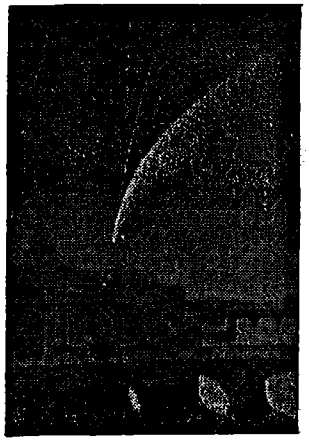

THE COMET'S TALE

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.

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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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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

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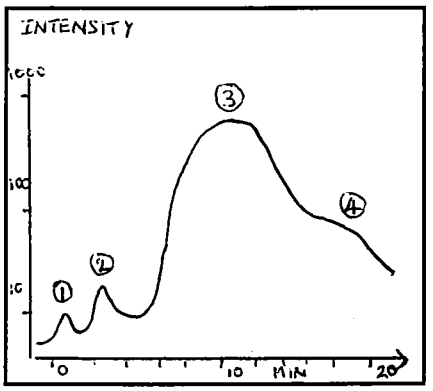
Lunch had been prepared by the CUAS committee, and allowed the perusal of displays by the BAA, the Comet and Jupiter Sections, and the Japan Amateur Astronomers' Convention. Rosemary Naylor from 'Earth and Sky' had a stall, including a proof copy of the new book on Jupiter by John Rogers due out next 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 northest, 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.

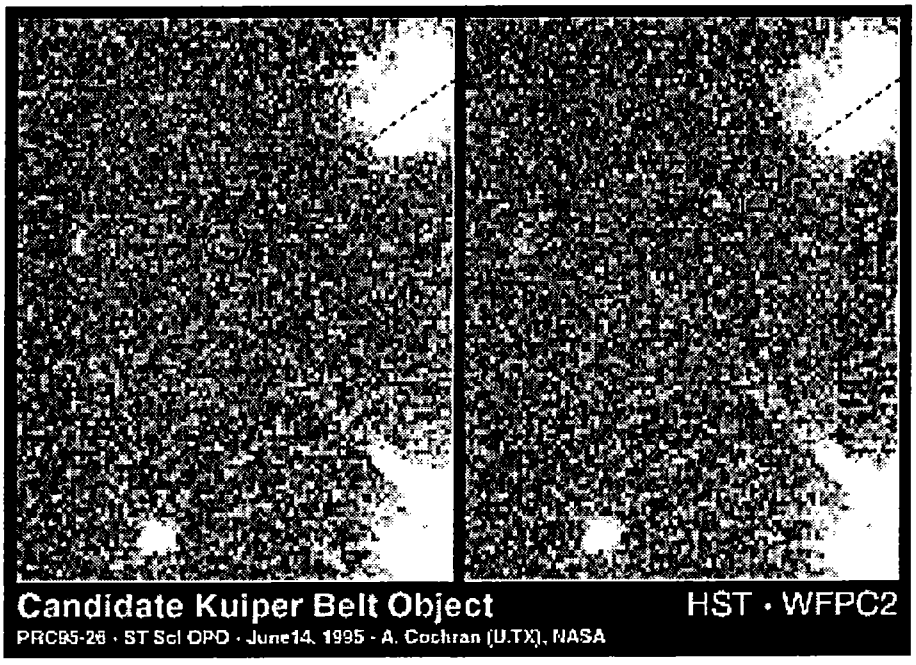
Based on the Hubble observations, a team of astronomers consisting of Anita Cochran of the University of Texas, Austin, TX, Hal Levison and Alan Stern of Southwest Research Institute, San Antonio, TX branch office in Boulder, CO, and Martin Duncan of Queen's University, Ontario, Canada, estimate the 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	Number	Name
50P	Arend	115P	Maury
49P	Arend-Rigaux	97P	Metcalf-Brewington
47P	Ashbrook-Jackson	28P	Neujmin 1
3D	Biela	25D	Neujmin 2
85P	Boethin	42P	Neujmin 3
19P	Borrelly	13P	Olbers
16P	Brooks 2	39P	Oterma
5D	Brorsen	18P	Perrine-Mrkos
23P	Brorsen-Metcalf	80P	Peters-Hartley
87P	Bus	12P	Pons-Brooks
101P	Chernykh	7P	Pons-Winnecke
95P	Chiron	30P	Reinmuth 1
67P	Churyumov-Gerasimenko	44P	Reinmuth 2
108P	Ciffreo	83P	Russell 1
71P	Clark	89P	Russell 2
32P	Comas Sola	91P	Russell 3
27P	Crommelin	94P	Russell 4
6P	d'Arrest	92P	Sanguin
33P	Daniel	24P	Schaumasse
54P	de Vico-Swift	106P	Schuster
72P	Denning-Fujikawa	29P	Schwassmann-Wachmann 1
66P	du Toit	31P	Schwassmann-Wachmann 2
79P	du Toit-Hartley	73P	Schwassmann-Wachmann 3
57P	du Toit-Neujmin-Delporte	61P	Shajn-Schaldach
2P	Encke	102P	Shoemaker 1
4P	Faye	105P	Singer Brewster
15P	Finlay	56P	Slaughter-Burnham
37P	Forbes	74P	Smirnova-Chernykh
34P	Gale	113P	Spitaler
90P	Gehrels 1	38P	Stephan-Oterma
78P	Gehrels 2	64P	Swift-Gehrels
82P	Gehrels 3	109P	Swift-Tuttle
21P	Giacobini-Zinner	98P	Takamizawa
84P	Giclas	69P	Taylor
26P	Grigg-Skjellerup	9P	Tempel 1
65P	Gunn	10P	Tempel 2
1P	Halley	11D	Tempel-Swift
51P	Harrington	55P	Tempel-Tuttle
52P	Harrington-Abell	62P	Tsuchinshan 1
100P	Hartley 1	60P	Tsuchinshan 2
103P	Hartley 2	8P	Tuttle
110P	Hartley 3	41P	Tuttle-Giacobini-Kresak
117P	Helin-Roman-Alu 1	112P	Urata-Niijima
111P	Helin-Roman-Crockett	40P	Vaisala 1
35P	Herschel-Rigollet	53P	Van Biesbroeck
17P	Holmes	76P	West-Kohoutek-Ikemura
45P	Honda-Mrkos-Pajdusakova	20D	Westphal
88P	Howell	36P	Whipple
58P	Jackson-Neujmin	63P	Wild 1
48P	Johnson	81P	Wild 2
59P	Kearns-Kwee	86P	Wild 3
68P	Klemola	116P	Wild 4
75P	Kohoutek	107P	Wilson-Harrington
70P	Kojima	46P	Wirtanen
22P	Kopff	114P	Wiseman-Skiff
99P	Kowal 1	14P	Wolf
104P	Kowal 2	43P	Wolf-Harrington
77P	Longmore		
93P	Lovas 1		
96P	Machholz 1		

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.

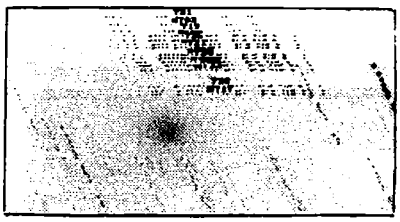
Finally, there is an analysis of possible perturbations by the Kuiper belt or Planet X, but there is no significant evidence for either of these.

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

James Lancashire

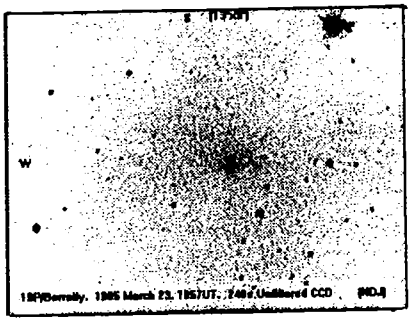
Images

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)

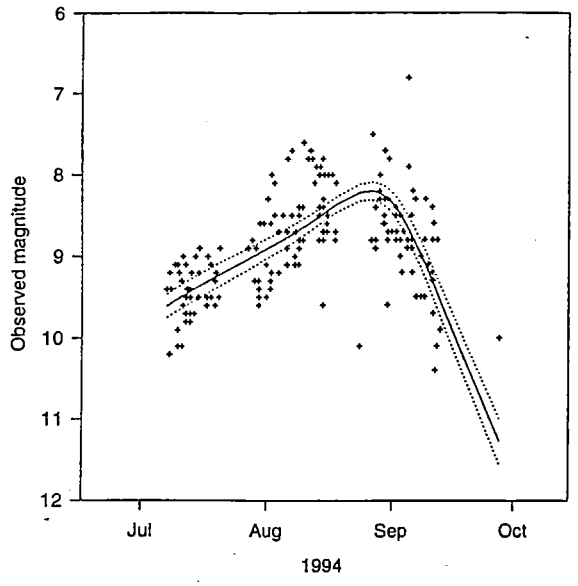


CCD image by Nick James taken on 1995 March 23 at 1957 UT. Exposure is 240 s. In the original image, there is a broad tail extending from the comet nucleus to the SE (upper right) which is difficult to reproduce here. The comet was about 13^m visually

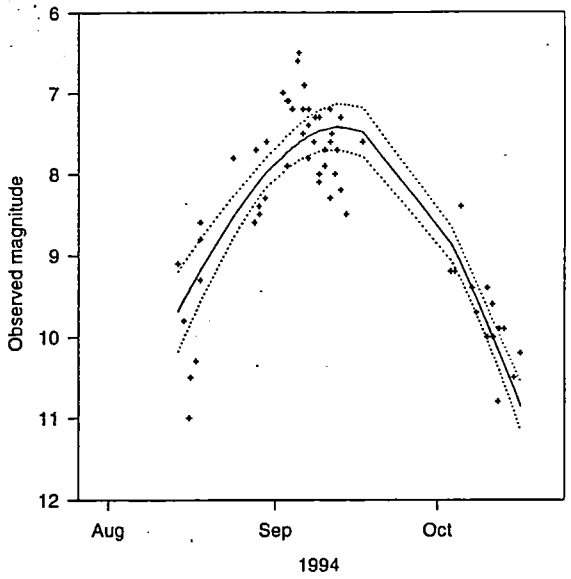
Lightcurves

follow overleaf ...

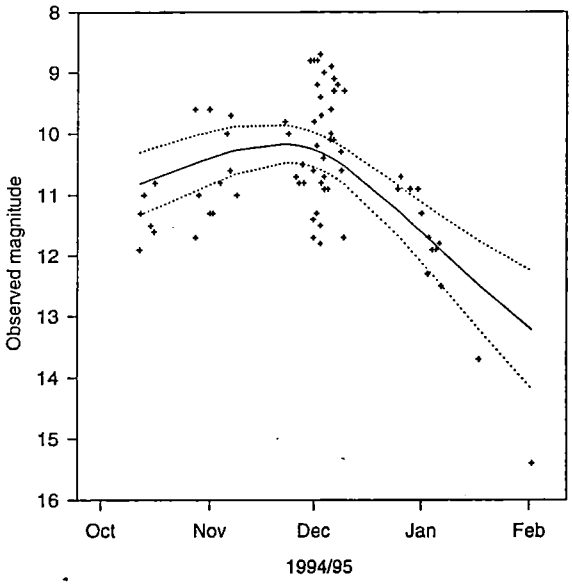
Comet C/1994 N1 (Nakamura-Nishimura-Machholz)



Comet P/1994 P1 (Machholz 2)



Comet C/1994 T1 (Machholz)



Comet 19P (Borrelly)