He would like to create an archive of Afrho measurements supported by a helpful web page at cara.uai.it. AstroArt software includes tools for generating the information needed. As an example photographic data for 67P from Kitt Peak in the 1980s gives very similar results to recent Italian observations using CCD. He would welcome more observations. Mark Kidger suggested that the archive should do the calculation of Afrho from the input data.

Mike Kretlow concluded the papers with a talk on the splitting of comets. In the past 160 years we have seen about 35 split comets. There are two split comet families - the Kreutz group and the Marsden/Mayer/Kracht group. D/1993 F2 split as a result of tidal forces. High resolution imagery shows that fragments are sub kilometre in size. There are two types of fragmentation: A: two or three fragments leaving a primary body, a process which may recur and the fragments can survive for years. B: many fragments, with no primary (eg D/1993 F2, 1999 S4) with the parent completely destroyed. Backward integration generally doesn't give a satisfactory break-up point, which makes it tricky to link up fragments. Sekanina has published lots of papers on more than 30 comets over the last 25 years. This uses a simple 2-body model, which is not suitable for type B and even the 2-body model gives multiple solutions. The model implies that splits can occur anywhere along the orbit and the lifetime of fragments can be very variable, being weeks to years. The separation velocity is 0.1 to 15 m/s, but generally 0.3 - 4 m/s. The splitting rate is around 2%/century/object so that over the lifetime of a comet (10^7 years) about 1000 events may happen to a comet. If each fragment was 50-m in radius this sums to a parent 0.5 - 1 km in radius so it is an important mass loss factor. Splitting may be due to tidal forces, rotational forces, thermal stress, internal gas pressure or impact. The first known example is 3D/Biela, which split into 2 in 1845/6. It was seen again in 1852/3 and has been lost since then. 73P/Schwassmann-Wachmann split in 1995, with an outburst occurring just before the split and perihelion. 57P/du Toit-Neujman-Delporte split in many fragments in July 2002, although there was still one primary. Coma arc-lets or ring-lets as seen in image processed views of 2001 A2 may indicate breakup or may relate to outgassing. Amateurs need to monitor comets, both as a light curve and high resolution CCD images in order to detect break-up events closer in time to the actual event.

Several poster papers were on display in the foyer of the planetarium, which also housed an exhibition of meteorites. Mark Kidger had a poster on 'Revealing the nucleus of long-period comets with Canaricam'. This is a mid-infrared imager planned to be installed on the Gran Telescopio Canarias, a 10 metre telescope which is due to start operation in 2005. By combining the infrared and visible photometry it will be possible to determine the albedo and diameter of distant comets.

The next MACE is planned for Frasso Sabino near Rome in 2004.

Jonathan Shanklin, with thanks to the speakers for corrections to my original notes

Springer Competition Winners

Thanks to the generosity of Springer-Verlag the comet Section was able to run a competition in the spring, with prizes being copies of the new book on *Observing Comets* by Nick James and Gerald North. The winning entries appear in this edition of *The Comet's Tale* and the runners up will appear next time. A review of the book, by Guy Hurst, appeared in the August Journal and one by John Bortle appeared in the September issue of Sky and Telescope. The book is a valuable addition to the observers' library and I can strongly recommend it.

Margaret Cullen submitted her drawing "Cat watching Hale-Bopp" to win the SPA Members division, Gabriel Oksa's essay won the BAA division and Bill Ward's essay won the open division. Congratulations to all these on their success.

Why I Observe Comets

Gabriel Oksa

I began with a systematic observing of comets in 1996 during my stay at the Loughborough University, Loughborough, England, where I received the Royal Society Fellowship in the field of parallel computing. At that time, the Internet was new to me and by means of it I established first contacts to the British Astronomical Association, especially to its Comet Section. From April 1996 onwards I am the only Slovak member of the BAA.

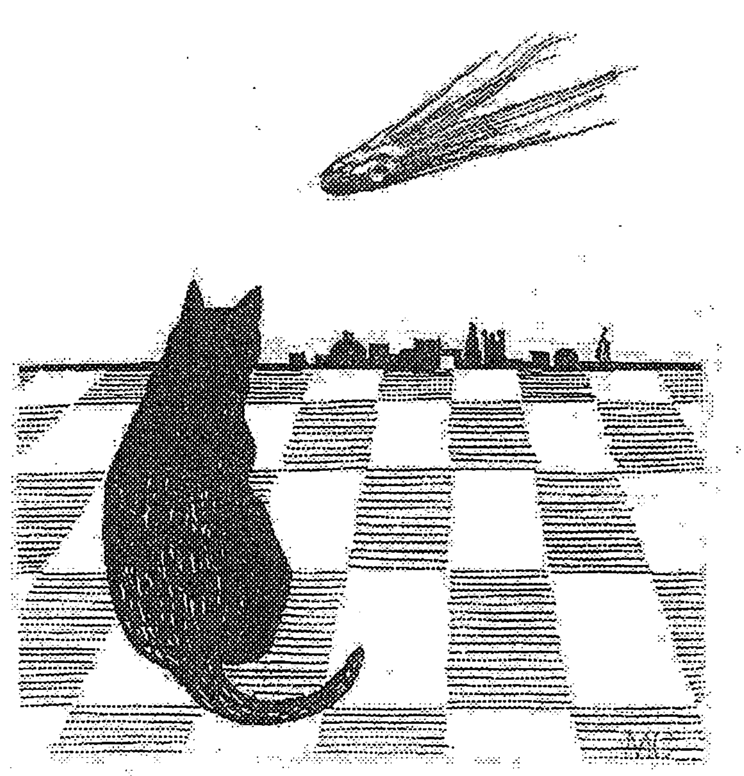
The year 1996 will be recalled as the year of Great Comet Hyakutake. I remember those foggy days in Loughborough when its finding was announced and the special BAA circular was issued with a map of comet's visibility. And then I remember the increasing frustration due to the 'English' weather when several weeks were totally clouded off with no sign of Sun, stars and comet. But exactly around the time of the comet's closest approach to the Earth, the weather changed and I vividly recall that evening in late March with the comet nearly overhead, having large coma and long tail - a stunning sight even from the middle of the city!

And then, of course, the Great Comet Hale-Bopp! My observations were split between England and Slovakia. The climax came in those cold evenings of April 1997, when I was able to record photographically the changing forms of its wavy plasma tail and to observe the brightening and lengthening of its dust tail and the famous dust envelopes around its pseudo-nucleus. Using even small binoculars, an amazing colour contrast between the blue plasma and yellowish dust was easily visible.

Since that time, seven years of the regular observing of comets have gone and my interest did not vanish. I observed, among many others, the famous comet 55P/Tempel-Tuttle rushing across the sky in January 1998, interesting changes in the tail and coma of the comet C/1999 S4 in spring and summer 2000 (the comet disintegrated in July 2000), the outburst of comet 41P/Tuttle-Giacobini-Kresak in December 2000 and a beautiful visual emission spectrum of the distinctly bluish pseudo-nucleus of comet 153P/Ikeya-Zhang in March 2002. Having used several observational techniques including the CCD camera, I am fascinated by wonderful cometary drawings of late Mr Alcock, so nowadays I am trying to reproduce some of my observations in this way.

To observe a comet, you must not be lazy. Sometimes you have to abandon your warm bed early in the morning - often too early for 'ordinary' people. Sometimes you have to change your evening plans suddenly when a beautiful transparent sky of a special blue colour appears following the passage of cold front. You have to know the sky well enough to find a comet. You have to remember that things completely change during an evening or morning twilight so that, in such circumstances, to find even a bright comet close to the horizon may be a challenge. You need a lot of patience in those cloudy nights when only a few holes of clear sky bring you some hope, and you firmly believe that one of them will reach a comet and stay there for a sufficiently long time to make an observation. You need all of these skills - and still, a successful observation is not guaranteed! Every time I go out to observe comets I am not sure what, if anything, I shall see. This uncertainty is a substantial part of my life with comets.

So, why do I observe comets? It is a joy - every time a comet is in my eyepiece I feel lucky. It is a thrilling experience - just think of the depths of space and time, which a comet is coming from! It is a perception of beauty and very special order in the cosmos. It is a curiosity - how will a comet appear today? I would say that some sort of relationship arises between an observer and a comet, especially if a comet is observable for a longer timeperiod. And it is a communication and sharing with a community of equally-minded people in the world.



Cat watching Hale-Bopp - Margaret Cullen

Exciting days should be ahead for all cometary enthusiasts. Several space probes are planned to visit some comets and analyse their composition by 'in situ' measurements in near future. Unprecedented details will be added to the enigmatic nuclear images of comets 1P/Halley and 19P/Borrelly. But, regardless to the advances of science, the comets will remain delightful objects for amateur astronomers due to their intrinsic beauty, unpredictable behaviour and connection with the origin of our Solar system.

The Importance of Amateur Comet Observations

Bill Ward

Every comet is different with it's own story to tell and each one presents a new piece of information about the solar system. Comets by their very nature are varied and unpredictable. It is because of this that amateur astronomers can and do play an important part in cometary astronomy simply by the virtue of being "amateur". In this context amateur has nothing to do with the standard of workmanship only in the meaning of being un-waged and in conducting observations for the enjoyment to be found in it.

Amateur cometary astronomy is sometimes viewed as slightly quaint and reminiscent of the 18th and 19th centuries with their famous comet hunters. Nowadays there are relatively few professional cometary programmes with most solar system observing programmes dealing with other small bodies such as near earth asteroids and more recently trans Neptunian objects.

A great deal of time is required to conduct searches and carry out observations. From the discovery of a comet to its orbit back into the far reaches of the solar system may be months or years. As comets are unpredictable there is no way of scheduling observing time in advance as it is impossible to say when an interesting comet will appear or an unusual event will occur. The process by which telescope time is granted is highly competitive with large telescopes being over subscribed. This process tends to favour projects with a definite short-term goal and that will yield a scientific paper suitable for publication. Comet observations require a longer time scale. Major observatories simply cannot justify the expense of using major instruments for such work because of the restrictions placed upon them.

Considering this situation begins to reveal the importance of amateur comet observations. The key issue is one of flexibility, of being in the position to observe whatever and whenever without any other concerns or restrictions. A flexibility which professional observatories cannot match.

Another important element that is now fundamental to amateur comet observations is one of technology. The developments in detectors, that is the now ubiquitous CCD camera, allow the amateur to work at magnitudes that were impossible only a few years ago! Combined with the availability of powerful desktop computers, this allows real quantitative data to be produced to a high standard. Software is readily available and photometry and astrometry are now relatively simple tasks. Images of remarkable detail are now common place through the use of both modem film and CCD cameras. (A by-product of these spectacular images is to raise public awareness about astronomy in general. With the appearance of Comet Hyakutake in 1996 and Comet Hale-Bopp in 1997 coupled to the imminent appearance of two more possibly bright comets (Comet 2002 T7 and Comet 2001 Q4) a whole new generation of people have been (or shortly will be) exposed to comets and astronomy.)

Even with nothing more than ones eyes, there is a huge array of binoculars ranging from lightweight models to huge 150mm monsters which allow many comets to be followed visually. It should be noted that hand written visual observations are just as valuable as the "hi tech" CCD ones. One only has to consider historical observations to see this. Many comets would not have been found had it not been for those 18th and 19th century amateurs exploring the heavens and our understanding of comets would be poorer if it were not for these same people leaving us their notes. Properly recorded amateur comet observations constitute a major scientific archive.

Amateurs also have the advantage of numbers and coverage. With many eyes watching the skies there is the chance that any given event will be caught somewhere. Even casual observations are important too if a bit of care is taken. As astronomers we are plagued by the weather and you just might happen to be in the right place at the right time to get that critical observation, it could be cloudy elsewhere!

The importance of amateur comet observations cannot be underestimated as it is through the inherent flexibility, readily available technology and coverage that amateurs have which allows useful observations to be made in conjunction with professional research ultimately allowing us to know more about these fascinating objects.

Comet Prospects for 2004

2004 sees the return of 18 periodic comets. None are particularly bright and the best are likely to be 78P/Gehrels and 88P/Howell. Three long period comets are likely to put on good shows. 2001 Q4 (NEAT) reaches perihelion in May, when it could reach at least 3rd magnitude. Northern Hemisphere observers will first pick it up just after perihelion as it rapidly moves north. 2002 T7 (LINEAR) could also reach 3rd magnitude at closest approach in May, however Northern Hemisphere observers will have lost it as a binocular object in mid March. Observers at far southern latitudes may be able to see these two naked eye comets at the same time. 2003 K4 (LINEAR) could reach 6th magnitude as it brightens on its way to perihelion. Several other long-period comets discovered in previous years are still visible.

Theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter periodic comets, which are often ignored. This would make a useful project for CCD observers. As an example 51P/Harrington was observed to fragment in 2001. Ephemerides for new and currently observable comets are published in the *Circulars*, Comet Section Newsletters and on the Section, CBAT and Seiichi Yoshida's web pages. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 18^m are given in the International Comet Quarterly Handbook; details of subscription to the ICQ are available from the comet section Director. The updated section booklet on comet observing is available from the BAA office or the Director.

29P/Schwassmann-Wachmann is an annual comet that has frequent outbursts and seems to be more often active than not at the moment, though it rarely gets brighter than 12^m. It begins the year in Aquarius, but spends most of the year in Pisces, reaching opposition at the end of September. The comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. UK based observers should be able to follow it throughout the second half of the year.

43P/Wolf-Harrington is at its brightest (12th mag) at the beginning of the year, and slowly fades as its elongation in the evening sky decreases. This is the comet's tenth observed return. It is in a chaotic orbit, and made a close approach to Jupiter in 1936 which reduced its perihelion distance from 2.4 to 1.6 AU. It made an exceptionally close (0.003 AU) approach to Jupiter in 1841, which switched its previous perihelion distance into the new aphelion distance. It was discovered in 1924, then lost until 1951. Its next apparition, in 2010, will be unfavourable.

48P/Johnson was discovered by Ernest Johnson at the Union Observatory in South Africa in 1949, following a very close approach to Jupiter in 1931. It is now in a stable orbit between Mars and Jupiter and no close approaches are predicted for some centuries. At favourable apparitions, such as its first two returns, it reaches 13th magnitude. The next three returns were unfavourable, with the comet reported to reach only 18th magnitude. Returns are now improving, and at the last return, Werner Hasubick reported observing it at 13.5. It could reach a similar magnitude at this apparition, though it will be best seen from the Southern Hemisphere.

62P/Tsuchinshan The comet was discovered at Purple Mountain Observatory, Nanking, China in 1965, following a close approach to Jupiter in 1960, which reduced the perihelion distance from 2 to 1.5 AU. Unusually, the comet's name derives from that of the observatory rather than those of the discoverers. At a good apparition such as in 1985 it can reach 11^m and as the perihelion distance will continue to decrease future returns may be even better. At the last return the comet was recorded at around 13^{th} magnitude and this time it could do a magnitude or more better. It should be picked up as a 13^{th} magnitude object in the September morning sky, brightening throughout the rest of the year. It tracks from Gemini in September through into Leo at the end of the year, when it could be 11^{th} magnitude.

69P/Taylor A series of Jupiter encounters in the 19^{th} century reduced the perihelion distance from 3.1 to 1.6 AU and led to its discovery by Clement Taylor, with a 0.25-m reflector from Herschel View, Cape Town South Africa, in November 1915. It was quite bright, 9th magnitude at best, and shortly after perihelion, in 1916 February, E E Barnard found a double nucleus, each with a short tail. The secondary nucleus became brighter than the primary, but then rapidly faded and the primary also faded more rapidly than expected. The comet was then lost until 1977, when new orbital computations led to the recovery of the 'B' component by Charles Kowal with the Palomar Schmidt. The 'A' component was not found. The comet has had several encounters with Jupiter, the closest recent one being in 1925, and had very close (0.06 AU) encounters in 1807 and 1854. The comet was not expected to be brighter than 15^{th} magnitude at its last return, however it was discovered at around 12.5 in mid January 1998. The observations suggest that it suffered two outbursts. This makes it difficult to predict the likely brightness at this return, but if it maintains the level of activity it might reach 11^{th} magnitude at the end of the year. It will become visible in the late summer morning sky at perhaps 13^{th} magnitude and CCD observers should treat it as a priority object.

78P/Gehrels Tom Gehrels discovered this comet at Palomar in 1973. Its perihelion distance is slowly decreasing and is currently around the lowest for 200 years. The eccentricity is slowly increasing, with a marked jump in both following a moderately close approach to Jupiter in 1995. This return is extremely favourable, with the comet reaching opposition and perihelion within a fortnight of each other. At the last return the comet reached 12^{th} magnitude and it should do at least a magnitude better this time round. It should become within visual range of favourably placed observers by late spring, but UK observers will probably need to wait until July when it should be a 12^{th} magnitude object in the morning sky. It continues to brighten on its way to opposition and by October should be at 10^{th} magnitude. It spends most of the apparition in Aries, where it completes its retrograde loop in mid December, by which time it is fading towards 11^{th} magnitude.

88P/Howell Ellen Howell discovered the comet in 1981 with the 0.46-m Palomar Schmidt. It passed 0.6 AU from Jupiter in 1978, which reduced the perihelion distance, but the biggest change to its orbit occurred in 1585 when an encounter reduced q from 4.7 to 2.4 AU. The standard light curve was not a good fit to the observations at the last return and a better fit was obtained using a linear light curve that peaked 28 days after perihelion, thus confirming the view that the comet is brighter after perihelion. The comet was never well placed for viewing in the UK at the last return and will not be at this return either. Elsewhere it should be picked up at 12^{th} magnitude in January as it emerges from solar conjunction. The comet should be at its best in mid March when it could be 10^{th} magnitude.

95P/Chiron is an unusual comet in that it is also asteroid 2060. It will reach around 17^m when at opposition in July in Sagittarius. CCD V magnitudes of Chiron would be of particular interest as observations show that its absolute magnitude varies erratically; it is currently around 6. It began an outburst in 2000/01 though it is likely to be fading again in 2004. It was at perihelion in 1996 when it was 8.5 AU from the Sun and will be nearly 19 AU from the Sun at aphelion in around 40 year's time.

Two long period comets are likely to become naked eye objects. **C/2001 Q4 (NEAT)** was discovered at Palomar on 2001 August 24.40 when it was nearly three years from perihelion and over 10 AU from the Sun. It begins the year as a Southern Hemisphere binocular or easy telescopic object and remains at high Southern declination until it nears perihelion in May. By then it will have brightened considerably, and could be an easy naked eye object. Adopting a conservative magnitude equation predicts a peak of 3^{rd} magnitude as it emerges into the northern evening twilight in the second week of May, though it could be 1^{st} magnitude. Tail development is likely to be good, particularly in the first half of May, with a maximum length of 10° - 25°. Observing opportunities are best in the second week of May as the moon leaves the sky. It remains an evening object, becoming circumpolar in June, when it may still be just visible to the naked eye. It passes from binocular range by the end of July, but will remain visible to telescopic observers to the end of the year.

C/2002 T7 (LINEAR) reaches perihelion a few weeks before 2001 Q4, but will be at its best at around the same time, though only for Southern Hemisphere observers. It too begins the year as a binocular object, but at this time it is best placed for Northern Hemisphere observers. It remains a binocular object, dropping into the evening twilight in the first week of March. It emerges from solar conjunction as a naked eye object in mid April and continues brightening, even after perihelion, as the distance from earth decreases on the way to a moderately close approach at 0.27 AU in mid May. Equatorial observers get the best view as it emerges from conjunction, but at closest approach it is a Southern Hemisphere object of 3^{rd} or perhaps 1^{st} magnitude. The tail at this time could extend as much as 40°. Thereafter the comet fades, passing from binocular view in July and re-enters solar conjunction in August. It might be picked up again as a 13^{th} magnitude object at the end of October.

C/2003 K4 (LINEAR) reappears in 2004 February after solar conjunction and reaches binocular range in May. We will loose it into conjunction again at 6^m in 2004 September and it will pass through the SOHO LASCO fields as a 5^m object in 2004 October. Southern Hemisphere observers will pick it up at the end of the month and it should remain a naked eye object until 2005 January.

A few other long period comets will still be visible at the beginning of 2004. **2001 HT_{50} (LINEAR-NEAT)** will be fading from 12th magnitude at the start of the year, but it is well placed in the evening sky in Pisces. It will be lost in the evening twilight by the end of February. **2002 O7 (LINEAR)** is fading from 11th magnitude in Aquarius, but sinks into the twilight even more quickly and will be gone by the beginning of February. **2003 H1 (LINEAR)** is best placed for observation from the Southern Hemisphere and may reach 11th magnitude in March.

Several other comets are at perihelion during 2004, however they are unlikely to become brighter than 13th magnitude or are poorly placed. 40P/Vaisala, 42P/Neujmin and 121P/Shoemaker-Holt are 13th magnitude or fainter but within range of larger amateur telescopes. 58P/Jackson-Neujmin, 103P/Hartley, 104P/Kowal and D/Haneda-Campos have unfavourable returns. 111P/Helin-Roman-Crockett, 120P/Mueller, 130P/McNaught-Hughes, 131P/Mueller, 1996 R2 (Lagerkvist), 2002 L9 (NEAT), 2003 E1 (NEAT), 2003 L2 (LINEAR), 2003 O1 (LINEAR) and 2003 S1 (P/NEAT) are intrinsically faint or distant comets and will not come within visual range. Ephemerides for these can be found on the CBAT WWW pages. D/Haneda-Campos has not been seen since its discovery in 1978.

Looking ahead to 2005, no bright comets are predicted to return. The best object for UK observers is likely to be 9P/Tempel, which will be a faint object in large binoculars from May to June. Several other periodic comets have favourable returns, but they will all be telescopic objects.

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Jonathan Shanklin

Comets reaching perihelion in 2004

Comet	T	q	P	N	H_1	K_1	Peak
58P/Jackson-Neujmin	Jan 10.0	1.39	8.27	5	11.0	15.0	15
D/Haneda-Campos	Jan 10.2	1.27	6.41	1	13.5	10.0	16
2003 L2 (LINEAR)	Jan 19.3	2.86			10.0	10.0	17
40P/Vaisala	Jan 22.9	1.80	10.83	6	8.9	15.0	13
2003 E1 (NEAT)	Feb 13.5	3.25	50.9		12.5	5.0	17
2003 H1 (LINEAR)	Feb 22.6	2.24			6.5	10.0	11
2003 O1 (LINEAR)	Mar 17.2	6.85			6.0	10.0	18
43P/Wolf-Harrington	Mar 17.9	1.58	6.45	9	9.9	5.8	12
2003 S1 (P/NEAT)	Mar 26.0	2.60	9.69	0	11.5	10.0	18
2002 L9 (NEAT)	Apr 6.2	7.03			8.5	5.0	17
88P/Howell	Apr 12.6	1.37	5.50	5	4.7	24.9	9
2002 T7 (LINEAR)	Apr 23.6	0.62			6.0	7.5	3
104P/Kowal	May 9.7	1.40	6.18	3	9.8	9.3	13
2001 Q4 (NEAT)	May 15.9	0.96			6.5	7.5	3
103P/Hartley	May 18.0	1.04	6.40	3	8.1	15.0	10
1996 R2 (P/Lagerkvist)	Jun 7.4	2.62	7.39	1	11.0	10.0	17
29P/Schwassmann-Wachmann	Jul 10.8	5.72	14.65	6	0.5	10.0	12
42P/Neujmin	Jul 15.9	2.01	10.70	4	9.5	15.0	14
121P/Shoemaker-Holt	Sep 1.7	2.65	8.01	2	4.5	15.0	13
120P/Mueller	Sep 30.2	2.75	8.43	2	12.0	10.0	18
48P/Johnson	Oct 12.0	2.31	6.96	8	5.6	15.0	12
2003 K4 (LINEAR)	Oct 13.8	1.02			3.5	10.0	5
130P/McNaught-Hughes	Oct 23.3	2.10	6.67	2	12.5	10.0	17
78P/Gehrels	Oct 27.1	2.01	7.22	4	7.1	10.0	10
69P/Taylor	Nov 30.4	1.94	6.95	5	8.9	15.0	10

62P/Tsuchinshan	Dec 7.9	1.49	6.63	6	8.0	15.0	11
131P/Mueller	Dec 17.6	2.42	7.07	2	13.0	10.0	18
111P/Helin-Roman-Crockett	Dec 27.1	3.47	8.12	2	5.0	20.0	18

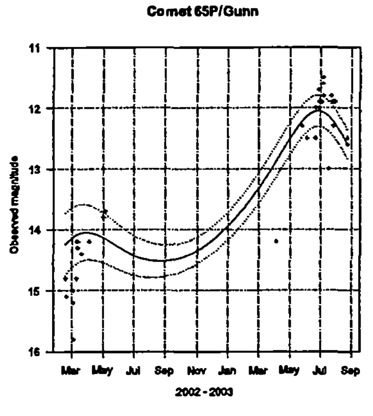
The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N), the magnitude parameters H_1 and K_1 and the brightest magnitude are given for each comet. The brightest magnitude given for 29P and 69P is that typical of an outburst.

Note: $m_1 = H_1 + 5.0 * \log(d) + K_1 * \log(r)$

Review of comet observations for 2003 April - 2003 September

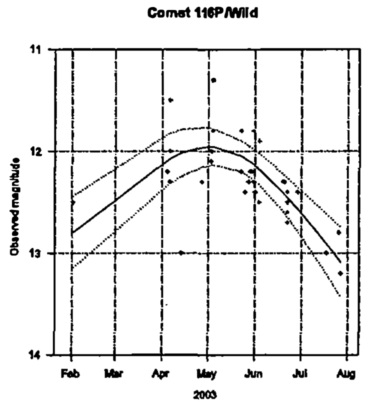
The information in this report is a synopsis of material gleaned from IAU circulars 8117 – 8212, The Astronomer (2003 May – 2003 September) and the Internet. Note that the figures quoted here are rounded off from their original published accuracy. Lightcurves for the brighter comets are from observations submitted to The Astronomer and the Director. A full report of the comets seen during the year will be published in the Journal in due course. I have used the convention of designating interesting asteroids by A/Designation (Discoverer) to clearly differentiate them from comets, though this is not the IAU convention.

65P/Gunn was relatively well observed by more southerly located observers, peaking at around 12th magnitude. The observations received so far give a magnitude equation of $m = 8.6 + 5 \log \Delta + 6.8 \log r$.



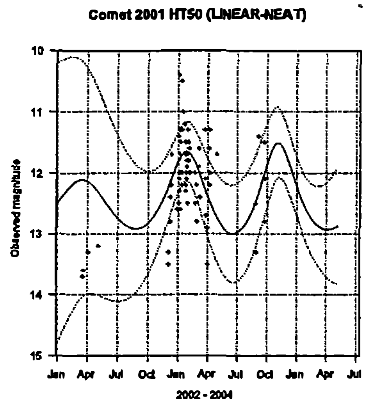
116P/Wild was also relatively well observed, peaking at a similar magnitude, however the observations do not allow a well constrained magnitude equation.

2000 QD_{101} (156P/Russell-LINEAR) IAUC 8118 (2003 April 19) announced the linkage of a comet discovered on UK Schmidt plates in September 1986, with an asteroid found at the end of August 2000 by LINEAR. Although it only appeared cometary in 1986, the identity is secure. Calculations by Kenji Muraoka show that the perihelion distance has been decreasing over the last 100 years, with significant changes around 1934 and 1970. The next significant change will be around 2017, when the perihelion distance will reduce to 1.33 AU from its present 1.60 AU.



R. H. McNaught, Siding Spring Observatory, reports observations of a comet found in Sept. 1986 by K. S. Russell on a 90-min exposure taken by F. G. Watson earlier that month with the U.K. Schmidt Telescope. Unsuccessful attempts were made by Russell, and later by McNaught, to locate the comet on the 30-min follow-up exposure by M. Hartley obtained on Sept. 25. T. B. Spahr, Minor Planet Center, has recently identified the comet with 2000 QD_{181}, an apparently asteroidal object observed by LINEAR on 2000 Aug. 31 and Sept. 5 (cf. MPS 18353), and itself linked by Spahr (MPO 9348) to another LINEAR discovery 2000 XV_{43} (observations Nov. 2000-Jan. 2001 on MPS 23109 and 25364), as well as to 1993 WU, recorded by C. S. Shoemaker et al. with the 0.46-m Palomar Schmidt telescope on 1993 Nov. 19 and 20 (MPS 397), the appearance again being evidently asteroidal. With the knowledge of the clearly cometary orbit, McNaught and M. A. Read have now located and measured the object on the Hartley follow-up plate. The 1986 observations were given the designation P/1986 R1. [IAUC 8118, 2003 April 19]

Comet P/2000 QD_{181} = 2000 XV_{43} = 1986 R1 = 1993 WU (Russell-LINEAR), announced on IAUC 8118, has been given the permanent number 156P (MPC 48317). [IAUC 8128, 2003 May 3]

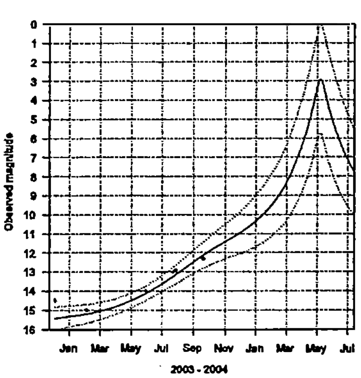


2001 HT_{50} (LINEAR-NEAT) could reach 11th mag at the second of its two oppositions in 2003. The light curve is not very well constrained by the observations made so far.

2001 Q4 (NEAT) was discovered when still over 10 AU from the Sun and will reach perihelion next May. Brian Marsden notes on MPEC 2003-R40 that the "original" and "future" barycentric values of 1/a are +0.000037 and -0.000708 (+/- 0.000003) AU**-1, respectively. [2003 September 9] The "original value of 1/a suggests that this is a new visitor from the Oort cloud. Michael Mattiazzo gives the dates of the orbital plane crossings as 2003 Oct 24, 2004 April 20 and 2004 October 23.

Observations in early September 2003 put the comet at around 12th magnitude. Alexandre Amorim, observing on September 20.31 with a 0.14-m reflector x80 estimated the comet at 12.3 with a 0.5' coma. The comet should be a bright object in May 2004. Adopting a conservative magnitude law (7.5 log r), suggests a peak of around 3rd magnitude, whereas the standard 10 log r gives around 0 magnitude. The observations made so far do not provide a good constraint on the likely peak brightness.

Comet 2001 Q4 (NEAT)

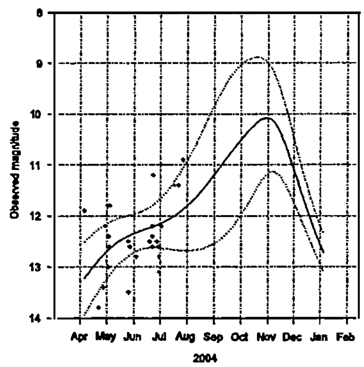


2002 CE_{10} (P/LINEAR) As I suggested in issue 17 (2002 April) this object has turned out to be a comet. Observations made in mid August 2003 revealed the presence of a faint thin straight tail some 21" long, thus confirming the cometary nature of the object, although any coma was <6" in diameter. The further observations made since discovery confirm the perihelion date as June 22.1, perihelion distance at 2.05 AU and the period as 30.7 years. There have been no recent planetary encounters, though it approached to 0.6 AU from Jupiter in 1912 December.

N. Takato, T. Sekiguchi, and J. Watanabe, National Astronomical Observatory of Japan, obtained nine CCD images with the 8.2-m Subaru telescope of the apparently asteroidal object 2002 CE_{10} (first reported by the LINEAR team, whose discovery observation is given below; originally announced on MPEC 2002-C83 and MPS 50101) on Aug. 22.4 UT that show a very faint, straight tail about 21" long in p.a. 212 deg; the tail is also present on shorter exposures from Aug. 21.5-21.6, when any coma as bright as the tail must have been < 6" in diameter. Recent astrometry, orbital elements (T = 2003 June 22, Peri. = 126 deg, Node = 147 deg, i = 145 deg, e = 0.79, P = 30.8 yr), and an ephemeris appear on MPEC 2003-R20. [IAUC 8193, 2003 September 3]

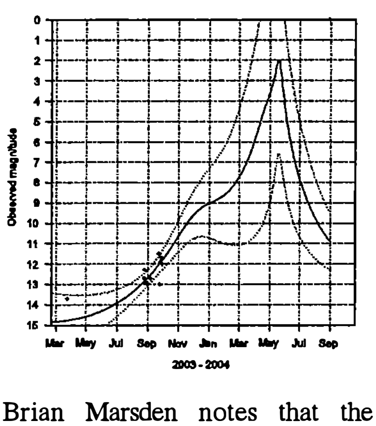
2002 O7 (LINEAR) did not reach perihelion until September 2003, however the last observations were made in late July and it has not been seen visually since. CCD observations by Michael Mattiazzo in late September show a faint diffuse cloud and it seems that it did not survive perihelion. The pre-perihelion light curve suggests a relatively slow rate of brightening, presaging things to come.

Comet 2002 O7 (LINEAR)



2002 T7 (LINEAR) will reach perihelion on 2004 April 23 at 0.61 AU. The comet could be an impressive object in the spring and early summer of 2004, however it will then be a southern hemisphere object. Making reasonable assumptions about the rate of brightening suggests a likely peak of 2nd magnitude in early May, giving the opportunity of viewing two naked eye comets at the same time [2001 Q4 should be around the same brightness].

Comet 2002 T7 (LINEAR)



Brian Marsden notes that the "original" and "future" barycentric values of 1/a are +0.000050 and -0.000590 (+/- 0.000003) AU**-1, respectively. [MPEC 2003-R42, 2003 September 9] The first value suggests that this is a "new" comet from the Oort cloud. Michael Mattiazzo gives the orbital plane crossings as 2003 December 25, 2004 December 25.

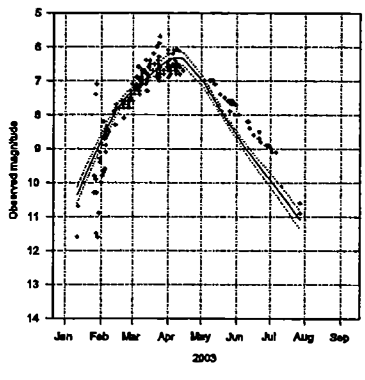
Observations made in 2003 August put the comet around 13th magnitude, brightening to 12th magnitude in September.

2002 VQ_{94} (LINEAR) is another object first noted as asteroidal and identified as suspicious in the last issue. Observations made towards the end of August 2003 revealed a clear coma, thus confirming the cometary nature of the object.

An apparently asteroidal object reported by LINEAR (announced on MPEC 2002-V71, where B. G. Marsden noted "whether this object is a comet or not is inconclusive", and MPS 66506) has been found to have a prominent 10" coma with a fanlike morphology spanning p.a. 180-300 deg on images taken by D. Jewitt on Aug. 28.5 UT with the University of Hawaii 2.2-m telescope. Recent astrometry, the orbital elements below, and an ephemeris appear on MPEC 2003-R22. [IAUC 8194, 2003 September 3]

Brian Marsden notes on MPEC 2003-R43 [2003 September 9] that the "original" and "future" barycentric values of 1/a are +0.005297 and +0.005403 (+/- 0.000000) AU**-1, respectively, suggesting that this is not a "new" comet from the Oort cloud. The period is around 3000 years.

Comet 2002 Y1 (Juels-Holvorcem)



2002 Y1 (Juels-Holvorcem) faded rather more slowly than expected, but was a southern hemisphere object. The most recent observations are from Michael Mattiazzo who estimated it at approaching 11th magnitude at the end of July.

Although around 50 more **SOHO comets** have been discovered over the last six months, few have had their positions measured. At the moment there is no-one in the SOHO team responsible for making the measurements and it may be some time before designations are announced. There have been some problems with the spacecraft, which is past its design lifetime. The ground control team have so far kept it going through technical fixes, but its days may be numbered. A replacement for the spacecraft is not scheduled for launch before 2007. SOHO now has a total of 669 comets, with over 100 awaiting designation.

Meyer Group SOHO comets **2003 H5 SOHO, 2003 K5 SOHO** and **2003 K6 SOHO** were discovered with the SOHO LASCO coronographs and have not been observed elsewhere.

2003 F2 (P/NEAT) is a distant periodic comet discovered by NEAT on March 27.20. It has a perihelion distance of 2.9 AU, a period of 16 years and will fade. Syiuchi Nakano notes that the preliminary orbit is very similar to that of 2001 BB50 (P/LINEAR-NEAT) and that both objects were last at perihelion in late March 1987. Maik Meyer notes that based on the present orbits their separation was only 0.016 AU in July 1989. Further observations unfortunately remove the possibility of splitting at the last return, although retain the similarity of the orbits. Nakano also notes that the angular elements of the orbit are similar to those of C/1931 AN, which has a poorly defined orbit based on observations made over a few days.

An apparently asteroidal object of 20th magnitude, found by the NEAT project on March 27.20, and posted on the NEO Confirmation Page, has been reported as faintly cometary by a few observers. G. Masi reports that CCD observations in good conditions (0".9 seeing) with the Danish 1.54-m telescope at the European Southern Observatory on Mar. 28.3 and 29.1 UT show the object to be nonstellar, with a slight elongation toward p.a. 315 deg, such that a nuclear condensation appears on the southeast side of a coma that has size 5".5 along a southeast-northwest axis and 4" along a northeast-southwest axis. Images taken with the 1.06-m KLENOT telescope at Klet on Mar. 31.9 by M. Tichy and M. Kocer show the object as slightly diffuse with a coma diameter of 6". [IAUC 8104, 2003 April 1]

2003 G1 (LINEAR) was discovered by LINEAR on April 8.45. It has a perihelion distance of 4.9 AU. It was at perihelion in early February and will not brighten significantly from its current 15th magnitude.

An apparently asteroidal object of 17th magnitude, discovered by LINEAR on April 8.45, and posted on the NEO Confirmation Page, has been found to be cometary by several CCD observers, including L. Sarounova and P. Kusnirak (Ondrejov), A. Galad (Modra), P. Birtwhistle (Great Shefford, U.K.), G. Hug (Eskridge, KS), P. R. Holvorcem (0.81-m Tenagra II telescope; m_1 = 15.4 on Apr. 9.46 UT), and M. Tichy (Klet). The general description of the comet gives a coma of diameter 8"-15" and a straight tail about 40"-90" long in p.a. 210-225 deg during Apr. 9.1-10.0. The available astrometry, preliminary parabolic orbital elements (T = 2003 Feb. 7, q = 4.9 AU, i = 67 deg), and ephemeris appear on MPEC 2003-G56. [IAUC 8115, 2003 April 10]

Brian Marsden notes on MPEC 2003-P15 [2003 August 6] that the "original" and "future" barycentric values of 1/a are +0.000014 and -0.000372 (+/-0.000005) AU**-1, respectively, suggesting that this is a "new" comet from the Oort cloud.

2003 G2 (LINEAR) was discovered by LINEAR on April 8.38. It has a perihelion distance of 1.6 AU. It is near perihelion and will not brighten significantly from its current 17th magnitude.

L. Manguso, Lincoln Laboratory, Massachusetts Institute of Technology, reports the LINEAR discovery of a comet with a 13" coma visible on Apr. 9-10 (discovered on April 8.38 at 18th magnitude). Following posting on the NEO Confirmation Page, the object was also reported to have cometary appearance by G. Hug (Eskridge, KS, 0.3-m reflector; diffuse with m_1 = 16.6 on Apr. 9.4 UT and m_1 = 17.3 on Apr. 10.4) and by A. C. Gilmore and P. M. Kilmartin (Mt. John University Observatory, 0.6-m reflector; diffuse on Apr. 11.6). [IAUC 8116, 2003 April 11]

2003 G3 (SOHO) was a non group comet discovered by John Sachs in C3 and C2 images on April 4. The preferred retrograde orbit suggests that it was at around 30 degrees elongation from the Sun in late April and early May, but no observations were reported.

2003 H1 (LINEAR) was discovered by LINEAR on April 24.38. It reaches perihelion at 2.2 AU in late February 2004. It will slowly brighten from its current 15th magnitude, perhaps reaching visual range in the autumn and reaching 12th magnitude at its best.

An apparently asteroidal 17th magnitude object reported by LINEAR on April 24.38, and posted on the NEO Confirmation Page, has been reported to be cometary on Apr. 25 CCD frames taken by H. Mikuz (Crni Vrh, 0.60-m reflector + R filter; strongly condensed with coma diameter about 20" and m_1 = 15.9), P. Kusnirak (Ondrejov, 0.65-m reflector; "seems to be slightly diffuse"), and T. Spahr (Mount Hopkins, 1.2-m reflector; faint fan-shaped tail about 5" long toward the south). [IAUC 8122, 2003 April 25]

Brian Marsden notes on MPEC 2003-P16 [2003 August 6] that the "original" and "future" barycentric values of 1/a are +0.000745 and +0.000450 (+/-0.000008) AU**-1, respectively, suggesting that this is not a "new" comet from the Oort cloud.

2003 H2 (LINEAR) was discovered by LINEAR on April 24.40. It is near perihelion at 2.2 AU and will not brighten significantly from its current 17th magnitude. The orbit is a long period ellipse, with period around 240 years.

Another apparently asteroidal object of 19th magnitude reported by LINEAR on April 24.40, and posted on the NEO Confirmation Page, has also been reported to be cometary on CCD frames taken on Apr. 25 by Mikuz (diffuse with condensation and coma diameter about 20"), M. Tichy (Klet, 1.06-m reflector; diffuse with faint tail in p.a. 270 deg), and Kusnirak (coma diameter about 10"). [IAUC 8122, 2003 April 25]

Further to IAUC 8122, J. McGaha (Tucson, AZ) reports that six stacked 2-min CCD exposures taken on Apr. 25.3 UT (0.30-m reflector) show a 6" coma and a 10" tail in p.a. 50 deg. [IAUC 8125, 2003 April 30]

Brian Marsden notes on MPEC 2003-P17 [2003 August 6] that the "original" and "future" barycentric values of 1/a are +0.026849 and +0.026146 (+/- 0.000000) AU**-1, respectively, confirming that this is not a "new" comet from the Oort cloud.

2003 H3 (NEAT) was discovered by NEAT on April 30.45. It was near perihelion at 2.9 AU and will not brighten significantly from its present 16th magnitude.

S. H. Pravdo, Jet Propulsion Laboratory, reports the NEAT discovery on Haleakala images of a 17th magnitude comet on April 30.45 with a coma diameter of about 14" and an unresolved core of diameter about 4" or less. Following posting on the NEO Confirmation Page, other observers have also reported the cometary appearance from CCD images, including J. E. McGaha (0.30-m reflector, Tucson, AZ; fainter outer coma of diameter about 10" with a brighter core of diameter about 5"); J. Young (0.6-m reflector, Table Mountain; coma diameter about 8", and 16" tail in p.a. 250 deg, affected by cirrus clouds), and P. R. Holvorcem and M. Schwartz (Tenagra IV 0.36-m telescope, near Nogales, AZ; coma diameter 28" and m_1 = 15.4-15.7 on May 1.47). [IAUC 8126, 2003 May 1]

Brian Marsden notes on MPEC 2003-P18 [2003 August 6] that the "original" and "future" barycentric values of 1/a are +0.000438 and -0.000114 (+/- 0.000005) AU**-1, respectively, suggesting that this is not a "new" comet from the Oort cloud.

2003 H4 (P/LINEAR) was discovered by LINEAR on April 29.33. It is near perihelion at 1.70 AU and will not brighten significantly from its present 18th magnitude. The period is 6.1 years. The comet approached within 0.46 AU of Jupiter in December 2000 and approached the planet even closer at some previous returns. An encounter to within 0.02 AU in April 2012 will reduce the perihelion distance to 1.16 AU, though the subsequent two apparitions are not particularly favourable.

M. Bezpalko, Lincoln Laboratory, Massachusetts Institute of Technology, reports the discovery by LINEAR of a comet with a tail in p.a. 270 deg on images taken on Apr. 29.3 UT. Following posting on the NEO Confirmation Page, other CCD observers have also reported the object as cometary, including G. J. Garradd (Tamworth, N.S.W., 0.45-m reflector; slightly diffuse on most images taken on Apr. 30.6), J. E. McGaha (Tucson, AZ, 0.30-m reflector; faint coma of size 5" x 10" and m_1 = 17.7-17.9, aligned north-south, with uniform brightness and no apparent nuclear condensation or core on May 2.2), and J. G. Ries (McDonald Observatory, 0.76-m reflector; 20" tail pointing slightly south of west on May 2.3; m_1 = 17.7-18.0). [IAUC 8127, 2003 May 1]

Orbital elements on MPEC 2003-K34, indicate that this comet passed 0.07 AU from Jupiter in June 1929, before which q and P were larger. [IAUC 8135, 2003 May 24]

2003 H6 (SOHO) and 2003 H7 (SOHO) were non group comets discovered by Rainer Kracht in C2 images on April 30. They are clearly related to each other.

2003 HT15 (P/LINEAR) An apparently asteroidal object of 18th magnitude found by LINEAR on April 26.26 was found to be cometary by Carl Hergenrother on images taken with the Mount Hobkins 1.2-m telescope on June 24.3. The comet has perihelion at 2.7 AU and a period of 9.9 years. It passed 0.6 AU from Jupiter in 2001 March. It will fade.

An apparently asteroidal object reported by LINEAR (discovery observation published on MPS 78496; prediscovery LINEAR observations published on MPS 80247; orbital elements on MPO 48372) has been found cometary by C. Hergenrother, who reports a diffuse coma of diameter 15" (and mag 18.6 within an aperture of radius 8") and a broad tail 60" long in p.a. 115 deg on co-added 900-s R-band images taken on June 24.3 UT with the Mount Hopkins 1.2-m reflector. [IAUC 8156, 2003 June 25]

A/2003 HP32 (Kitt Peak) is an asteroid, of 21st magnitude, discovered by J A Larsen with the 0.9-m telescope at the Steward Observatory, Kitt Peak on 2003 April 26.31. It is in a 5.1 year orbit, with perihelion at 0.56 AU and an eccentricity of 0.81. It reaches perihelion at the end of August, but will remain near its current magnitude for the next few months. [MPEC 2003-H50, 2003 April 30, 4-day orbit] The orbit is typical of a Jupiter family comet. It can approach to within 0.3 AU of Jupiter and within 0.1 AU of the Earth.

2003 J1 (NEAT) was discovered by NEAT on May 13.59. Originally reported at 19.4, amateur CCD observations put it at around 17th magnitude. It reaches perihelion at 5.1 AU in October.

K. J. Lawrence, Jet Propulsion Laboratory, reports the discovery by NEAT of a comet on May 13.59. Following posting on the NEO Confirmation Page, other CCD observers reported the following total magnitudes and coma diameters: May 14.5 UT, m_1 = 16.4-17.0, 10" (P. Holvorcem, Tenagra II 0.81-m telescope; three co-added 120-s exposures); 15.5, 17.5, 8" (J. Young, Table Mountain, CA, 0.6-m reflector). [IAUC 8133, 2003 May 17]

Brian Marsden notes on MPEC 2003-O37 [2003 July 30] that the "original" and "future" barycentric values of 1/a are +0.001841 and +0.001804 (+/- 0.000077) AU**-1, respectively, suggesting that this is not a "new" comet from the Oort cloud.

A/2003 JC11 (Kitt Peak) is an asteroid, of 21st magnitude, discovered by J V Scotti with the 0.9-m telescope at the Steward Observatory, Kitt Peak on 2003 May 1.40. It is in a 5.3 year orbit, with perihelion at 1.35 AU and an eccentricity of 0.56. It was at perihelion at the end of November and will fade. [MPEC 2003-J35, 2003 May 6, 5-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent close approaches to either Jupiter or the Earth.

2003 K1 (Spacewatch) An object initially reported as asteroidal by Spacewatch has been found to be cometary by other observers, including some using the 0.41-m OAM relector at Costitx, Mallorca. It is past perihelion and will fade from 18th magnitude.

An object of 20th magnitude initially reported as asteroidal by J. A. Larsen on CCD images obtained with the 0.9-m Spacewatch reflector on May 23.38 was posted on the NEO Confirmation Page. CCD images taken by A. Lopez and R. Pacheco (Mallorca, 0.41-m reflector) on May 23.9 UT showed cometary appearance (and m_1 = 18.2-18.6). A. E. Gleason found the coma to be quite obvious on May 24.3 images taken with the 1.8-m Spacewatch II reflector at Kitt Peak, and Larsen found a 10" coma on Spacewatch I images taken on May 24.4. [IAUC 8135, 2003 May 24]

2003 K2 (P/Christensen) An object discovered by the Catalina sky survey on May 26.18 was quickly confirmed as cometary. It passed perihelion at 0.55 AU in April, but is intrinsically faint. It was visible on SWAN imagery and at brightest probably reached 10th magnitude; it seems likely that it was the object reported in SWAN imagery between April 5 to 19, but which was not confirmed visually due to low elevation and poor elongation from the Sun. It will fade from 14th magnitude. Its elongation remained relatively small and it was not very favourably placed for observation. As astrometric observation accumulated there was increasing evidence that it was a short period comet, with a period between 12 and 17 years and perihelion distance around 0.6 AU. These indications from orbits by Muraoka and others were confirmed on IAUC 8145 [2003 June 7] which gave an orbit with period of 6.5 years. Further orbit computations by Muraoka, Stoss and others have revised the orbit and the latest orbit gives P as 5.75 years and q at 0.55 AU. The comet passed 0.8 AU from Jupiter in 1996 January. There are no significant changes to the orbit at the next return.

Eric Christensen, Lunar and Planetary Laboratory, reports the discovery of a 15th magnitude comet on May 26.18 by the Catalina Sky Survey on CCD images taken with the 0.7-m Schmidt telescope. Following posting on the NEO Confirmation Page, many observers noted the obvious cometary nature of the object on CCD images taken during May 27.1-27.2 UT, including R. Elliot (Fall Creek, WI; coma diameter about 10"), P. R. Holvorcem and M. Schwartz (near Nogales, AZ; coma diameter about 35", with a 30" tail in p.a. 106 deg), J. Young (Table Mountain, CA; 10" coma and a very faint 40" tail in p.a. 115 deg with a slight curve halfway along its length to p.a. 130 deg), and J. McGaha (Tucson, AZ; coma diameter 12", with slight nuclear condensation and a 6" tail). [IAUC 8136, 2003 May 27]

It has been noted by numerous individuals that the preliminary orbital elements of comet C/2003 K2 (cf. IAUC 8136) place it close to the position of an unconfirmed object found on SWAN ultraviolet SOHO website images and reported to the Central Bureau on Apr. 14 by X.-m. Zhou (Bo-le, Xin-jiang, China). Measurements of the object on six dates, Apr. 5-19, were forwarded to the Central Bureau by Zhou (via D. H. Chen), by M. Mattiazzo, and by S. Hoenig; the positions differed considerably, due to the poor resolution of SWAN (uncertainty on the order of 1 degree). Two search ephemerides based on various positions were circulated by the Bureau to numerous visual and CCD observers in the hopes of optical confirmation, but the searches (undertaken during the last week of April by Zhou, A. Hale, Mattiazzo, Y. Kushida, and Y. Ezaki) revealed nothing to as faint as mag 14.5. The following improved parabolic orbital elements for C/2003 K2 (from MPEC 2003-K49) indicate that the search-ephemeris positions in late April for the SWAN object were no closer than about 2.5 degrees from C/2003 K2. The comet might be of short period. [IAUC 8138, 2003 May 30]

2003 K3 (SOHO) was a faint non group comet discovered by Heiner Otterstedt in C3 images on May 25. It appeared to be fading in images from late on May 28, although not due at perihelion until June 1. The preliminary orbit suggested that it would reach 25 degrees elongation from the Sun in mid June, but was not reported by ground based observers in the Southern Hemisphere. It was not favourably placed for discovery prior to perihelion.

2003 K4 (LINEAR) An apparently asteroidal object of 18th magnitude found by LINEAR on May 28.38 has been found to be cometary by other observers. The preliminary orbit suggests that it is a distant object with perihelion at 8.5 AU in September, however other, more interesting orbit solutions were possible according to Maik Meyer. New elements issued on MPEC 2003-L08 [2003 June 3] confirmed the more interesting orbit, and the latest put perihelion at 1.02 AU on 2004 October 13.8. The apparition circumstances are not particularly favourable, however the comet could reach 5th magnitude. By early August it had brightened to 16th magnitude (CCD). The comet may come within visual range from October this year and be visible until the end of the year when it enters conjunction.

An apparently asteroidal object found by the LINEAR survey on May 28.38, posted on the NEO Confirmation Page, has been found to show a round coma of diameter 5"-7" (m_1 = 17.5) on CCD images taken by J. Young on May 29.5 and 30.4 UT with the 0.6-m reflector at Table Mountain. J. McGaha, Tucson, AZ, reports that three stacked, 2-min CCD images, taken on May 29.4 with a 0.30-m reflector, show a 3" nuclear condensation and a 6" coma that is offset to the northeast. [IAUC 8139, 2003 May 30]

Brian Marsden notes on MPEC 2003-R44 [2003 September 9] that the "original" and "future" barycentric values of 1/a are +0.000020 and -0.000199 (+/-0.000014) AU**-1, respectively, suggesting that this is a "new" comet from the Oort cloud. Such comets often brighten relatively quickly at first, so that we should not necessarily expect a good display at perihelion.

2003 KV2 (P/LINEAR) An asteroidal object of 18th magnitude discovered by LINEAR on May 23.16 has been found to be cometary by other observers. It reaches perihelion on July 10 at 1.06 AU and has a period of 4.85 years, the third shortest amongst currently extant comets. It passed within 0.55 AU of Jupiter in February 2001, before which the perihelion distance was somewhat larger. It will not get much brighter than its present magnitude. The preliminary orbit given for the comet on MPEC 2003-K27 was not particularly cometary, whereas that for 2003 KU2 looked more promising.

Another apparently asteroidal LINEAR object found on May 23.16, announced on MPEC 2003-K27 as 2003 KV_2 (see also MPEC 2003-K38 and 2003-K47), has been found cometary on R-band images taken by C. Brinkworth and M. Burleigh on May 28.9 and 29.9 UT with the 1-m Jacobus Kapteyn Telescope on La Palma (communicated by A. Fitzsimmons), in which the object shows a tail about 4"-5" long in p.a. 125 deg and a small coma that is somewhat larger than the surrounding field stars. The preliminary orbit shows a passage 0.55 AU from Jupiter in Jan. 2001, before which the perihelion distance was somewhat larger. [IAUC 8139, 2003 May 30]

A/2003 KP2 (LINEAR) is an asteroid, of 19th magnitude, discovered by LINEAR on 2003 May 22.34. It is in a 4.53 year orbit, with perihelion at 0.82 AU and an eccentricity of 0.70. It will be at perihelion in mid October and will brighten a little. [MPEC 2003-R63, 2003 September 13] The orbit is typical of a Jupiter family comet, though there have been no recent close approaches to Jupiter. It will pass 0.18 AU from the Earth in early October.

A/2003 KU2 (Kitt Peak) is an asteroid, of 20th magnitude, discovered by A Tubbiolo with the 0.9-m telescope at the Steward Observatory, Kitt Peak on 2003 May 22.29. It is in a 4.6 year orbit, with perihelion at 0.80 AU and an eccentricity of 0.71. It will be at perihelion at the end of October and will brighten a little. [MPEC 2003-K26, 2003 May 24, 2-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent close approaches to either Jupiter or the Earth. It is a potentially hazardous asteroid passing 0.026 AU from Earth at the ascending node.

2003 L1 (P/Scotti) Jim Scotti discovered this faint comet in Spacewatch data. Further prediscovery images were found in Palomar NEAT data from 2002 April. The comet is three months past perihelion, which was at 5.0 AU. The period is 17.3 years. It will fade.

J. V. Scotti, Lunar and Planetary Laboratory, University of Arizona, reports the discovery of a 20th mag comet on CCD images taken with the Spacewatch 0.9-m f/3 reflector at Kitt Peak on June 4.21, showing a coma of diameter 6" and a faint tail about 0'.62 long in p.a. 273 deg. Images taken by A. S. Descour on June 5.3 UT with the 1.8-m f/2.7 Spacewatch reflector also show a tail, and June 7.2 images by Scotti with the larger instrument show the tail 0'.30 long in p.a. 273 deg. [IAUC 8145, 2003 June 7]

Clearly diffuse NEAT images of this comet, taken with the Palomar 1.2-m Schmidt telescope on three nights in 2002 April, were identified and measured by M. Meyer. Additional astrometry and the following orbital elements (MPEC 2003-M21) confirm the suspicion (cf. IAUC 8145) that this is a short-period comet. [IAUC 8153, 2003 June 19]

2003 L2 (LINEAR) was discovered by LINEAR on June 12.33. It will reach perihelion at 2.9 AU in mid January 2004 and will brighten a bit from its current 18th magnitude.

An apparently asteroidal object found by LINEAR, and posted on the NEO Confirmation Page, has been found to be cometary on CCD images taken by S. Sanchez, R. Stoss, and J. Nomen (Mallorca, 0.30-m f/9 reflector; 10" coma on June 12.95 UT) and by S. Gajdos (Modra, 0.6-m f/5.5 reflector; diffuse with coma diameter about 5" on June 13.97; m_1 = 18.0). [IAUC 8151, 2003 June 14]

Brian Marsden notes on MPEC 2003-R45 [2003 September 9] that the "original" and "future" barycentric values of 1/a are +0.006356 and +0.006809 (+/-0.000011) AU**-1, respectively, and the eccentricity is 0.9814155 showing that this is not a "new" comet from the Oort cloud.

A/2003 MT (Kitt Peak) is an asteroid, of 19th magnitude, discovered by M T Read with the 0.9-m telescope at the Steward Observatory, Kitt Peak on 2003 June 23.20. It is in a 5.3 year orbit, with perihelion at 1.22 AU and an eccentricity of 0.60. It will be at perihelion in early August but will fade. [MPEC 2003-M42, 2003 June 24, 1-day orbit] The orbit is typical of a Jupiter family comet, though there have been no recent close approaches to either Jupiter or the Earth.

2003 O1 (LINEAR) An 18th magnitude comet was discovered by LINEAR on July 20.13. The provisional orbit (given to rather high accuracy for only a three day arc) suggested that it was a distant object some way from perihelion at 4.5 AU. Nick James reported imaging it on July 20.97 in a rather crowded field, with Peter Birtwhistle imaging it on July 20.95 and Stephen Laurie on July 20.96. Further observations confirmed the distant orbit, though with perihelion at 6.8 AU in March 2004.

An apparently asteroidal object reported by LINEAR, and posted on the NEO Confirmation Page, has been found to have cometary appearance on CCD images taken by P. Kusnirak (Ondrejov; 0.65-m f/3.6 reflector; well-condensed condensation and a faint 20" tail toward the southeast) and by P. Birtwhistle (Great Shefford, U.K.; nuclear condensation of diameter about 6" with a faint, short, broad tail about 15" long in p.a. 139 deg; mag 17.3-18.2). [IAUC 8170, 2003 July 30]

Brian Marsden notes on MPEC 2003-R09 [2003 September 2] that the "original" and "future" barycentric values of 1/a are +0.000225 and +0.000217 (+/-0.000018) AU**-1, respectively, suggesting that this is probably not a "new" comet from the Oort cloud.

2003 O2 (P/LINEAR) A 19th magnitude comet was discovered by LINEAR on July 29.38, although other CCD observers estimate it at 17th magnitude. Peter Birtwistle imaged it on July 31.04. It showed a surprisingly long tail, perhaps suggesting a recent outburst. Further observations confirmed the short period nature of the orbit, with perihelion at 1.5 AU in early September and a period of 8.7 years. It has had no recent planetary encounters. It will not get much brighter than at present.

M. Bezpalko, Lincoln Laboratory, reports the LINEAR discovery of a comet, showing a tail approximately 42" long in p.a. 230 deg. Other CCD observers report mag 16.9-17.9 and a tail of up to 6' long in p.a. 245-250 deg on July 30-31 (including S. Sanchez, R. Stoss, and J. Nomen at Mallorca; R. Trentman and R. Frederick at Louisburg, KS; and P. Birtwhistle at Great Shefford, U.K., who also noted a 9" central condensation of mag 17.9, adding that the tail was very diffuse and wide). [IAUC 8172, 2003 July 31]

2003 O3 (P/LINEAR) A 19th magnitude comet was discovered by LINEAR on July 30.39, although other CCD observers estimate it at 18th magnitude. It was confirmed as cometary by Peter Birtwhistle amongst others. The comet reached perihelion at 1.25 AU in mid August and will fade. It passed 0.5 AU from Jupiter in 1956 July and the period is 5.5 years.

An apparently asteroidal object reported by LINEAR, and posted on the NEO Confirmation Page, has been found to be apparently cometary on CCD images taken by P. Birtwhistle (Great Shefford, U.K., 0.30-m reflector; very faint tail about 10" long in p.a. approximately 270-280 deg on July 31.10 and Aug. 2.08 UT; mag 18.1 and coma diameter about 5" on Aug. 2.08), by J. Ticha and M. Tichy (Klet, 1.06-m KLENOT telescope; diffuse with a wide tail in p.a. 260 deg on Aug. 3.01), and by J. McGaha (near Tucson, AZ; possible tail spike 5" long in p.a. 300 deg on Aug. 3.38 with a 0.30-m reflector; possible fan-shaped tail 5" long in p.a. 260 deg on Aug. 5.33 with a 0.62-m reflector). The preliminary orbital elements indicate that the comet passed 0.3 AU from Jupiter in Nov. 1979. [IAUC 8174, 2003 August 5]

2003 QX_{29} (P/NEAT) A 20th magnitude asteroid was discovered by NEAT on August 23.28. It was found to be cometary and some CCD observers estimate it a little brighter. The comet is nearly a year past perihelion and will fade. The perihelion distance is 4.3 AU and the period around 22 years. It passed 0.8 AU from Jupiter in 1911 May.

An apparently asteroidal object reported by NEAT (Palomar discovery observation originally posted on the NEO Confirmation Page, then assigned the designation 2003 QX_29 on MPEC 2003-Q33; observations on MPS 93475-93476) has been found to have cometary appearance on CCD images taken by I. Griffin and S. G. Huerta (Cerro Tololo 0.9-m reflector, Aug. 31.1 UT; visible coma of red mag 18.0-19.4 with FHWM = 2".3-2".6 in raw 300-s images, while stacked 10-exposure image shows a fan-shaped tail at least 17" long in p.a. 58 deg) and by J. Young (Table Mountain 0.6-m reflector, Sept. 1.2; 3" coma, slightly elongated in p.a. 260 deg, with a 16" curved tail starting in p.a. 243 deg; possible slight brightening in the tail at a point 4"-5" from the coma edge). J. Ticha subsequently reports that Klet images from Aug. 23.9 show the object to be slightly diffuse, while on Aug. 24.9 it exhibited a 8" coma. Astrometry, orbital elements (T = 2002 Oct. 17.3 TT, Peri. = 37.1 deg, Node = 264.9 deg, i = 11.4 deg, equinox 2000.0, e = 0.445, q = 4.311 AU, P = 21.6 yr), and an ephemeris appear on MPEC 2003-R14. [IAUC 8192, 2003 September 2]

2003 R1 (LINEAR) was discovered by LINEAR on September 2.37. It reached perihelion at 2.2 AU in early July. It will not brighten significantly from its current 19th magnitude.

An apparently asteroidal object reported by LINEAR, and posted on the NEO Confirmation Page, has been reported to have cometary appearance on CCD images obtained by J. Ticha and M. Tichy (Klet, 1.06-m KLENOT telescope; slightly diffuse object with a 6" coma on Sept. 5.08 UT, and asymmetric coma to the northwest on Sept. 6.05); and by J. E. McGaha (Tucson, AZ, 0.30-m f/10.0 Schmidt-Cassegrain reflector; 3" coma with a fan-shaped tail 8" long in p.a. 320 deg on Sept. 6.39). [IAUC 8195, 2003 September 6]

A/2003 RW_{11} (Table Mountain Observatory) is an asteroid, of 19th magnitude, discovered by J Young with the 0.6-m telescope at Table Mountain Observatory on 2003 September 15.47. It is in a 5.1 year orbit, with perihelion at 0.46 AU and an eccentricity of 0.84. It was at perihelion in mid June. [MPEC 2003-S03, 2003 September 16, 1-day orbit] The orbit is typical of a Jupiter family comet, and it can approach to within 0.5 AU of Jupiter and 0.08 AU of the Earth.

2003 S1 (P/NEAT) A 19th magnitude comet was discovered by NEAT on September 23.60, with some LINEAR prediscovery images found from September 4.3 and 20.3. Peter Birtwhistle was amongst those making confirming images. The comet reaches perihelion next March, though will remain near its present brightness. The perihelion distance is 2.6 AU and the period around 9.7 years. It passed 0.2 AU from Jupiter in 1972 October.

2003 S2 (P/NEAT) An 18th magnitude comet was discovered by NEAT on September 24.61, with some LINEAR prediscovery images found from September 19.36. Peter Birtwhistle was amongst those making confirming images. The comet reached perihelion in July and will fade. The perihelion distance is 2.3 AU and the period around 8.6 years. The preliminary orbit suggests that the comet passed 0.25 AU from Jupiter in January 1958. This is NEAT's 37th comet.

2003 S3 (LINEAR) was discovered by LINEAR on September 27.38. It is a distant object near perihelion at 8.2 AU. It will not brighten significantly from its current 19th magnitude.

2003 S4 (LINEAR) is LINEAR's 120th – a distant object.

For the latest information on discoveries and the brightness of comets see the Section www page: http://www.ast.cam.ac.uk/~jds or the CBAT headlines page at http://cfa-www.harvard.edu/cfa/ps/Headlines.html

The Comet's Tale is produced by Jonathan Shanklin, with thanks to the British Antarctic Survey and the Institute of Astronomy, Cambridge for the use of computing facilities. E&OE.

Introduction

This issue has ephemerides, for the UK or Southern Hemisphere, for the comets that are likely to be brighter than 10th magnitude:

- 2P/Encke
- 2001 Q4 (NEAT) (Southern Hemisphere)
- 2002 T7 (LINEAR)
- 2003 K4 (LINEAR)

The actual magnitudes may differ from those given here by several magnitudes. Several other comets, including, 40P/Vaisala, 43P/Wolf-Harrington, 65P/Gunn, 66P/du Toit, 81P/Wild, 88P/Howell, 2001 HT50 (LINEAR-NEAT), 2002 J4 (NEAT) and 2003 H1 (LINEAR) may be brighter than 14^m. 29P/Schwassmann-Wachmann has frequent outbursts and is currently best seen from the Southern Hemisphere. Many comets undergo outbursts and it is worth monitoring all periodic comets that are well placed for observation in case they are in outburst. Current ephemerides for the fainter comets, and for other locations, are available on the Section web page. Elements from the CBAT are given for comets within reach of a CCD equipped 0.20-m SCT.

Comet Ephemerides

Computed by *Jonathan Shanklin*

The comet ephemerides are for the UK at 53° N, or when the comet is invisible from the UK they are for the Southern Hemisphere at 40° S. They are always for a station on the Greenwich meridian. This means that the times given can be used as local times elsewhere. The following are listed:-

- Name of comet
- Orbital elements (epoch 2000). The orbital elements are abridged from the IAU web pages.
- Magnitude formula
- Month, year. The positions are for 00:00 Universal Time (UT) (strictly ephemeris time is used which is currently some 60 seconds ahead of UT. If you are away from the Greenwich meridian you can treat the times of transit and observability as local time.
- Column headings:

a) Double-date.

b) Right ascension in hours and minutes. Declination in degrees and minutes. (These are given for epochs B1950 and J2000).

c) Magnitude of comet. This is an indication only and may be several magnitudes out. A comet appears much fainter in a large telescope than in binoculars.

d) Distance from the Earth in AU.

e) Distance from the Sun in AU.

f) Time of transit, i.e. when the comet is highest in the sky.

g) Period of visibility subject to the constraints that the sun must be 13° or more below the horizon (ie the sky is dark) and the comet a distance above the horizon depending on its brightness. The comet may be visible outside this period and it should be taken as a rough guide only. A comet may be visible outside these limits if conditions are good or it is brighter than predicted; equally you might find that a comet is invisible within them, particularly in poor skies.

h) Elongation from the sun and moon in degrees.

i) Lunar phase in percent.

j) Predicted tail length in minutes of arc and position angle of the radius vector. The prediction is based on a formula developed by Andreas Kammerer. The actual tail may be shorter or longer and in a different position angle.

k) Hourly motion in RA and dec in tenths minute of arc.

Ephemeris for comet 2P/Encke (UK)

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Omega=186.4893 OMEGA=334.5939 i= 11.7700 q= 0.338520 a=  2.217085
e=0.847313  P=    3.301  T= 2003 December  29.8794    Equinox= 2000
Magnitudes calculated from m=11.5+5.0*Log(d)+15.0*Log(r)
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Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
October 2003																
1/ 2	2 13.0	34.07	2 16.0	34.21	14.3	0.77	1.67	1.35	19.48 to 4.40	140	133	41	0	224	0	0
6/ 7	2 4.1	35.47	2 7.1	36.01	13.7	0.68	1.60	1.06	19.11 to 4.49	144	70	90	0	215	-9	8
11/12	1 51.4	37.35	1 54.3	37.50	13.2	0.60	1.54	0.34	18.35 to 4.58	147	26	98	0	202	-12	8
16/17	1 33.3	39.29	1 36.2	39.44	12.6	0.52	1.47	23.56	18.24 to 5.07	149	61	65	1	185	-17	9
21/22	1 8.0	41.23	1 10.8	41.39	12.0	0.45	1.40	23.11	18.14 to 5.15	148	118	16	1	164	-23	9
26/27	0 32.8	42.59	0 35.5	43.16	11.3	0.39	1.33	22.16	18.04 to 5.24	144	137	3	2	142	-32	8
31/32	23 45.4	43.44	23 47.9	44.01	10.7	0.34	1.26	21.09	17.55 to 5.32	136	80	48	3	120	-43	3
November 2003																
5/ 6	22 45.9	42.40	22 48.1	42.56	10.0	0.30	1.18	19.49	17.47 to 4.31	124	49	92	5	100	-54	-5
10/11	21 39.4	38.48	21 41.5	39.02	9.3	0.27	1.11	18.23	17.39 to 2.50	108	84	97	9	82	-64	-19
15/16	20 35.3	31.57	20 37.4	32.08	8.7	0.26	1.03	16.59	17.33 to 0.46	91	125	62	14	68	-67	-34
20/21	19 40.4	23.12	19 42.5	23.19	8.2	0.27	0.94	15.44	17.27 to 22.44	72	99	12	20	58	-63	-43
25/26	18 55.7	14.09	18 58.0	14.14	7.8	0.29	0.86	14.40	17.23 to 20.56	55	43	6	25	51	-54	-45
30/31	18 19.6	5.53	18 22.0	5.54	7.3	0.32	0.77	13.44	17.20 to 19.22	40	72	53	30	45	-44	-41
December 2003																
5/ 6	17 49.9	-1.17	17 52.5	-1.17	6.8	0.37	0.68	12.55	17.18 to 18.00	26	132	93	34	35	-37	-35
10/11	17 25.6	-7.21	17 28.3	-7.24	6.2	0.43	0.58	12.11	Not Observable	16	151	96	38	15	-30	-30

Ephemeris for comet 2001 Q4 (NEAT) (Southern Hemisphere)

Omega= 1.1993 OMEGA=210.2692 i= 99.6385 q= 0.961999 e=1.000725 T= 2004 May 15.9375 Equinox= 2000
Magnitudes calculated from m= 3.5+5.0*Log(d)+10.0*Log(r)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
October 2003																
1/ 2	4 39.2	-63.05	4 39.7	-62.59	11.3	3.08	3.39	3.59	19.13 to 4.29	99	89	41	2	297	0	-11
11/12	4 35.6	-67.09	4 35.7	-67.03	11.0	3.00	3.28	3.15	19.21 to 4.12	97	84	98	2	308	-1	-10
21/22	4 24.9	-71.03	4 24.5	-70.57	10.8	2.94	3.17	2.24	19.34 to 3.55	94	104	16	3	321	-2	-9
31/32	4 2.9	-74.36	4 1.9	-74.28	10.6	2.89	3.05	1.22	19.48 to 3.39	90	72	48	3	336	-4	-8
November 2003																
10/11	3 24.3	-77.28	3 22.9	-77.18	10.4	2.84	2.94	0.04	20.02 to 3.26	85	101	97	4	355	-5	-6
20/21	2 25.9	-79.18	2 24.9	-79.04	10.2	2.81	2.82	22.27	20.17 to 3.14	81	96	12	4	19	-7	-3
30/31	1 16.7	-79.45	1 17.3	-79.29	10.0	2.77	2.70	20.40	20.31 to 3.07	76	70	53	5	45	-7	0
December 2003																
10/11	0 16.9	-78.56	0 19.1	-78.39	9.8	2.73	2.58	19.02	20.42 to 3.03	71	118	96	6	69	-6	2
20/21	23 36.9	-77.20	23 40.0	-77.04	9.6	2.68	2.46	17.44	20.50 to 3.05	66	78	8	7	88	-4	4
30/31	23 14.3	-75.25	23 17.7	-75.09	9.3	2.62	2.34	16.42	20.53 to 3.12	63	80	56	8	103	-2	4
January 2004																
9/10	23 3.7	-73.28	23 7.2	-73.11	9.0	2.55	2.22	15.52	20.51 to 3.23	59	126	95	9	117	-1	4
19/20	23 1.0	-71.36	23 4.4	-71.20	8.7	2.46	2.09	15.10	20.45 to 3.36	57	59	4	12	128	0	4
29/30	23 3.7	-69.55	23 7.0	-69.39	8.3	2.34	1.97	14.33	20.35 to 3.51	56	96	57	15	139	0	4
February 2004																
8/ 9	23 10.4	-68.28	23 13.6	-68.12	7.9	2.21	1.84	14.00	20.22 to 4.07	56	118	93	20	149	1	3
18/19	23 20.4	-67.18	23 23.4	-67.01	7.4	2.05	1.72	13.30	20.07 to 4.21	57	50	2	28	157	2	2
28/29	23 33.6	-66.26	23 36.5	-66.10	6.9	1.87	1.60	13.04	19.50 to 4.35	59	111	58	41	165	3	1
March 2004																
9/10	23 50.7	-65.55	23 53.4	-65.39	6.3	1.66	1.48	12.42	19.33 to 4.47	62	101	89	63	171	4	1
19/20	0 13.7	-65.47	0 16.1	-65.31	5.6	1.43	1.36	12.25	19.16 to 4.59	65	58	1	101	175	6	0
29/30	0 46.8	-66.01	0 48.9	-65.45	4.8	1.18	1.25	12.18	18.60 to 5.09	70	119	60	169	176	9	0
April 2004																
3/ 4	1 10.1	-66.13	1 11.9	-65.57	4.4	1.05	1.20	12.21	18.52 to 5.14	72	117	98	222	175	11	0
8/ 9	1 40.6	-66.19	1 42.0	-66.04	3.9	0.92	1.15	12.32	18.44 to 5.19	74	85	84	296	172	15	0
13/14	2 21.7	-66.02	2 22.9	-65.48	3.4	0.78	1.11	12.53	18.37 to 5.24	76	65	30	401	167	20	1
18/19	3 17.3	-64.39	3 18.1	-64.28	2.8	0.64	1.07	13.28	18.30 to 5.29	78	75	0	552	158	29	6
23/24	4 27.6	-60.34	4 28.3	-60.28	2.2	0.52	1.04	14.19	18.23 to 5.33	79	88	17	771	145	43	20
28/29	5 43.9	-50.48	5 45.1	-50.47	1.6	0.40	1.01	15.16	18.17 to 2.04							
									4.29 to 5.38	78	88	63	1079	131	60	48
May 2004																
3/ 4	6 52.1	-31.50	6 54.0	-31.54	1.0	0.33	0.98	16.05	18.12 to 23.58	76	98	99	1413	119	72	94
8/ 9	7 44.8	-6.14	7 47.2	-6.22	1.0	0.33	0.97	16.39	18.07 to 22.51	74	146	77	1509	110	65	127
13/14	8 23.0	15.17	8 25.8	15.07	1.3	0.40	0.96	16.58	18.02 to 21.54	72	129	24	1285	105	46	107
18/19	8 50.7	28.54	8 53.8	28.43	1.9	0.50	0.96	17.06	17.59 to 21.01	70	71	0	997	102	30	68
23/24	9 11.3	37.12	9 14.4	36.59	2.4	0.63	0.97	17.07	17.56 to 20.07	68	20	19	762	100	20	41
28/29	9 27.1	42.32	9 30.3	42.18	2.9	0.77	0.99	17.03	17.54 to 19.09	66	51	67	584	98	14	26

Ephemeris for comet 2002 Q4 (NEAT) (UK)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
May 2004																
1/ 2	6 26.4	-40.37	6 28.1	-40.39	1.2	0.35	0.99	15.47	Not Observable	77	89	90	1290	124	70	88
6/ 7	7 25.6	-16.35	7 27.8	-16.42	0.9	0.32	0.97	16.27	Not Observable	75	125	94	1519	113	70	120
11/12	8 9.2	7.41	8 11.9	7.32	1.1	0.36	0.96	16.52	21.40 to 23.19	72	149	44	1398	107	54	121
16/17	8 40.7	24.17	8 43.6	24.06	1.6	0.46	0.96	17.04	21.55 to 1.10	71	94	4	1109	103	35	83
21/22	9 3.8	34.21	9 6.8	34.09	2.2	0.58	0.97	17.07	22.09 to 1.44	69	38	7	848	101	23	50
26/27	9 21.2	40.40	9 24.4	40.27	2.7	0.71	0.98	17.05	22.24 to 1.30	67	29	47	649	99	16	31
31/32	9 34.9	44.53	9 38.1	44.40	3.1	0.85	1.00	16.59	22.39 to 1.17	64	90	94	500	97	12	21

Ephemeris for comet 2002 T7 (LINEAR) (UK)

Omega=157.7429 OMEGA= 94.8535 i=160.5794 q= 0.614454 e=1.000432 T= 2004 April 23.0724 Equinox= 2000
Magnitudes calculated from m= 4.0+5.0*Log(d)+10.0*Log(r)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
October 2003																
1/ 2	5 31.9	33.43	5 35.2	33.45	11.5	2.93	3.31	4.54	22.18 to 4.40	103	172	41	2	265	-2	2
6/ 7	5 28.5	34.12	5 31.8	34.14	11.3	2.79	3.25	4.31	21.45 to 4.49	109	109	90	2	263	-3	2
11/12	5 23.9	34.43	5 27.2	34.46	11.1	2.64	3.19	4.07	21.10 to 4.58	115	47	98	2	261	-4	2
16/17	5 18.1	35.16	5 21.4	35.18	10.9	2.50	3.13	3.41	20.34 to 5.07	120	17	65	2	259	-5	2
21/22	5 10.7	35.48	5 14.0	35.52	10.7	2.37	3.06	3.14	19.56 to 5.15	127	80	16	2	256	-7	2
26/27	5 1.6	36.21	5 5.0	36.25	10.5	2.24	3.00	2.45	19.17 to 5.24	133	153	3	2	252	-9	2
31/32	4 50.7	36.51	4 54.0	36.55	10.3	2.11	2.94	2.15	18.35 to 5.32	139	130	48	2	246	-10	2
November 2003																
5/ 6	4 37.6	37.16	4 41.0	37.22	10.1	2.00	2.88	1.42	17.52 to 5.41	146	66	92	2	238	-12	2
10/11	4 22.5	37.34	4 25.8	37.41	9.9	1.90	2.81	1.07	17.39 to 5.49	153	14	97	2	227	-15	1
15/16	4 5.1	37.41	4 8.5	37.49	9.7	1.80	2.75	0.30	17.33 to 5.56	158	62	62	2	210	-17	0
20/21	3 45.9	37.33	3 49.2	37.42	9.5	1.73	2.68	23.51	17.27 to 6.04	162	131	12	2	184	-19	0
25/26	3 25.1	37.06	3 28.3	37.16	9.3	1.66	2.62	23.11	17.23 to 6.11	162	144	6	2	152	-20	-2
30/31	3 3.4	36.18	3 6.6	36.30	9.1	1.61	2.55	22.29	17.20 to 6.18	157	75	53	3	125	-21	-3
December 2003																
5/ 6	2 41.6	35.10	2 44.7	35.22	8.9	1.58	2.48	21.47	17.18 to 5.55	150	20	93	4	107	-22	-5
10/11	2 20.4	33.42	2 23.4	33.56	8.8	1.56	2.42	21.06	17.17 to 5.06	142	58	96	6	96	-22	-7
15/16	2 0.5	31.60	2 3.4	32.14	8.7	1.56	2.35	20.27	17.17 to 4.16	133	121	58	8	87	-21	-8

20/21	1 42.3	30.08	1 45.1	30.23	8.6	1.57	2.28	19.49	17.19 to 3.28	125	153	8	10	81	-19	-9
25/26	1 26.0	28.12	1 28.8	28.27	8.5	1.59	2.21	19.13	17.22 to 2.41	116	83	9	12	76	-17	-9
30/31	1 11.9	26.16	1 14.6	26.32	8.4	1.63	2.14	18.39	17.26 to 1.56	108	23	56	14	72	-15	-9
January 2004																
4/ 5	0 59.7	24.26	1 2.4	24.42	8.3	1.66	2.07	18.07	17.30 to 1.14	100	53	94	16	69	-13	-9
9/10	0 49.3	22.42	0 52.0	22.59	8.2	1.71	2.00	17.37	17.36 to 0.36	92	113	95	18	67	-11	-8
14/15	0 40.6	21.07	0 43.2	21.23	8.1	1.75	1.93	17.08	17.42 to 23.60	85	162	52	19	65	-10	-7
19/20	0 33.3	19.41	0 35.9	19.57	8.0	1.80	1.85	16.41	17.50 to 23.26	77	103	4	21	63	-8	-7
24/25	0 27.2	18.23	0 29.8	18.40	7.8	1.85	1.78	16.15	17.57 to 22.55	71	34	12	23	61	-7	-6
29/30	0 22.2	17.14	0 24.7	17.31	7.7	1.89	1.71	15.51	18.05 to 22.25	64	38	57	25	59	-6	-5
February 2004																
3/ 4	0 18.0	16.13	0 20.5	16.29	7.6	1.93	1.63	15.27	18.13 to 21.58	58	95	95	27	58	-5	-5
8/ 9	0 14.5	15.18	0 17.0	15.35	7.4	1.96	1.56	15.04	18.22 to 21.32	52	156	93	29	56	-4	-4
13/14	0 11.5	14.29	0 14.1	14.46	7.2	1.99	1.48	14.41	18.30 to 21.07	46	128	45	32	54	-3	-4
18/19	0 9.1	13.45	0 11.7	14.01	7.0	2.01	1.40	14.19	18.39 to 20.44	40	58	2	34	52	-2	-3
23/24	0 7.0	13.05	0 9.5	13.21	6.7	2.02	1.33	13.57	18.48 to 20.21	35	18	14	37	49	-2	-3
28/29	0 5.1	12.27	0 7.7	12.44	6.5	2.02	1.25	13.35	18.57 to 19.59	29	73	58	39	46	-2	-3
March 2004																
4/ 5	0 3.4	11.52	0 5.9	12.09	6.2	2.01	1.17	13.14	19.06 to 19.37	24	133	96	41	41	-2	-2
9/10	0 1.7	11.18	0 4.3	11.34	5.9	1.99	1.09	12.52	19.16 to 19.16	19	154	89	42	34	-2	-2
14/15	0 0.1	10.43	0 2.6	10.60	5.5	1.95	1.02	12.31	Not Observable	14	86	37	42	23	-2	-2

Ephemeris for comet 2002 T7 (LINEAR) (Southern Hemisphere)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
April 2004																
5/ 6	23 52.0	7.37	23 54.6	7.53	3.6	1.62	0.72	10.56	Not Observable	16	156	100	188	274	-2	-4
10/11	23 50.4	6.37	23 53.0	6.54	3.1	1.49	0.67	10.35	5.15 to 5.21	21	85	63	330	265	-1	-4
15/16	23 49.6	5.27	23 52.1	5.44	2.7	1.35	0.63	10.14	4.49 to 5.26	26	18	13	533	259	-1	-5
20/21	23 50.4	4.05	23 53.0	4.21	2.3	1.18	0.62	9.56	4.24 to 5.30	31	48	1	789	254	1	-6
25/26	23 54.3	2.25	23 56.8	2.42	1.9	1.00	0.62	9.40	4.01 to 5.35	36	107	33	1071	250	4	-8
30/31	0 3.5	0.21	0 6.1	0.37	1.6	0.81	0.64	9.29	3.43 to 5.39	39	168	82	1355	247	14	-10
May 2004																
5/ 6	0 23.1	-2.31	0 25.6	-2.14	1.3	0.62	0.68	9.29	3.32 to 5.44	41	122	99	1653	241	24	-14
10/11	1 4.6	-7.04	1 7.1	-6.48	0.8	0.44	0.73	9.51	3.38 to 5.48	40	57	55	2036	231	51	-22
15/16	2 40.5	-14.43	2 42.9	-14.31	0.4	0.30	0.79	11.07	4.26 to 5.52	36	29	9	2525	200	116	-38
20/21	5 37.7	-20.12	5 39.9	-20.11	0.5	0.27	0.85	13.44	17.58 to 20.46	48	47	2	2159	145	207	-27
25/26	7 50.3	-16.42	7 52.6	-16.50	1.6	0.38	0.93	15.37	17.55 to 22.24	66	45	37	1150	123	158	17
30/31	8 50.5	-13.02	8 52.8	-13.14	2.7	0.55	1.00	16.18	17.53 to 22.48	73	70	86	616	118	73	18

Ephemeris for comet 2003 K4 (LINEAR) (UK)

Omega=198.4420 OMEGA= 18.6770 i=134.2533 q= 1.023580 e=1.000364 T= 2004 October 13.7066 Equinox= 2000
Magnitudes calculated from m= 3.5+5.0*Log(d)+10.0*Log(r)

Day	R.A. B1950	Dec	R.A. J2000	Dec	Mag	D	R	Trans	Observable	Elong Sun	Elong Moon	Moon Phase	Comet Tail	pA	d RA	dDec
December 2003																
10/11	19 19.4	16.27	19 21.7	16.33	13.2	4.78	4.23	14.05	17.17 to 18.21	51	136	96	0	40	2	-1
15/16	19 21.5	16.08	19 23.8	16.14	13.1	4.77	4.18	13.47	17.17 to 18.02	48	117	58	0	35	2	-1
20/21	19 23.8	15.52	19 26.0	15.58	13.0	4.76	4.12	13.30	17.19 to 17.43	45	68	8	0	30	2	-1
25/26	19 26.2	15.39	19 28.4	15.45	13.0	4.74	4.07	13.12	17.22 to 17.24	43	44	9	0	25	2	-1
30/31	19 28.7	15.29	19 31.0	15.36	12.9	4.71	4.02	12.55	Not Observable	41	82	56	0	19	3	0

The comet is at a poor elongation in January

February 2004																
3/ 4	19 48.3	15.52	19 50.6	16.00	12.3	4.38	3.65	10.57	Not Observable	38	137	95	1	329	3	1
8/ 9	19 51.2	16.09	19 53.4	16.17	12.2	4.31	3.59	10.40	6.01 to 6.07	39	120	93	1	322	3	1
13/14	19 54.0	16.29	19 56.2	16.37	12.1	4.23	3.54	10.23	5.38 to 5.58	41	71	45	1	316	3	1
18/19	19 56.7	16.53	19 58.9	17.01	12.0	4.15	3.48	10.06	5.15 to 5.49	43	42	2	1	310	3	1
23/24	19 59.3	17.20	20 1.5	17.28	11.9	4.06	3.43	9.49	4.51 to 5.39	45	77	14	1	305	3	2
28/29	20 1.8	17.51	20 4.0	17.59	11.8	3.96	3.37	9.32	4.27 to 5.28	47	120	58	1	300	2	2
March 2004																
4/ 5	20 4.1	18.25	20 6.4	18.34	11.6	3.87	3.32	9.14	4.02 to 5.17	50	136	96	1	295	2	2
9/10	20 6.3	19.04	20 8.5	19.13	11.5	3.76	3.26	8.57	3.37 to 5.05	53	97	89	1	291	2	3
14/15	20 8.2	19.47	20 10.4	19.56	11.4	3.66	3.21	8.39	3.11 to 4.53	56	52	37	2	287	2	3
19/20	20 9.9	20.34	20 12.1	20.43	11.2	3.54	3.15	8.21	2.45 to 4.40	59	56	1	2	283	1	3
24/25	20 11.2	21.25	20 13.4	21.35	11.1	3.43	3.09	8.02	2.17 to 4.27	62	97	15	2	280	1	4
29/30	20 12.3	22.22	20 14.4	22.31	10.9	3.31	3.04	7.44	1.49 to 4.14	66	130	60	3	276	1	4
April 2004																
3/ 4	20 12.9	23.23	20 15.0	23.32	10.8	3.19	2.98	7.25	1.20 to 4.01	69	120	98	3	273	0	5
8/ 9	20 13.0	24.30	20 15.1	24.39	10.6	3.06	2.92	7.05	0.49 to 3.47	72	74	84	3	270	0	5
13/14	20 12.5	25.42	20 14.6	25.51	10.4	2.94	2.87	6.45	0.18 to 3.33	76	50	30	4	266	0	6
18/19	20 11.4	27.00	20 13.5	27.10	10.2	2.81	2.81	6.24	23.44 to 3.19	79	77	0	4	263	-1	6
23/24	20 9.5	28.25	20 11.5	28.34	10.0	2.69	2.75	6.02	23.09 to 3.04	83	113	17	5	259	-2	7
28/29	20 6.6	29.56	20 8.6	30.05	9.8	2.56	2.69	5.40	22.32 to 2.50	87	125	63	6	255	-3	7
May 2004																
3/ 4	20 2.6	31.34	20 4.6	31.42	9.6	2.43	2.63	5.16	21.53 to 2.36	90	96	99	6	251	-4	8
8/ 9	19 57.2	33.18	19 59.1	33.26	9.4	2.31	2.57	4.51	21.32 to 2.21	93	61	77	7	246	-5	8
13/14	19 50.2	35.09	19 52.0	35.16	9.2	2.19	2.52	4.24	21.46 to 2.07	97	69	24	8	241	-7	9
18/19	19 41.1	37.05	19 42.9	37.12	9.0	2.07	2.46	3.55	22.01 to 1.52	100	98	0	9	236	-9	9
23/24	19 29.6	39.04	19 31.3	39.11	8.8	1.96	2.40	3.24	22.15 to 1.38	103	115	19	11	229	-11	9
28/29	19 15.2	41.04	19 16.9	41.10	8.5	1.85	2.34	2.50	22.30 to 1.25	106	102	67	12	221	-13	10

Format for electronic submission of observations

TA Format can be used if you submit via email. The number of characters for each group is given in brackets: Date (yymmdd.dd) (9), MM (M) (2), Total Mag ([mm.m:) (7), Ref (RF) (3), Tel ap (aaa.a) (6), Tel typ (T) (2), f no (fn) (6), Tel mag (mag) (4), Coma Diam (cc.c) (5), DC (5), Tail len (tt.tt) (7), Tail PA (ppp) (4), 3 spaces, Observer Name. An example is given below. Minor changes to the format are under consideration.

TA format (examples)

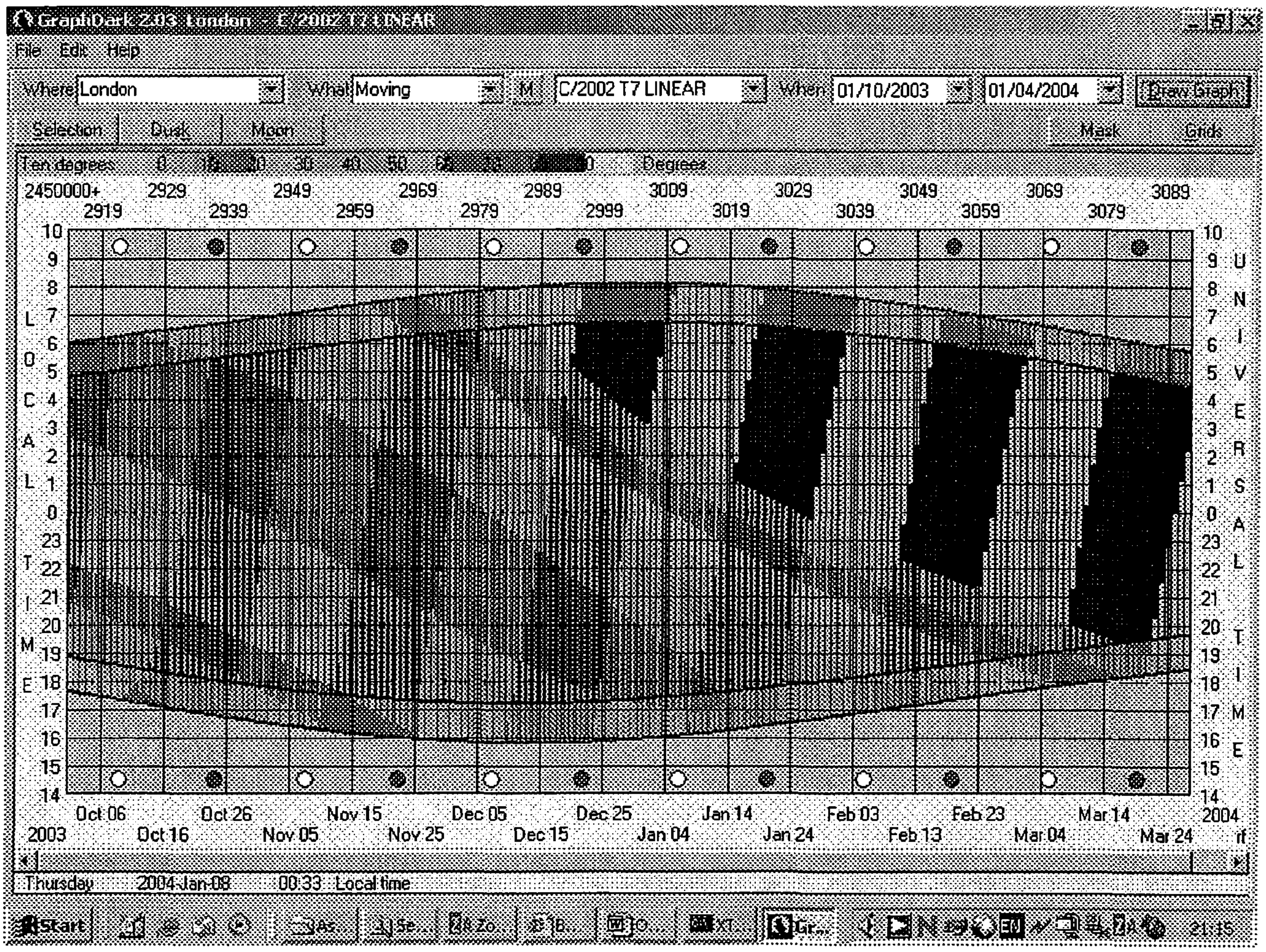
```
          1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
yymmdd.dd M [mm.m: RF aaa.a T    fn mag cc.c  DC tt.tt  ppp   Observer
970313.02 S [13.4  VB  30   R    18 290                      Shanklin
970328.89 S   9.5  NP  20   T    10  75  2.5   2              Shanklin
961214.70 S   3.8  AA   8   B        20  6     7/  0.50   40   Baroni
```

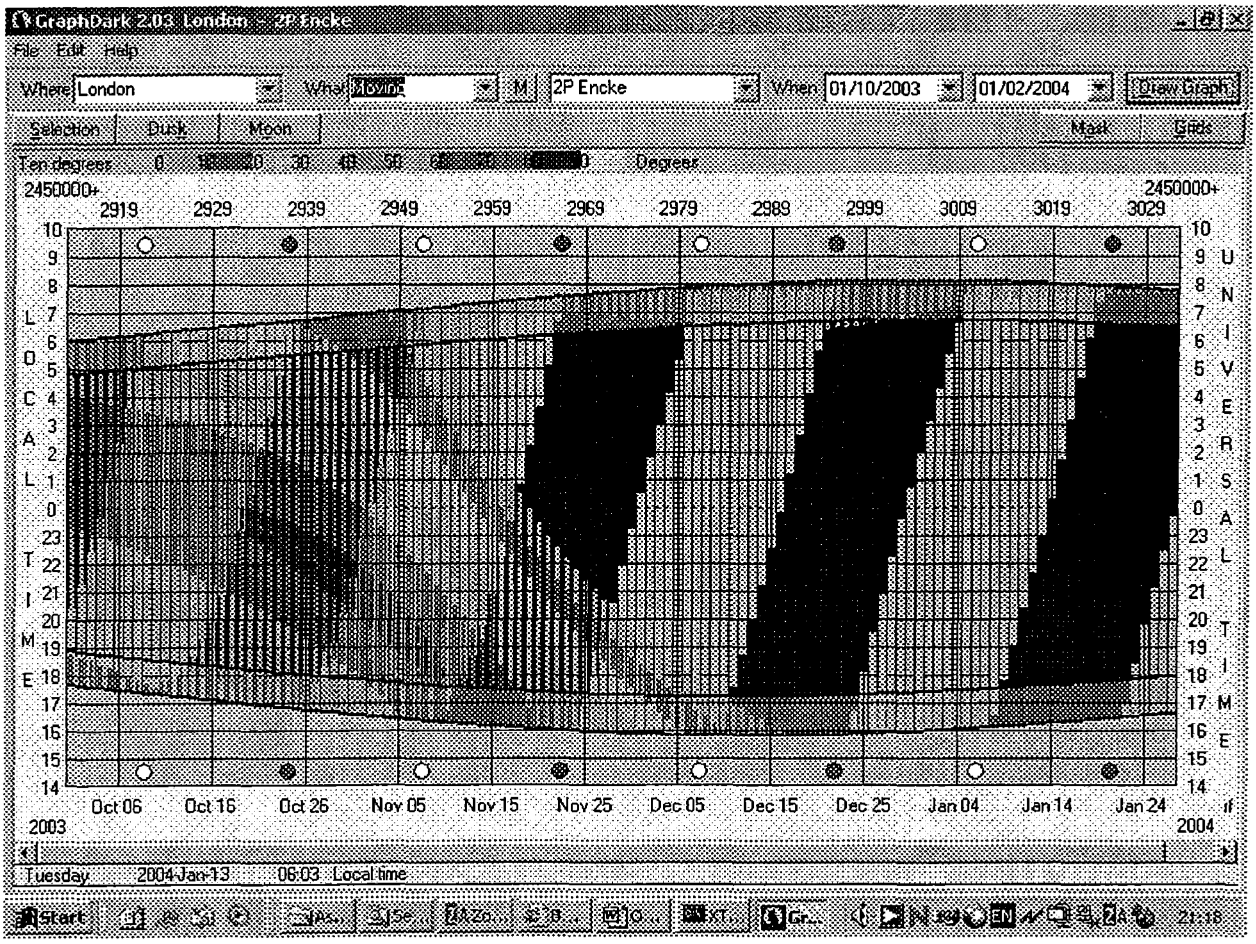
ICQ format (examples)

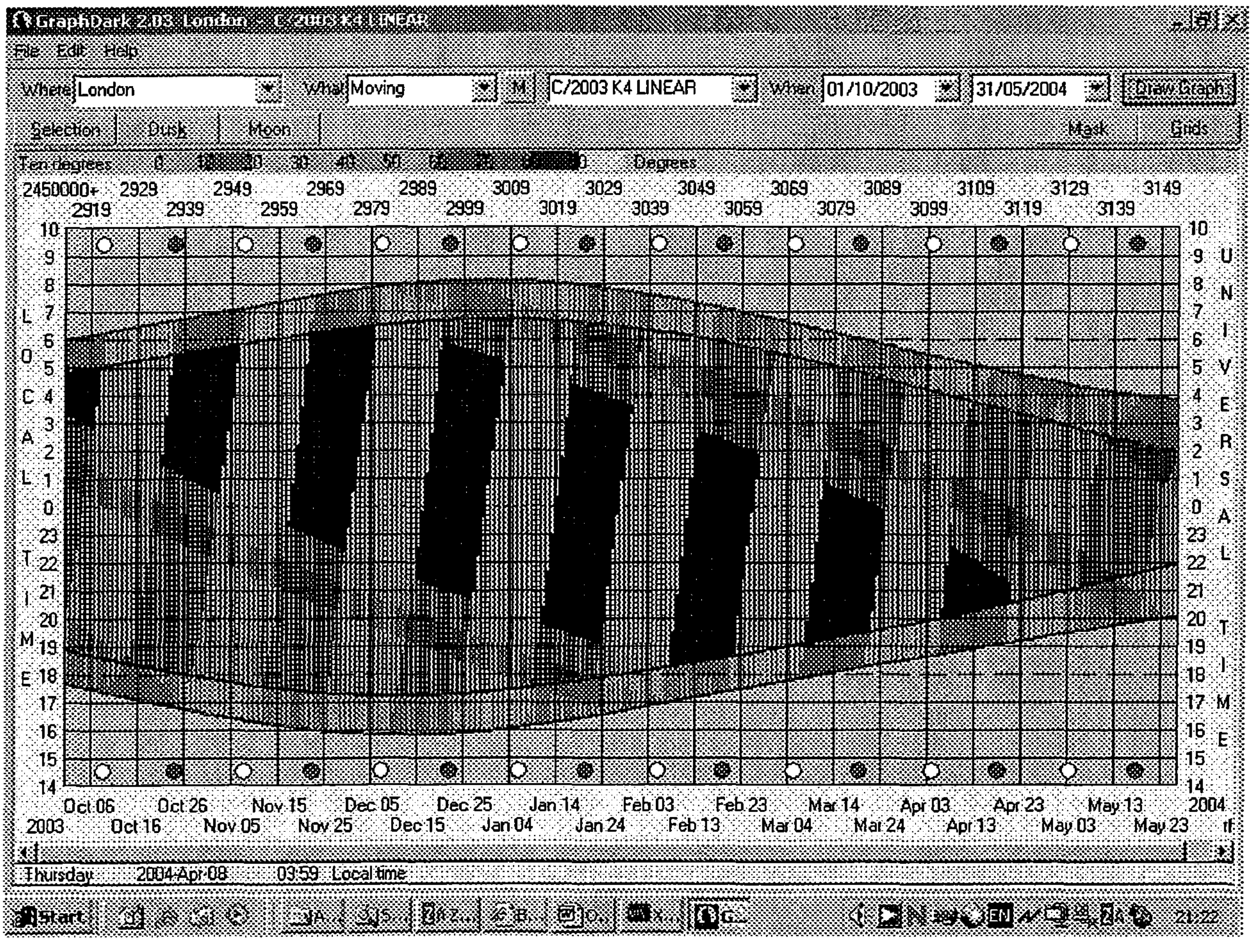
```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
IIIYYYYMnL YYYY MM DD.dd !M mm.m:SS AA.ATF/xxxx /dd.ddnDC       m
   1992F1  1992  5 18.94  S  9.3 AA  7.5R    50    6    4        135 ICQ XX BEA
  1        1985 11 16.04  S  6.9 AA 20  R14   40    6   s7    0.12 130 ICQ 59 SHA02
   1999T2  2001  1 28.25 Comet possibly seen at mag 13.6 (S, HS) in 20cm f10 T x120, with
coma 1.0' DC 1.
   1999T1  2001  1 28.25 Possible tail 5' long in pa 345.
```

Charts

The lunar interference diagrams show the dark observing windows, after nautical twilight, when the Sun is 12° below the horizon for three comets. The charts were generated using the latest version of Richard Fleet's GraphDark software, which is downloadable via the Section web page.




GraphDark 2.03 London - 2P Encke
File Edit Help
Where London
What Moving
2P Encke
When 01/10/2003
01/02/2004
Draw Graph
Selection Dusk Moon
Mask Grids
Ten degrees 0 10 20 30 40 50 60 70 80 90 Degrees
2450000+
2919 2929 2939 2949 2959 2969 2979 2989 2999 3009 3019 3029
LOCAL TIME
UNIVERSAL TIME
Oct 06 Oct 16 Oct 26 Nov 05 Nov 15 Nov 25 Dec 05 Dec 15 Dec 25 Jan 04 Jan 14 Jan 24
2003
2004
Tuesday 2004-Jan-13 06:03 Local time
Start
21:18


GraphDark 2.03 London - C/2003 K4 LINEAR
File Edit Help
Where London
What Moving
C/2003 K4 LINEAR
When 01/10/2003
31/05/2004
Draw Graph
Selection Dusk Moon
Mask Grids
Ten degrees 0 10 20 30 40 50 60 70 80 90 Degrees
2450000+ 2929 2949 2969 2989 3009 3029 3049 3069 3089 3109 3129 3149
2919 2939 2959 2979 2999 3019 3039 3059 3079 3099 3119 3139
LOCAL TIME
UNIVERSAL TIME
Oct 06 Oct 26 Nov 15 Dec 05 Dec 25 Jan 14 Feb 03 Feb 23 Mar 14 Apr 03 Apr 23 May 13 2004
2003 Oct 16 Nov 05 Nov 25 Dec 15 Jan 04 Jan 24 Feb 13 Mar 04 Mar 24 Apr 13 May 03 May 23
Thursday 2004-Apr-08 03:59 Local time
Start
21:22

Name	Number	T	q	e	ω	Ω	i	H1	K1	Epoch	Source
Encke	2P	2003 12 29.8768	0.338461	0.847339	186.4985	334.5876	11.7696	11.5	15.0	2000	MPC 40671
Schwassmann-Wachmann	29P	2004 07 14.3735	5.723434	0.044301	49.2115	312.7220	9.3932	4.0	10.0	2000	MPC 42666
Whipple	36P	2003 07 06.6244	3.088266	0.258889	202.2074	182.4003	9.9332	8.5	15.0	2000	MPC 40670
Vaisala	40P	2004 01 22.9020	1.795916	0.633113	47.1912	134.7342	11.5387	5.5	30.0	2000	MPC 42666
Wolf-Harrington	43P	2004 03 17.8473	1.578646	0.544612	187.2718	254.6945	18.5202	8.0	15.0	2000	MPC 42666
Johnson	48P	2004 10 12.0479	2.309856	0.366308	207.7186	117.3287	13.6591	10.0	15.0	2000	MPC 42667
Van Biesbroeck	53P	2003 10 09.4321	2.415372	0.552052	134.0953	149.0043	6.6103	7.7	12.0	2000	MPC 40671
Jackson-Neujmin	58P	2004 01 09.9944	1.388664	0.660469	200.4388	160.6152	13.4560	15.5	15.0	2000	MPC 42666
Gunn	65P	2003 05 11.8668	2.445896	0.318842	196.3780	68.4122	10.3833	5.0	15.0	2000	MPC 40670
du Toit	66P	2003 08 27.9793	1.274256	0.787710	257.2459	22.2134	18.7012	12.0	9.0	2000	MPC 48097
Taylor	69P	2004 11 30.3506	1.942015	0.467053	355.5007	108.8032	20.5629	9.5	30.0	2000	MPC 42667
Gehrels	78P	2004 10 27.0934	2.007947	0.462675	192.9635	210.5539	6.2522	5.5	20.0	2000	MPC 42667
du Toit-Hartley	79P	2003 02 15.4035	1.230052	0.594213	253.0972	307.9621	2.8945	16.0	10.0	2000	MPC 48097
Wild	81P	2003 09 25.9327	1.590358	0.538717	41.7484	136.1416	3.2403	7.0	15.0	2000	MPC 40671
Howell	88P	2004 04 12.5698	1.367517	0.561116	235.8405	56.8262	4.3828	11.0	15.0	2000	MPC 42666
Russell	94P	2003 08 29.1612	2.231084	0.364613	92.9268	70.9292	6.1852	9.0	15.0	2000	MPC 40671
Hartley	100P	2003 08 18.0499	1.979766	0.419149	181.5409	37.8915	25.6634	9.0	20.0	2000	MPC 40670
Hartley	103P	2004 05 17.9816	1.036243	0.699556	180.8082	219.9010	13.6019	8.5	20.0	2000	MPC 42666
Kowal	104P	2004 05 09.7326	1.395950	0.585557	192.0368	246.0873	15.4889	12.5	10.0	2000	MPC 42666
Helin-Roman-Crockett	111P	2004 12 26.5137	3.473662	0.140509	10.4631	91.9391	4.2325	5.0	20.0	2000	MPC 42667
Wild	116P	2003 01 21.6824	2.170012	0.375616	173.4455	21.0723	3.6158	2.5	25.0	2000	MPC 43760
Shoemaker-Levy	118P	2003 07 16.7732	2.010945	0.422507	302.0868	152.0386	8.4824	12.0	10.0	2000	MPC 46622
Mueller	120P	2004 09 30.1923	2.746641	0.336935	30.1899	4.4602	8.7864	12.0	10.0	2000	MPC 42667
Shoemaker-Holt	121P	2004 09 01.6223	2.648274	0.338541	6.2040	99.6719	17.7169	6.5	20.0	2000	MPC 42667
West-Hartley	123P	2003 12 09.1212	2.128691	0.448506	102.9165	46.6199	15.3467	4.0	25.0	2000	MPC 40671
Holt-Olmstead	127P	2003 06 12.4655	2.159142	0.369484	6.4996	14.0081	14.3963	11.0	15.0	2000	MPC 40670
McNaught-Hughes	130P	2004 10 23.3152	2.104316	0.405697	224.1246	89.8873	7.3073	10.0	15.0	2000	MPC 42667
Mueller	131P	2004 12 17.6531	2.423718	0.342362	179.8674	214.2374	7.3483	11.0	10.0	2000	MPC 42667
Brewington	154P	2003 02 19.4744	1.591090	0.672002	48.0689	343.6395	18.0609	2.5	30.0	2000	MPC 46622
Hale-Bopp	C/1995 O1	1997 03 30.5914	0.928971	0.995004	130.8166	282.3356	89.4162	-2.0	10.0	2000	MPC 42547
Lagerkvist	P/1996 R2	2004 06 07.4051	2.622945	0.308525	334.2622	40.2251	2.6022	11.5	10.0	2000	MPC 42666
LINEAR	C/2000 B4	2000 06 17.8917	6.839197	0.621432	126.3977	0.6422	15.8962	11.5	5.0	2000	MPC 45182
LINEAR	C/2000 CT54	2001 06 19.3499	3.153725	0.997954	272.5961	18.9587	49.2378	11.0	5.0	2000	MPC 44030
LINEAR	C/2000 K1	1999 12 12.2915	6.271887	0.999104	15.6396	260.1585	116.7905	4.0	10.0	2000	MPC 42547
LINEAR	C/2000 SV74	2002 04 30.4852	3.542814	1.004160	76.2597	24.1845	75.2414	5.5	10.0	2000	MPC 45961
LINEAR	C/2000 WM1	2002 01 22.6773	0.555310	1.000286	276.7894	237.8264	72.5120	7.5	10.0	2000	MPC 46619
Tubbiolo	C/2000 Y1	2001 02 04.0780	7.977425	1.002867	181.8597	239.4225	137.9899	11.0	5.0	2000	MPC 48380
Scotti	P/2000 Y3	2000 10 24.1406	4.042520	0.194575	87.8405	354.9320	2.2525	9.0	10.0	2000	MPC 44030
NEAT	C/2001 B2	2000 09 01.1327	5.318031	0.998806	304.8855	145.1097	150.6287	4.0	10.0	2000	MPC 44182
LINEAR	C/2001 C1	2002 03 28.4191	5.104887	1.000307	219.9576	33.6831	68.9448	6.0	10.0	2000	MPC 45961
NEAT	P/2001 F1	2000 11 24.3818	4.156469	0.357152	81.0234	92.8345	19.0794	8.5	10.0	2000	MPC 48380
LONEOS	C/2001 G1	2001 10 10.3293	8.237945	1.004525	343.3462	203.8857	45.3352	3.5	10.0	2000	MPC 45334
LINEAR-NEAT	C/2001 HT50	2003 07 09.0274	2.792141	0.997745	324.0724	42.9132	163.2125	4.5	10.0	2000	MPC 47291
NEAT	P/2001 K1	2000 11 07.6796	2.468939	0.358218	94.7214	84.8108	16.9075	11.0	10.0	2000	MPC 43160
LINEAR	C/2001 K5	2002 10 11.7466	5.184302	0.999445	47.0587	237.4436	72.5876	4.0	10.0	2000	MPC 44860
NEAT	C/2001 M10	2001 06 20.2470	5.299197	0.800187	5.3797	293.9054	28.0820	8.0	10.0	2000	MPC 46619
LINEAR	C/2001 N2	2002 08 19.5961	2.669390	1.000548	151.9144	52.8212	138.5456	7.5	10.0	2000	MPC 45654
LONEOS	C/2001 OG108	2002 03 15.0978	0.994847	0.925091	116.4389	10.5336	80.2366	11.0	10.0	2000	MPC 45654
NEAT	C/2001 Q1	2001 09 19.9244	5.831090	0.964945	175.3683	139.2635	66.9616	7.0	10.0	2000	MPC 47727
NEAT	C/2001 Q4	2004 05 15.9340	0.961894	1.000723	1.2047	210.2770	99.6425	3.5	10.0	2000	MPC 49591
LINEAR	C/2001 RX14	2003 01 18.6441	2.057547	1.001178	121.4731	14.1654	30.5793	6.5	10.0	2000	MPC 46619
NEAT	C/2001 T4	2002 05 20.0746	8.564206	0.382599	321.8494	64.4870	15.3709	5.5	10.0	2000	MPC 46619
LINEAR	C/2001 U6	2002 08 08.8869	4.406471	0.997346	85.7423	115.2371	107.2504	7.5	10.0	2000	MPC 46620
LINEAR	P/2001 YX127	2003 03 04.8299	3.425429	0.177805	115.5885	31.0627	7.9165	14.5	5.0	2000	MPC 47292
LINEAR	C/2002 A1	2001 11 22.5454	4.705801	0.713711	18.9759	81.2822	13.9983	12.5	5.0	2000	MPC 48096
LINEAR	C/2002 A2	2001 11 29.7052	4.700821	0.711393	19.3295	81.2955	13.9665	11.0	5.0	2000	MPC 48096
LINEAR	C/2002 A3	2002 04 20.9719	5.160004	0.973417	329.5766	136.4413	48.5602	6.5	10.0	2000	MPC 47292
Yeung	P/2002 BV	2002 03 11.2195	2.243840	0.361596	178.7994	40.1195	11.5152	13.0	10.0	2000	MPC 45654

LINEAR	C/2002 B1	2002 04 20.0120	2.272132	0.770720	76.1924	58.1833	51.0084	11.5	10.0	2000	MPC 45962
LINEAR	C/2002 B2	2002 04 06.7711	3.842966	1.000000	257.0670	54.3227	152.8720	9.0	10.0	2000	MPC 45334
LINEAR	C/2002 B3	2002 01 14.4151	6.052462	1.000000	122.9251	289.3856	73.6796	7.0	10.0	2000	MPC 45183
LINEAR	C/2002 C2	2002 04 10.8356	3.254423	0.999563	159.9521	242.9690	104.8839	8.5	10.0	2000	MPC 46620
LINEAR	C/2002 CE10	2003 06 22.0988	2.046759	0.791474	126.1882	147.4441	145.4586	13.0	5.0	2000	MPC 49591
Snyder-Murakami	C/2002 E2	2002 02 21.6886	1.466587	1.000277	9.0208	244.5629	92.5579	7.5	10.0	2000	MPC 46099
Utsunomiya	C/2002 F1	2002 04 22.8985	0.438299	0.999541	125.9001	289.0294	80.8767	8.5	10.0	2000	MPC 45655
NEAT	C/2002 J4	2003 10 03.1332	3.633892	1.000083	230.7026	70.8795	46.5207	5.5	10.0	2000	MPC 48380
LINEAR	C/2002 J5	2003 09 19.3267	5.726793	1.001123	74.8359	314.1093	117.2278	11.0	5.0	2000	MPC 46100
NEAT	C/2002 K1	2002 06 16.2780	3.229653	0.999163	4.4263	280.5378	89.7180	10.0	10.0	2000	MPC 46762
LINEAR	C/2002 K2	2002 01 05.3646	5.234632	0.991778	26.6260	294.5499	130.8945	12.0	5.0	2000	MPC 48921
NEAT	C/2002 K4	2002 07 12.8315	2.764556	0.841648	24.4125	308.0983	94.0637	10.5	10.0	2000	MPC 46620
NEAT	C/2002 L9	2004 04 06.0811	7.033269	0.998724	231.4318	110.4613	68.4491	8.5	5.0	2000	MPC 49276
Hoenig	C/2002 O4	2002 10 01.9400	0.775735	1.000654	105.9055	321.0407	73.1280	9.5	10.0	2000	MPC 46762
SWAN	C/2002 O6	2002 09 09.4491	0.494649	0.998608	78.7480	330.9520	58.6247	10.0	10.0	2000	MPC 46620
LINEAR	C/2002 O7	2003 09 22.5619	0.903290	1.000338	252.0686	12.8015	98.7471	6.5	10.0	2000	MPC 47292
NEAT	P/2002 O8	2002 05 07.7120	3.228224	0.199194	222.1237	75.4837	12.7863	8.0	10.0	2000	MPC 46762
NEAT	C/2002 P1	2001 11 22.6548	6.528325	0.984009	347.7199	310.6699	34.6045	6.0	10.0	2000	MPC 49276
LINEAR	C/2002 Q5	2002 11 19.2008	1.242628	1.001503	133.3766	33.8390	149.1866	9.0	10.0	2000	MPC 47727
LONEOS	C/2002 R3	2003 06 13.4268	3.869522	1.003101	45.0652	54.3032	161.0973	8.0	10.0	2000	MPC 47292
Skiff	P/2002 S1	2002 03 26.8528	2.314227	0.429844	36.0463	347.3097	27.7337	11.0	10.0	2000	MPC 47049
LINEAR	P/2002 T5	2003 06 28.0699	3.934417	0.437199	326.7855	123.3333	30.9016	8.0	10.0	2000	MPC 47292
NEAT-LINEAR	P/2002 T6	2003 06 26.9942	3.387906	0.556939	217.5597	209.0428	11.0093	10.5	10.0	2000	MPC 49591
LINEAR	C/2002 T7	2004 04 23.0610	0.614477	1.000482	157.7406	94.8555	160.5807	4.0	10.0	2000	MPC 49591
NEAT	C/2002 V1	2003 02 18.2881	0.099256	0.999896	152.1707	64.0706	81.7218	8.0	10.0	2000	MPC 48096
LINEAR	C/2002 V2	2003 05 13.7637	6.812199	0.999137	314.6827	20.2323	166.7769	6.0	10.0	2000	MPC 48096
LINEAR	C/2002 VQ94	2006 02 06.6569	6.796717	0.966856	100.0364	35.0164	70.5154	9.5	5.0	2000	MPC 49591
LINEAR	C/2002 X1	2003 07 12.9072	2.486794	0.998195	207.3316	281.8883	164.0890	8.0	10.0	2000	MPC 47728
NEAT	P/2002 X2	2003 03 29.7680	2.528942	0.373734	356.0918	78.1367	25.3462	12.0	10.0	2000	MPC 48097
Kudo-Fujikawa	C/2002 X5	2003 01 28.9761	0.190286	1.000088	187.6055	119.0879	94.0780	8.5	10.0	2000	MPC 48097
Juels-Holvorcem	C/2002 Y1	2003 04 13.2491	0.713667	0.997124	128.8088	166.2227	103.7831	6.5	10.0	2000	MPC 48381
	P/2003 A1	2003 02 01.2665	1.916045	0.481045	357.1046	55.1782	46.2595	13.5	10.0	2000	MPC 48381
Gleason	C/2003 A2	2003 11 06.5838	11.426450	1.006987	346.6955	154.5445	8.0613	3.5	10.0	2000	MPC 48381
LINEAR-NEAT	P/2003 CP7	2003 04 29.2570	3.017013	0.248114	42.6069	133.1241	12.3394	14.5	5.0	2000	MPC 48921
NEAT	C/2003 E1	2004 02 13.6266	3.245049	0.763475	103.8617	137.0690	33.5374	12.5	5.0	2000	MPC 49276
LINEAR	C/2003 F1	2003 06 28.4764	4.007890	0.806199	121.1891	87.4911	70.2185	7.0	10.0	2000	MPC 49276
LINEAR	C/2003 G1	2003 02 03.6784	4.916324	1.001432	11.4265	246.0854	66.8461	5.0	10.0	2000	MPC 49276
LINEAR	C/2003 H1	2004 02 22.6135	2.239685	0.999324	196.1358	18.9996	138.6680	6.5	10.0	2000	MPC 49277
LINEAR	C/2003 H2	2003 05 17.9746	2.178559	0.943017	155.0849	79.8364	74.2154	13.0	10.0	2000	MPC 49277
NEAT	C/2003 H3	2003 04 24.2335	2.901361	0.999759	6.4796	269.4137	42.8092	9.5	10.0	2000	MPC 49277
LINEAR	P/2003 H4	2003 05 14.3227	1.703123	0.490102	10.4586	226.7890	18.1476	16.0	10.0	2000	MPC 49277
LINEAR	P/2003 HT15	2003 04 17.7627	2.671635	0.419949	124.0597	81.4737	27.6688	14.0	5.0	2000	MPC 49277
NEAT	C/2003 J1	2003 10 10.6504	5.125526	0.991513	196.0352	122.0330	98.3155	7.0	10.0	2000	MPC 49277
Spacewatch	C/2003 K1	2002 12 21.5847	2.089543	0.955078	314.6471	250.0709	129.8747	12.5	10.0	2000	MPC 49277
Christensen	P/2003 K2	2003 04 07.8527	0.549207	0.828869	345.5363	93.9068	10.1402	13.5	10.0	2000	MPC 49277
LINEAR	P/2003 KV2	2003 07 10.8481	1.063011	0.629242	188.7415	66.4101	25.5389	16.5	5.0	2000	MPC 49277
LINEAR	C/2003 K4	2004 10 13.7066	1.023580	1.000364	198.4420	18.6770	134.2533	3.5	10.0	2000	MPC 49592
Scotti	P/2003 L1	2003 03 08.2784	5.009943	0.252410	355.2520	226.0365	9.0224	8.5	10.0	2000	MPC 49278
LINEAR	C/2003 L2	2004 01 19.2334	2.864595	0.981423	119.8549	273.5575	82.0510	10.0	10.0	2000	MPC 49592
LINEAR	C/2003 O1	2004 03 17.1770	6.847289	1.001244	81.6698	347.6434	117.9815	6.0	10.0	2000	MPC 49592
LINEAR	P/2003 O2	2003 09 05.8093	1.505376	0.645852	32.7216	344.7079	14.6899	14.5	10.0	2000	MPEC 2003-S98
LINEAR	P/2003 O3	2003 08 14.0637	1.246383	0.598578	0.7631	341.5009	8.3645	18.0	10.0	2000	MPEC 2003-S99
NEAT	P/2003 QX29	2002 10 27.458	4.24328	0.47036	37.464	264.554	11.395	8.5	10.0	2000	MPEC 2003-SA0
LINEAR	C/2003 R1	2003 06 29.750	2.10257	0.89440	302.742	356.685	149.201	15.0	5.0	2000	MPEC 2003-SA1
NEAT	P/2003 S1	2004 03 28.138	2.59487	0.43137	175.998	241.032	5.949	11.5	10.0	2000	MPEC 2003-SA2
NEAT	P/2003 S2	2003 09 04.820	2.45275	0.36097	283.339	87.884	7.624	12.5	10.0	2000	MPEC 2003-SA3
LINEAR	C/2003 S3	2003 09 19.814	8.16889	1.00000	164.242	226.822	151.586	5.5	10.0	2000	MPEC 2003-S85

Source: CBAT web pages. H1 and K1 are also from the CBAT; alternative values are given in the main section and on the Section web pages.

How to fill in the forms

Full details on how to complete the report forms are given in the section Observing Guide. The most important aspects to complete are shown clear. Progressively less important items are shown with darker shading. The ICQ will not accept observations unless the clear and lightly shaded sections are complete. Submission via e-mail is much appreciated, but please make sure that you get the format **EXACTLY** right. It is advisable to send the report as a text attachment as many mailers cut what they consider to be long lines.

Some observers are making mistakes in reporting comet observations, which increases the workload for both Guy and myself. These notes explain some of the problems and give some tips and hints on how to make your observations more useful.

It will help if you wait a few days and send in final observations rather than sending in preliminary observations, which are corrected a few days later. If you do send a preliminary observation make it clear that this is for information only, so that Guy doesn't type it in twice. Normally, monthly submission is fine. If you would like the observations to appear on the Comet Section 'recent observations' web page, then send the final observations to me, but don't send them to both of us. If you can send observations to Guy in the exact TA format or to me in ICQ format or on BAA forms (or at least with the information in the same order!) this is a big help.

Using the smallest aperture and magnification that show the comet clearly gives more consistent results. For a comet brighter than about 3rd magnitude this will normally be the naked eye.

Please make a measurement or estimate of the coma diameter at the same time and with the same instrument as the magnitude estimate. This is very important for the analysis of the observations as the coma diameter also gives information about your observing conditions. For an elongate coma, report the smaller dimension as the diameter and the longer radius as the tail length.

Always measure the magnitude, coma diameter and DC with the **same** instrument (which may be the naked eye, binoculars or telescope) and only report this instrument. If you make additional measurements of magnitude, coma diameter etc with different apertures, report them separately. I can use these observations to help quantify the aperture effect.

You can measure the tail or features in the coma with whatever instrument is most suitable. Note the aperture, magnification, seeing etc as with any other astronomical observation.

When observing a comet please try to forget how bright you think the comet should be, what it was when you last viewed it, or what other observers think it is.

The following abbreviations are used in the reports:

MM Method used for magnitude estimate. The recommended method is the Sidgwick (S) method (also known as the In-Out method).

Total Mag If you do not have an atlas or catalogue then identify the comparison stars with a field sketch on an attached sheet. A [before the magnitude indicates the comet was fainter than the given magnitude. A : after the magnitude indicates a reliability 2 or 3 observation.

Ref Source or catalogue for comparison stars. The preferred ones are TJ (Tycho J - the default for Megastar), TK (Tycho 2), TT (Tycho VT), VB (BAA VS chart), SC (Sky Catalogue 2000), HS (Hubble catalogue), AA (AAVSO atlas).

Tel ap Telescope aperture in centimetres. Only give the decimal if it is known exactly.

Tel typ Telescope type. eg Binoculars (B), reflector (L), refractor (R), Schmidt-Cassegrain (T).

Tel mag Telescope magnification. Give to the nearest 5 for powers above 20 unless you have measured it exactly.

Tail len Length of the longer tail. Other tails should be recorded under comments.

Tail PA Position angle of the longer tail, measured with respect to lines of RA. Do not report tail details unless you are certain of their reality.

Sky Observing conditions. 0 (impossible to make any observation), 5 (average), 9 (Milky way visible down to the horizon.

Rel Reliability of magnitude estimate: 1 (good) to 3 (poor).

Comments Add any extra information here. For example note if there is a separate sheet with a field sketch, coma drawing, tail sketch, etc.

The **visual observation observing blank** can be used when you have made a drawing of the comet, perhaps because it shows some interesting features or because you want to identify comparison stars. Record your name, the name and year identifier of the comet you have observed (eg P/1994 P1 (Machholz)), the year, month, day and time of the observation (eg 1994 Nov 20/21, 23:30) and your observing location (eg Cambridge) and conditions at the top of the form. Also note the instrument type, aperture, eyepiece and magnification. Record the scale of the image by noting the diameter of the circle in minutes of arc and mark the north point with an arrow; also note if you have used a star diagonal. Space at the bottom of the form can be used for a description of the observation. If there is a lot of detail you may want to use more space to record it, for example on an A4 sheet, but please record all the information that is on the normal form.

The ICQ have recently produced detailed guidelines for submitting magnitude estimates made using CCD images and these are available on their web page at http://cfa-www.harvard.edu/cfa/ps/icq/ICQFormat.html

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Observing Blank

Observer	Comet
Date : 19 / /	Time (UT)
Location	Conditions
Instrument	Aperture
Eyepiece	Magnification
Field of view	Star diagonal ?

Please indicate north point on the drawing

Description

BAA Comet Section Visual Observation Report Form

Observer	Comet
Year	Location

Month	Day.dd UT	M M	Total Mag	ref	Tel ap	Tel typ	f no	Tel mag	Coma Diam	D C	Tail len	Tail PA	Sky	Rel	Comments