



Diebold Schilling, Disaster in connection with two comets sighted in 1456, Lucerne Chronicle, 1513 (Wikimedia Commons)

THE COMET'S TALE

Comet Section – British Astronomical Association

Journal – Number 38 2019 June

britastro.org/comet



Evolution of the comet C/2016 R2 (PANSTARRS) along a total of ten days on January 2018. Composition of pictures taken with a zoom lens from Teide Observatory in Canary Islands. J.J Chambó Bris

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1 From the Director – Nick James

I hope you enjoy reading this issue of the Comet's Tale. Many thanks to Janice McClean for editing this issue and to Denis Buczynski for soliciting contributions. Thanks also to the section committee for supporting me, and particularly to our former Director, Jonathan Shanklin, who continues to perform detailed analyses of cometary activity. There is plenty of material in this edition. I hope that you find something that will interest you.

I was pleased to see so many of you at our recent Comet Section meeting in York. Many thanks to Hazel Collett and to the York Astronomical Society for providing all the local organisation and to our cast of excellent speakers. It was a perfect venue and I think everyone enjoyed the day. Videos from the meeting are online here: <https://www.britastro.org/video/15371>

We will aim for another meeting in two years' time at a venue to be decided but I'm open to suggestions. Denis did suggest that we held the meeting in the Carnegie Hall. Not the New York one but the one just down the road from his observatory in Tarbatness, Highland Scotland. It's a nice idea but probably a bit too far for most.

The BAA will hold this year's Autumn meeting in Armagh on the weekend of 2019 September 7/8. Armagh is a location with close ties to cometary astronomy and several of the talks have a comet theme. I hope to see many of you there. Full details are on the BAA website: <https://www.britastro.org/node/15409>

We have had a couple of relatively bright but diffuse comets through the winter and there are plenty of images of 46P/Wirtanen and C/2018 Y1 (Iwamoto) in our archive. It is good to see an increasing number of observers taking up the challenge of estimating total magnitudes, either visually or using images. This will be particularly important when C/2017 T2 reappears from behind the Sun in July since it will help Jonathan update what is currently a very uncertain lightcurve.

Currently we're having to make do with mostly rather faint comets. Of the current crop C/2018 R3 (Lemmon) is one of the brightest at around mag 10 low in the bright summer sky under the pole. Not far away in Camelopardalis is C/2018 W2 (Africano). This is currently around 14th mag but it is brightening and may reach 10th magnitude in late September. At its brightest it will be well placed from the UK moving from Perseus to Andromeda.

C/2017 T2 (PANSTARRS) was discovered at 20th magnitude in 2017 September when it was 9.3 au from the Sun. It is heading for a perihelion at $q=1.6$ au in early 2020 May. The comet is currently in conjunction but it was apparently brightening rapidly when last seen in April. It should become visible from the UK in mid-July very low in the morning sky as it moves slowly NE in Taurus. By then it will be 3.8 au from the Sun and 4.5 au from the Earth. It moves higher in the sky and will be visible throughout the autumn, winter and spring as a circumpolar object and it remains well

placed in UMa at perihelion (see chart). Magnitude estimates through the late summer and autumn should help to constrain the lightcurve. An analysis by Jonathan Shanklin on limited data suggests it could be anywhere between 9th or 2nd magnitude by the end of the year! Definitely one to watch.

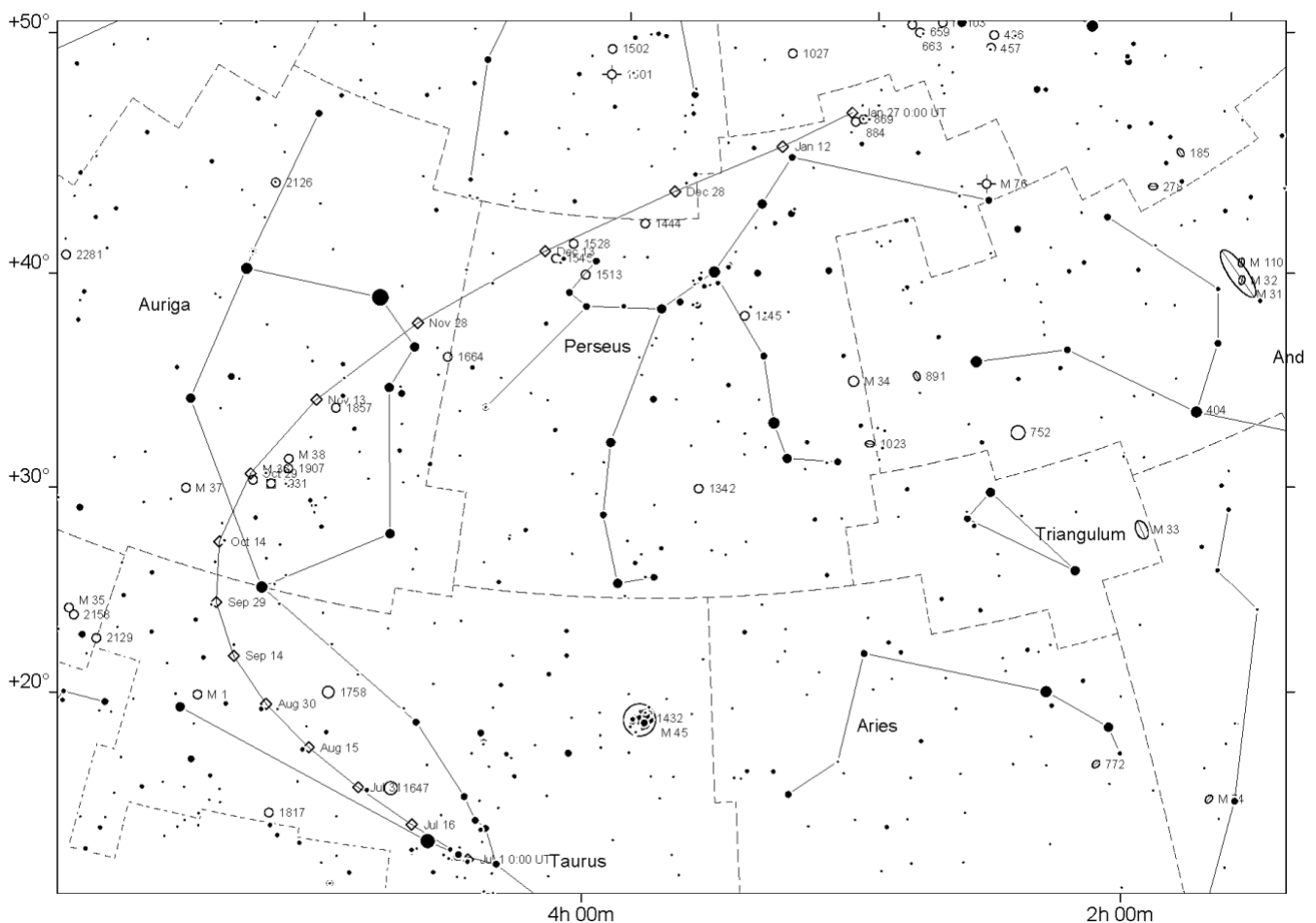
29P/Schwassmann-Wachmann is now well placed and moving north of the equator. It is at opposition in September and a very good target for continuous monitoring given its frequent outbursts.

Let's hope for good weather as the nights lengthen into the autumn and I look forward to receiving your observations of these comets and others.



Nick James Section Director

19th June 2019



Join us in Armagh this September

The British Astronomical Association Weekend Meeting

Armagh 6th - 8th September 2019

Venue: Armagh City Hotel,
Armagh, BT60 4FR

The meeting is open to members and non-members and will include an optional visit to the Planetarium.

The observatory was founded in 1790. In the grounds there are scale models of the Solar System and the Universe, two sundials and historic telescopes. The Human Orrery, launched in 2004, is located close to the main Observatory building

Dr. Kate Maguire - *Supernovae*
Dr. Michele Bannister - *Small worlds of the outer Solar System.*
Prof. Alan Fitzsimmons - *Comets*
Dr. John Mason - *Meteor streams*
Dr. Jorik Vink - *The formation of our Solar system.*

Prof. Michael Burton - *Armagh observatory*
Prof. Mark Bailey - *Giant comets and their impacts through time*
Janice McClean - *Agnes Mary Clerke*
Terry Mosely - *The closest comet encounters*

BAA

For more details visit the BAA website at :
britastro.org/armagh2019

(V4) Details subject to change

BAA

2 Melvyn Taylor's Observations of Comet C/1995 O1 (Hale-Bopp) – Alex Pratt



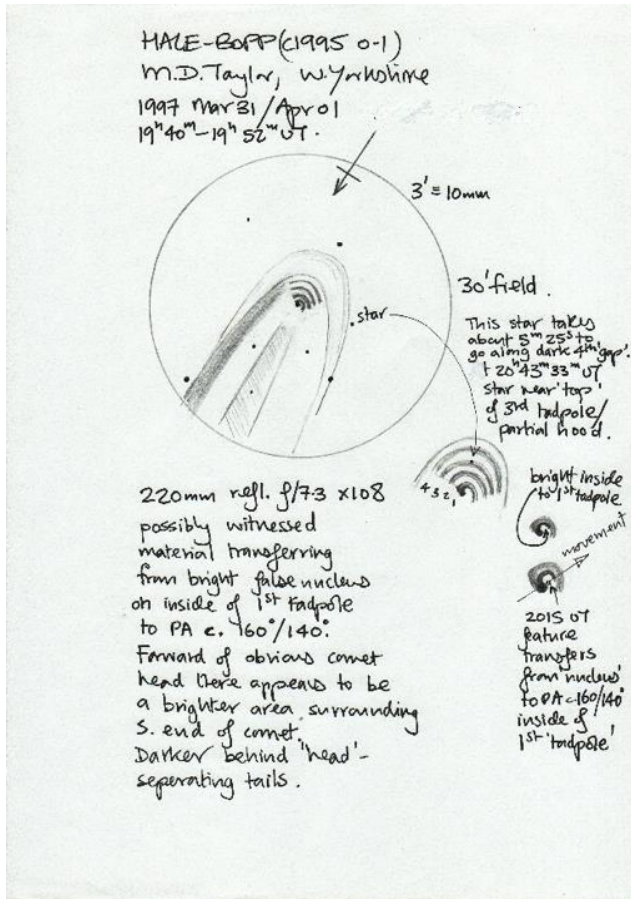
Melvyn Taylor - 2005 BAA Merlin Medal - ARP

Melvyn was one of the UK's most prolific visual observers, specialising in the observation of variable stars, comets, meteors and occultations using the naked eye, binoculars and small telescopes. He observed from his light-polluted back garden in Wakefield, West Yorkshire. He passed away in August 2017, shortly before his 70th birthday. Thanks to his family, his notebooks have been preserved and a long-term project is underway to ensure that his observations are logged in the appropriate databases and archived for posterity. In his memoirs he stresses the importance of record keeping:

'During the early 1960s Patrick Moore's books and the JAS (Junior Astronomical Society, now the Society for Popular

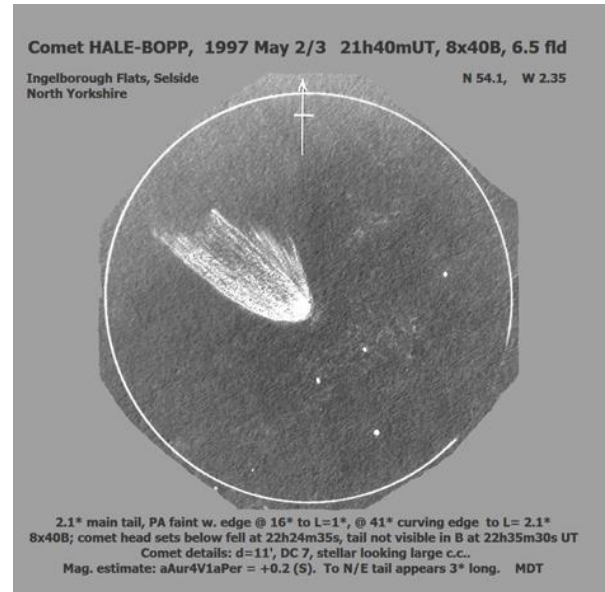
Astronomy) observing sections - occultations, meteors, variable stars, and solar - suggested that it was not just about keeping an astro-diary but an attempt at proper, to the best of one's ability, astronomical recording that may lead to the creation of vaguely useful or usable work. This has been done now for over 33 years or so, with observational reports being sent to the relevant JAS and BAA sections.'

An observer from 1963 he systematically recorded observations in 1967. Generalised summaries in year order are hand written in a set of A4 hardback notebooks of main fields: variables (c. 91,000 in 2011), meteors/fireballs, comets (recorded 60th individual in 2011), aurorae, NLC, occultations (stellar and asteroidal), minor planets, some deep-sky. Melvyn observed most comets that came within his visual range. As he gained experience his records became more detailed, maturing into comprehensive summaries of each comet's magnitude, the diameter of its coma, its degree of condensation, details in the coma such as hoods or envelopes, details of any dust or gas tail(s), their length and position angle. His sketches of comet C/1995 O1 (Hale-Bopp) have now been scanned and can be viewed in the Comet Section's image archive. A couple of examples are given below, including his comments on this great comet.



Comet Hale-Bopp - an appreciation

At Levisham, North Yorkshire Moors, on 1995 August 26 John Blockley's Celestron 8 was used to spot the small cometary image which looked like a defocused 10th magnitude star near delta Sagittarii, the chart in the BAA Circular was used as a finder chart. High altitude observing conditions were truly remarkable, some of the best experienced, and afterwards when the comet had set a series of variable star estimates were made together with some static tripod star-field photography.



Comet Hale-Bopp hanging over Ingleborough Flats, Yorkshire Dales. 1997 May 2/3. Colour slide. By Melvyn Taylor.

The final sighting used the Swift 16x70mm binocular on 1997 May 13 at 21h 15m UT with a smidgen of cometary light visible in bright twilight just about to set behind roof tops from the back garden. Both the first and last observations were not conducive for worthwhile measures.

The primary observing site is the observer's address in Wakefield and all sites used are listed with latitude, longitude and approximate height above sea-level.

Period of observation: 1995 August 26 to 1997 May 13.

Instrumentation: For a while naked-eye was used!

Binoculars: 8x21mm; 10x50mm (5.7°); 8x40mm (5.7°); 8x40mm (6.5°); 16x70mm (5°)

Refractors: 76mm f/12 alt/az; 82mm f/12 manual eq. (the Herschel/Ross refractor of Leeds AS**)

Reflectors: 220mm f/5.0 alt/az; 220mm f/7.3 alt/az.

** This 3¼-inch Ross refractor (optics by Dallmeyer) was donated by Sir John Herschel to Leeds AS after its founding in 1859.

Observing sites:

EDALE, North Derbyshire
N.53.35 W.1.80 250m

LEVISHAM, North Yorkshire
N.53.308 W.0.725 210m

St. JUST, Cornwall
N.50.105 W.5.658 90m

SELSIDE, North Yorkshire
N.54.1 W.2.35 365m

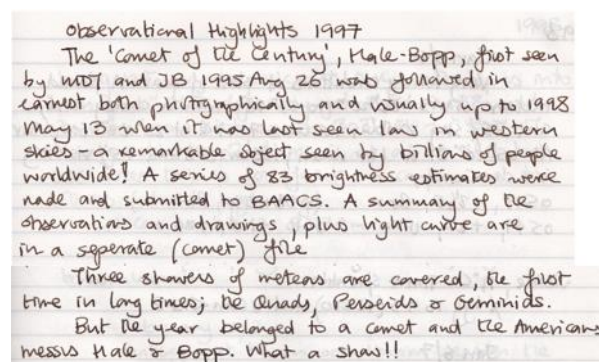
WAKEFIELD, West Yorkshire
N.53.676 W.1.517 30m

WAKEFIELD, Heath Common, West Yorkshire
N.53.675 W.1.456 50m

COSTA TEGUISE, Lanzarote, Spain
N.29 W.13.3 10m

BAA Comet Section Circulars used for ephemerides and position of the comet. 83 brightness estimates were made either by the Sidgwick or Bobrovnikoff method

utilising the magnitudes from the AAVSO Variable Star Atlas and the requirements of the Comet Section. 20 final drawings (for presentation) done using soft pencil; made in situ or soon after the end of each observing session and with reference to in situ sketch from observational notebook or atlas. Position angles and coma diameters measured from Atlases Borealis or Eclipticalis. Dark adaptation was always tried for, despite moonlight.



(Note that Melvyn incorrectly wrote '1998' in his notebook).

People who saw Hale-Bopp (C/1995 O1) sporting twin tails will surely never forget it. From wherever comet Hale-Bopp came, out amongst interstellar space, would it not be great if a similar icy world could appear nearer Earth for the new millennium? (MDT - 1997)



Alex Pratt

3 The Enigma of Comet Encke Neil Norman

***Object: Comet 2P/Encke 26 03 2017 Date: 27 03 2017 UT 3h16m Location: Farm Tivoli,
Namibia SW-Africa Telescope: ASA 12" f3.6 Camera: FLI PL 16200 Mount: ASA DDM85
Exposure time: LRGB 12/4/4/4 min. Copyright Gerald Rhemann***



http://www.britastro.org/cometobs/2p/2p_20170327_grhemann.html

With the shortest period known for a comet at just 3.3 years (or 1,204 days), comet 2P/Encke is very much a familiar

object on many a backyard astronomer list of objects to observe; but it is an object that has some mystery to it as we shall see.

We begin with its discovery; nothing new there you may say, but even this isn't straightforward. It was first discovered by the French astronomer Pierre Méchain (1744-1804) on the 17th January, 1786.



Pierre Méchain 1744 - 1804

Though recorded, not enough observations were gathered to determine the orbit at that apparition, but it was said to have been quite bright in the constellation of Aquarius. It was then discovered again by Caroline Herschel (1750 - 1848), on 7th November 1795.



Caroline Herschel 1750 - 1848

The comet was just two days away from its closest approach to Earth of just 0.26 astronomical units and was followed by astronomers until it plunged into a twilight sky on the 28th of November. Again, not enough observations were seen to determine an orbit even though, at its closest approach, it had made naked eye visibility. The third discovery was made by Jean -Louis Pons (1761- 1831) on 20th October 1805, and was again a naked eye object, noted to match M31 in both brightness and apparent size.



Jean Loius Pons 1761 - 1831

The fourth discovery was made by Pons again on 27th November 1818, and he described it as very faint. (the comet was at a distance of 0.6 AU at closest approach in January the following year, so this was a poor return).

It was with this fourth discovery that the German astronomer and mathematician, Johann Franz Encke (1791- 1865) began work on determining an orbit for it. With laborious calculations he was able to link the comets of 1786, 1795, 1805 and 1818, and concluded that they were all one and the same. This would ultimately lead to the

comet being named in his honour, though Encke himself only referred to it as Pons comet.



Johann Franz Encke 1791 - 1865

Characteristics

The comet, when at perihelion, comes within the orbit of Mercury to a distance of 0.33 AU's and at aphelion goes out to 4.11 AU's, which is within the orbit of Jupiter. Added to this is its low inclination of just 11 degrees; it has the potential to make close approaches to the inner planets and Jupiter itself. For example during the 20th century it made one close approach to Mercury, eleven close approaches to Earth and two close approaches to Jupiter respectively. The next close Earth approach is due on the 11th July 2030 at a distance of 0.27 AU's. Close approaches to Earth occur every 33 years.

The comet is also the parent comet of the

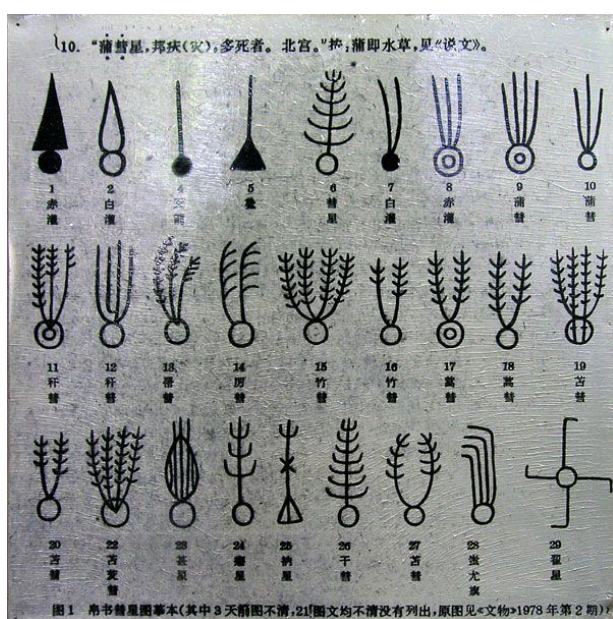
Taurid meteor stream which is seen each year from September to November. These are known as the Southern Taurids. A Northern Taurid shower occurs from October to December each year, but this shower's parent body is an asteroid designated 2004 TG10 which is classed as a potentially hazardous asteroid of the Apollo group measuring some 0.35-0.78 kilometres in diameter. This object is of interest also as it could very well be a fragment of comet Encke itself.

Apparition possibilities

The comet begins brightening three months before perihelion and on good returns, after just a month, the comet is of magnitude 6-7, making it a binocular target. Be warned though that it is a very diffuse object with a low surface brightness. The trend of brightening then slows and it stays around magnitude 6 or 7 for approximately 45 days, then it begins to rapidly fade some 20 days post-perihelion, quickly becoming asteroidal in appearance. Due to its inclination, the northern hemisphere is favoured pre-perihelion and southern hemisphere post-perihelion. The best times to see it ranges between September and the following February. December perihelion is the best time to see it from the northern hemisphere. For the southern hemisphere, January and August are the best viewing times, but even then, it only attains magnitude 8. Orbital calculations indicate that the comet has been in a stable orbit since at least the mid 18th century, and will remain so until the end of the 21st century.

Overall however, the comet has been fading for quite some time. If one looks

through the history books, one will see documentation of what appears to be a comet breaking up that was depicted on the Han Dynasty Silk, dating from around the second century B.C. It was recovered from the Mawangdui tomb and shows drawings of 29 comets. One illustration of interest is an object that appears to look like a swastika. This image is believed by scholars to show the fragmentation of a large comet that may very well have been the parent of comet Encke.



Encke is a relatively large comet with a nucleus around 4.8 km in diameter. One must remember that this comet has been orbiting the Sun every 3.3 years for at least 2,200 years and has made at least 650 plus perihelion passes in that time within the orbit of Mercury. Even at its aphelion point, tucked inside the orbit of Jupiter, it is still warm enough for the sublimation of volatile ices; this comet has experienced a serious amount of cooking which would have thickened its crust quite considerably. Consequently, the magnitude of the comet

has declined steeply since its first discovery.

Its brightest magnitude was documented at 3.5 in 1829, then magnitude 4 in 1805. It reached magnitude 5 in 1964 but other than this return the comet was magnitude 6 plus during all visits during the 20th century. A 3 degree tail was seen in 1805 and a tail of 2 degrees was seen in 1871 and 1961.

Now to the perplexing oddity of this comet - why was it not documented in the past? The fact that the comet only appeared in the late 18th century makes no sense because orbital calculations show it was already in place, the parent comet is believed to have broken up 20-30,000 years ago. The Taurid meteor stream is the largest in the solar system with the Earth taking weeks to pass through it, but it takes several millennia for one piece to awaken. Though there is no definitive answer, my theory is as follows:

Comet Encke has been within its orbit for thousands of years but a close Jupiter approach a few hundred years ago tweaked this orbit that eventually decreased the perihelion distance to what it is today, then the increased solar radiation caused this inactive chunk of rock and ice to have a cracking event on its surface which allowed volatile ices inside to escape and thus create a comet rather than an asteroid. With perihelion, being close to the Sun, the comet is able to continue to vent its ices but on the flip side to this, the repeated passes of the Sun greatly alters the comet's landscape meaning that the open vents may very well be closing up which would

cause a decrease in activity. Like-wise the comet may very well have been lacking suitable reserves of the volatile materials meaning that it will shortly become an asteroid once more. Whichever is correct we can safely say that comet Encke will not survive for more than a few hundreds or more years in its current state.

The next return is that of 25th June 2020. Be sure to get out and see it if you can during its apparition as there won't be many more for old faithful.



Neil Norman

4 Setting up the C*Hyperstar for Imaging Comets - David Swan



The C8 Hyperstar. A small mono planetary camera is attached. A 2in Baader UV/IR cut filter is mounted inside the Hyperstar (not visible)

In the June 2018 issue of *The Comet's Tale*, the section director Nick James highlighted the upcoming apparition of the periodic comet 46P/Wirtanen. It would be a favourable fly-by, with the comet passing 11 million km from the earth in mid-December, just days after perihelion. Nick predicted it might reach mag 3.5, but as the comet would be passing relatively close to us, the coma's apparent size would be large

and therefore the object as a whole would have a low surface brightness. This would make it a difficult visual target, as it would not contrast well with the sky background in areas with significant light pollution.

As I didn't have a short focal length imaging set-up either, I was concerned I might miss out entirely. After all, we are in a bit of a fallow period for good comets at the moment! This is essentially what

propelled me into buying and installing Starizona's Hyperstar. I should say that many established BAA members, including David Arditti and David Strange, have been using the Hyperstar for some time with excellent results and are no doubt better placed to give expert advice on its use. Here, I simply talk about why I bought the Hyperstar and how I went about setting it up for use with the rest of my equipment.



C/2017 S3 (Pan-STARRS). 2018/07/19 22:42. 200mm SCT + f/6.3 reducer/corrector (operating at f/7) + ASI183MM + UV/IR cut. 56 x 10s. 30 x 20 arcmin; up is 16.2deg E of N.

I hope that other amateurs who are in a similar situation to me and are considering buying the Hyperstar might find this article useful. Or perhaps this article will simply be of interest to the curious; the Hyperstar does certainly seem to have its proponents ... and its detractors!

I have a single scope, a classic (not EdgeHD) Celestron 8in 'orange tube' SCT. Before I installed the Hyperstar, I was using it in two modes: at native f/10 for visual observation of planets and star clusters, and lucky imaging of planets; and with the Celestron reducer/corrector (operating at about f/7) for imaging of comets and deep sky objects. The first

cameras I bought (ZWO ASI 178MM and 178MC, mono and one shot colour respectively) were specifically for imaging the planets: they have small (7.4 x 5.0mm) CMOS chips, have very small pixels (2.4um) and are uncooled.

I started with driving the telescope on an alt-az mount (and this is fine for high-speed imaging of the planets) and I have continued with this method because I find it the only practical course if one does not have an observatory and has limited time. Field rotation limits sub exposures to around 20s, so certainly this is not the ideal configuration for imaging dim and diffuse objects. Nonetheless, I found that with the reducer in place and 3x3 software binning of the camera output (scale ~ 1 arcsec/pixel) I achieved sufficient sensitivity for many comets to become accessible with co-added exposures. Later I bought a larger sensor (ZWO ASI 183MM) to expand my field of view to around 30 x 20 arcmin, and this allowed me to follow the brighter comets as they changed over time and moved across our sky.

With this set-up, I thoroughly enjoyed following C/2017 S3, capturing one spectacular outburst in July 2018 (see left). I was also able to capture significant morphological detail in the coma and tail of 21P/Giacobini-Zinner during its recent pass.

In both cases, I found that the comets were occupying a good portion of the field of view provided by the larger sensor. And of course I couldn't take colour images with my one shot colour camera as colour information is lost on binning.



The 21P/Giacobini-Zinner. 2018/09/08 02:21. 200mm SCT + f/6.3 reducer/corrector (operating at f/7) + ASI183MM + UV/IR cut. 15 x 20s. 29 x 19 arcmin; up is 48.7deg E of N.

By the end of summer 2018 I was fixed on not missing out on 46P/Wirtanen. The priority was buy something, at a reasonable price, that would give me a wide field of view, give bright subs with short exposures, and be compatible with as much of the rest of my equipment as possible. The clock was ticking so not much of an ask!

After some web searches I alighted on the Hyperstar. At first glance it seemed like it might be a good solution. I would only have to buy one item, and because it is a removable accessory I would be able to switch between f/10, f/7 and f/2 imaging systems with the C8 backbone. Further internet searches however turned up mixed reports on the various astronomy forums. Many non-sophisticated users (like myself) were having terrible trouble with focusing and collimation. I then came across David Arditti's report on the Hyperstar on the BAA website. David had got the Hyperstar working on one of his scopes and it now seemed to be an established part of his imaging stable. He was however clearly an advanced amateur

and indeed he referred in his article to setting up the Hyperstar as an 'interesting challenge', which I interpreted as code for 'a total nightmare'. Conscious that it might not prove an easy move, I nonetheless placed an order directly with Starizona in the US.

The Hyperstar is an assembly of lenses that sits in the centre of the SCT corrector plate, in place of the secondary mirror (see opening image) It brings to a focus the broad light cone from the primary mirror at the front of the scope. The C8 Hyperstar operates at about f/2 and there is very little tolerance in the required spacing between the last optical element of the Hyperstar and the imaging sensor. When you order the Hyperstar you are asked with which camera you will be using it, and you are provided with an adaptor that will ensure the spacing is just right.

On receiving the Hyperstar, I was pleasantly surprised that the unit felt relatively light and was easy to mount onto the corrector. I have never been concerned about damaging the corrector when mounting and unmounting the Hyperstar and now that everything is optimised, I find neither focusing nor collimation a problem. Image download is fast from USB3 CMOS cameras and I simply set up continuous half-second exposures of a moderately bright star before proceeding with focusing and collimation adjustments - assisted by Maxim DL's subframe, zoom and star image statistics tools.

The key message I'd like to get across is just how much the performance of the Hyperstar, and, just as importantly, its ease of use, can be improved by carrying out a few optimisations of your optical system. I

was guided by John Hayes' excellent 'A Guide to Optimising Performance of the Hyperstar', so I refer you to that article for more details (search the web for 'Hayes optimize Hyperstar').

In summary:

- Use the right adaptor for your camera, and make sure everything is screwed down properly.
- If it is a low cost CMOS camera (and really only intended to be used at higher f/ratios), the sensor might be badly mounted and therefore tilted relative to the focal plane when it is attached to the scope. I was able to fix an out-of-focus corner in images from the 183MM camera by simply by judging tilt of the chip by eye and adjusting the screws on the circuit board on which the sensor is mounted.
- Ensure the secondary mirror holder is tilted as little as possible with respect to the corrector plate and fits snugly into the corrector plate, so it does not move.
- Set the Hyperstar collimation screws so that you have some degree of freedom to make push and pull adjustments.
- Translate and rotate the corrector plate to minimise aberrations in the image. This is the most laborious part! I found that the manufacturer-installed position was not optimal for the Hyperstar. Visual performance when the secondary mirror is put back remains excellent.
- Get the camera settings right for this fast optical system. With the Hyperstar, I run the camera at zero gain and the appropriate offset.

Once you've done this, you'll be ready to go. I have found that individual sub-exposures are sufficiently bright to show passers-by bright comets and certain deep sky objects in 'real-time'. I take out both my colour and mono cameras every session and it is easy to swap between the two. Collimation and focus remain very stable. Typically I acquire about 30 - 50 subs per comet (the limit being my patience) and then stack on the comet, either manually in Maxim DL or using Astrometrica's Track and Stack after a Maxim DL align to fix the position angle of the image series. At the C8 Hyperstar focal length of around 390mm, the ASI178 and 183 sensors work at a scale of about 1.3 arcsec per pixel when unbinned. The smaller 178MM and 178MC chips give FoVs of about 60 x 40 arcmin and the larger 183MM chip a FoV of about 110 x 70 arcmin. The Hyperstar does not produce stars as tight as with the f/6.3 reducer, but with careful focusing on a night of good seeing I achieve stars with FWHM values in the range 4 - 5 arcsec.

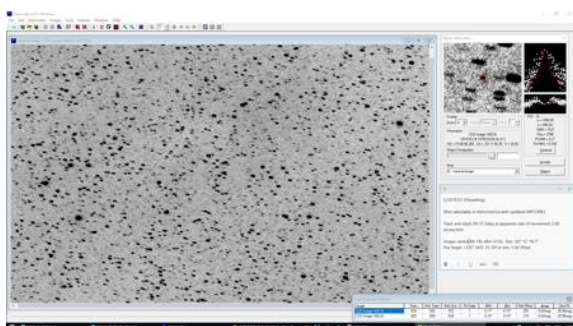
Whilst I was a little late getting the Hyperstar right, I successfully captured images of 46P during the latter half of its fly-by. In January 2019 I captured perhaps my favourite image of the comet, which shows the bright central condensation and expansive green coma.

At the moment I am focused on following some of the dimmer comets that are around, and I contribute regularly to the international Comet Observations Database (COBS) using data from co-added



46P/Wirtanen. 2019/01/07 20:05. 200mm SCT + Hyperstar + ASI178MC + UV/IR cut. 100 x 10s. 60 x 40 arcmin; up is 62.8deg E of N.

Hyperstar images, properly calibrated with bias, dark and flat frames using Maxim DL. In mid-March, I used the Hyperstar to find the recently discovered dim comet C/2018 D1 (Flewelling) in the crowded star fields of Aquila.



C/2018 D1 (Flewelling). The Hyperstar can be used for finding dim comets and measuring their brightness - as well as generating pretty pictures. 2019/03/24 04:44. 200mm SCT + Hyperstar + ASI178MM + UV/IR cut. 29 x 20s. Other detail on image.

Pretty much all of the imaging I carry out now is with the Hyperstar, but of course I retain the ability to image with the f/7 reducer too. This means that if a spectacular comet appears, I have the capacity to record both the whole object and interesting features around the central condensation. Here's hoping!



David Swan

5 Comet Software – Owen Brazell

We live in an interesting transition period as to how and where people get their information. Books and other traditional sources have been replaced by the web and mobile devices and this is as true for getting information on comet tracks as it is for everything else. If you asked the ordinary observer where they get their information from it is more likely to be a website such as <https://www.heavens-above.com/> or <https://cometchasing.skyhound.com/> than it is from more traditional sources such as the BAA Handbook. The traditional way of finding comets, by marking their tracks on an atlas has also given way now to the use of software. In many cases for non-computer-controlled telescopes the ability to load comet elements into a digital telescope computer and then use push to or GoTo to locate the comet has made life a lot easier. These devices are not infallible and they do have issues computing the locations of certain comets. The following gives a run through of some of the various commercial software packages for both charting and planning your comet observations.

Most of the programs covered are Windows only, although there are some that run on Mac's. I have no experience of the Linux world for these tools although undoubtedly there will be software that does similar things there. We may also be in a time where even these methods are passing out of favour in terms of other resources and the use of desktop software

may well be part of the older generation's toolkit. Without doing a full review of each piece of software the best that can be done is a brief vignette of the capabilities for comet observers.

Charting software

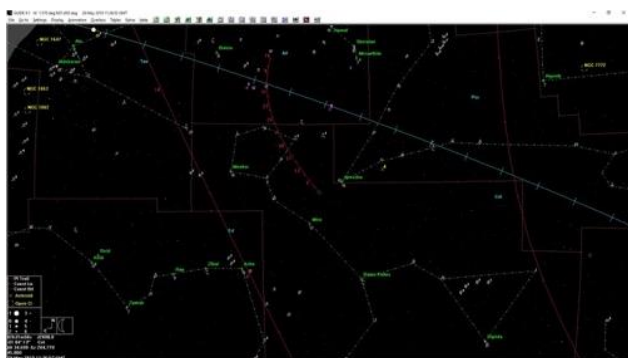
Charting software is software that will provide a decent finder chart that could either be printed out or perhaps used on a device next to the telescope. Many of these programs can also be used to control a telescope with the right driver software. The difference between what I define as 'Charting' software and 'Planetarium' software is that planetarium software is more likely to provide a less technical but more real time view of the sky and probably does not allow the production of decent finder charts/plot comet tracks. Most of the software discussed here makes use of elements downloaded either automatically or manually from the MPC at <https://www.minorplanetcenter.net/iau/Ephemerides/SoftwareEls.html>. It should be pointed out as well that there are many free charting programs available and for the comet observer, they mostly offer the same kind of thing, i.e. the ability to automatically download comet data from MPC. The usability or otherwise of much of this software depends on your patience.

Megastar 5 <https://www.willbell.com/>

This software has been used for a long time both in the old BAA circulars and for providing charts online. It is very effective

but requires the user to manually download software elements from the MPC and then rename the file to make it work. Recently the internal orbit computations have been having problems with a number of comets and it throws up errors. There is now a standalone package to modify the raw comet file from MPC to fix this. However new comets keep coming up with orbits that do not easily compute and they have to be added to the program. Many of these are SOHO comets. Unfortunately, the cause of these errors has not yet been identified. If the comet database is fixed it is still a very useful piece of software to show comet positions in an eyepiece field. Its stellar database is very out of date and uses a variant of the GSC. Comet magnitudes here are calculated from the raw data from the MPC. Megastar has the advantage that it can plot comet tracks.

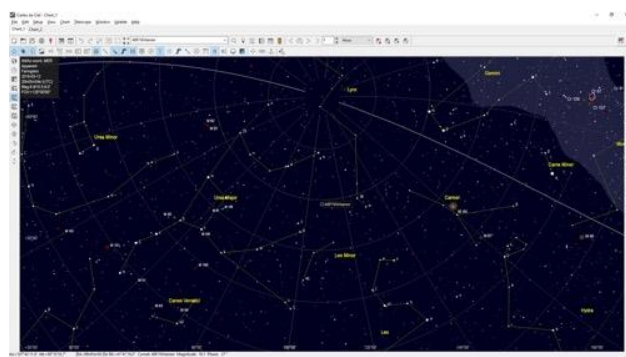
Guide 9.1 <https://www.projectpluto.com/>



This software is a real throwback in terms of its display to the DOS days. Nevertheless, it is used by a lot of observers because of the accuracy of its internal calculations. The software can automatically download the MPC data but has had issues when MPC changed from http to https and it needs a new standalone program to be able to access the data now. The comet magnitudes are based on the MPC data although the H and G parameters

could be modified to match observed values. The program is now free under a GPL license. It has the advantage that it can use more modern stellar data such as the UCAC 4 data and one would assume that somebody will come up with a file which would allow it to load GAIA data. The software does allow you to plot comet tracks. Guide 9.1 has not really been updated in the last 4 years.

Carte Du Ciel <https://www.ap-i.net/skychart/en/start>



This is also freeware that allows you to download the latest comet data and plot new comets. The software is continually developing and as of early 2019 is at 4.1 beta. It is quite complex to use to create anything more than wide field views and cannot for instance create multi pane finder charts. I have not seen an option for plotting comet tracks either. The comet data update is automatic along with the asteroid data.

The Sky X <http://www.bisque.com/sc/>

The Sky X comes in multiple versions varying from a low feature edition up to the Pro edition. It supports downloading of raw MPC data but you have to pay a yearly fee for support and may not get anything for your money. For example, the mid-range edition has not been updated for a

couple of years (at time of writing). The change in the MPC URL's also mean that you need to manually modify the locations in the program where it bases its data. Nevertheless, this is a very popular piece of software for those remotely controlling telescopes and cameras. In theory it can plot comet tracks but I have not been able to get the SAE edition to do this. I am not sure if this feature is only available in the Pro edition. There is also a cut down version that runs on iOS devices called the Sky HD.

Planetarium Software

Probably the two most common pieces of software here are **Starry Night Pro//Pro Plus** <https://www.starrynight.com/starry-night-8-professional-astronomy-telescope-control-software.html> and the freeware software Stellarium - <http://stellarium.org/>



Both of these programs will download comet data although it is not always clear where their data is sourced. In the case of Starry Night Pro it is probably not directly from the MPC so you need to wait for the data to be updated on a special server. There is also an issue with how many comets are loaded at startup so getting to see new comets may require changes to the configuration. The defaults have been updated in the latest version 8 but still it

can give issues. Stellarium will download directly from MPC but the method of doing so is somewhat obscure. The main advantage of this program is that it is free and can give decent images for showing at outreach type events.

Mobile devices

The advent of large screen phones and tablets running both iOS and Android has meant that there have been a number of decent star charting programs written for these devices. Probably the best of these is **SkySafari** (now at version 6 as of early 2019) <https://skysafariastromy.com/>. SkySafari downloads comet and other minor body data from their own server which is updated from the MPC. The stellar databases can be quite large, indeed in SkySafari Pro 6 you can have a 75 million star database from GAIA as an add on. The search for comets is pretty efficient and certainly for wide screen views the comet positions appear very accurate. I have used this software extensively for finding comets from my light polluted home location. This software does have a night mode and this can be improved by using a red cling film to reduce light leakage. On Android devices the displays are often far more sophisticated than on iOS and they do have displays that have very little light leakage. SkySafari runs on iOS, Android and Mac OS's.

Planning software

The other group of software programs that can be used for creating comet charts is what is generically known as planning software. In general these will take in comet ephemerides and then allow you to choose the best time to see the comet.

There are four common pieces of software in use here.

Eye and Telescope 3.2

<https://www.softpedia.com/get/Science-CAD/Eye-Telescope.shtml>

DeepSky

<http://www.mikehotka.com/DAS/whatis.htm>

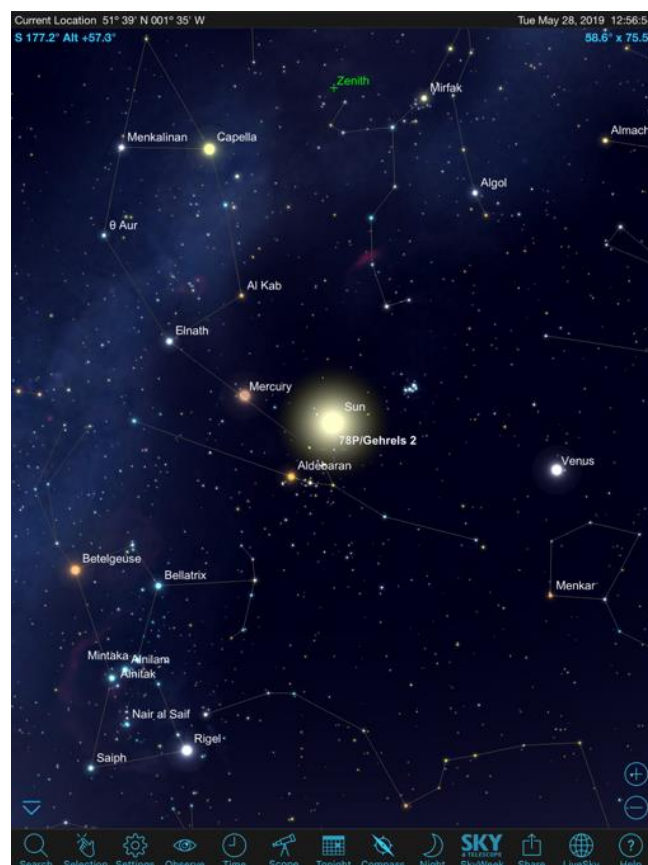
Skytools 4 <https://www.skyhound.com/>

AstroPlanner <https://astroplanner.net/>

Deep Space Planner 7

<https://knightware.biz/dsp/preview.php>

Eye and Telescope 3.2 does not import any form of comet data and is pretty much unsupported now anyway.

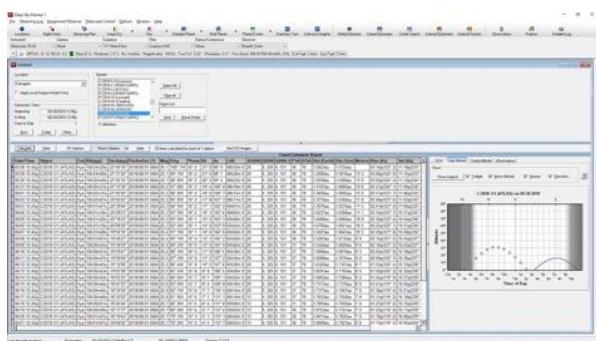


DeepSky, was a very useful piece of software but is becoming out of date and the developer has retired. After the MPC changes to the URL's it can no longer import comet data and there is no way to import either a file or add the data manually so it is probably no longer of much use. There are some very complicated hacks to try and let it load data but these are probably beyond most users.

The three pieces of software that do still work are Skytools 3 (Skytools 4 Imaging), AstroPlanner and Deep Space Planner 7. All of these programs allow you to automatically download the comet (and other solar system minor body data) from the MPC but they also allow you to add the data manually or from a file.



Deep Sky Planner 7



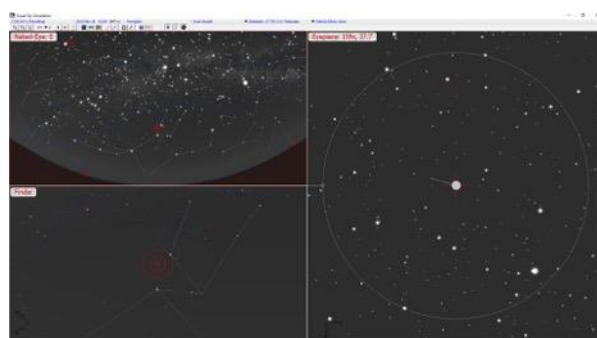
This software is based around planning but does not have its own star charting resources so it relies on external charting software to display the location of the comet. Unfortunately this is one of its major weaknesses as the software it integrates with is not the best. You can search for comets in constellations, get ephemerides for them, plot the current location on a chart. It does not have the functionality to generate a comet track and takes the raw elements from MPC so comet magnitudes may be off. You do have the option however to modify the H and G parameters yourself if you wish. There will be a mobile edition of this software, probably in Q2 2019.

AstroPlanner 2.3

This is probably the most restricted of the planning software in terms of what it can do with comets. It will load data from the MPC or from a file and display information about the comet. It does not display comet tracks or calculate ephemerides for a comet. It basically just shows the location of the comet at a given time. It does have the advantage of running natively on both Windows and Apple Macs. It can be used to create FOV charts and will include the UCAC4 catalogue for fainter stars, assuming you have a copy of UCAC4. The

software has been in a two-year alpha cycle so when 2.3 comes out is not really known

Skytools 3



As of early 2019 there is no visual version of Skytools 4. There is an imaging version which allows you to determine the best imaging parameters for a comet but does not have the tools to plot ephemerids or comet tracks so I will concentrate here on Skytools 3 for this. One assumes that a visual version of SkyTools 4 will come out at some time but as it has been promised for two years and it is not clear if or when it may appear. SkyTools 3 is probably the most advanced of the programs in this genre. It allows you to autoload comets from MPC as well as add the data manually from file or by widget. Once the data is in you can calculate ephemerides, show comet tracks and workout the best time to view a comet. You can also filter what comets are likely to be visible with your equipment, observing conditions and observing time availability. The author also provides a current comet list every month which can be downloaded and will show what comets are visible. You can plot fields of view, load the data into an Argo Navis for the comets of interest. It will try to determine whether a comet will be visible in a given instrument at a given time and shows 3 pane charts (for a telescope) including naked eye, finder and eyepiece

view for a comet. The main difference with this software is that the author tries to modify the H and G values to accurately model the magnitude based on reports from observers. Whether this is right or not may depend on the believability of the sources of these reports. This is probably the most advanced program for working with comets out there.

Digital telescope computers

There are two of these out there, that I am aware, of that support loading comet elements rather than just a single position. These are the Argo Navis (<http://www.wildcard-innovations.com.au/>) from Wildcard Innovations and the NexusDSC (<http://www.astrodevices.com/>) from AstroDevices, both Australian firms. These devices are most likely to be used on Dobsonian or other Alt-Az mounts, although they can be used on equatorial mounts as well.

Argo Navis

The Argo Navis can load up to 9 sets of comet elements and it will then compute the positions on the fly for the current time. Loading the elements can be done either by its own loading facility or through external software that talks to it via a serial cable. The internal software has had some issues with its position calculations and certain

comets have not been in the right positions (early 2019). Hopefully this will be fixed at some point. Once loaded you can scroll through the comets and choose which one you want to observe and then just move the telescope until the pointers read 0.

NexusDSC

The Nexus DSC is slightly different as it takes the SoftComet0.txt file directly from the MPC and you put that file on a microSD card and put that in the device. It can then calculate any comet position from that file. Of course, you may want to edit the file down before you load it or there will be a lot of comets to skip through before you find the one you want. The basic operation then is the same as the Argo Navis in that you move the telescope until the pointers show 0.



Owen Brazell

6 Pro-Am Astrophotography of Comets - José Joaquín Chambó Bris

I first became interested in Astronomy in the early 80's, when I was about 15 years old and I think it was the famous Cosmos series by Carl Sagan that seduced several friends and myself to become absorbed into this fascinating subject. We founded a small amateur society in the town of Algemesí, a few kilometres south of the province of Valencia. The association still exists today, it is called 'Grup Astronomic Valencià'. a small group of amateurs. Our aims are the dissemination of astronomy, giving lectures and sharing observations with secondary schools and the general public. We have a clubhouse at 1,000 metres altitude in the mountains of the Sierra de Enguera, where we usually climb monthly to observe. Our website is <http://astronoms.org/>



*The Author observing in the Sierra Enquera.
Telescope GSO 8 F4 Camera Atik 383L+*

A short time later Halley's Comet made its last appearance, and between 1985 and 1986 I was observing it with a pair of 10x50 binoculars, the only instrument I had at that time. I began to learn about comets, which seemed to me very exciting objects.

During the following years I continued to visually observe other fainter comets, with binoculars and with a Meade 8 "SCT that we had purchased via our society. It was between 1996 and 1997 with the arrival of the comets Hyakutake and then Hale-Bopp when I started taking my first photographs. Of course, then it was with chemical film and comparatively rudimentary means.

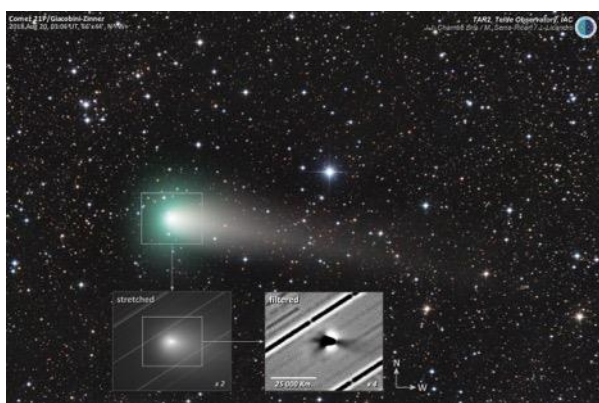
After some trials and tribulations in my penchant for astronomy in 2006 I finally bought my first digital DSLR camera and began to obtain images through a telescope. That's when I also decided to devote myself more seriously to comets.

I launched my website "cometografia.es" offering regularly updated information on observable comets, whilst I was still learning how to obtain better photographs of comets and how to optimise their collection and processing.

In 2013 I started using remote telescopes, renting through the Internet, which allowed me to obtain higher quality photographs that I could not get with my own equipment. The improvement in my processing techniques and the quality of the data obtained through remote telescopes began to bear fruit over the years, and my images of comets began to be recognised and to be published in

astronomical journals, and several of them appearing as Astronomy Picture of the Day of the NASA website. In addition, I was a finalist in the 2016 and 2017 editions of the Astrophotographer of the Year contest held at the National Maritime Museum, Greenwich Observatory. I was very pleased.

In 2017 during the Asteroid Day conferences at the Castellón Planetarium I met Miquel Serra, administrator of the Teide Observatory (Institute of Astrophysics of the Canary Islands). He is a very experienced astronomer and he invited me to collaborate with the Observatory in projects related to comets. Since then I have travelled several times to the Teide Observatory and participated in the imaging of comets.



Two images of Comet 21P/Giacobini-Zinner on August 20th 2018, one taken with the Telescope in Teide Observatory and the other with my own equipment from Hoya Redonda, combining the data. The image shows not just the comet's appearance, but also to register internal coma structures using gradient filters. The graphical image shows the internal coma enlarged and filtered (inverted monochrome) revealing the presence of four jets emerging from nucleus.

I have been processing the images of several comets obtained from one of the telescopes at the observatory for the group of solar system research, such as the C / 2016 R2 (PANSTARRS), 21P / Giacobini-

Zinner, 29P / Schwassmann-Wachmann and recently the asteroid 6478 Gault. This group is especially interested in monitoring phenomena such as jets, to determine the rotation period of the cometary nucleus. The data with which we work is usually made up of hundreds of images obtained during a single night of the same object, which then have to be calibrated, stacked and processed. I use PixInsight software that makes batch work much easier. I take this opportunity to say that this magnificent and well-known software has been developed at the University of Valencia, which is an honour as Valencian.

Apart from this type of more scientific images, I have also made some more artistic compositions of these comets, which serve as dissemination and promotion of the work that is done in the Teide Observatory, very important for the institution.



Inside the control room at Teide Observatory

Currently I am developing a project to make a systematic record of the morphological evolution of the next bright comets using observatory telescopes, and I am optimistic that it will be launched later this year. In addition to continuing with

the collaboration Pro-Am with the Teide Observatory, I will continue taking pictures with remote telescopes, with my own equipment, and to keep my website about comets up to date. In between I fit in family and my career - I think I have a lot of work ahead.



José Joaquín Chambó Bris

Comet Observers of the Past – Histories Contributions and Achievements

Director's Note - This section introduces historical perspectives on comet discoveries, their role in general society and in politics. I hope you enjoy it and also feel free to contribute.

7 Elizabeth Roemer: A Consummate Comet Observer

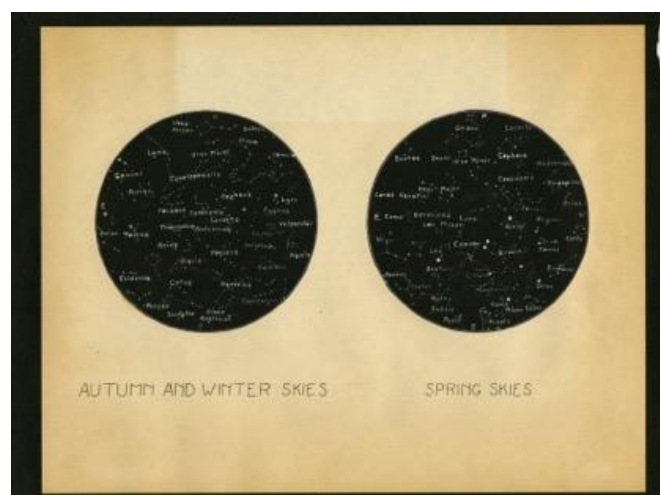


Elizabeth 'Pat' Roemer at her desk at USNO Flagstaff 1963

In the mid-20th Century arguably one of the most prolific and consistent comet observers was the astronomer Elizabeth (Pat) Roemer who worked mainly at the United States Naval Observatory's Flagstaff Arizona Station. During her career she recovered 79 periodic comets on their return to perihelion using long exposure emulsion photography. She also monitored the changing aspect of many of the active long period comets visible during that time. Her reports and publications were regular and timely. She gave monthly reports on the appearance of comets for many years in

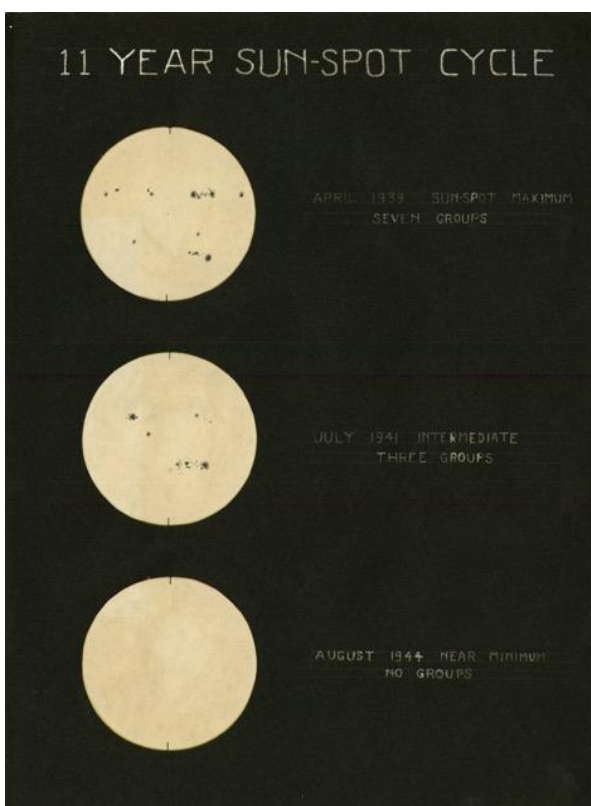
her "Comet Notes" in the Journal of The Astronomical Society of the Pacific. Her accomplishments led to wide recognition in the astronomical and scientific community and she was awarded many prizes and honours.

She was born in Oakland California USA on September 4 1929 and was raised in Alameda, California where she was a valedictorian of her 1946 high school class, and a winner of that year's national Westinghouse Science Talent Search.



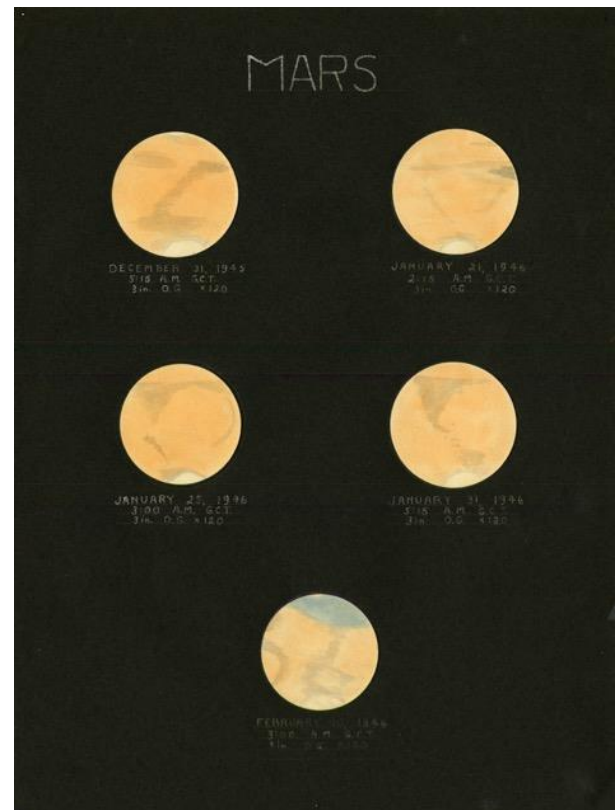
High School project: Winner of Westinghouse prize in 1946

The project for which she gained that accolade was entitled "Exploring the Skies from a City Backyard". She was then 16 years old. Clearly, she was already a serious amateur astronomer by then. This was evident from her drawings of the sun and planets made with a 3 inch refracting telescope. Her drawings of sunspots show observations made in 1939 when she was only 10 years of age.



Sunspot drawings over a 5 year period 1

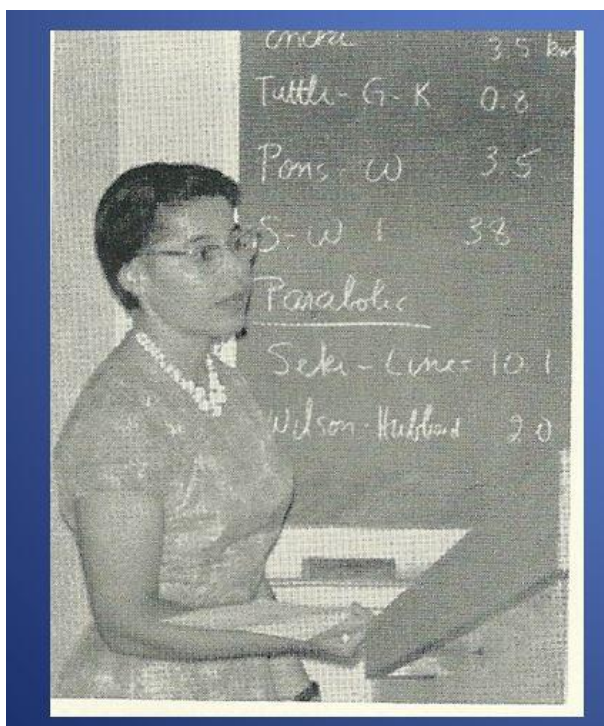
Her dedication is also evidenced when we see the observations of Mars she made, showing delicate features. These were done in the early hours (03:00) during the winter months of 1945/46. In a later interview she recalled her introduction to astronomy,



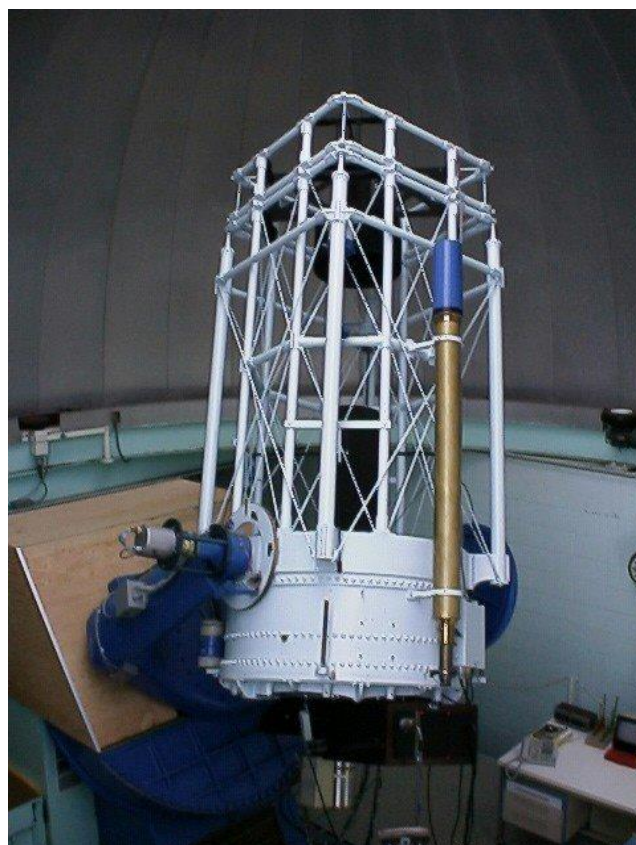
Mars drawings made in 1946

'It came about when I was a freshman in high school during the years of the Second World War, when many people were teaching on emergency credentials and were not properly qualified teachers. A general science teacher made a number of statements that had astronomical implications. One involved a map of the tilt of the Earth's axis and how the seasons came about, and one involved the statement that Polaris was the largest star. I can't tell how, but even at that stage I knew enough to know that what we were being told was not so. But I didn't know what the right answers were. I was encouraged that if I didn't find things in books - you don't find what is the largest star - then to look elsewhere. I was in touch with one of the teaching assistants in the Astronomy Department at Berkeley who helped me get information, and that led to interest in other aspects of astronomy'.

Her high school days over, she graduated from the University of California, Berkeley in 1950 with a B.A. in astronomy as a Bertha Dolbeer Scholar. Her passion for teaching blossomed during her graduate studies at Berkeley. She taught adult extension classes in Oakland to help finance her own tuition fees.

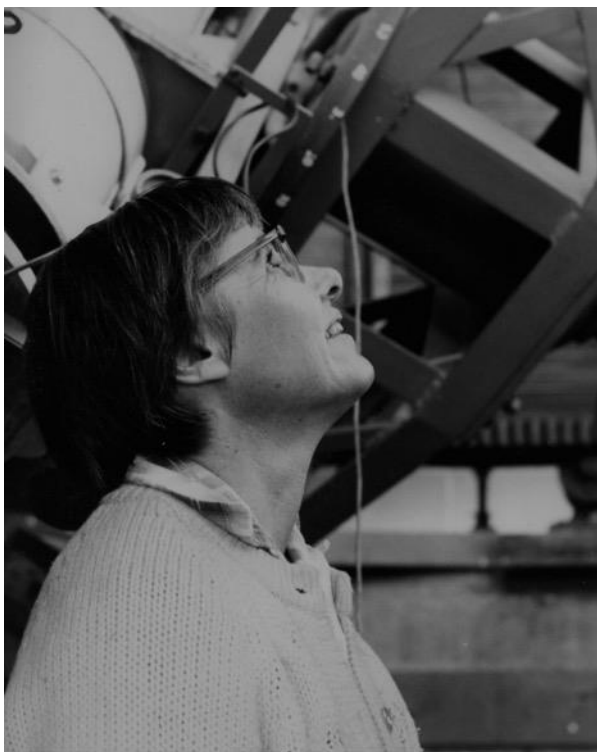


Her academic path led her to work at Lick Observatory on Mount Hamilton, The Yerkes Observatory at Chicago, The McDonald Observatory in Texas, and the USNO at Flagstaff in Arizona. Her PhD theses concerned the spectroscopic binary star Polaris. She had working contact with Professor George Van Biesbroeck at Yerkes and McDonald Observatory. He was a prolific observer of spectroscopic and visual binary stars. He was also the leading comet observer in the USA from the 1920s-1960's and no doubt influenced Pat Roemer in her observational choices.



USNO 40 inch Astrometric f/8 reflector

In 1957 she began her comet observing career in earnest at the USNO at Flagstaff using the recently installed 40 inch astrometric reflecting telescope for the systematic recovery of faint periodic comets. This telescope was particularly suited to the task of wide-field long exposure photography, having been constructed to the Ritchey-Chretien design by Ritchey himself. She became the world leader in this field working mainly on her own, and occasionally with student assistants. One of her summer students was Brian Marsden (later the Director of the Minor Planet Centre at Harvard). A recent letter to this writer from Brian Skiff at Lowell Observatory revealed,



Roemer with the 40 inch at USNO Flagstaff

'I think she did all the observing, certainly before she got to Tucson, when occasional student helpers were involved. At least one of the summers (maybe two?) in the early 1960s at USNO-Flagstaff she did have a student --- that young whipper-snapper Brian Marsden! She also obviously did all the preparatory work calculating orbits and ephemerides and lines-of-variation for objects that needed to be recovered along some uncertainty-track, did the reductions of the (then) faint 'Astrographic Catalogue' stars to get RA/Dec of reference stars for astrometry in small telescopic fields, made the measurements by hand on x,y travelling microscopes, did all the reductions, and calculated new orbits to check the residuals etc. Many of the plates are tracked along the ephemeris, so she must have had some way to do the guiding to accomplish that (and calculated the motion at least approximately ahead of time).'

A quotation from an interview with Brian Marsden read, 'As Van B was finishing up, Pat Roemer was the new generation of comet observers at that time. She was the leading comet observer in the 1960s, from the much of the '50s and into the '60s'.

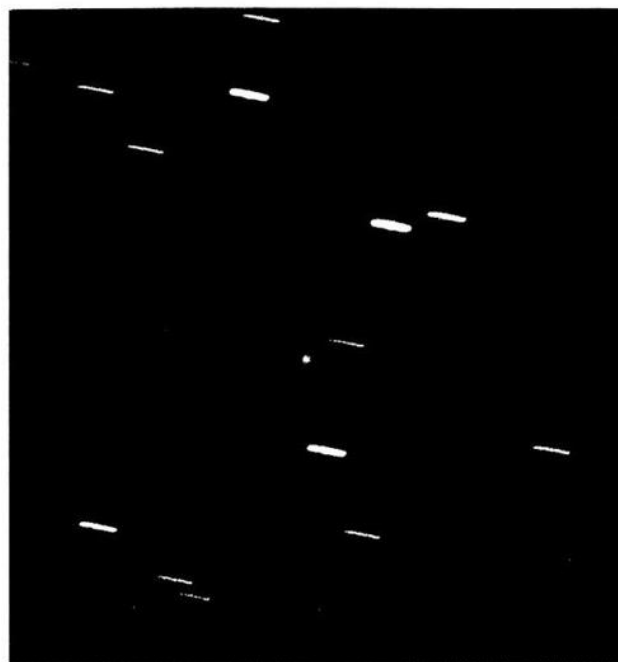
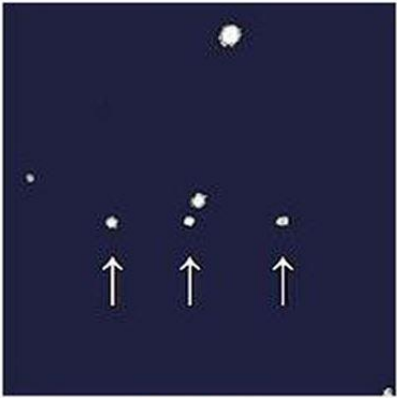


PLATE I
A 23-minute exposure of P/d'Arrest, 1970 d, taken on a Kodak 103a-O plate with the 229-cm reflector of the Steward Observatory on Kitt Peak on May 7, 1970. The photographic magnitude of the nuclear condensation was about 17.9.

The programme of recovery of periodic comets was very successful and a total of 79 comets were recovered by her. The astrometry and photometry of these comets led to a greater understanding of the dynamics of the solar system and the physical characteristics of comets. Thousands of photographic plates were exposed during this programme, and as a by-product other solar system objects were found. The minor planets 1930 Lucifer in 1964, and 1983 Bok in 1975 were discovered by her.

Themisto



Discovery	
Discovered by	Charles Kowal (1975) Elizabeth Roemer (1975) Scott S. Sheppard (2000) David C. Jewitt (2000) Yanga R. Fernández (2000) Eugene A. Magnier (2000)
Discovery date	September 30, 1975 November 21, 2000

A major find came in 1975 when Themisto, a moon of Jupiter, was discovered on Sept. 30, 1975 by Charles Thomas Kowal and Elizabeth Roemer when they were using the 48 inch Schmidt Telescope on Palomar.

By 1965 she was Acting Director at USNO Flagstaff Station and at this time a minor planet discovered in 1961 by Paul Wild was named in her honour, 1657 Roemera.

PUBLICATIONS OF THE
ASTRONOMICAL SOCIETY OF THE PACIFIC

Vol. 74 October 1962 No. 440

ACTIVITY IN COMETS AT LARGE
HELIOCENTRIC DISTANCE*

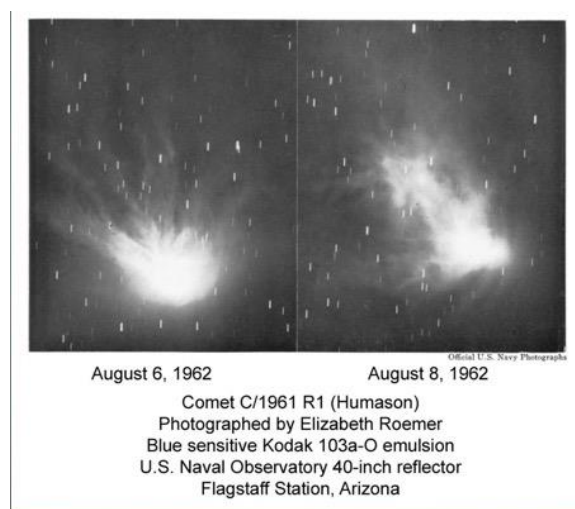
ELIZABETH ROEMER

U.S. Naval Observatory
Flagstaff Station

Almost all that we know of the physical characteristics of comets has been learned from observing objects of moderately small perihelion distance. By far the greatest number of the objects represented in the catalogs of comets and comet orbits were discovered when they were relatively bright and therefore moderately close to the sun and to the earth. Details of structure in the head and tail can be studied only in the brighter comets. An

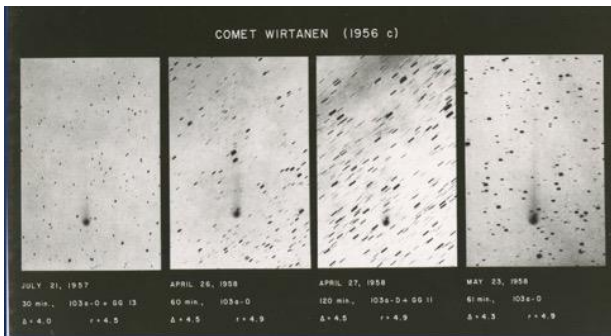
For many years she wrote and published, on a monthly basis, "Comet Notes" in the Journal of the Astronomical Society of the Pacific. These notes were a review of all the comets discovered and recovered during that month as well as comments on the current status of the comets that were being observed by astronomers across the world. This was an invaluable resource for comet observers and researchers.

She published many scientific papers in the leading journals and contributed to conferences and colloquia over many years. An example being her 1962 paper entitled "Activity in Comets at Large Heliocentric Distance" in Vol 74 PASP.

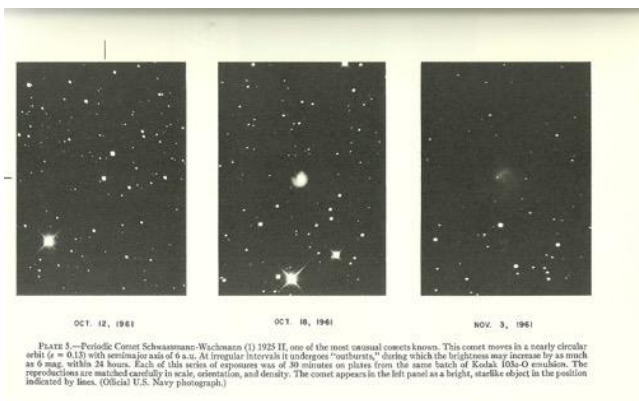


Her review chapters "The Cometary nucleus and its Dimensions" in the report on the 1965 conference in Belgium on the Nature and Origin of Comets benefitted from her examination and measurements of thousands of the USNO plates. Similarly her review chapter "Comets: Discovery, Orbits, Astrometric Observations" in the 1963 University of Chicago publication The Moon Meteorites and Comets Volume 4 of The Solar System series was both insightful and authoritative.

Some of her early studies followed the outbursts and evolution of the very active comet C/1961 R1 Humason, and in 1958 the splitting of a newly discovered short periodic comet 46P Wirtanen.



She also paid particular attention to outbursts of another active short period comet 29P/Schwassmann-Wachmann in 1961. These studies were reported in the papers and review chapters she wrote.



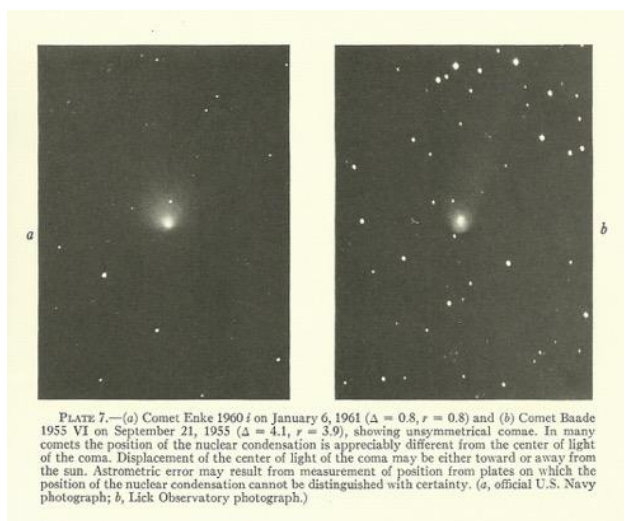
She was employed by the University of Arizona in Tucson as an associate professor in the Lunar and Planetary Laboratory in 1966 and was promoted to a full professorship in 1969. In 1972 she headed the committee which set up the University of Arizona's Department of Planetary Sciences. Beginning in 1980, while remaining a UA professor, Pat served as an astronomer at Tucson's Steward Observatory. She retired in 1998, but continued her research on comets and asteroids.



PLATE 3.—Comet Mrkos 1957 V. Bright at the time of discovery on August 2, 1957, this comet was widely observed for a number of weeks during August and early September, 1957.

Brian Skiff at Lowell Observatory commented, *'Some years before she died we acquired the few thousand (mostly 4x5-inch) plates taken at USNO. Most of the comet plates in this collection are minimal exposures done for astrometry. So many do not look like there's a comet on them, since only the pseudo-nucleus appropriate for astrometry is present. There is also a drawer labelled "comets for appearance" that has long tracked exposures of, for instance, the numerous outbursts of Comet S-W1 (or Comet Humason), another famous one from those days). Then we collected about another four thousand 8x10-inch plates in Tucson. Pat was an excellent record-keeper, indeed a pack-rat, so we acquired a lot of paper results from the measurement and reduction of plates (line-printer printouts), more printouts of the actual software code used for the reductions,*

beautifully kept telescope logbooks and ledgers, and more'.



Elizabeth Roemer will be remembered as the most prolific and influential comet observer of the mid-20th Century. Her observations were made using the difficult medium of long exposure photography, the techniques of which she successfully mastered. Her reputation gained her access to telescope time on the largest astronomical instruments in the USA and the records of her comet observations are preserved at Lowell for future researchers and historians to study. She was a popular figure and was respected by all who worked with her and knew her. She dedicated her life to the study of comets. Her accomplishments were unique for a female astronomer in that era. The only surprise is that she never discovered a comet herself despite exposing thousands of hours of photographic plates to the excellent Arizona skies that she loved.

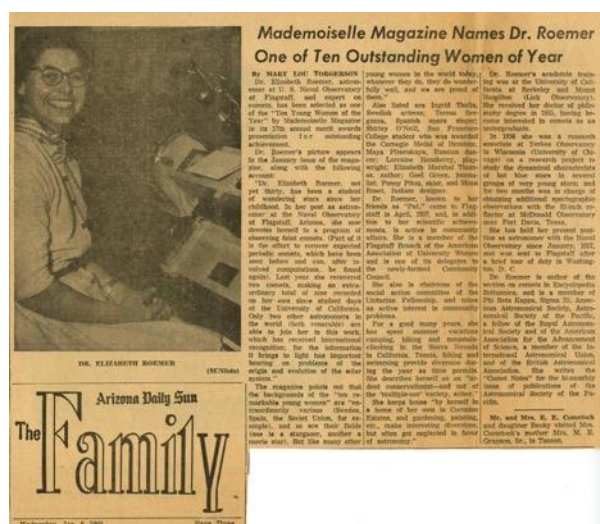


Elizabeth Roemer at her retirement in 1998

She died in April 2016 and left a bequest to The Lowell Observatory Foundation for the creation of a fund to support the maintenance of the instruments at Lowell Observatory. Besides her work, Pat also was passionate about the environment and was a generous supporter of many conservation organisations. She was an intrepid hiker and camper and enjoyed bird-watching. Pat liked to travel and document her adventures via her love of photography. She was an avid stamp collector and has left her collection to the Tucson Postal History Foundation.

Her achievements resulted in many prizes and honours in the astronomical community. Even in the wider world her achievements were acknowledged. For example, in 1959 she was listed in *Mademoiselle Magazine* as one of the 10 outstanding women of the year and also that year the Science Clubs of America recommended that a New York newspaper

(The World Telegram and Sun) should include an article about her work under the title "Opportunities for Women in Science".



In terms of academic posts, honours and prizes there were many. A list in an obituary reads thus,

'Pat Roemer was an exemplary member of the astronomy community and served on many astronomical commissions and organisations, including stints as president and vice president of the International Astronomical Union's Commission 6 and vice president of its Commission 20. She also served as chairman of the American Astronomical Society's Division on Dynamical Astronomy. In addition to her leadership in the field, she received numerous awards for her ground-breaking work; among those were the BA Gould Prize of the National Academy of Sciences, the NASA Special Award, and the Donohoe Lectureship of the Astronomical Society of the Pacific. Her achievements reflected her passion and love for astronomy.

In this article I have relied heavily on four sources:

The Lowell Observatory Archives with the kind permission of Lauren Amundson the Archivist

An obituary written by Craig H Wisnom, Attorney, Bogutz and Gordon PC, Tucson, USA. In A&G • October 2016 • Vol. 57 • aandg.org

<https://www.legacy.com/obituaries/Tucson/obituary.aspx?page=lifestory&pid=180702223>

A personal communication from Brian Skiff astronomer at Lowell Observatory Flagstaff Arizona

Elizabeth Roemer's CV

Education: Bachelor with honours, University California, Berkeley, 1950. Doctor of Philosophy (Lick Observatory fellow), University California, Berkeley, 1955.

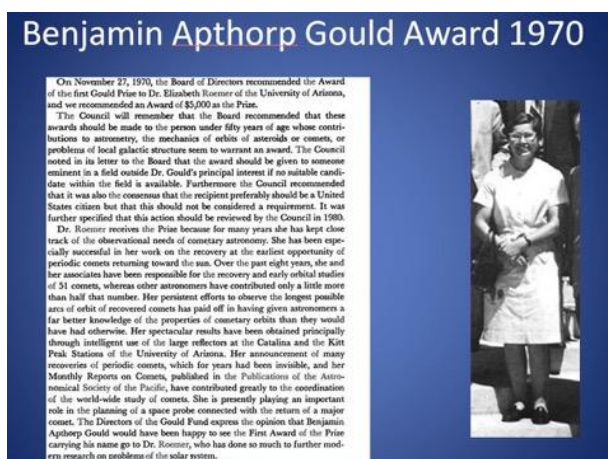
Career Teacher: adult class Oakland public schools, 1950-1952. Lab technician, University California at Mount Hamilton, 1954-1955.

Graduate research astronomer University California at Berkeley, 1955-1956.

Research associate Yerkes Observatory University Chicago, 1956. Astronomer United States Naval Observatory, Flagstaff, Arizona, 1957-1966. Associate Professor in the Department of Astronomy She was also in The Lunar and Planetary Laboratory University Arizona, Tucson, 1966-1969, becoming Professor in 1969-1997. She was then Professor emerita there from 1997. She was astronomer at Steward Observatory, 1980-1997, becoming astronomer emerita until 1997.

She was the chairman of the working group on orbits and ephemerides of comets in commission 20 of The International Astronomical Union in 1964-1979, 85-88 and vice president communications commission 20 IAU and in 1979-1982 she was president in 1982-1985. She was vice president of commission 6, 1973-1976, 85-88, and president, 1976-1979, 88-91.

She was on the Advisory panels of The Office Naval Research, The National Academy of Sciences-National Research Council and The National Aeronautics and Space Administration.



Achievements: Her achievements include research in astrometry and astrophysics of comets and minor planets including 79 recoveries of returning periodic comets, visual and spectroscopic binary stars, computation of orbits of comets and minor planets.

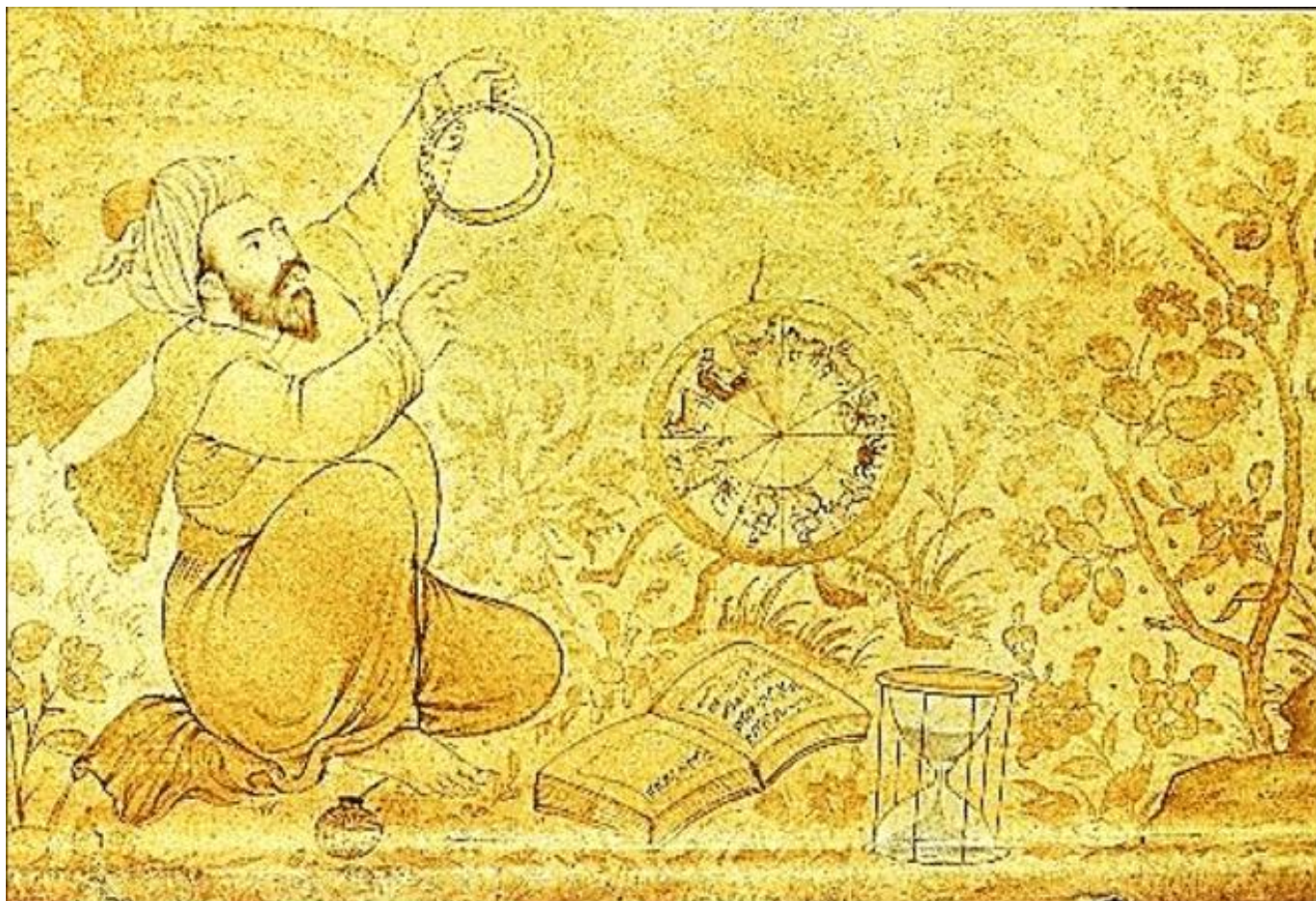
Membership: Fellow American Association for the Advancement of Science (council 1966-1969, 72-73), Royal Astronomical Society (London). Member American Astronomical Society (program visiting professors' astronomy 1960-1975, council 1967-1970, chairman division dynamical astronomy 1974), Astronomical Society Pacific (publications committee 1962-1973, Comet medal committee 1968-1974, Donohoe lecturer 1962), International Astronomical Union, American Geophysical Union, British Astronomical Association, Phi Beta Kappa, Sigma Xi.

Recipient Dorothea Klumpke Roberts prize University California, Berkeley, 1950, Mademoiselle Merit award, 1959. Asteroid (1657) named Roemera, 1965. Benjamin Apthorp Gould prize National Academy of Sciences, 1971, National Aeronautics and Space Administration Special award, 1986.



Denis Buczynski Secretary Comet Section

8 Historical Cometary Observations in India: Part 2 - Mughal Empire 16th and 17th Century -- Amar A Sharma



An astrologer/astronomer and his equipment – drawing from the folio of Jahangir's Album

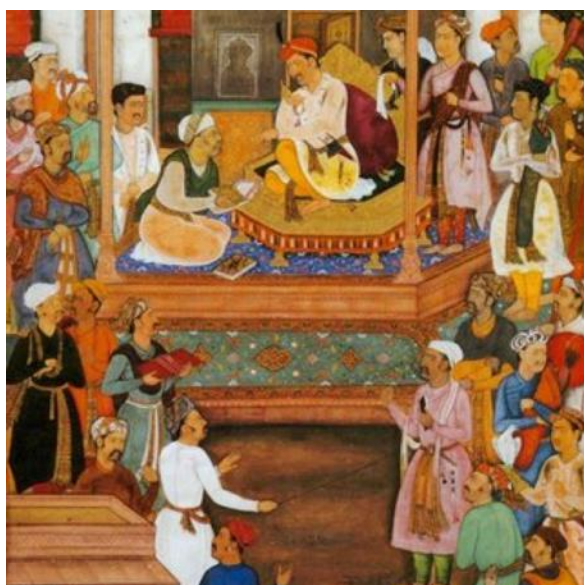
The ancient astronomical history of India was dominated by computational astronomy of indigenous mathematicians and astronomers. There was a period of relative inactivity on the cometary front till the mid-2nd millennium – except for sporadic records of visual observations of then unknown entities we know as comets.

However, there was a brief revival of cometary astronomy on the Indian landscape under the Mughal Empire in the 16th and 17th century. Some of the Mughal Emperors were interested in astronomy and built measuring instruments for cometary astronomy.



Akbar by Govardhan c 1630 (wikipedia)

Abu'l-Fath Jalal-ud-din Muhammad Akbar (1542–1605), also known as Akbar I or Akbar the Great, was the third Mughal emperor of India, and was of wise character and had many interests including astronomy. One of the Grand Viziers of the Mughal Emperor was Abu'l-Fazl ibn Mubarak, or Abu'l-Fazl, the author of the *Akbarnāmā* in Persian, the official history of Akbar's reign in three volumes, which includes vivid and detailed descriptions of his Emperor's life and times.



A miniature showing Abū'l Faḡl presenting the Akbarnāmā to Emperor Akbar – Courtesy of Ramesh Kapoor

The third and last volume is known as the *Ain-i-Akbari*. Abū'l Faḡl was not an astronomer, yet he writes in this volume on cosmogony and also writes about comets in some detail, citing a few past occurrences recorded elsewhere. The comet of 1264 (C/1264 N1) was described as being 'hairy' and those of 1402 (C/1402 D1) and 1433 (C/1433 R1) 'tailed'. He gives detailed descriptions of them, their angular positions from the Sun, the number of days over which they were seen, and the countries from which they were viewed.

In the same way that Aristotle describes in his book *Meteorologica* dating back to 330 BCE, the Islamic astronomers also describe comets and meteors as atmospheric, with dry and warm exhalations in the upper atmosphere that belonged to the sublunary sphere, rather than heavenly phenomena. Therefore they were mostly ignored. The commentary is prefaced by a description of the formation of vapour versus steam rising from the Earth by the heat caused by the rays of the Sun.

Abū'l Faḡl classifies comets, as 'tailed stars' into four categories:

those possessing locks of hair,

those with tails,

those resembling a lance in the hands of a person,

those resembling an animal

In the *Akbarnāmā*, Abū'l Faḡl quotes the views on comets expressed by Greek, Roman, Egyptian, Islamic & Hindu scholars, and the calamities associated with them. He also refers to Ptolemy, who said that comets presented an omen that was

The heir to Akbar, Nur-ud-din Muhammad Salim (1605–1627) also known by his imperial name Jahāngīr, was only eight years old when the prior-discussed Great Comet of 1577 (C/1577 V1) appeared, and he probably witnessed it. Like his emperor-father, he had certain interest in astronomy and maintained records in his journal *Tūzūk-i Jahāngīrī* and in the other memoir he wrote, *Wākī'āt -i Jahāngīrī*. In these memoirs we find descriptions of a few solar and lunar eclipses, of an iron meteorite fall, and of the appearance of the two Great Comets of 1618.



This painting, Walters manuscript leaf W W.705, depicts the Mughal ruler Jahangir (reigned 1014-1037 AH/AD 1605-1627), standing in three-quarter profile, a pose that was common in official Mughal portraiture. It is attributable to the 13th century AH/AD 19th. During that time, portraits of earlier Mughal rulers were copied and disseminated. This work is executed in opaque watercolour and gold. (Wikipedia Commons)

Jahāngīr took a journey from the States of Gujarat to Uttar Pradesh in the 13th year of his accession and he reports seeing three Great Comets grace the sky that year. 1618 I (C/1618 Q1) [August], 1618 III (C/1618 V1) [November], and 1618 II (C/1618 W1) [November]. After Halley's Comet of 1607, these were the first significant comets to appear and these were three apparitions in quick succession. 1618 I Comet holds the distinction of being the first recorded comet to be observed with a telescope.

Comet 1618 III was found by Jahāngīr's astronomers using astrolabes, and they measured an average of 24 degrees, the tail *"the shape of a spear, thin at two ends, and thick in the middle, a little curved like a reaping sickle, with its back towards the south, and its edge towards the north,"*. The comet was placed in Scorpio moving into Libra. The date for his first comet's sighting is traced as 10th November.

"Sixteen nights" after the first one of November, another with a *"shining nucleus with a tail about two or three yards long, but in the tail there was no light or splendour"*, was reported. *"It has now appeared for eight nights; when it disappears, the fact will be noticed, as well as the results of it."* The date for this comet's sighting is traced as 26th November. According to Yeomans (2007), its brightest magnitude was reached on 29 November at 0-1. Considering the dates of the accounts entered in his Memoirs, Jahāngīr turns out to be an independent discoverer of these two Great Comets of November 1618.

We can only guess the spectacle it must have been when both comets were visible

together in the same region of the sky. Both were dawn sightings. Elsewhere in the world, the tail of Comet 1618 I was reported to be 5° long, of Comet 1618 III 60° long, and that of Comet 1618 II an unusual 104° long.

Apart from Jahāngīr, there were many others who observed the November 1618 comets from India. In his travelogue "A Voyage to East India" that was originally published in 1655, the Reverend Edward Terry (1590–1660) recorded occurrence of the two comets of 1618, "*...two great blazing stars, the one of them north, the other south. One of these strange comets, in the north appeared like a long blazing torch, or launce fired at the upper end; the other, in the south, was round, like a pot boiling over fire...*".

1618 was the time when the telescope had just made its debut on Indian soil and that will then be the subject of my next article. Here we only looked at the pre-telescopic observations of comets during the Mughal India rule.

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Arma Sharma

9 Dr Reginald Lawson Waterfield: His Medals – Denis Buczynski



Reginald L Waterfield 1920 - 1980

Reggie Waterfield was one of the BAA Comet Section's most celebrated and internationally recognised members. He was an expert comet photographer and most of his work was done in the period 1920-1980. His particular area of expertise was photographic cometary astrometry. In this field he was a leader in the UK and was frequently the only astronomer who obtained positions for both newly- discovered and returning comets. He also made long photographic exposures specifically to study the development of comet tails. His most famous sets of images were those of Comets C/1956 R1 Arend-Roland, C/1957 P1 Mrkos and C/1969 Y1 Bennett. These

three comets were all naked- eye objects in the UK skies and as such created much interest in the media at the time.



1956r1_19570429_rwaterfield



1957p1_19570821_rwaterfield



comet bennett 1969r1_19700402_rwaterfield

Waterfield was the person to whom the media turned for information and images. His work on comets and other astronomical objects was recognised with medals from the Royal Astronomical Society, The British Astronomical Association and The Astronomical Society of the Pacific.

I was fortunate to have known and worked with Reggie Waterfield in the 1980's at his observatory near Yeovil in Somerset. At that time he was confined to a wheelchair having contracted polio in 1949. He remained very enthusiastic about comet observing and was assisted by friends and colleagues, he used his 6-inch Cooke refractor at every opportunity. When visiting his home in Somerset I often looked through his extensive library. Amongst the items there were three

medals which had been awarded to him by the Societies mentioned above.



The BAA Walter Goodacre Medal awarded to Reginald Waterfield in 1966

I did not see his medals again and after his death I occasionally wondered what had become of them. Then about 5 years ago I belatedly noticed one of them for sale on the Astrobuysell site. It was his BAA Walter Goodacre award (1966). It was too late for me to offer to buy it as it had already been sold. Luckily it had been purchased by a BAA member (Paul Stephens) with whom I was in communication. He kindly sent me pictures of the medal. The whereabouts of the other two medals are unknown.



RAS Hannah Jackson Gwilt awarded to Reginald Waterfield in 1942

These are 1942 RAS Hannah Jackson-Gwilt award and his 1969 Comet medal awarded by The Astronomical Society of the Pacific. It would be nice if these medals turned up and if anyone knows if they are still in existence then please let us know. I attach some pictures of the medals and some of the famous comets that were imaged by the great Reggie Waterfield.



Comet Medal of the Astronomical Society of the Pacific awarded to Reginald Waterfield in 1969

His BAA obituary written by Mike Hendrie who was his life-long friend and a BAA Comet Section Director can be found at :

<http://adsabs.harvard.edu/full/1987JBAA..97..211H>

or in print at:

Journal of the British Astronomical Association, vol.97, no.4, p.211-214



Denis Buczynski – Section Secretary

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Comet's Tale and Newsletter Editor	Janice McClean events@britastro.org

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MaximDL, Astrometria, FITS Liberator, Photoshop.
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COMET 38p



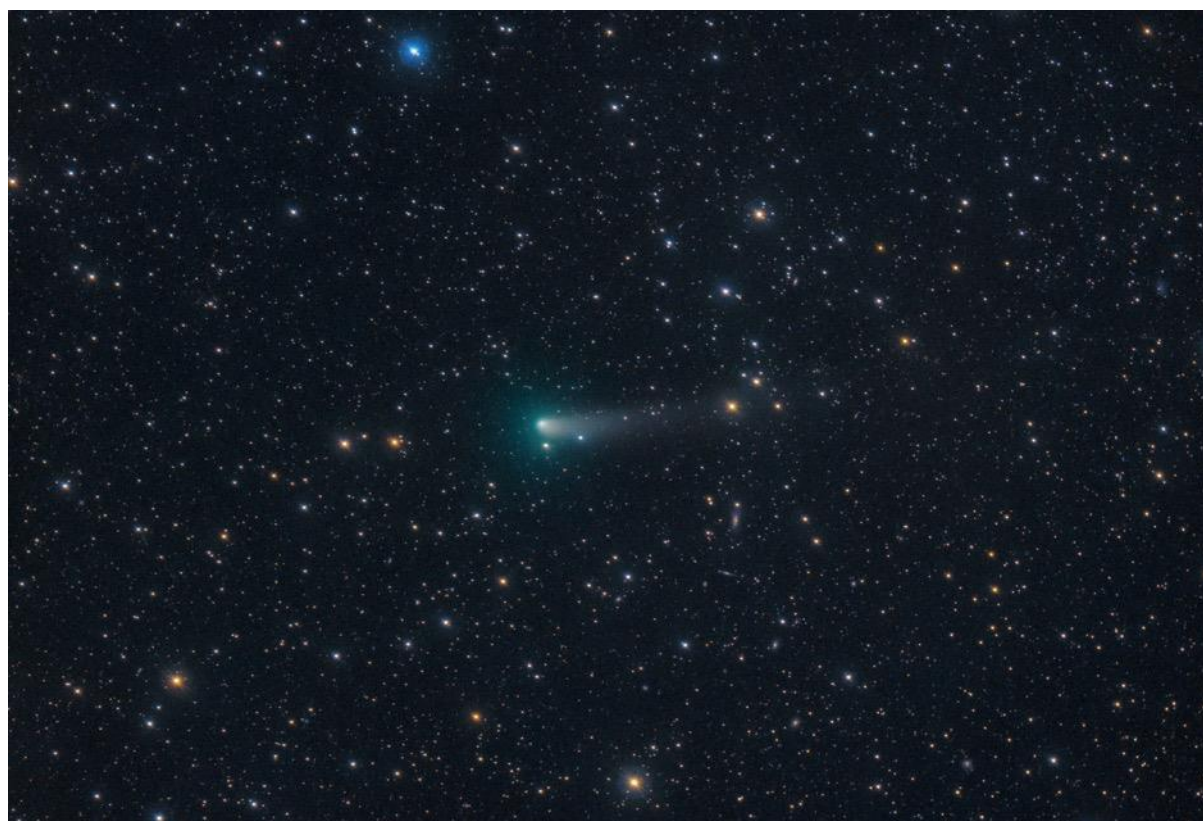
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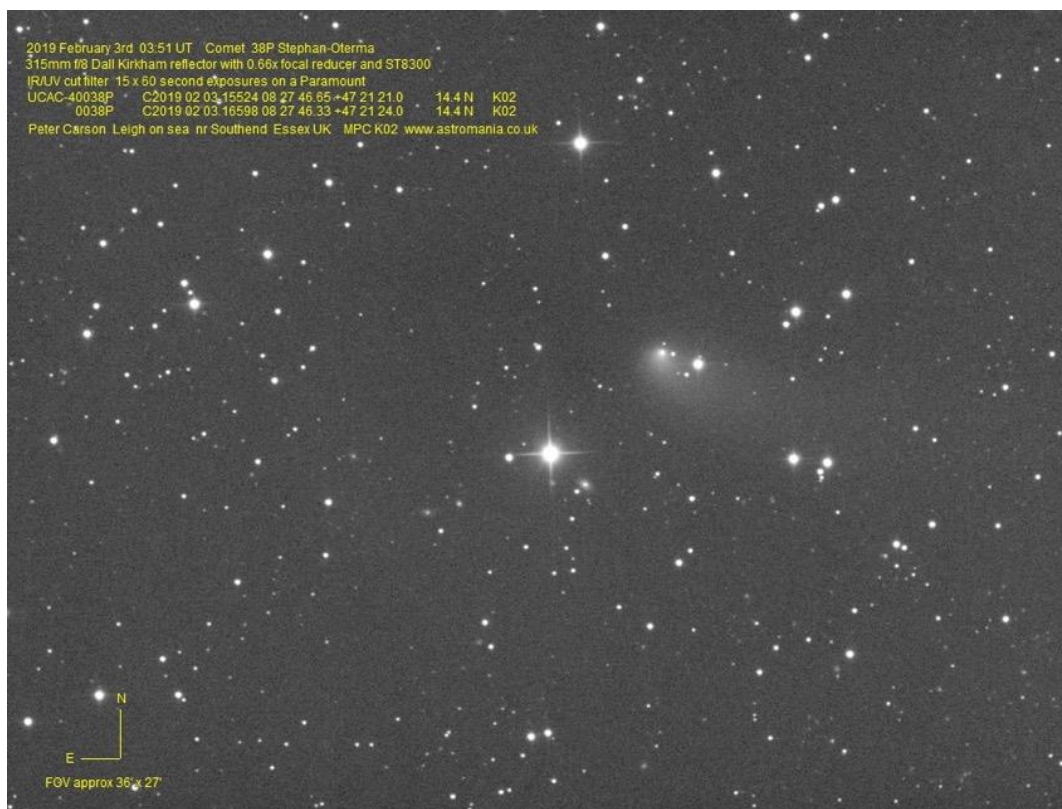
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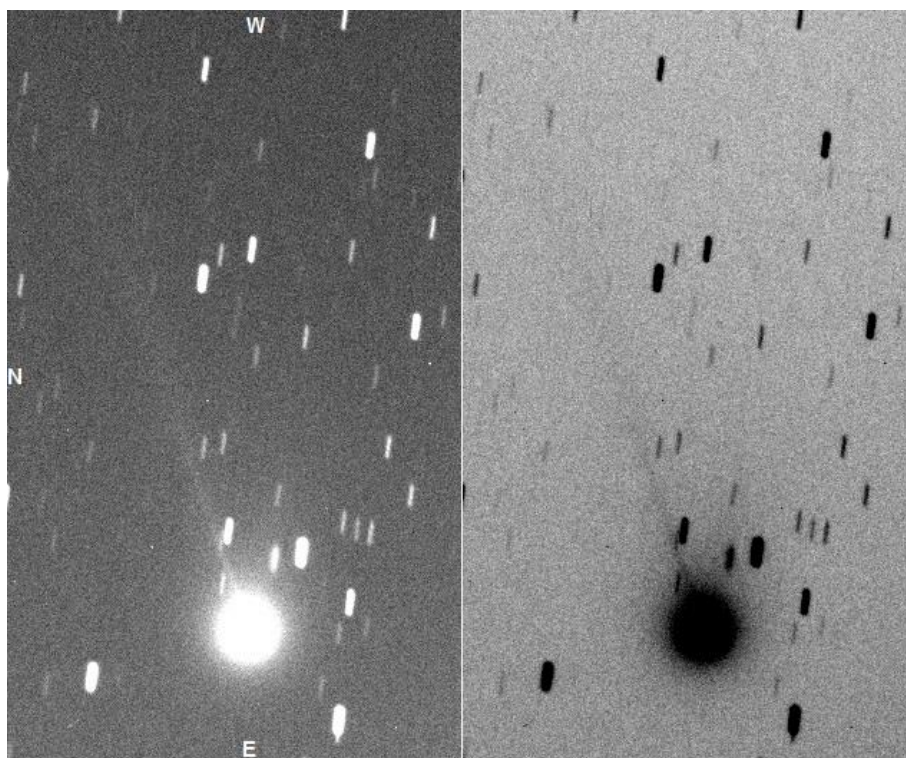
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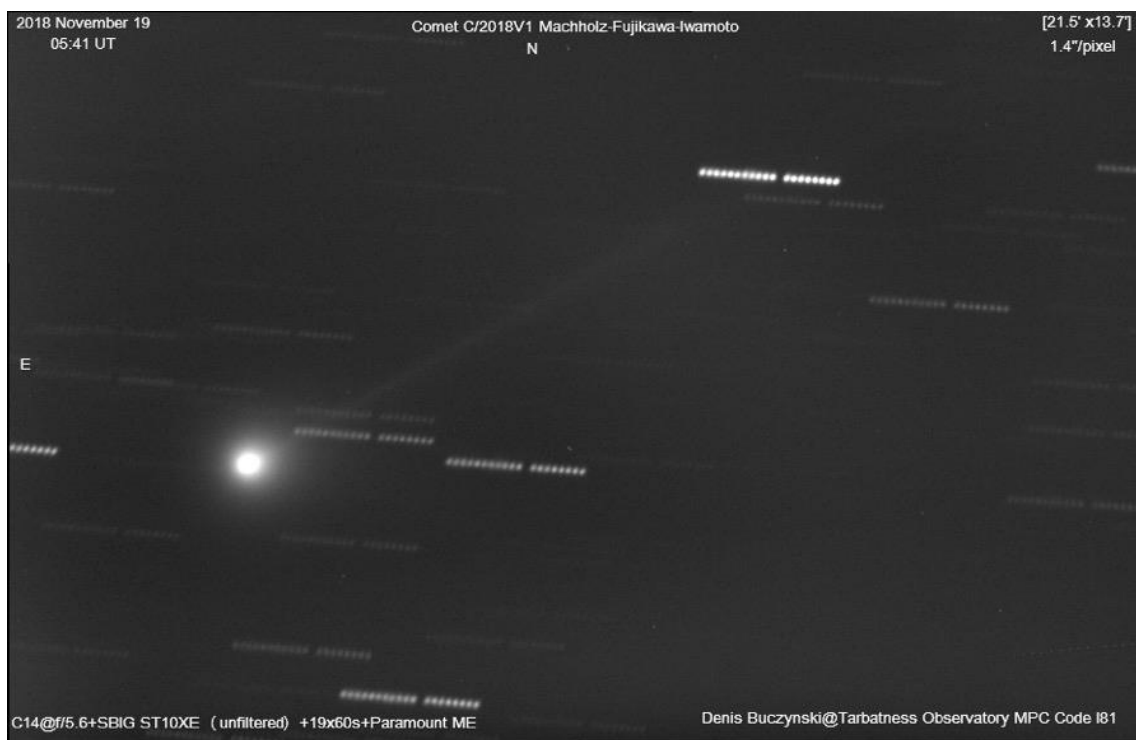


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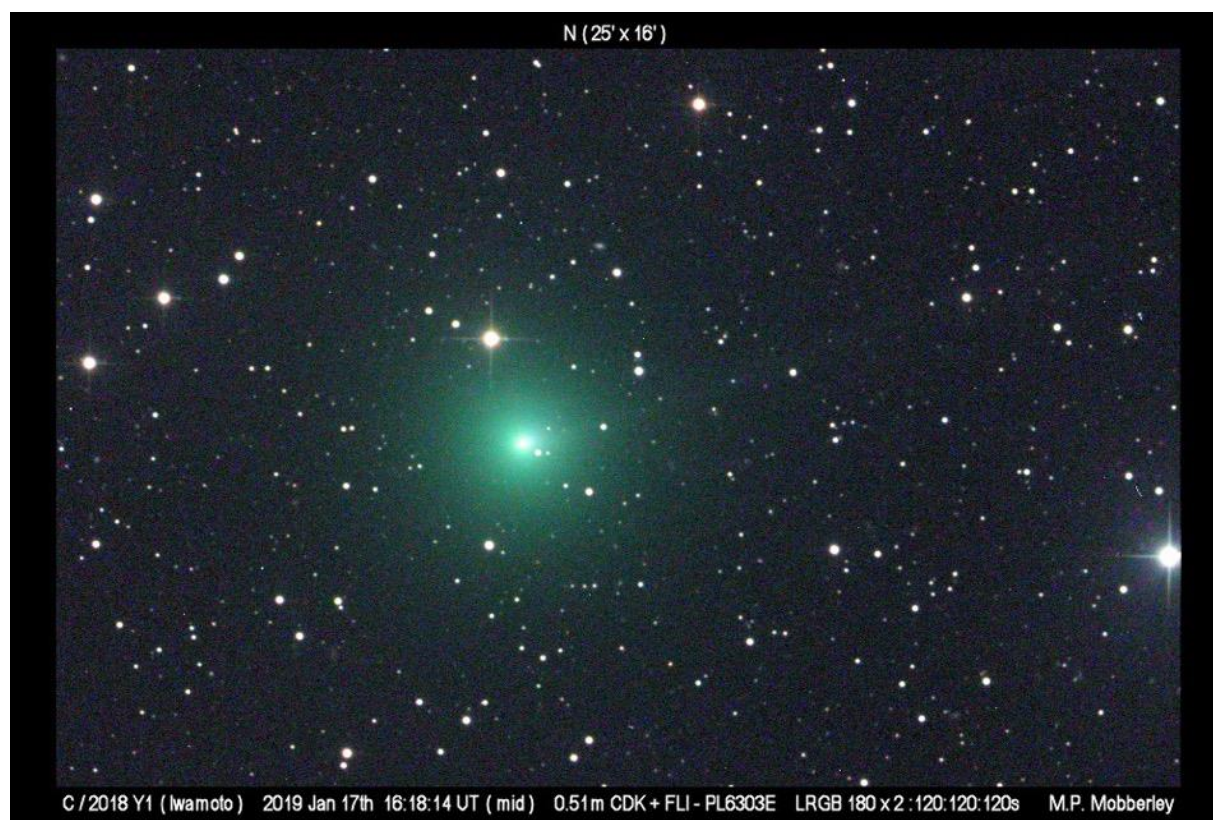
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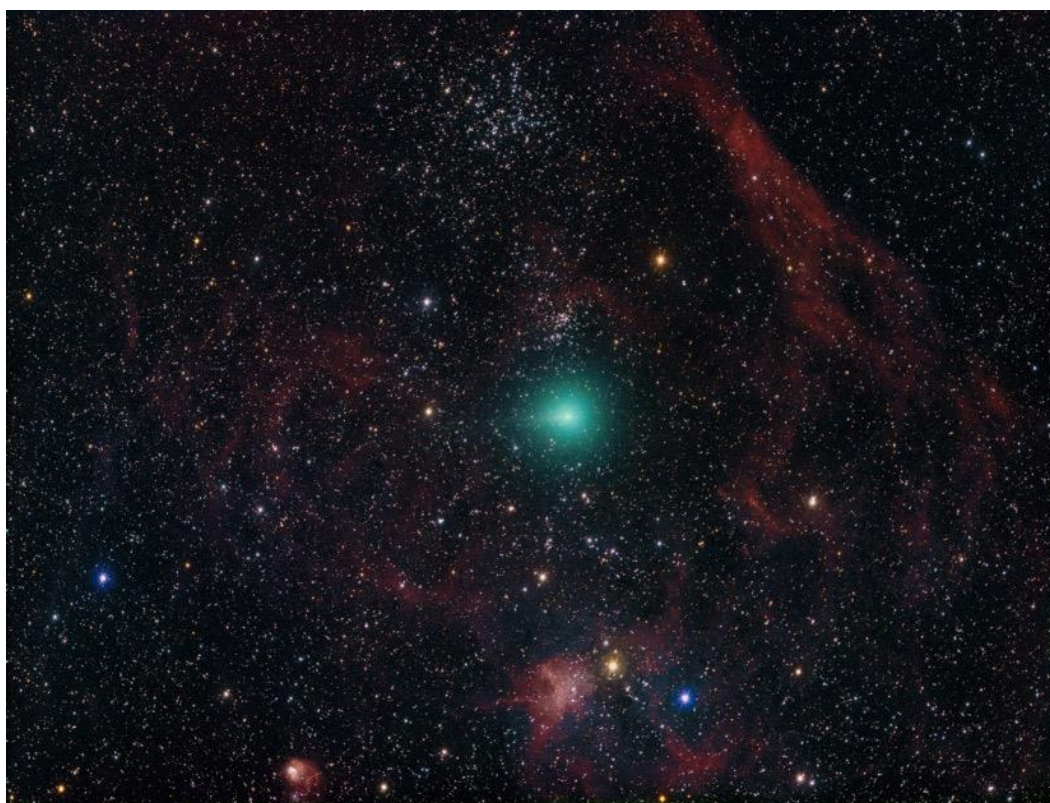
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