THE COMET'S TALE

THE NEWSLETTER OF THE BAA COMET SECTION

https://britastro.org/comet

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EDITORIAL

Nick James (ndj@nickdjames.com)

Welcome to this edition of the Comet's Tale. This is the first edition since 2023 and we have been lucky with several really impressive comets in the last couple of years. The front cover shows an image of C/2024 G3 (ATLAS) taken from Australia by Michael Mattiazzo on 2025 January 22. This sunskirter comet had a spectacular tail post-perihelion but the full spectacle was only visible from the southern hemisphere. I travelled to Tenerife to get the end of this tail from a northern hemisphere location and you can read about that trip on page 11. In fact, this comet disintegrated when it was near to the Sun and it became one of the "headless wonders" referred to by Denis Buczynski in his article starting on page 14.

A few months before C/2024 G3 came to perihelion we had C/2023 A3 (Tsuchinshan-ATLAS) at its best. This comet was remarkably well behaved and it did pretty much everything that was expected of it. It was discovered in early 2023. It was a dynamically new comet and it was intensively observed by section members. The comet started to fade in mid-April and this led to considerable discussion online. In July, the respected cometary scientist Zdenek Sekanina published a pre-print claiming that the comet was fragmenting. Our detailed and frequent observations of this comet provided much evidence that this was not the case.

This comet was well seen from the northern hemisphere (weather permitting) and we received many images from section members. The best views from the northern hemisphere were just after perihelion and I went to La Palma where we had rather variable weather. Luckily it was perfectly clear on 2024 October 14 when we passed through the plane of the comet's orbit. As predicted, the comet had a spectacular anti-tail, and images are reminiscent of the photographs of the famous comet C/1956 R1 (Arend-Roland) taken in late April, 1957. I could see this anti-tail with the naked eye, despite the very bright, near full Moon.

Another recent comet which looked promising but which turned out to be a dud was C/2025 F2 (SWAN). This was discovered in SWAN images by Michael Mattiazzo and others (see page 7). Initially it brightened rapidly but it then broke apart and became another headless wonder.

Figure 1 – The remarkable anti-tail of C/2023 A3 on 2025 October 14.8. 100mm FL, Sony A7s.

Some of the fainter comets seen in the past couple of years have also been very interesting. Halley type comet 12P/Pons-Brooks was known to produce outbursts pre-perihelion at previous apparitions but coverage then was sparse. This time around the section had a project to image the comet and measure the near-nucleus magnitude using a standardised aperture of 9 arcsec. This produced a very consistent dataset which showed multiple outbursts as described in the article on page 5. This data has been used by professional comet scientist, David Jewitt, in a recent paper and it is a great example of how amateur observations are being used in the professional community. The outbursts of 12P were similar in character to those seen in 29P/Schwassmann-Wachmann which is monitored using similar techniques in a section programme run by Richard Miles. Richard has developed a theory which attempts to explain this outburst behaviour and this is, again, based on extensive amateur observations.

The Section continues to be very active with observations and images being received daily. We do not have a formal membership but there are 155 people signed up to our mailing list. Anyone can submit observations and join our mailing list but we have a hard-core of observers who regularly provide material. The Section has close links with other observers and comet groups around the world.

Observations

A number of observers report total magnitudes, either directly to the section or via the Comet Observations Database (COBS) website. Many of these observations are electronic but there are still a few dedicated visual observers. The visual observers help to maintain the continuity of historical records for periodic comets and they provide a reference which we use to check electronic estimates.

Some of our observers submit comet astrometry to the MPC and this makes a significant contribution to the data available for brighter comets. In fact, our secretary, Denis Buczynski, is currently ranked 13 in the world for total astrometry submitted to the MPC which is a wonderful achievement for an amateur. A number of our observers, particularly Peter Carson and Kevin Hills, use the Section's Comphot software to extract total magnitudes from comet images. Jonathan Shanklin has continued to analyse quantitative data submitted by visual and electronic observers and he reports on these observations in each month's edition of The Astronomer magazine.

This period has shown the increasing ability of amateurs to produce comet spectra. These are lodged in the BAA spectroscopy database and the number of comet spectra in the database continues to increase but only slowly, indicating the difficulty of getting good quality results on faint and diffuse objects. Spectroscopy is an increasingly important activity used by amateur comet observers and is a crucial tool in understanding the chemical evolution of cometary objects.

Archive

We continued to scan items from the section archive and place material on line. In particular we have continued to scan photographic material from past observers, including images from Glyn Marsh, Reggie Waterfield and Harold Ridley.

The section's physical archive is split between items stored in Bedford, most of which have been scanned and indexed, and items stored at my house in Chelmsford which are awaiting scanning.

Denis Buczynski manages the Section's online image archive. At the end of 2025 April the archive contained 49,992 images. Images are being added at a rate of almost 4,000 per year and this must be one of the most comprehensive comet image archives available online. I am also very grateful to Helen Usher who has been working with the VESPA consortium to make this extensive database of images more widely available to the professional community.

Meetings

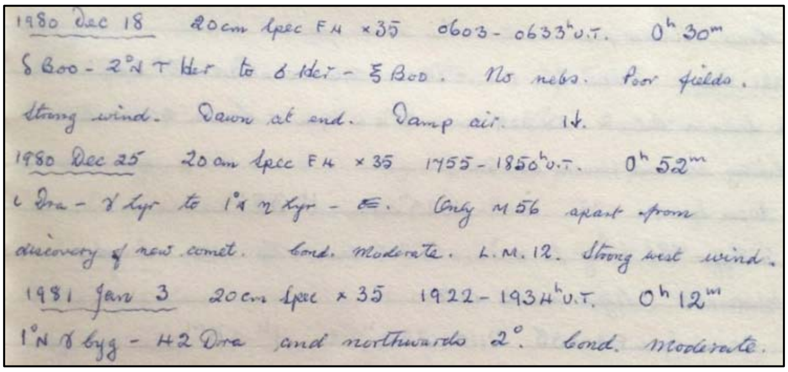
The section held a very successful meeting at the National Maritime Museum, Greenwich, on 2023 July 8 and this was attended by almost 100 people. The meeting was made possible by the NMM and Flamsteed Astronomy Society and I am immensely grateful to them for the excellent venue and organisation. The initial idea to hold a meeting at the NMM came from Janice McClean and the chair of Flamsteed, Bobby Manno. My thanks also to the speakers: Richard Miles, Helen Usher, Jonathan Shanklin, Thomas Lehmann, Robin Leadbeater, John Mason and Prof. Alan Fitzsimmons for a fascinating range of talks. Feedback after the meeting was universally positive. The meeting was recorded and it is available to watch on the BAA's Youtube channel.

Many thanks to Gill and Roger Perry for providing the video.

A meeting in Edinburgh is scheduled for Saturday, 2025 October 4 with support from the local society, The Astronomical Society of Edinburgh. This will be a joint meeting with the Meteor Section. We have a great range of speakers and you can now book via the Ticket Tailor website (see the ad on the previous page or go via the BAA website). The meeting is open to everyone, whether or not you are a member, although we might try to persuade you to join if you are not already a member of the Association! I look forward to meeting as many of you as possible there.

Roy Panther

Many of you will know that the BAA has been involved in legal proceedings regarding the will of Roy Panther, the discoverer of C/1980 Y2 (Panther). Those proceedings have completed and we now have access to Roy's observing notebooks. These will be available online soon but here is the page for the night he discovered his comet, 1980 December 25. A rather understated note: "only M56 apart from discovery of new comet".


1980 Dec 18 20cm Spec F4 ×35 0603-0633h U.T. 0h 30m
δ Boo - 2°N τ Her to δ Her - ξ Boo. No nebs. Poor fields.
Strong wind. Dawn at end. Damp air. 1↓.
1980 Dec 25 20cm Spec F4 ×35 1755-1850h U.T. 0h 52m
ι Dra - γ Lyr to 1°N η Lyr - ε. Only M56 apart from
discovery of new comet. Cond. Moderate. L.M. 12. Strong west wind.
1981 Jan 3 20cm Spec ×35 1922-1934h U.T. 0h 12m
1°N δ Cyg - 42 Dra and northwards 2°. Cond. Moderate.

Section officers

I rely on my section officers and would like to take the opportunity to thank them for all of the support that they have given me.

Visual observations and analysis - Jonathan Shanklin

Secretary - Denis Buczynski

TA liaison - Guy Hurst

Imaging advisor - Peter Carson

Newsletter editor - Janice McClean

As many of you will know, our newsletter editor, Janice McClean, is currently the President of the BAA. I'm sure we will all want to congratulate Janice for taking on this major role in the Association. This does mean though that Janice was unable to compile this edition of Comet's Tale so the job has fallen to me. Many thanks to all of the contributors this time around. I hope that I've presented your articles in an acceptable format.

Also, Guy has been unwell recently and has had to step back from editing TA. We wish him a speedy recovery and, in the meantime, Mark Kidger is doing a fantastic job as editor.

From the Visual Observations Co-ordinator

It has been a while since I made a submission to The Comet's Tale; I suspect not since I was the editor of it. I have got as far as pencilling the outline of an article, but the results will be for the next issue.

Since I handed over to Nick, I have continued producing the reports on the brighter or more interesting comets of each year for the Journal and have caught up with the backlog. In addition, I have used the data accumulated from the papers to carry out some analysis, which has also appeared in the Journal.

For these papers I have not carried out any analysis of the information in the many images that are submitted to the BAA archive. There is plenty of scope for work here, for example in extracting solar wind speeds.

More recently I have taken on editing the monthly comet section in *The Astronomer* magazine. For this I have changed the format so that it is no longer a list of observations, but instead gives a brief overview of the behaviour and trends of each comet under observation. This does take quite a lot more work than producing a simple list of observations.

Most observations are now submitted to COBS, which ensures consistency of formatting, though can make extracting observations from those observers not formally associated to the BAA more complex. I would encourage those few observers who use alternative formats to consider putting their observations into COBS. I would also like to encourage the many observers who take images to reduce them using Nick's Comphot software and submit the results to COBS.

For TA I exclusively use observations from those affiliated to the BAA or TA. For the Journal papers I do the same for the long period comets and new periodic comets, but use all the COBS observations for periodic comet that have sufficient numbers of returns to investigate any trends. I would welcome views as to whether I should use all the COBS observations for all comets, or restrict analysis to those from BAA and affiliated members.

Jonathan Shanklin, Visual Observation Co-ordinator

THE NEAR-NUCLEUS LIGHTCURVE OF 12P/PONS-BROOKS

Nick James (ndj@nickdjames.com)

Comet 12P was discovered by Jean-Louis Pons at Marseille whilst sweeping the morning sky on 1812 July 21. It reached perihelion on 1812 September 15 and calculations showed that it had an orbital period of around 70 years. On 1883 September 2 William Brooks in New York State discovered a comet which turned out to be the same object. 12P/Pons-Brooks came to perihelion on 1884 January 26 and it was an easy naked-eye object at its brightest. It also had a significant outburst on 1884 September 22 when it suddenly brightened by 2 to 3 magnitudes.

12P is a Halley-type comet with a current period of 71 years and a perihelion distance, q, of 0.78 au. The last return before this one was in 1954. On 1953 June 20 the comet was recovered by Elizabeth Roemer using the 36-inch Crossley reflector at Lick. This was around 11 months before perihelion which occurred on 1954 May 22.

This time the perihelion was on 2024 April 21 and it was recovered using the 4.3-m telescope at Lowell on 2020 June 10, almost four years before perihelion when it was almost 12 au out from the Sun. The comet appears to have quite a large nucleus with estimates of the diameter ranging up to 34 km although this is probably a significant overestimate and the true value is probably nearer to 20 km.

The comet has been followed by section members since 2022 June when it was around 21st magnitude. Throughout early 2023 it slowly brightened and by July it had reached 17th magnitude and showed a faint coma and stubby tail to the south west. On 2023 July 20.82, Elek Tamás in Hungary detected a very large outburst. The comet had risen from 17th magnitude to around 12th magnitude, brightening by a factor of 100 over a very short period. Early images showed an almost star-like point but gradually the new coma expanded outwards (Figure 1). At the time of the outburst the comet was 3.89 au from the Sun and 3.57 au from the Earth and an arcsecond corresponded to 2590 km projected on the sky at the distance of the comet.

Around 62 hours after the outburst the coma had expanded and started to show interesting detail. By 5.6 days after the outburst the coma had expanded to a diameter of 80 arc seconds, corresponding to around 200,000 km at the comet's distance. At 25 days after the outburst, the inner coma had expanded to a diameter of around 500,000 km, almost four times the diameter of Jupiter. A best-fit linear expansion rate of 13.7 arcsec/day. This corresponds to a physical expansion rate of around 200 m s^{-1}. Projecting the expansion back to zero diameter indicates that the outburst occurred at 2023 July 20.39. Using a different approach Richard Miles and the Comet Chasers team got an outburst time of July 20.45 ± 0.08 using data from metre class telescopes in the LCOGT network and this is nicely consistent with the results obtained using amateur instruments. The latest observation known before the outburst was on July 20.08 by station A02. At that time the magnitude was measured as 16.9. It appears that Tamás detected the outburst around 10 hours after it happened.

By the end of 2023 the comet had produced a further five significant outbursts. Continuous monitoring of the comet by BAA observers using local and remote telescopes means that we have excellent coverage of the behaviour for each outburst.

The magnitudes and amplitude are measured in a photometric aperture of approximately 9 arcsec radius, the images are mainly unfiltered and the reference is Gaia G. This radius corresponds to the area near the nucleus and it was chosen since it is a standard radius for astrometry so that we could get photometry with little extra effort.

It is worth noting that the last four outbursts took place on an approximately 15-day cadence. The approximately 15-day period was first noted by Richard Miles after the Nov 30 outburst and he speculates that this corresponds to the rotation period of the nucleus and that all of these outbursts come from a single source shortly after local sunrise. The lightcurve in Figure 2, taken from BAA data, shows the gradually decreasing amplitude of the last three outbursts.

We have particularly good photometry of the outburst of Nov 14. Photometry obtained using a 9.5 arcsec radius very shortly after the outburst commenced shows the comet brightening rapidly. Interestingly there is a change in slope of the brightening rate from 1.78 mag/hr to 2.90 mag/hr at around 18:15 UTC.

Following each outburst we see an expanding, bright dust coma surrounded by a larger gas coma. In colour images the two were very distinct with the dust coma white from reflected sunlight and the and the gas coma greenish from Swan band emission. Both of these are superimposed on the comae from previous outbursts. The morphology of the dust coma has been well followed by BAA observers and it is generally similar from outburst to outburst. It usually shows a dark lane with brighter features on either side. The position angle of this dark lane depends on the outburst geometry and so is different each time. Since the coma is optically thin this dark lane is not a shadow but it is caused by a change of the dust column density in our line of sight resulting from the outburst geometry. The weaker outbursts show distinct "horns" early in the outburst and the coma shape is quite distinctive. The bright outburst of Nov 14 showed rather different features since the intensity of the dust coma overwhelmed the other features but the basic mechanism is the same.

The outbursts are large but they have had no detectable effect on the motion of the very massive nucleus of 12P. Astrometry shows a large temporary displacement of the residuals around the time of major outbursts since the bright dust outflow biases the photo-centroid. As this dust cloud fades the astrometry returns to normal. This comet has a very large and massive nucleus and so we do not expect these outbursts to have any significant effect on its motion. Maik Meyer has demonstrated that this comet was seen in 1385 and 1487 and he comments that the perihelion arrival adjustment required was just a few days despite it not being seen at four consecutive perihelia (1527, 1597, 1668 and 1740). This implies the effect of accumulated non-gravitational forces on this comet is very small and so we would not expect to see much effect this time around either.

There were not many observations post perihelion, mainly because the comet had gone south. There was at least one significant post-perihelion outburst in 2024 June although it wasn't covered very well and another small one at the end of August. Details are shown in Figure 3

This dataset has been used by David Jewitt in an AJ paper, the pre-print of which is currently on ArXiv:

https://arxiv.org/abs/2504.20316

BAA data is merged with data obtained using the Nordic Optical Telescope (NOT) on La Palma. Jewitt finds that the energy source for the outbursts is consistent with crystallisation of amorphous water ice. This is the theory that is currently very popular with professional comet scientists. Richard Miles, who runs

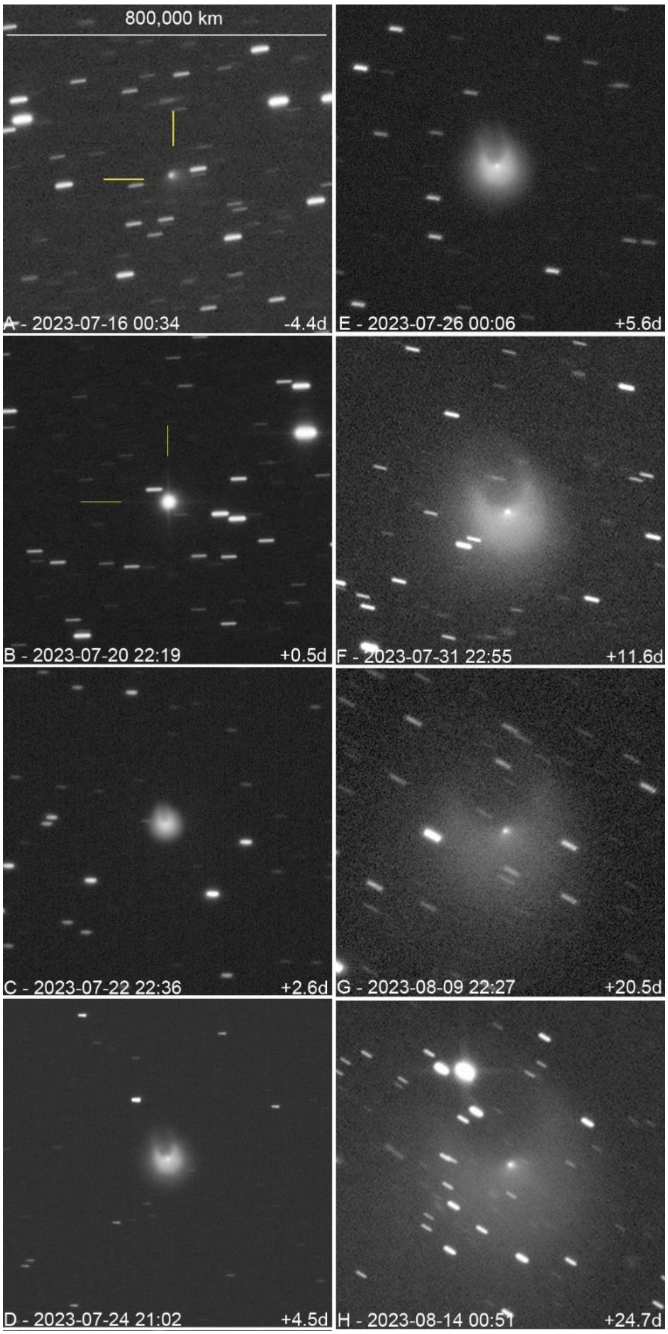


Figure 1 – Sequence of images following the major outburst of 2023 July 20.45. Nick James

the Mission 29P programme for the section has developed a very different theory for the outbursts of that object but this hasn't got much traction with professional scientists yet.

I hope that the observations that we are getting of these outbursting comets will resolve the question one way or another. If you would like to contribute to the BAA programme, please have a look at the following link for a discussion of the method we use:

https://britastro.org/section_news_item/12p-pons-brooks-observing-campaign

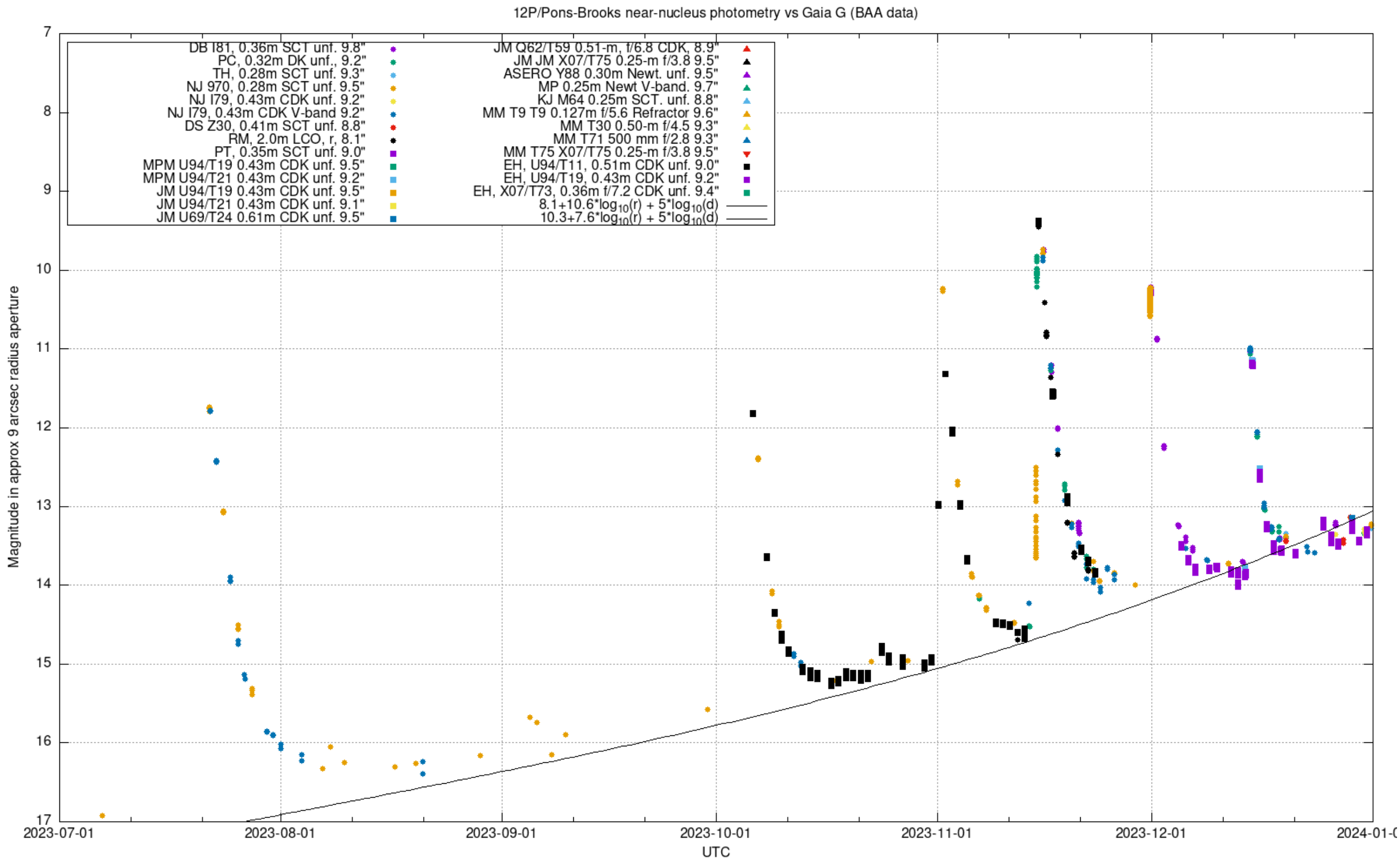


Figure 2 – Pre-perihelion 9 arcsec lightcurve

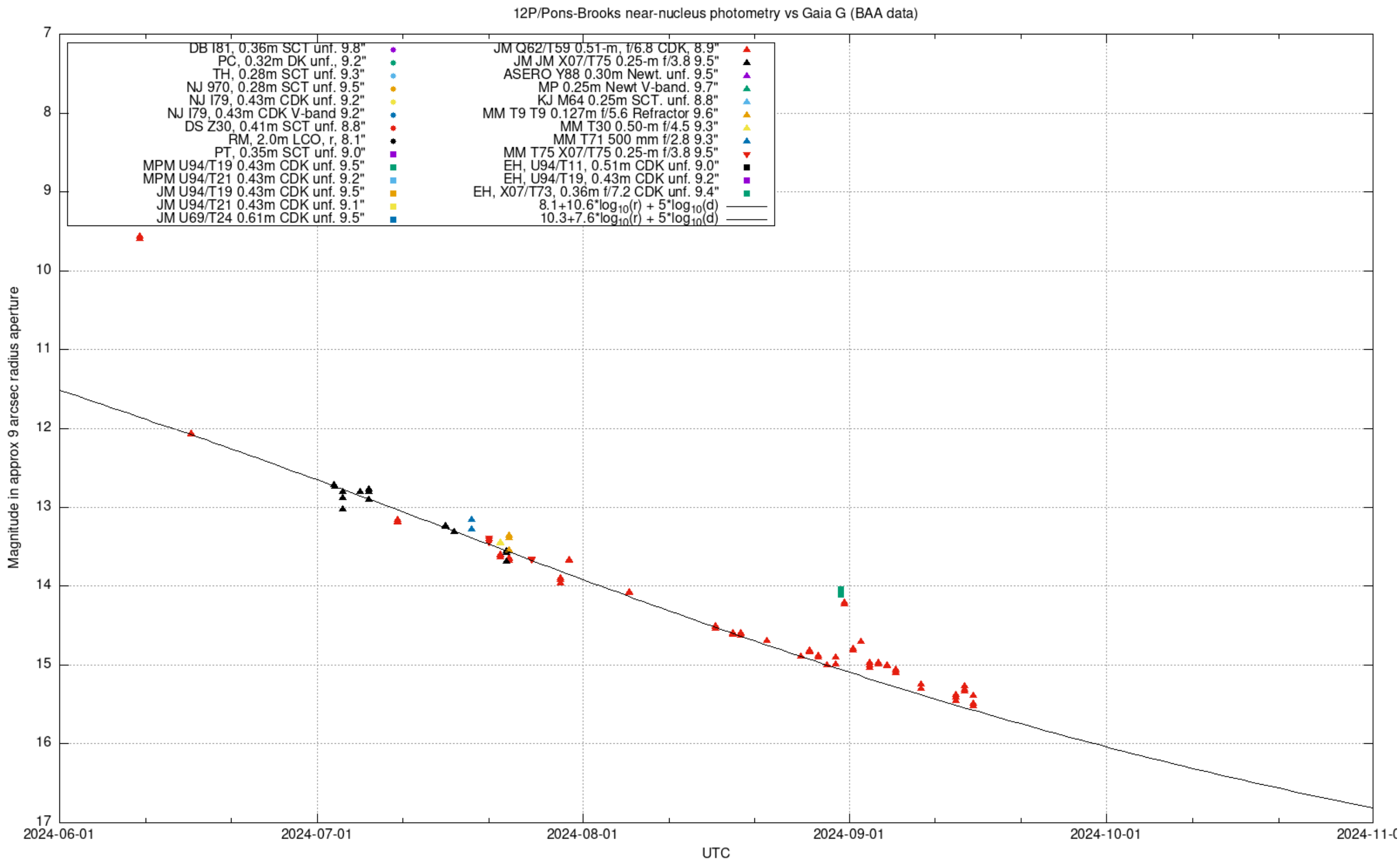


Figure 3 – Post perihelion 9 arcsec lightcurve

THE DISCOVERY OF COMET C/2025 F2 (SWAN)

Michael Mattiazzo. https://southerncomets.info/

The Solar Wind Anisotropy instrument (SWAN) is an ultraviolet camera on board the Solar and Heliospheric Observer (SOHO) spacecraft. SOHO was launched by NASA in 1995. It is in a stable orbit at the L1 Lagrange point, some 1.5 million kms from the Earth towards the Sun. Its primary purpose is to study the Sun by using various instruments, but as a side benefit the SWAN instrument is very good at detecting comets. They shine brightly in ultraviolet light due to the sublimation of water ice when near the Sun, via the Lyman Alpha emission line of ionised Hydrogen. SWAN captures a daily image of the entire sky at low resolution, about 0.5 degrees per pixel. This data is provided in a form suitable for comet tracking and can be downloaded at http://swan.projet.latmos.ipsl.fr/

I co-discovered comet SWAN by searching this publicly available data on the SWAN Project website. Other amateur hunters credited with this discovery were Vladimir Bezugly of Ukraine and Rob Matson of USA.

On 2025 March 30, I noticed a steadily brightening, moving object that did not correspond with any known comets. The new comet was faintly detectable as early as March 22 with a notable brightening over the days that followed (Figure 1).

When searching the data, it takes patience and experience because there are many false positives due to its very low resolution and many background sources, especially in the region of the Milky Way. Comets are most likely to be found approaching the Sun, so this region should be monitored carefully. Once you think you have found a possible candidate, you need to eliminate known comets.

The second challenge is to then find the potential new comet in the night sky. SWAN data is usually made publicly available after about a 3-day delay; therefore you need to forecast where the comet might be situated currently. It may be more favourable for southern or northern observers. In this instance, the comet was not visible from my location south of the equator, so I had to attempt a ground confirmation using a remote telescope. The SWAN positions indicated that the comet was situated only 30 degrees from the Sun in the morning sky in the constellation of Pegasus, suitable for northerners to follow up. Its low altitude in the dawn sky provides a challenge as most remote observatories have slew limits set up on their telescopes.

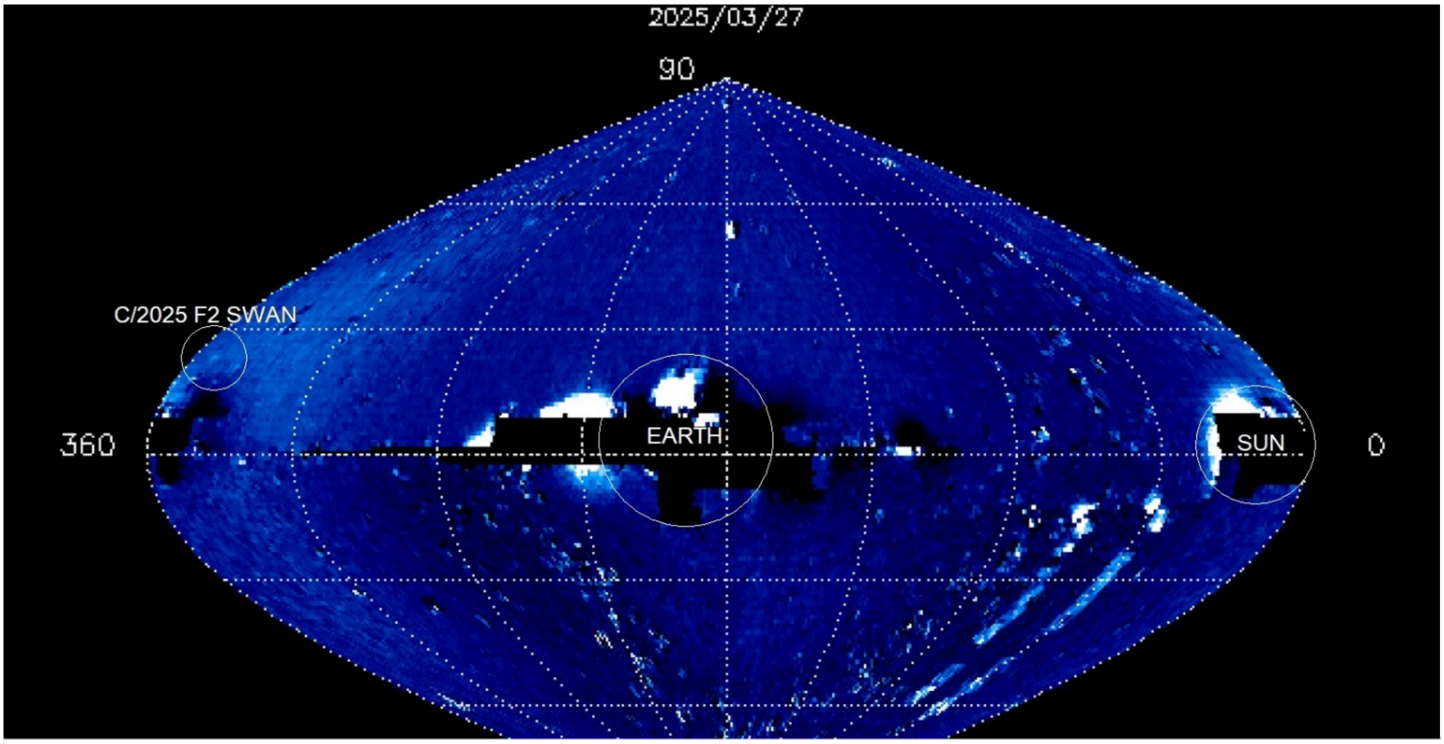


Figure 1 – SWAN all-sky ultraviolet image taken on 2025 March 27 indicating marked positions of C/2025 F2 SWAN, Earth and Sun. Note that each rectangle corresponds to a 30x30 degree patch of sky.

The SWAN data is also presented in ecliptic coordinates, which don't make a lot of sense to astronomers, but it is easy to convert to equatorial coordinates using planetarium software, such as Guide 9, which can display ecliptic and equatorial coordinates simultaneously (Figure 2).

Once you have a search area, it is best to use a camera and telephoto lens to photograph a wide area of sky. The more area you cover, the better your chances of confirming it.

Not having much success with weather using a remote telescope, I sent an email to the comets mailing list on April 1, requesting assistance from the comet community who quickly responded. Quicheng Zhang (Mormon Lake, Arizona) found it on the morning of 2025 April 3, using a 40 mm refractor. He saw a compact source of approximate magnitude 12 some 2.5 degrees west of predictions. Once detected and measured, the positions of the comet were then posted onto the Possible Comet Confirmation Page (PCCP) for immediate follow up by astronomers around the globe. Remote telescopes have become especially useful tools for this purpose. After a few days of astrometric data, a reasonable orbit was established which enabled identification of pre-discovery images taken by the PANSTARRS survey as early as October 2024.

This then enabled a precise orbital calculation which indicated that the comet would be closest to the Sun on 2025 May 1 at 0.33 au, near the orbit of Mercury. On the same day, it would be closest to the Earth at 0.96 au. These conditions were suitable for a comet potentially visible in binoculars, but the maximum brightness was uncertain at this time. The comet had an outburst around April 6 where it reached magnitude 7 before gradually fading and losing its central condensation. This indicated the disintegration of comet SWAN had begun. The comet entering southern skies in mid-May will likely be a faint speck of dust, visible only through large telescopes.

This is my 10th discovery credit for SWAN comets since 2004 and I do check the data on most days. SWAN is credited for 20 comets as well as recoveries of several others. Comet SWAN is not named after me as I did not use my own equipment, as per IAU naming guidelines.

My interest in comets were sparked by the arrival of comet Halley in 1986. Then in 1987, a comet by the name of Bradfield became visible in small scopes. I had the privilege of meeting Bill Bradfield after attending an Astronomical Society of South Australia (ASSA) meeting in 1995, after his comet discovery of that year. Overall, he managed to visually discover a total of 18 comets as an amateur, between 1972 to 2004, that will never likely to be repeated given today's technology. He was very keen to pass on his knowledge and experience to me. Bill was a life member of ASSA and was inducted into the ASSA Hall of Fame in 2013, and best described as a gentleman, scholar and a mentor.

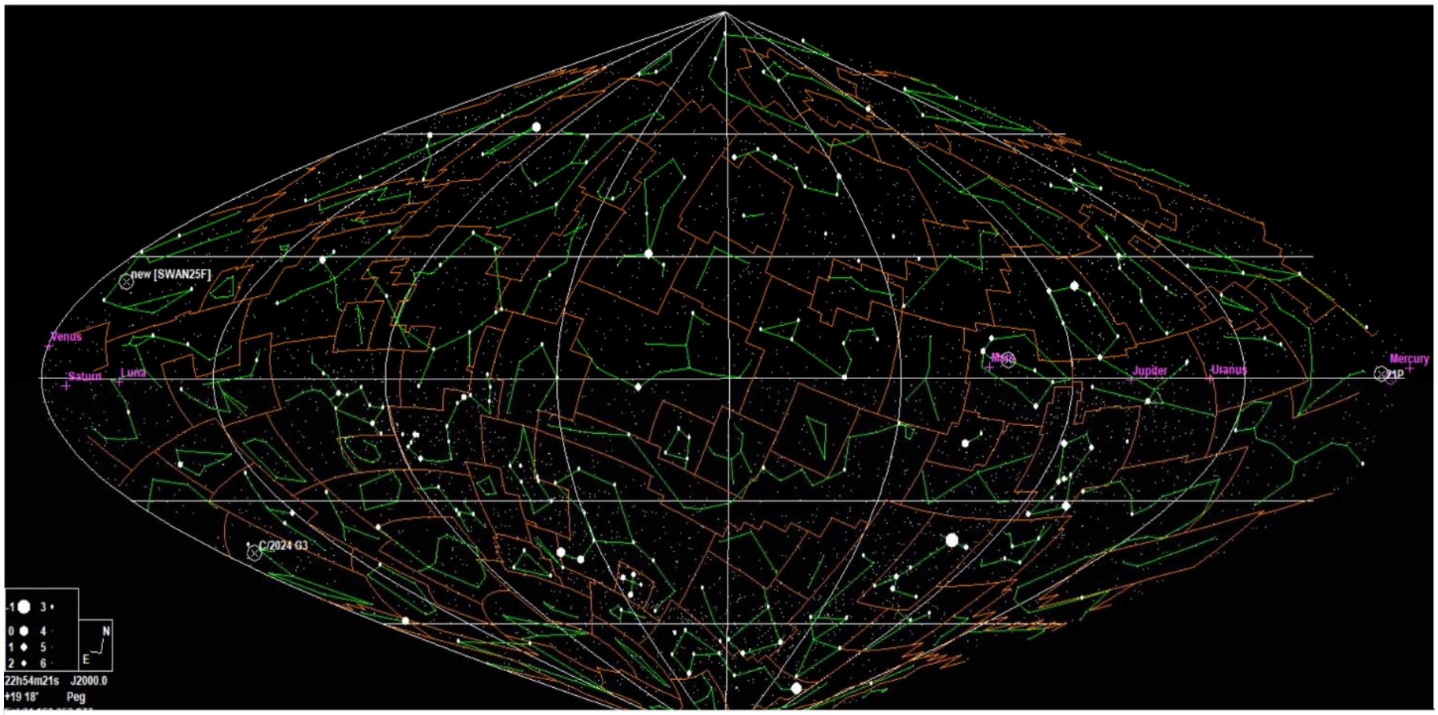


Figure 2 – Guide 9 representation of the SWAN comet tracker map on 2025 March 27. You can see that on 2025 March 27, the comet (circled at far left) was situated in Pegasus and about to enter the square of Pegasus.

I had taken up comet hunting in 1997 when I moved to Wallaroo, South Australia where my greatest success was making an independent visual discovery of comet C/2000 W1 Utsunomiya-Jones but was 24 hours too late and missed the cut.

In 2002, SWAN became a threat to the visual comet hunters when a couple of Japanese amateurs picked up C/2002 O6 and SWAN data was then becoming publicly available on the Internet as a comet tracker map. After that time, I concentrated on SWAN hunting and have since discovery credit for C/2004 H6, C/2004 V13, C/2005 P3, P/2005 T4, C/2006 M4, C/2015 C2, C/2015 P3, C/2020 F8, C/2021 D2 and finally C/2025 F2.

Follow me on southern comets Facebook page where I post regular updates of my recent comet observations or southern comets homepage, updated less frequently, but has a terrific record of my comet observations since 1996 as well as finder charts available for the brighter comets.

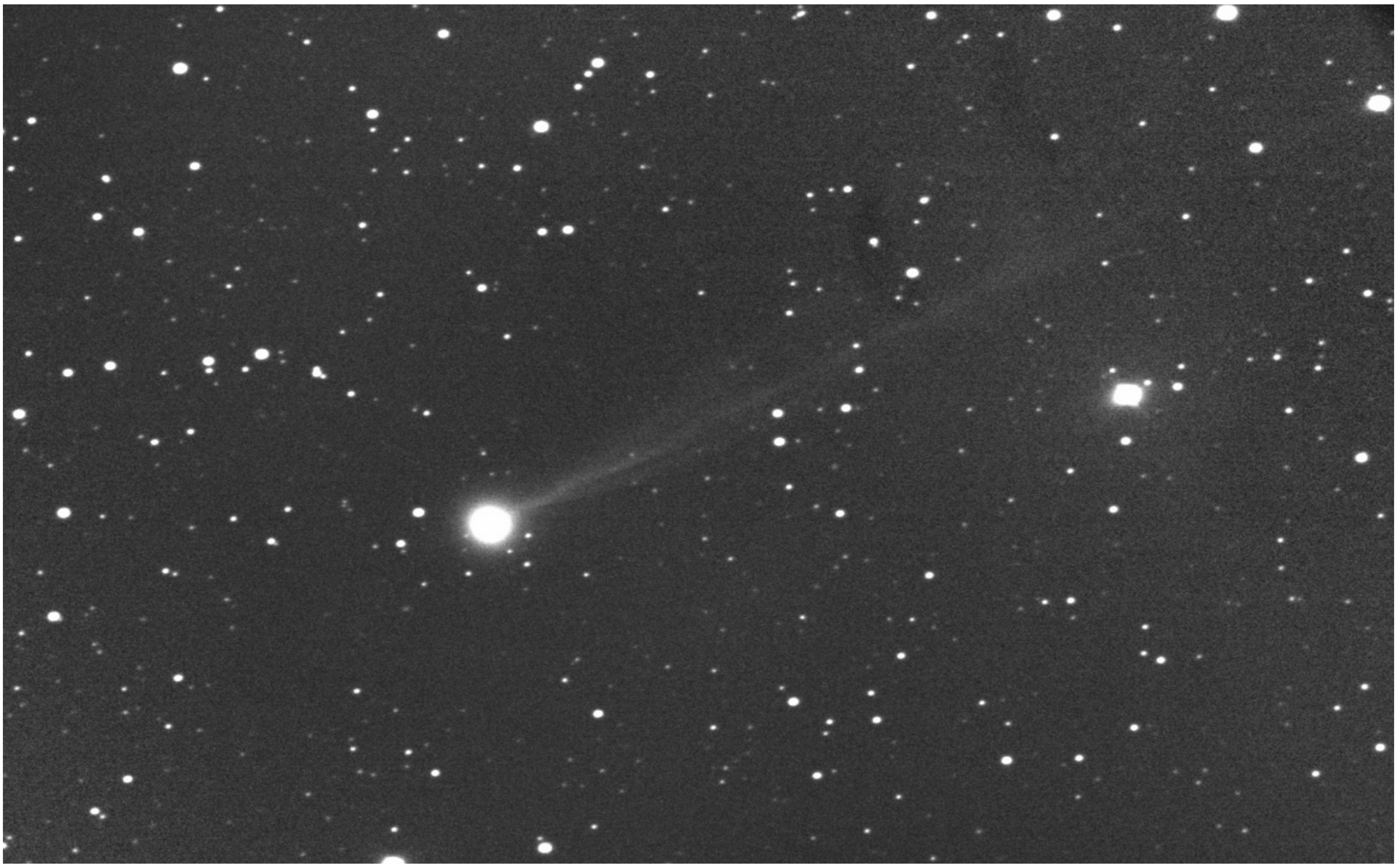


Figure 3 – C/2025 F2 (SWAN) on 2025 April 6. Michael Mattiazzo

Figure 4. The remnants of C/2025 F2 on 2025 April 21. Peter Carson

IMAGING C/2024 G3 (ATLAS) FROM TENERIFE

Nick James (ndj@nickdjames.com)

Figure 1 – The view from my observing site at El Retamar. Perfect for comets low in the west!

In early 2025 January I made a short-notice decision to travel to Tenerife (at a latitude of around 28° N) having looked at Nicolas Lefaudeux's online tail predictions for C/2024 G3. He noted that a low surface brightness tail might be visible low in the southwestern evening sky from mid-northern latitudes between January 19 to 26. There are plenty of inexpensive flights to Tenerife from the southeast of England at this time of the year so it was straightforward to book one along with a hotel for three nights from January 19. I decided to stay in Vilaflor, which is about 1400 m up the southern flank of Mt. Teide, around 40 minutes' drive from the airport.

I needed a good southwestern horizon and identified a few potential observing sites at 2100 m using Google Street View. These were around a 20-minute drive from my hotel up TF-21 which is a very good road. The site I eventually used was just inside the national park at El Retamar. There was room to pull off the road here and set up. I discovered that it was a very popular site for people to watch the sunset but the road became much quieter once that was over. The site was perfect with a sea/cloud horizon in the direction of the comet with only a few Canarian pines sticking up to around 0.5° on a ridge to the left of where the comet would be and the island of La Gomera visible in the distance.

My objective was to get an image of the comet itself, although that would be very low in the bright evening twilight from 28° N, and to get a widefield image of its extended dust tail as the sky darkened. For the comet I needed a fairly long focal length so I took a Redcat51 (250 mm FL, f/4.9) coupled to an ASI2600MC cooled camera. This was driven on an AM-3 mount. For the tail I used a Canon 100 mm FL, f/2 lens and a Sony A7s iii camera on a small, fixed tripod that I balanced on the top of the car. I also had a pair of 8x30 binoculars to look visually. On the 19th local sunset was at 18:37 UTC (Figure 3), the comet set at 19:20 when the Sun was 10° down and astronomical twilight ended at 19:59. One of the advantages of being at 2100 m is that the actual horizon is more than 1° depressed but, irritatingly, I couldn't get the AM-3 to track below 0° elevation. This is clearly not something that the software authors ever considered!

Shortly before I flew out the comet's nucleus had disintegrated and so there was no bright central condensation but southern observers were reporting a spectacular dust tail. The first two nights of the trip were beautifully clear and transparent with gorgeous sunsets. My technique for imaging in bright twilight is to take a 16-bit SER video with short exposures then stack the frames. This image (Figure 2) of the comet was taken at 19:18 UTC on January 19th when it was less than 1° above the geometric horizon. It is a stack of 100×0.1 s exposures processed to remove the very strong twilight gradient and the field of view is 1.6°×2.3°, zenith up. It shows a 2° tail with no central condensation but a bright spine which is due to dust grains that left the head at a very low velocity after the nucleus had fragmented. At around this time I searched around for the comet using binoculars but there was no sign of it. The twilight sky was just too bright.

Figure 2 2025-01-19, 1918 UTC. FoV 1.6x2.3. ASI2600 MC + Redcat 51

As the western sky darkened, I could start widefield imaging for the complex dust tail. The field of view of the 100 mm FL lens was 20°×14° and I aligned the camera so that the horizon was present at the bottom of the frame. As the end of astronomical twilight approached, I was taking 5 s exposures at ISO 1600 with the lens open at f/2. The image here is a stack of 41×5 s taken at 19:57 UTC on January 20th with significant processing to remove the background gradient. At the time this image was taken the comet's head was 7° below the horizon. The main part of the dust tail is aligned almost vertically to the horizon with the Helix Nebula (NGC 7293) in the faint upper reaches of the tail. There are at least three other streamers to the right of the main tail stretching to the top of the frame, at least 21° from the comet's head. I convinced myself that I could see the lower part of the dust tail with the naked eye as faint striations with a surface brightness about the same as the zodiacal light near the horizon. This is only the second time that I have imaged a significant tail when the head of the comet was below the horizon. The first time was for C/2006 P1 (McNaught) in 2007 January.

The third and last night of my stay was a combination of thick fog and high winds on the mountain but, by then, I had got what I came for. I decided to stay in Vilaflor and dine on goat stew (a Canarian staple) as a fitting end to the trip.

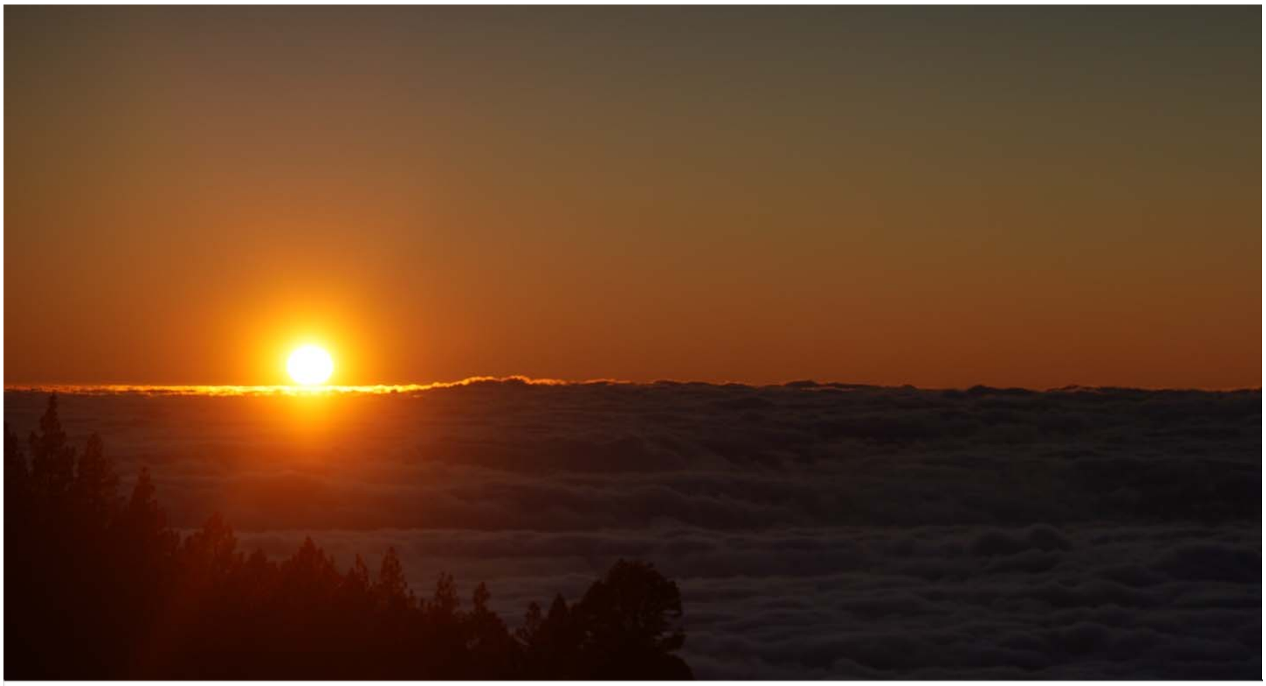


Figure 3 – The Sun at 1837 UTC on 2025-01-20. Sony A7s, 100 mm, f/2. The azimuth of the setting sun was 247°. The comet's elongation on this date was 18° above and to the left of the Sun.

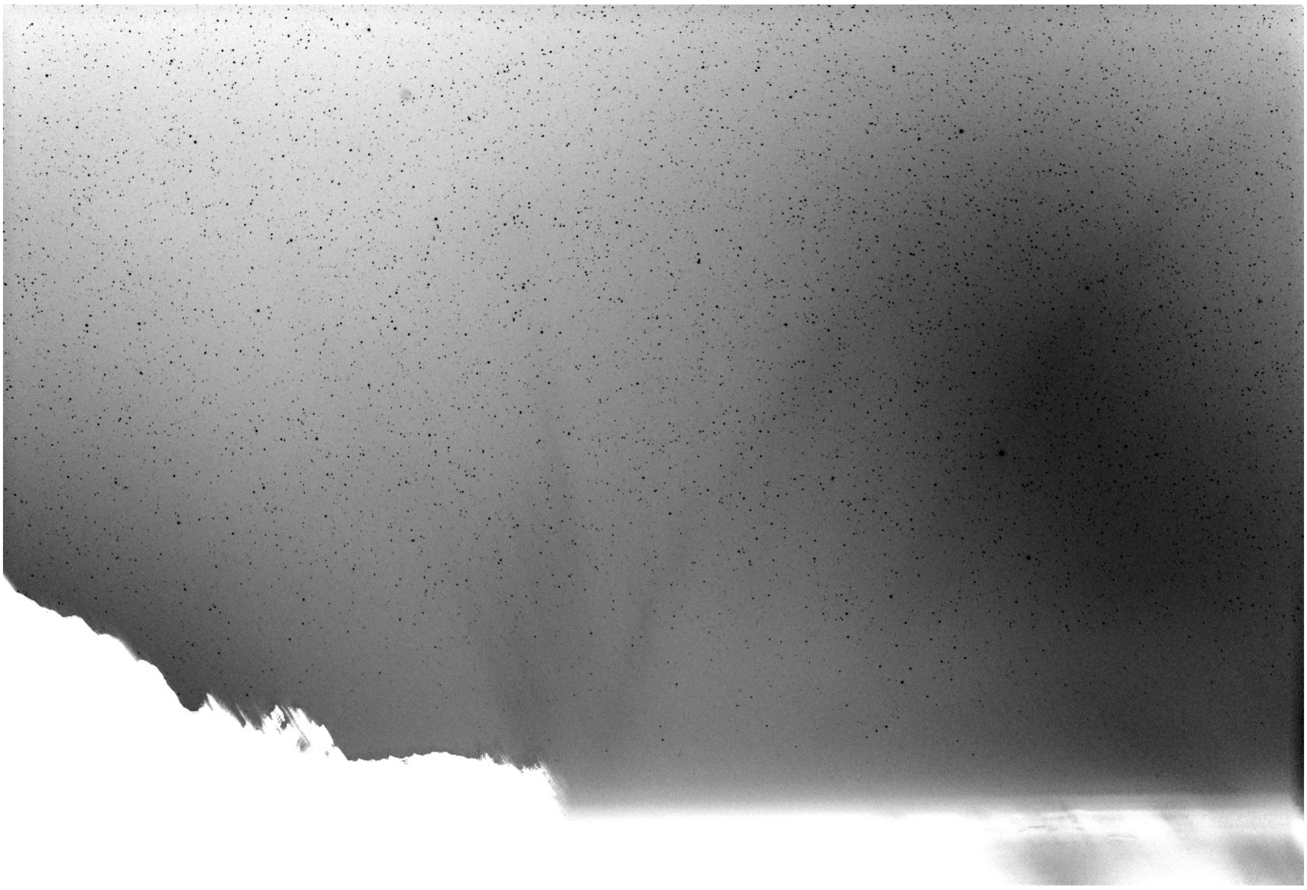


Figure 4. Negative green pixel image taken on 2025-01-19, 1956 – 2000 UTC. Sony A7s, 99×2 s, ISO 6400, 100 mm. f/2.

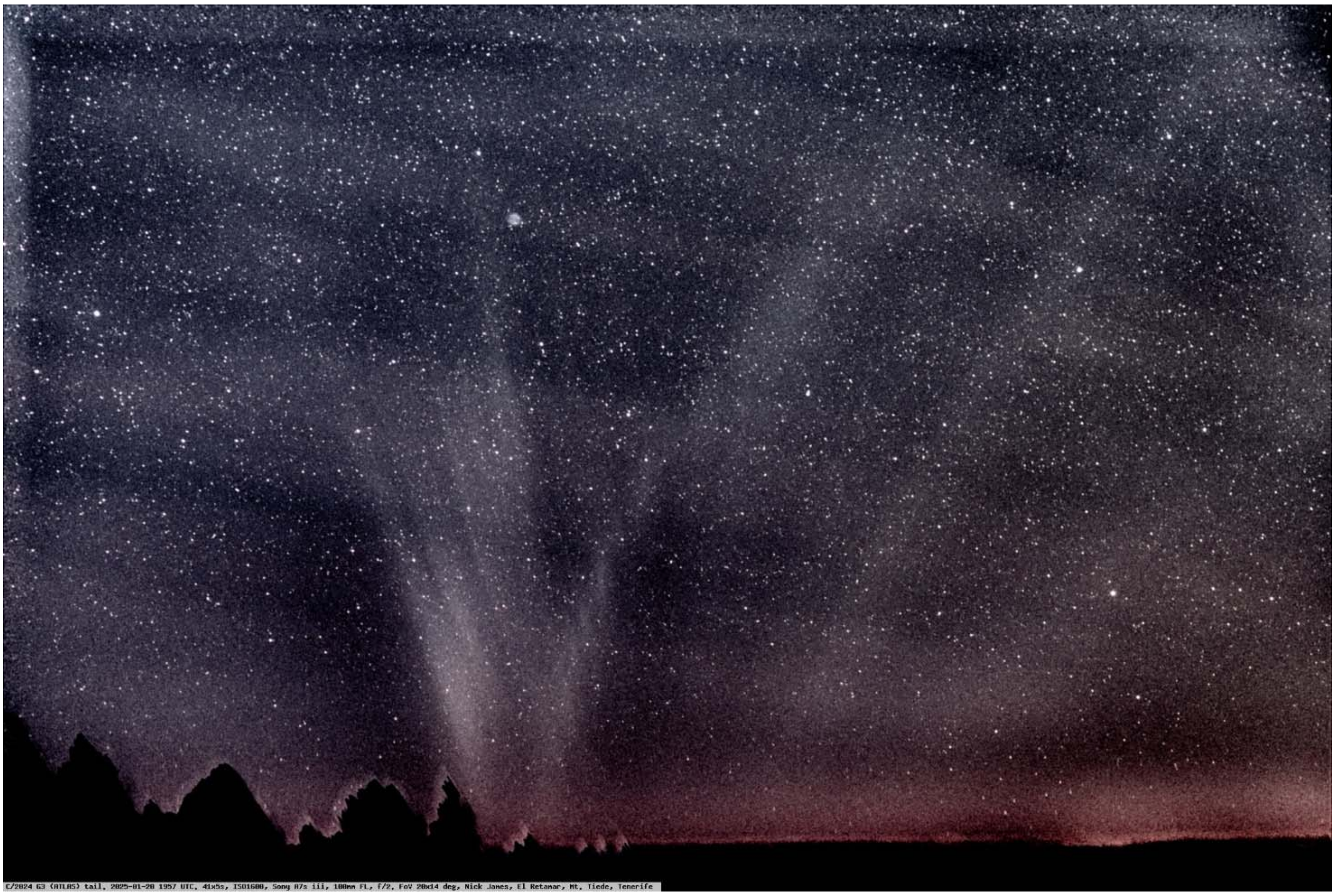


Figure 5 – 2025-01-20, 1956 – 1959 UTC. Sony A7s, 41×5s, ISO 1600, 100 mm, f/2

HEADLESS COMETS, 2000-2025

Denis Buczynski, BAA Comet Section

In recent years there have been a number of examples of comets which have lost their heads (nucleus or coma) but where the tail remains detectable. This article will detail those which have been recorded in the 21st Century. My choice of examples may not be exhaustive but will include the ones which were well-recorded.

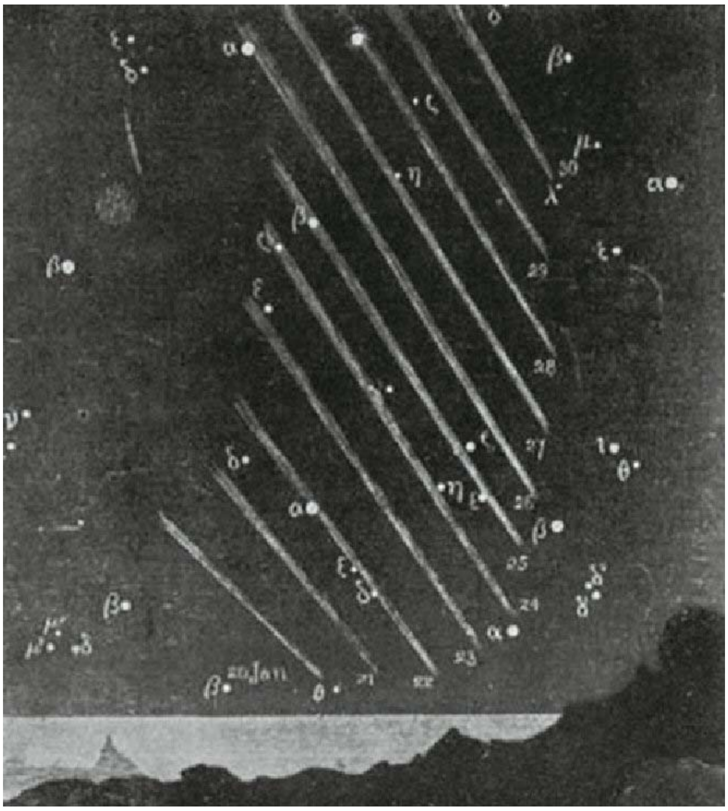


Figure 1 - A sequence of drawings of Comet C/1887 B1 (Great Southern Comet) showing the changing celestial location and length of the tail between 20 and 30 January 1887 (after Knowledge 1887)

Firstly, a definition of a comet which is detectable with a tail but no head is required. A "headless comet" refers to a comet which appears to have no visible nucleus or head, but instead displays only a tail. This can happen when a comet disintegrates, with the nucleus breaking apart and the dust and gases from the disintegration form the tail.

There will have been many comets in the past which could be classed as headless comets but one of the earliest, and the one most commonly referred to was "The Headless Wonder Comet". It was designated as the Great Southern Comet of 1887 (C/1887 B1). It was independently discovered in the southern constellation of Grus by observers in Argentina and South Africa within a day of each other on 1887 September 18-19. However, it was only the 25° tail that was ever seen, not a head or coma. This comet had passed perihelion only a week before discovery at 0.0048 au and it was subsequently identified as a member of the Kreutz Sungrazer group of comets. This close approach to the Sun probably resulted in the disintegration of its nucleus leaving only the dust comprising the tail visible. This process of disintegration is the most likely reason we see headless comets. The description by the all the observers of this comet were similar in that the tail could be seen, sometimes with the naked eye and up to 40° in length, yet in the telescope no distinctive nucleus was visible. A comparison with a view of Comet C/1880 C1 was made by B.A Gould in Argentina, who recorded that its tail "could only be recognised as a scarcely perceptible whiteness" (Figure 1).

The first comet of the new century to be classed as "headless" was C/1999 S4 (LINEAR). It was observed regularly through 2000 June and July when it became as bright as magnitude 6, then on July 27 the comet's head disintegrated. It came to perihelion on 26 July 2000, at a distance of 0.765 au from the Sun. This event was captured by HST on August 5 when images showed the fragmentary nature of the nucleus and the headless tail. (Figure 2) The comet pre-disintegration looked normal with a well-defined coma and tail (as seen in images and drawings). The first sign of a fundamental and catastrophic change within the comet's head was seen in images on July 21 when the leading edge of the coma took on a hammerhead shape. This seemed to herald the onset of disruption of the nucleus. We have seen this with other disrupted

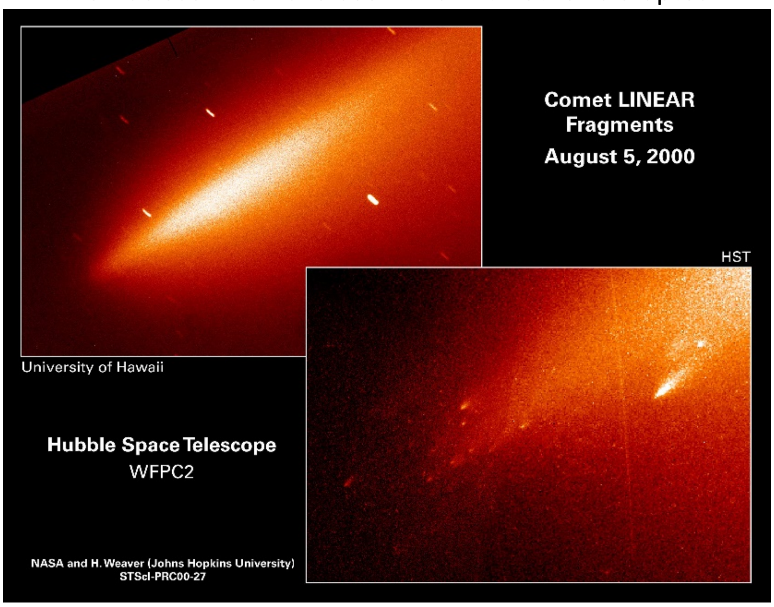


Figure 2 - HST images of C/1999 S4 LINEAR 2000 August 5

comets. This comet was not imaged again by Earth-based observers after the disintegration.

In 2011 there were two headless comets. Both made headlines for different reasons.

Figure 3 - Ligustri image of the remnant dust cloud of C/2010 X1 Elinen 2011 February 02

The first was C/2010 X1 (Elenin). This comet was the subject of numerous conspiracy theories and wild irrational speculations and fantasy statements, which can be read at the following link (a very amusing read) https://rationalwiki.org/wiki/Comet_Elenin. The facts are more interesting.

This comet was discovered on 2010 December 10 by Leonid Elenin a volunteer astronomer working at the newly installed (Russian funded) search discovery telescope (ISON) situated in the New Mexico desert. This comet was a first-time visitor from the Oort cloud and came within 0.483 au of the Sun at perihelion and was small at around 3 km diameter. Observations were made after discovery and continued from 2011 January until July. After August, when the comet was at a heliocentric distance of between 0.8 and 0.5 au its brightening slowed. The comet underwent a disintegration and its coma disappeared. There were reported observations of the remnant dust tail both visually and via imaging but with no reports of the comet's head. Links to the observations during the apparition and eventual analysis are:

https://cometography.com/lcomets/2010x1.html

https://ui.adsabs.harvard.edu/abs/2015AJ....149..133L/abstract

An image of this headless comet was obtained by Rolando Ligustri on 2011 February 2 (Figure 3).

The next comet in my list was much more interesting and impressive, C/2011 W3 (Lovejoy). This comet was discovered on 2011 November 27 by Australian amateur astronomer Terry Lovejoy who lives near Brisbane. He was conducting one of his regular comet searches using commercial equipment when he found this comet. It was a 13th magnitude fuzzy object in in the constellation of Centaurus. Initial astrometry showed that the comet was of the Kreutz-sungrazer class and that it would skim the solar surface on December 16 at 0.0056 au. Terry would become the first person to discover Kreutz sungrazers from Earth and using images from the SOHO spacecraft. As perihelion approached, and the comet was only visible in SOHO and STEREO images, the view was avidly watched hour by hour (Figure 4). As the comet passed through closest encounter the tail and head separated. The head was on one side of the Sun and the stripped tail on the other side. It quickly developed a new tail and began its long journey back to the outer reaches of the Solar System.

Further surprises were revealed. The post-perihelion observations on January 20 showed the comet nucleus had become bar-shaped indicating that the nucleus had suffered a cataclysmic event and had fragmented. No nucleus could be seen or imaged and the comet became a "headless wonder" (Figure 5). The images and visual spectacle of this naked eye sun-grazer were quite breathtaking. (Figure 6). On January 26 Robert McNaught imaged the comet using the Uppsala Schmidt telescope at Coonabarabran and this showed only a bright dust tail. An extended series of images taken by Lester Barnes in Australia over a period of 2

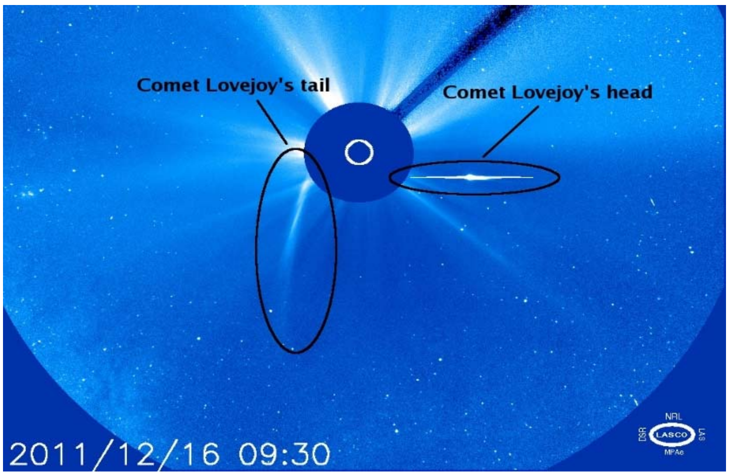


Figure 4 - LASCO image of C/2011 W3 Lovejoy 2011

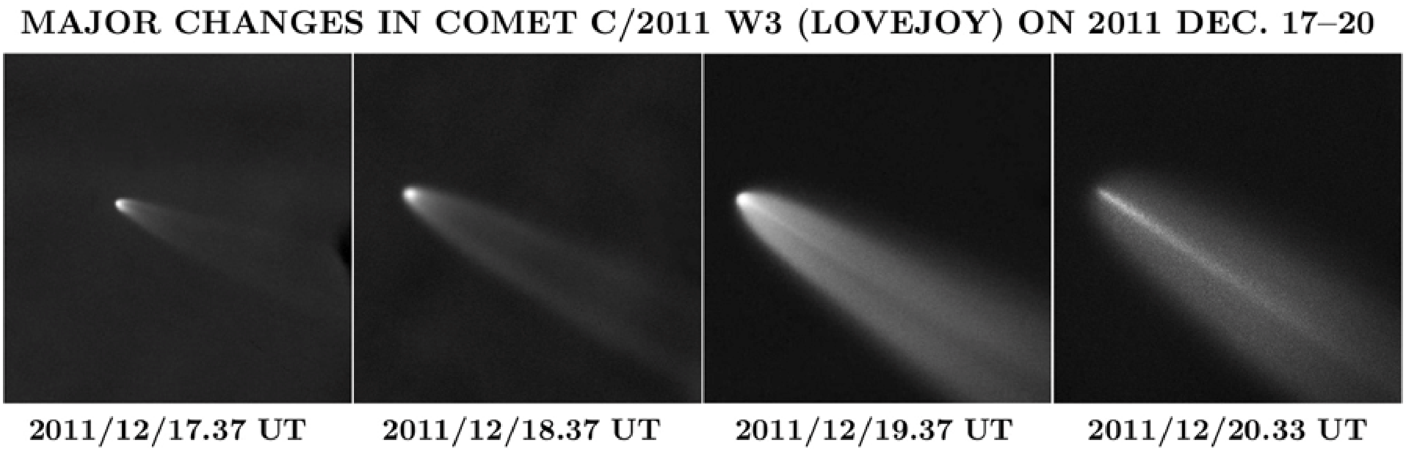


Figure 5 - Cerny images of C/2011 W3 Lovejoy 2011 December 17-20

months up to February 2011 showed the comet receding and fading.

https://britastro.org/cometobs/2011w3/thumbnails.html.

Another comet is a further Terry Lovejoy discovery, C/2017 E4 (Lovejoy). This comet was at perihelion at

Figure 6 - Legg image of C/2011 W3 Lovejoy 2011 December 22

0.5 au in 2017 April. It was intrinsically faint and having reached 7th magnitude did not survive perihelion. Observations were numerous and began immediately after discovery on 2017 March 10 but by early April, once again the imaging showed that the comet head and coma had become flattened or bar-shaped. This indicated that the comet was unlikely to survive and that disintegration would occur. By April 25 images showed only a broad diffuse headless tail. (Figure 7).

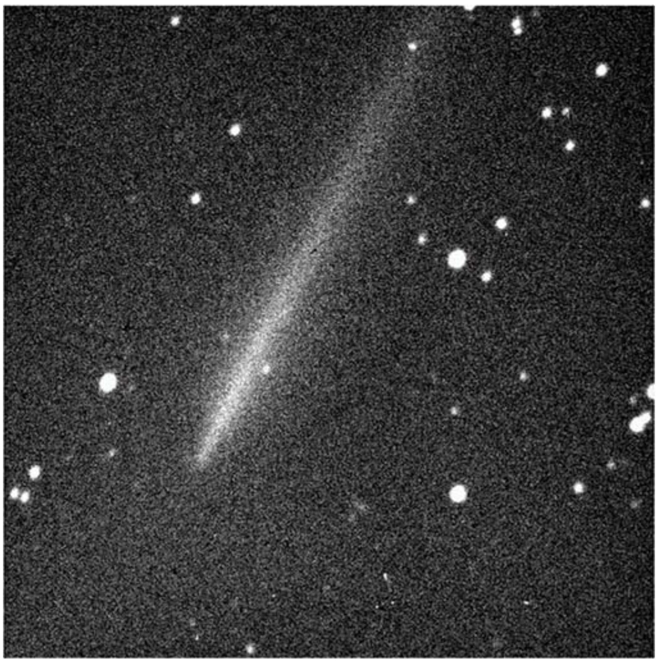


Figure 7 - Storey image of C/2017 E4 Lovejoy 2017 April 26

Following this came comet C/2017 S3 (PANSTARRS). This long period comet was discovered in 2017 September and was well observed and imaged. Then, in mid-July, 2018, the comet had a significant outburst and brightened quickly to approximately magnitude 7. There had been a disintegration event and by the end of July it appeared as yet another headless comet (Figure 8)

The next comet on my list is the well observed comet C/2019 Y4 (ATLAS) and its documented disintegration. It was discovered on 2019 December 28 by the ATLAS search and discovery system, a 0.5 m reflecting telescope on top of Mauna Loa in Hawaii. The discovery magnitude was 19.6 and early predictions were that it could become as bright as magnitude 0. The perihelion distance was 0.25 au in 2020 March. The comet never became brighter than magnitude 8 at perihelion and soon after, in early April, there were signs that the comet was disintegrating (Figure 9). Over the next few weeks. we saw fragmentation continue with multiple condensations appearing (Figure 10) in the inner coma. We then saw individual condensations looking like miniature tailed comets within the main tail (Figure 11). By the end of May the comet had totally disrupted and only the remnant was the headless tail (Figure 12).

The next comet is C/2020 F8 SWAN. It was discovered on March 25th by Australian amateur Michael Mattiazzo, on the date of perihelion. He was using publicly-available images taken by the Solar and Heliospheric Observatory's SWAN (Solar Wind Anisotropies) camera. The comet eventually passed out of the Solar glare and reached a magnitude 4.7 on May 2. It was a naked eye object and a well-formed comet. After that date the comet began to fade and by the end of May it became obvious that the comet had disintegrated and only the headless tail remained to be imaged (Figure 13).

Another comet which we can enter into the category of disintegrating, and eventually headless, comets is C/2021 A1 (Leonard). This long period comet was discovered at magnitude 19 by G. J. Leonard at the Mount Lemmon Observatory on 2021 January 3, a year before perihelion, when it was 5 au from the Sun. Perihelion was at 0.615 au on 2022 January 3. The comet was well observed on its inbound journey and by 2021 December the total magnitude has risen to 7 (Figure 14). During December there were reports of small outbursts and by late December just prior to the perihelion passage the comet's total magnitude had risen to 3 and it had become a naked eye comet with a fully developed ion tail which displayed multiple streamers. Another outburst following perihelion around 2022 January 7 probably proved fatal and the comet began to fade. Images of the comet taken in February and March showed it to be headless (Figure 15).

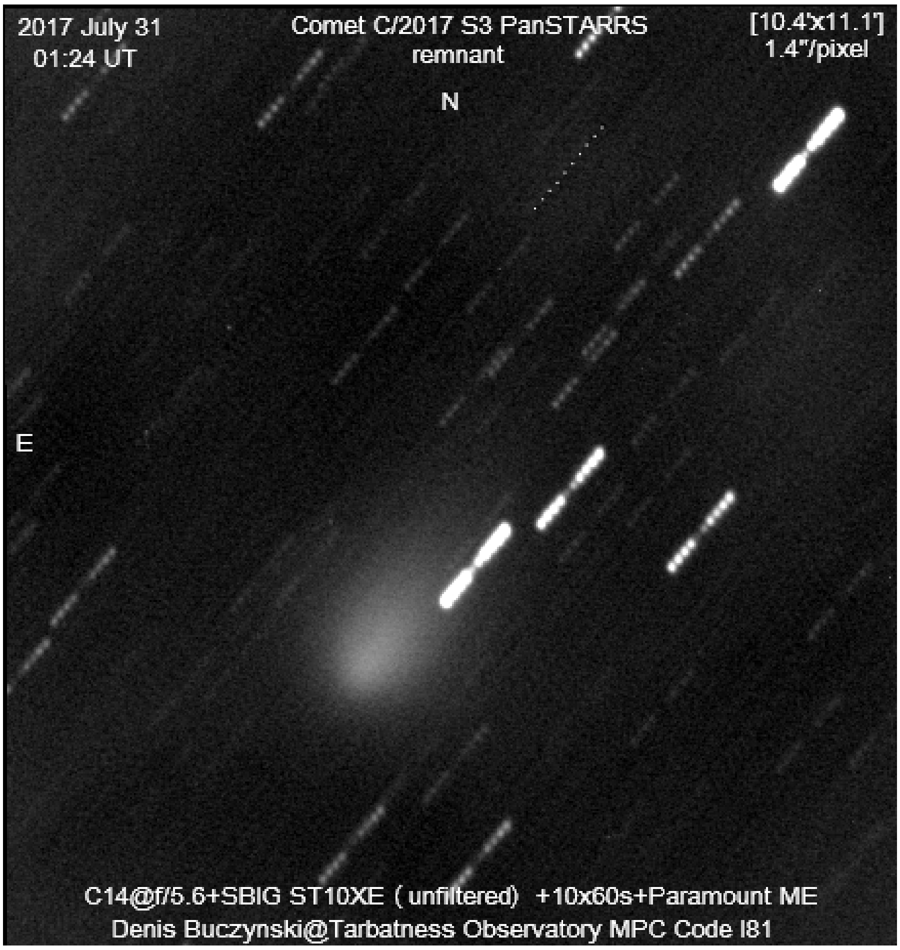


Figure 8 – Buczynski image of C/2017 S3 2018 July 31

Figure 9 - Haig image of C/2019 Y4 ATLAS 2020 April 7

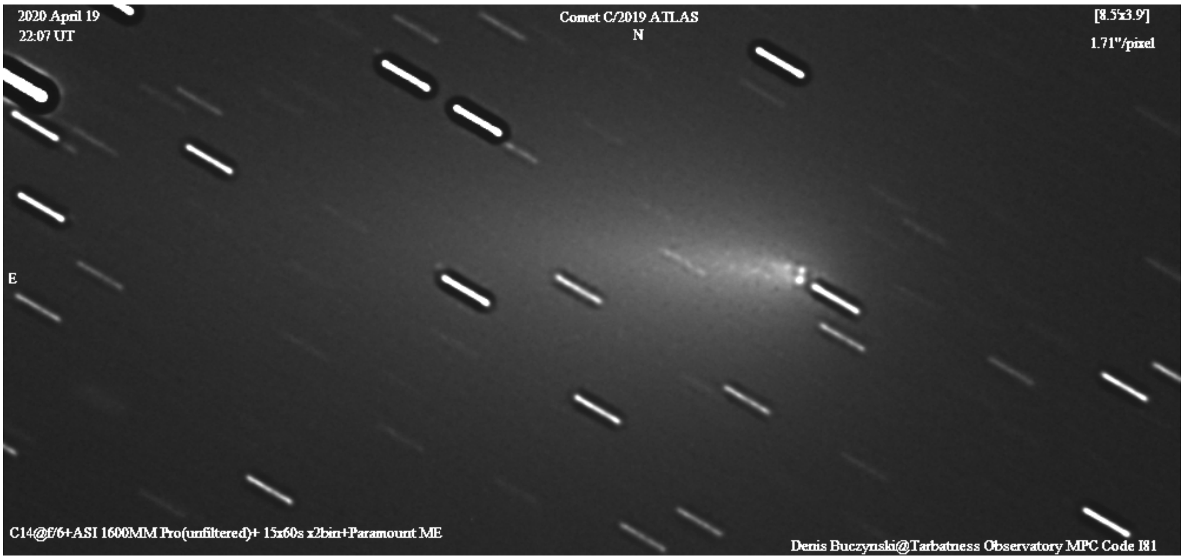


Figure 10 - Buczynski image of C/2019 Y4 ATLAS 2020 April 19

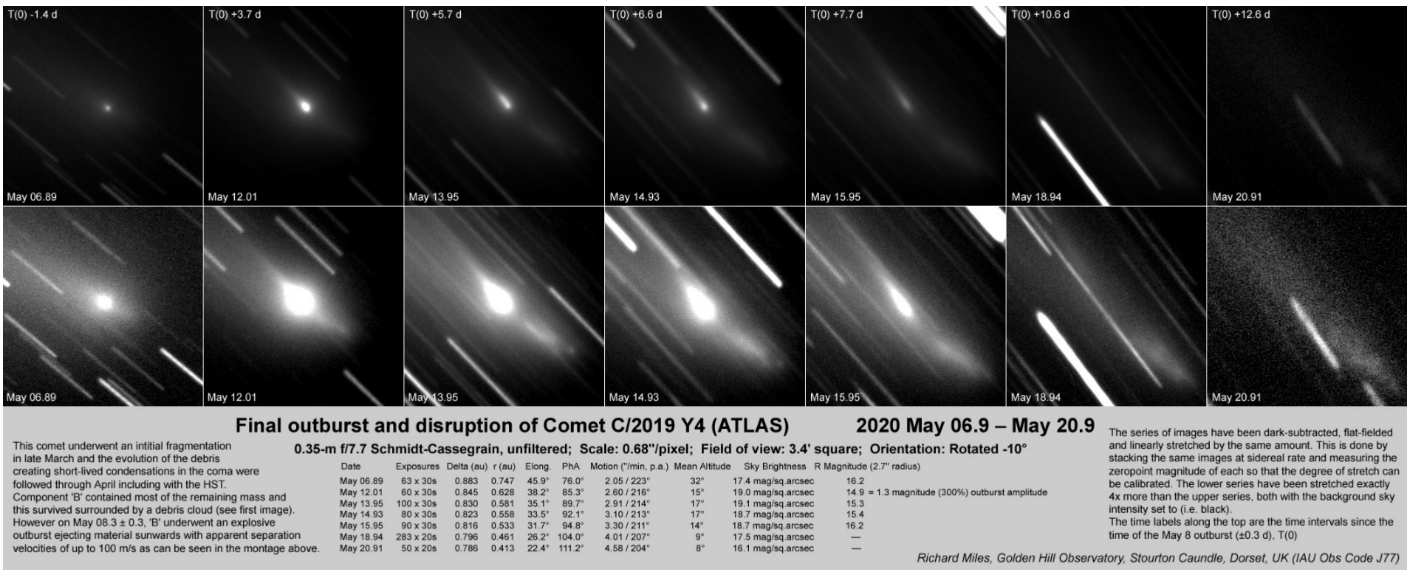


Figure 11 - Miles image of C/2019 Y4 ATLAS 2020 May 20

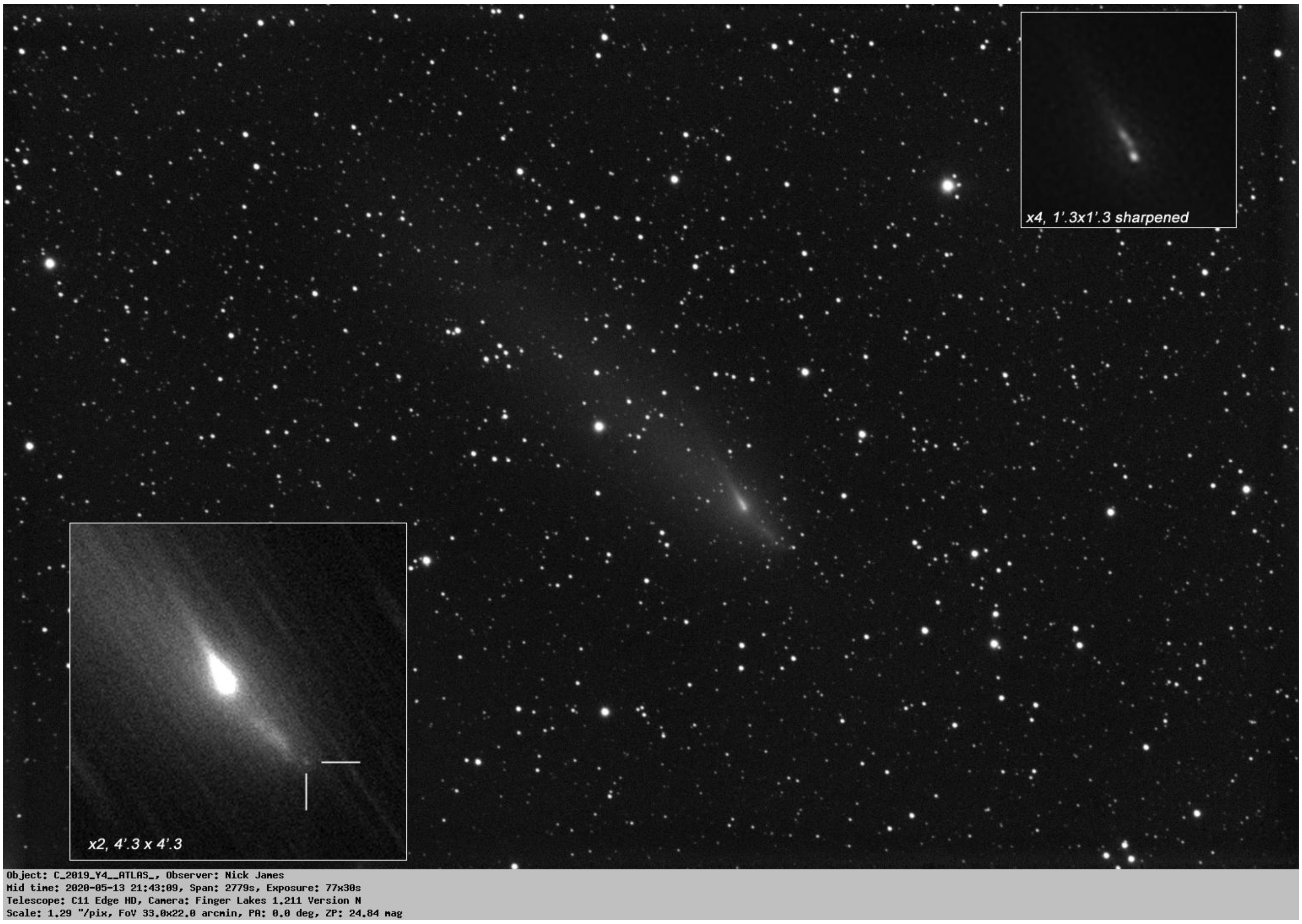


Figure 12 - James image of C/2019 Y4 ATLAS 2020 May 13

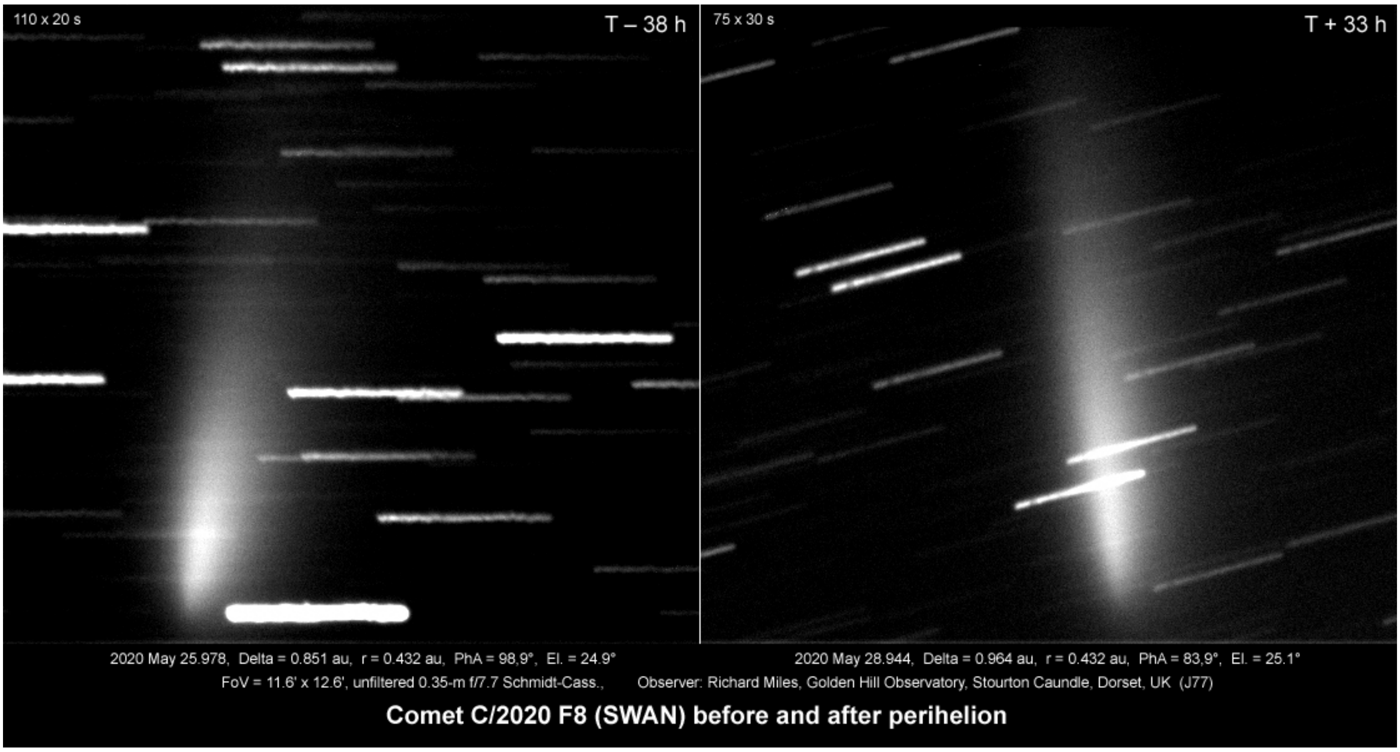


Figure 13 - Miles image of C/2020 F8 SWAN 2020 May 28

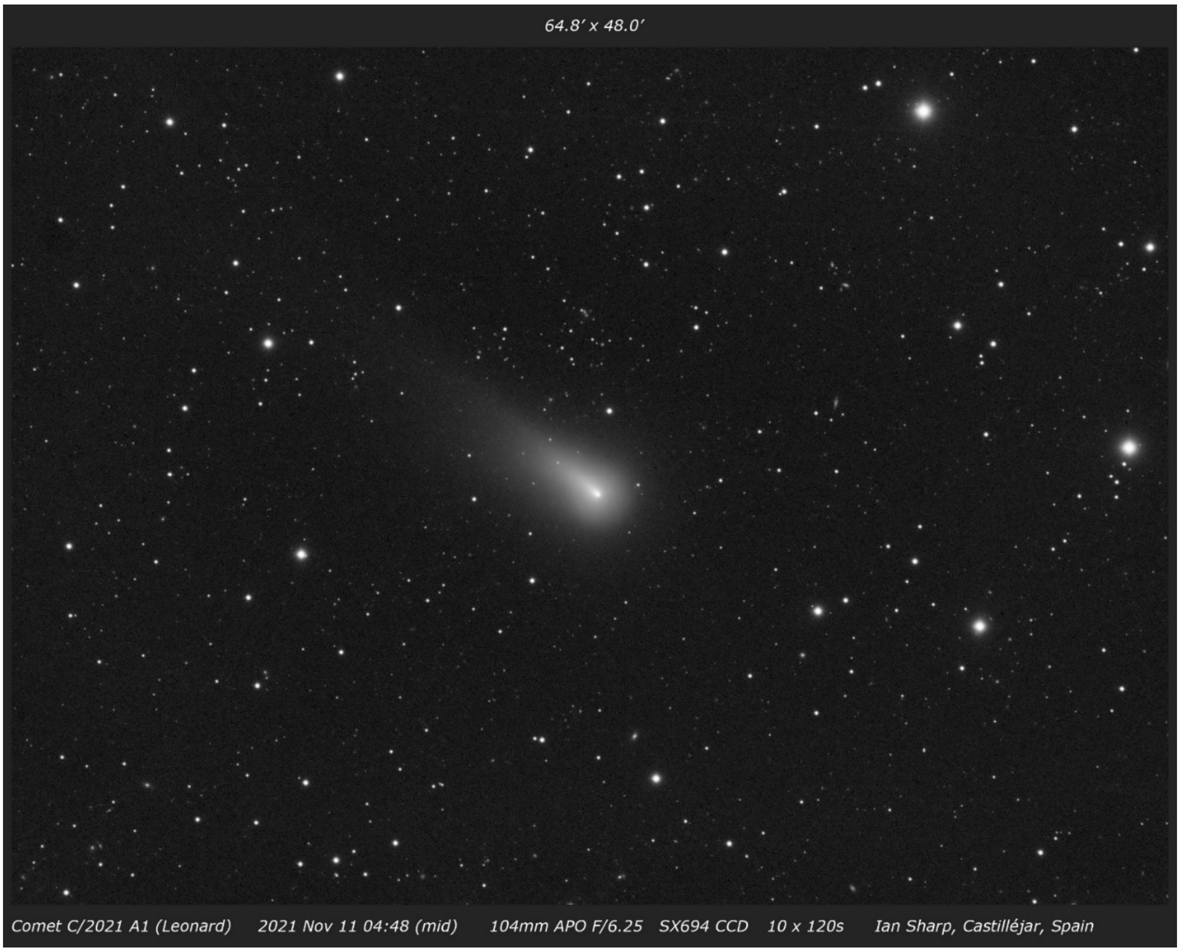


Figure 14 - Sharp image of C/2021 AI Leonard 2021 November 11

Figure 15 - Mattiazzo image of C/2021 A1 Leonard 2022 March 31

More recently, appearing in our skies and remarkably still under observation months after the comet disintegrated, the next comet on this list is C/2024 G3 (ATLAS). The discovery at magnitude 19 on 2024 April 5 by the ATLAS team in Chile was eventually recognised as being a long-period comet which had been through previous perihelion passages. The current perihelion was at 0.093 au on 2025 January 13. There was good observational coverage made after discovery all showing the comet brightening.

It was primarily a Southern hemisphere object. In late December the Solar elongation diminished and the comet was only observable within the Solar glare. On January 2 just prior to perihelion passage the comet underwent an outburst of around 2-3 magnitudes suggesting a catastrophic event. The appearance of a dark lane within the main tail indicated possible disintegration (Figure 16). The comet became bright enough to be imaged in daylight despite the Solar glare and its brightness was estimated to be magnitude -4. After perihelion the comet reappeared in the morning sky at magnitude 1 displaying an impressive tail in excess of 4° long with many striations (Figure 17). By Jan 26 the comet started to fade and the head was difficult to see, although the tail remained bright. Then the comet head disappeared completely and we were left looking at a modern day "headless wonder comet" (Figure 18). Remarkably, the tail continued to be imaged for months after the head had gone. A series of images by Rob Kaufman of the fading tail can be seen at this link:

https://britastro.org/cometobs/2024g3/thumbnails.html

John Bortle, veteran comet observer commented as follows:

"It seems to me that following the disruption of Comet G3 Atlas nucleus breakup during its perihelion passage, rather than totally dissipating and blowing away, as seems to have been the case with some other small q comets in the past, a rather substantial debris cloud remains at, or very near, the predicted ephemeris position projected for the former nucleus. In fact, the size, density, outline and total magnitude of the current debris cloud seems to me to be quite similar to what might be anticipated for that of a perihelion surviving nucleus-coma at this time and heliocentric distance. I have to wonder if a deep image with some very large, or orbiting telescope, might still show a dense cloud of tiny mini-comets at present, similar to those seen in conjunction with Comet LINEAR (C/1999 S4) about 25 years ago?"

The last comet on my list is C/2025 F2 (SWAN), which was discovered by Michael Mattiazzo, Vladimir Bezugly and Rob Matson in images from the SOHO spacecraft's SWAN instrument in late 2025 March (see the article starting on page 8). Perihelion passage was due on 2025 May 1 at 0.33 au. By early April the comet was well observed at magnitude 8 in the northern skies and the comet displayed a bright tail with many streamers. (Figure 19) By late April the comet had faded and images showed the false nucleus was elongated suggesting disintegration (Figure 20). By the end of April, the head had disappeared leaving only a diffuse dust tail (Figure 21).

It seems that the appearance of disintegrating comets has been more numerous in the past 25 years than had previously been noted although this is likely to be an effect of using more efficient imaging detectors than previously available. The remnant dust clouds are more easily imaged than in the past. The process of a comet's disintegration, as these small fragile bodies of the Solar System approach perihelion passage and are subjected to massive Solar tidal and gravitational forces is NOT unusual.

We do have the opportunity of predicting which comets are likely to disintegrate. There is a scale which we can use to consider cometary survival. It is called the Bortle scale. To understand the details of this scale and the rationale behind it consider reading this article written by late and great visual comet discoverer Don Machholz :

https://earthsky.org/astronomy-essentials/bortle-survival-limit-for-comets/

We need to take every opportunity to observe comets when they are visible in our skies as they may disappear before our own eyes!

Figure 16 - Prystavski image of C/2024 G3 ATLAS 2025 January 2

Figure 17 - Mattiazzo image of C/2024 G3 ATLAS 2015 January 22

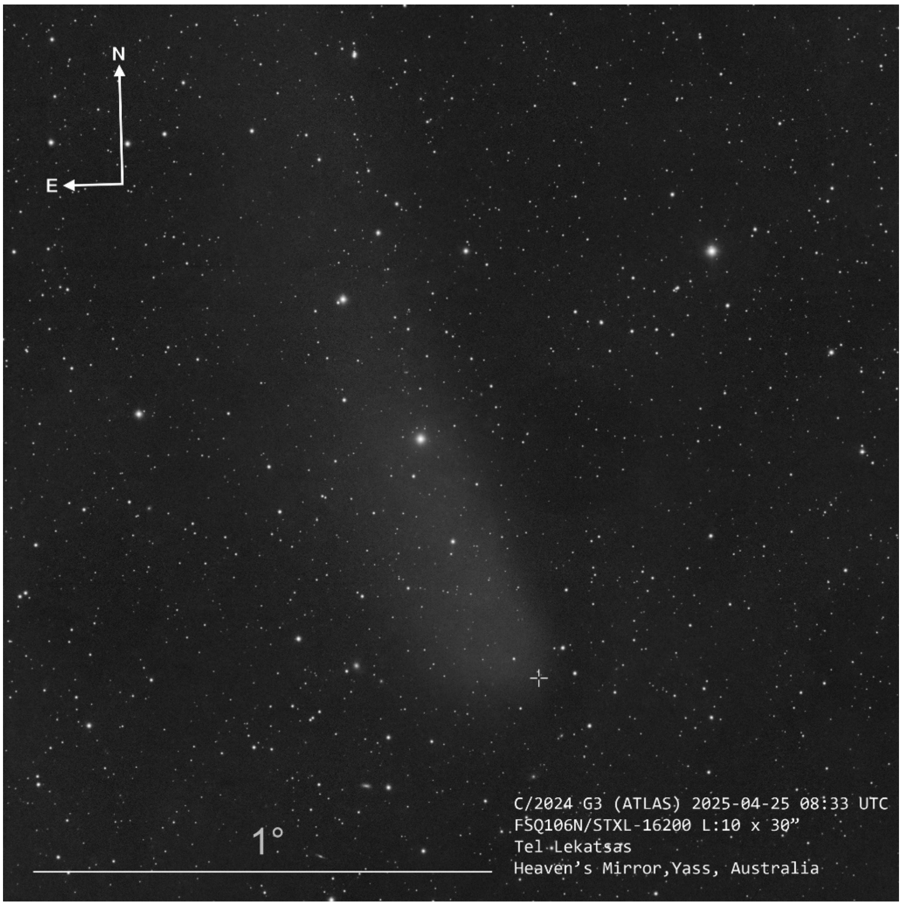


Figure 18 - Lekatsas image of C/2024 G3 ATLAS 2025 April 25

Figure 19 - Carson image of C/2025 F2 SWAN 2025 April 8

Figure 20 - Bartlett image of C/2025 F2 SWAN 2025 April 22

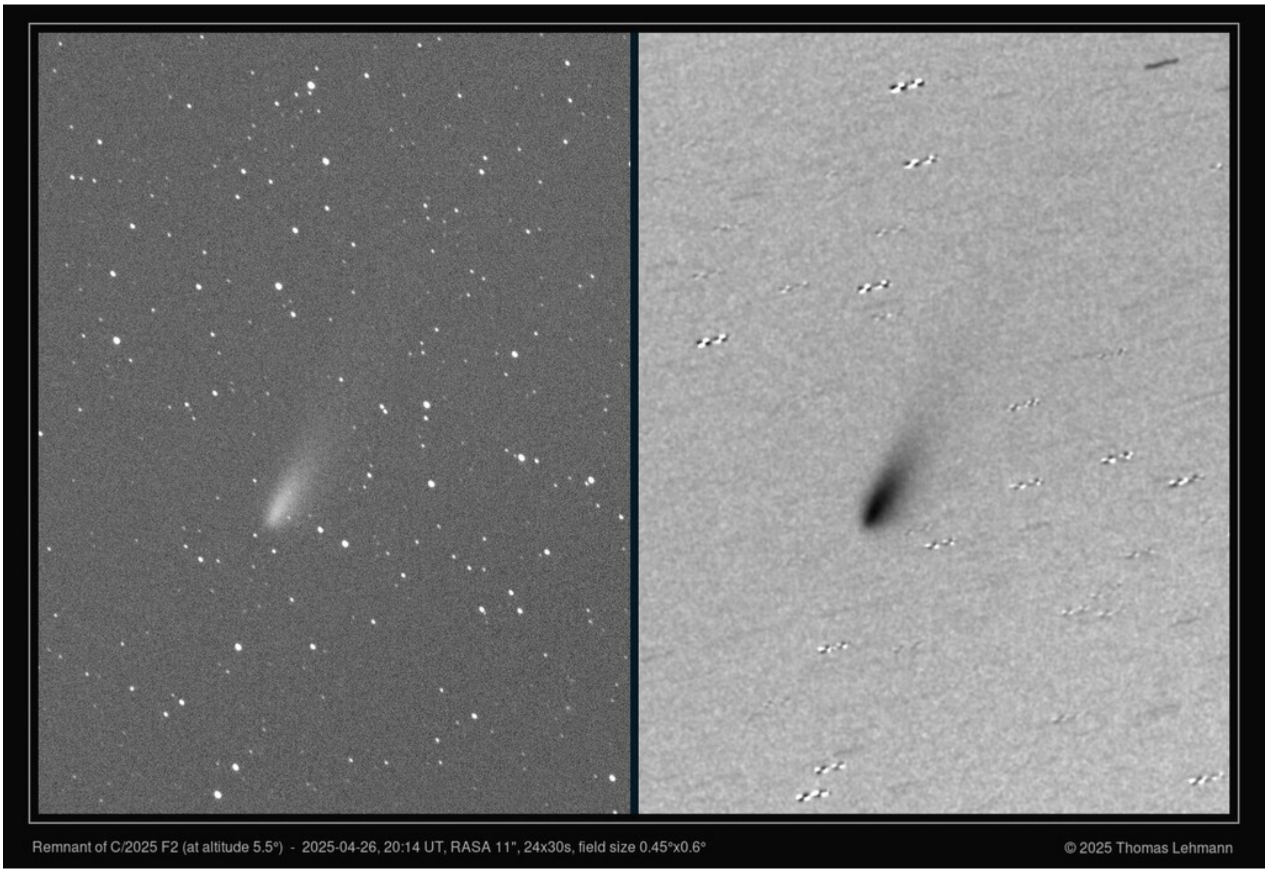


Figure 21 - Lehmann image of C/2025 F2 SWAN 2025 April 26

TYCHO TRACKER: A COMPREHENSIVE ALL-IN-ONE TOOL FOR COMET PHOTOMETRY

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Comet photometry is a crucial tool for understanding the physical and chemical properties of comets, including their brightness, activity levels, and dust production rates. Tycho Tracker v12 introduces a robust module dedicated specifically to comet photometry, streamlining the process of image calibration, alignment, and photometric measurements in one tool. This article demonstrates the capabilities of Tycho Tracker by comparing its results with other established comet photometry software, such as KOPR and Comphot. Using observational data from four comets with varying characteristics, we highlight Tycho Tracker's advanced tools for automatic star removal and photometric measurements. The results show Tycho Tracker as a reliable, user-friendly solution for both novice and experienced comet observers.

Introduction

Comets are among the most fascinating and dynamic objects in the solar system, displaying a wide range of physical and chemical phenomena. Photometry plays a critical role in studying these icy bodies by providing quantitative measurements of their brightness, activity levels, and morphological features. However, obtaining accurate comet photometry is challenging due to factors such as low surface brightness, complex morphology, and contamination from nearby stars or gradients in the sky background. Additionally, the total magnitude estimate is highly sensitive to the choice of photometric aperture, as it determines the coma's flux that is measured.

A variety of specialized tools, including KOPR [1], Comphot [2], FoCAs [3], and Airtools [4], have been developed to aid in comet photometry. While these tools are effective in their respective capacities, they often rely on additional preprocessing of images for image calibration and alignment using other software tools like Astrometrica [5], adding complexity to the workflow.

Tycho Tracker v12 [6] provides an all-in-one solution to address these challenges. Designed originally for the detection and measurement of asteroids, comets, variable stars, and artificial satellites, Tycho Tracker also supports advanced techniques such as synthetic tracking, enabling the detection of extremely faint, moving objects. The software includes modules for constructing light curves from a series of images and features a Period Search tool that can analyse both stationary sources (e.g., variable stars, exoplanets) and moving sources (e.g., asteroids). With the release of version 12, Tycho Tracker introduced a dedicated comet photometry module that simplifies the entire process from image calibration and alignment to photometric analysis.

In this article, we demonstrate the utility of Tycho Tracker's new comet photometry module through examples of four comets observed with varying magnitudes, coma structures, and tail properties. We also compare its results with those from other established comet photometry tools, including KOPR and Comphot, to evaluate its accuracy in measuring cometary magnitudes.

Using Tycho Tracker for Comet photometry

Detailed instructions for image calibration and alignment can be found in the Tycho Tracker User Guide [7]. This article focuses primarily on the capabilities and features of the new comet photometry module.

Verifying the quality of the images is always a recommended practice. With Tycho Tracker you need to load the images into the "Image Manager".

Images can be displayed and verified in the "Image Viewer" window that can be accessed from the **Action->View Images** main menu.

From the "Image Manager" you can click on the different images and see them displayed in the "Image Viewer" accordingly.

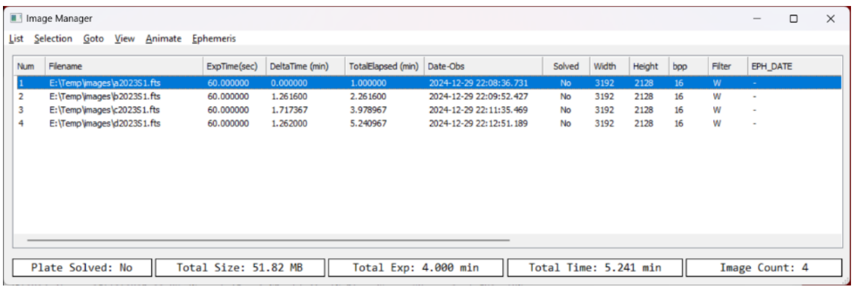

Figure 1 - Image Manager with four images Loaded.

Image calibration

To obtain reliable and accurate photometry measurements, it is crucial to properly calibrate all images using bias, dark, and flat frames. These calibration steps correct for sensor-specific noise, thermal noise, and optical imperfections, ensuring that your measurements reflect the true brightness of comet without contamination from instrumental effects.

While there are many tools available for performing image calibration, you can often rely on software you are already familiar with or use pre-processed data if it has been properly calibrated. However, a straightforward way to handle this process is also available in Tycho Tracker from the **Action->Calibrate Images** main menu. In the "Image Calibration" window you can specify pre-processed calibration files such as Master Bias, Master Dark, and Master Flat images.

While it is important to normalize images when using Tycho Tracker's synthetic tracker to ensure consistent background and flux scaling across the dataset, it is advisable to avoid applying additional normalization steps beyond the standard flat-field correction for sensitive photometric measurements, such as measuring faint objects. Additional normalization could introduce subtle errors in brightness measurements.

The resulting calibrated images will be saved in a new folder and automatically loaded in the "Image Manager".

Plate solving and image alignment

Utilizing multiple exposures in comet photometry is a well-established technique to enhance image quality by increasing the signal-to-noise ratio (SNR). This approach involves capturing a series of images of the same celestial object and combining them through a process known as image stacking. This is especially important in the photometry of faint comets.

In Tycho, the next step after Calibration is Plate Solving, which determines the exact coordinates and orientation of each image based on known star positions. Once the images are plate-solved, they can be aligned either on the background stars or directly on the moving comet.

Tycho Tracker simplifies this process. Begin by navigating to **Action > Plate Solve Images**. Once the solver has completed its task, proceed to align the images by selecting **Action > Align Images** and choosing the desired alignment options. The aligned images will be saved to a new directory and automatically loaded into the Image Manager.

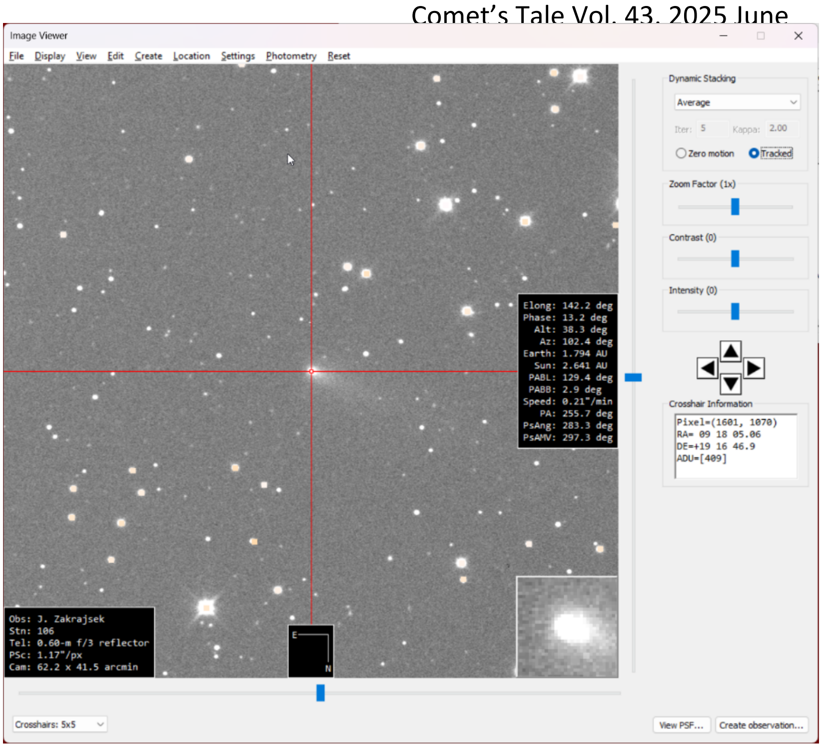

Figure 2 - Average stacked image created based on the comet's motion, displayed in the Image Viewer

Next, the ephemeris information must be attached to the image dataset. This can be done through the **Ephemeris > Attach from JPL Horizons** option in the Image Manager menu. Using the JPL Horizons interface, you can search for the comet by its designation and retrieve the necessary data. In addition to JPL Horizons, the Find_Orb ephemeris provides a solution for objects without a database entry.

With the ephemeris data attached, open the Image Viewer, and select all the images in the Image Manager. From there, you can display an average image aligned to the star positions (Zero motion stack) or create a stack based on the comet's motion using the **Create > Stack – Ephemeris** option in the Image Viewer menu.

Performing the comet photometry

Next, we can open the comet photometry window from the "Image Viewer" menu Photometry > Comet Photometry (Figure 3).

We need to set the Star Image (stack on the background stars – Zero motion stack) and the Comet Image (stack on the Comet motion – Tracked stack). We can do this by applying the appropriately stacked images from the Image Viewer. We also need to set the position of the Origin (centre of the comet's

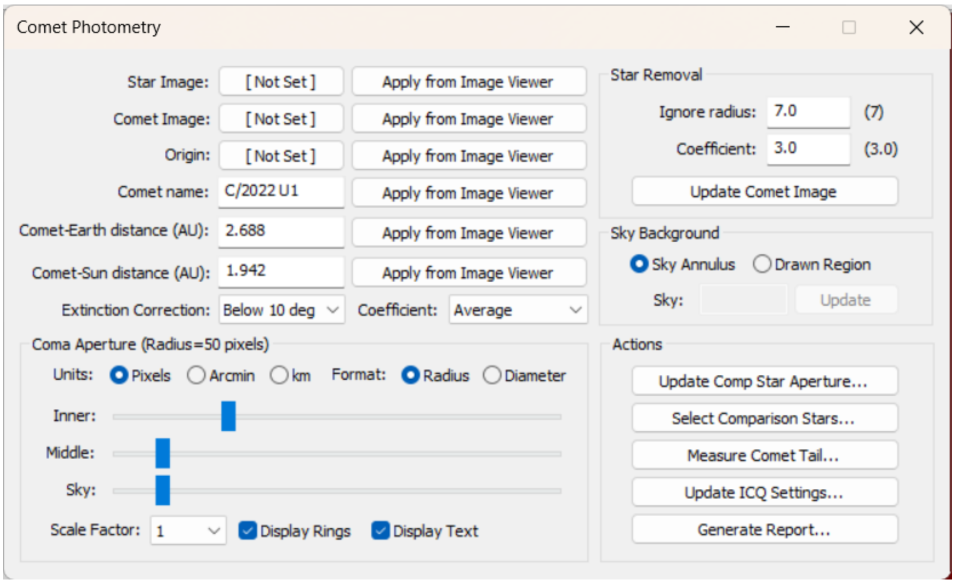

Figure 3 - Comet Photometry

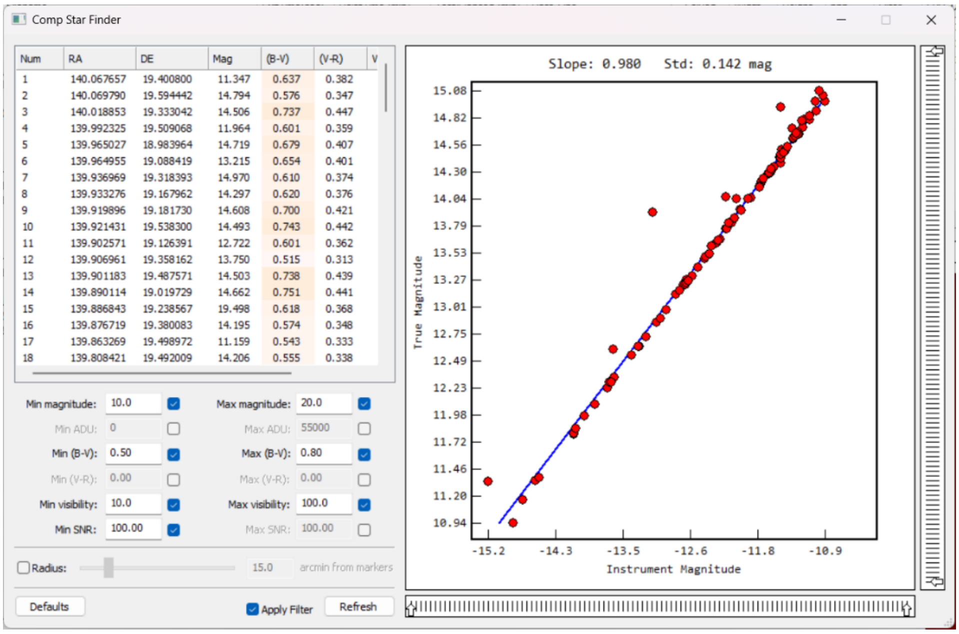

Figure 4 – Comparison star finder filtered to solar-like stars only

photocentre). The origin is automatically determined through centroiding when the images are stacked based on comet motion.

Selection of active comparison stars

To start the photometry process, we need first to select good comparison stars. We should use a recommended good photometric star catalogue like APASS or ATLAS, which is available in Tycho Tracker. The desired catalogue can be set through the **Settings > Star Catalog** main menu.

As the first step in the selection of the comparison stars, we need to set the photometry aperture used for the comparison stars. This can be done from the **Photometry > Modify Aperture Settings**. The comparison star aperture should normally be set to 4 times the FWHM (Full Width at Half Maximum) of the stellar PSF (Point Spread Function) [8]. The FWHM can also be measured using the Tycho Tracker in the "Image Viewer".

To find appropriate comparison stars, we select **Photometry > Find Comp Stars** menu in "Image Viewer". In the Comp Star Finder, we can filter comparison stars according to different parameters. Since our goal is to obtain a V magnitude, we will select only solar-like stars with B-V index between 0.5 and 0.8 (Figure 4).

For a good and reliable photometry measurement it is recommended to select 5 to 10 stars with as low delta magnitude as possible. We can select the points on the True Magnitude vs. Instrumental Magnitude plot, the software will move the aperture to the star on the image, and by right click we can add the selected star to the list of active comparison stars.

In the Active Comparison Stars window, we can display a plot of Delta magnitude (Figure 5), for all the selected stars, measured on individual images. It is best to eliminate stars with deviations of more than ±0.10 magnitude.

Coma Aperture setting

Now we need to set the appropriate Coma Aperture with the available sliders. It is recommended to increase a bit the contrast of the Comet Image to bring out the faint part of the comet's coma. The aperture size should surround the complete comet's coma (Figure 6).

Selection of the background region

The sky background value has a significant impact on the measured magnitude of the comet, making it essential to carefully select an appropriate background region. This region should meet several key criteria: should be measured close to the comet to minimize the influence of any sky gradient across the image and should avoid the comet's coma and tail to ensure the background measurement is not contaminated by additional light from these sources.

Tycho Tracker offers two methods:

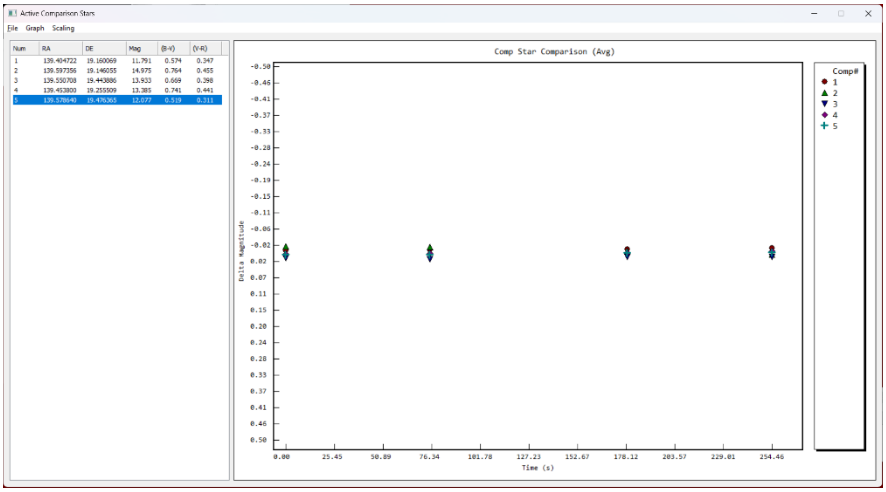

Figure 5 – Active comparison stars

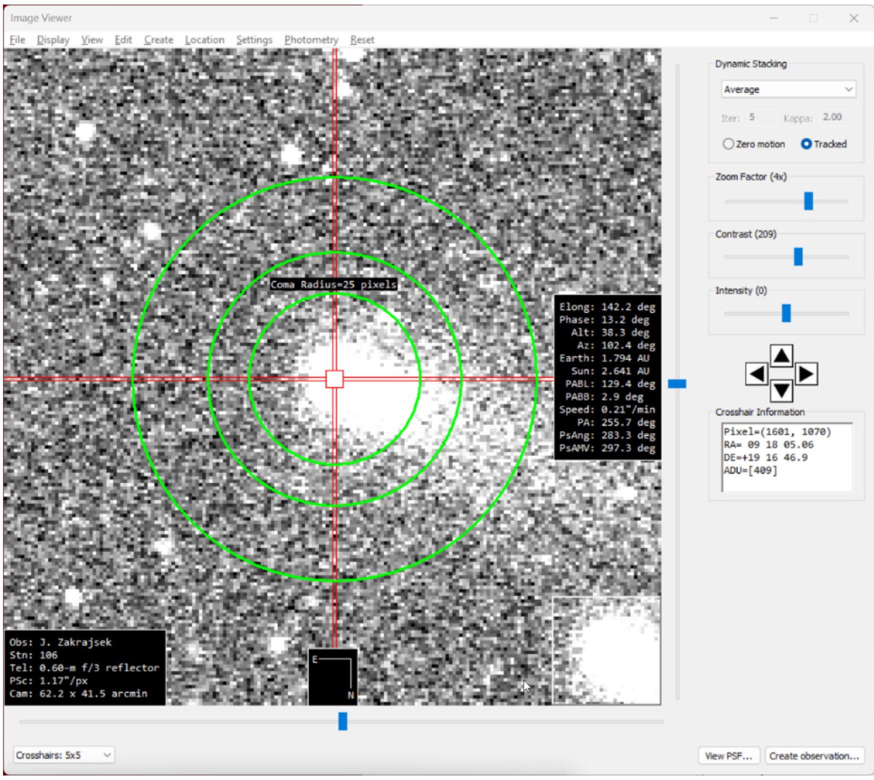

Figure 6 - Coma Aperture displayed in the Image Viewer with increased contrast

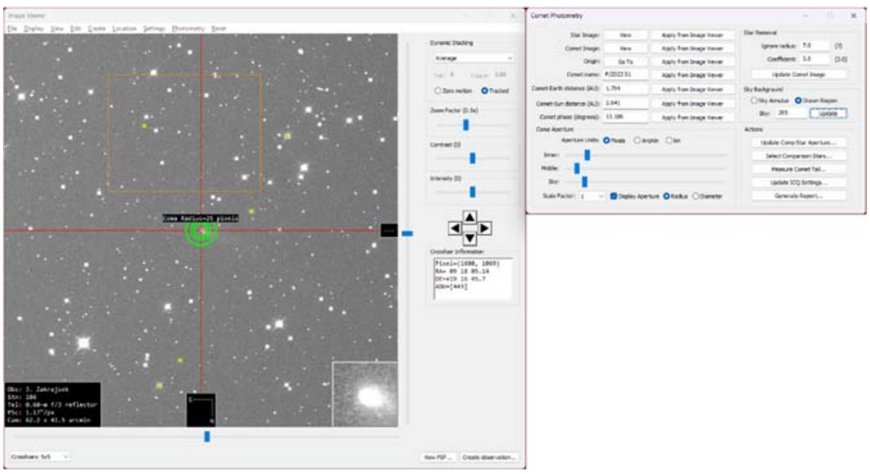

Figure 7 - Rectangular Drawn Region used for sky background determination

1. **Sky Annulus**: Measures the sky background in an annulus around the coma aperture.

2. **Rectangular Selection**: Which allows you to manually select a suitable background region anywhere in the image, by holding the Shift key and dragging the region on the image.

For bright comets with a prominent tail, using a rectangular selection for the background region is often preferable as it provides greater flexibility to select a clean area that avoids contamination from the tail extending into the sky annulus region. In contrast, for faint comets with low signal-to-noise ratio (SNR), it is recommended to use a regular sky annulus positioned around the coma aperture. This approach ensures more accurate background measurements, minimizing errors caused by incorrect background subtraction and improving the reliability of the results.

Measuring the tail length

In the Comet Photometry window of Tycho Tracker, we can also access a tool to create a ruler line on the image that allows to determine the length of the comet's tail by drawing a line from the comet's nucleus to the visible end of the tail (Figure 9). The ruler line is also used to measure the position angle of the tail, which is the angular direction of the tail relative to celestial north.

This tool provides an intuitive way to measure the comet's tail properties directly from the image, complementing photometric measurements with morphological details.

Star removal filter

For accurate photometric measurements of a comet, it is crucial to remove the contributions of stars and comet's tail within the comet's coma. The flux from these stars and the comet's tail can significantly affect the results, particularly for comets with low surface brightness, where even minor contributions can lead to overestimated brightness values. This effect is also pronounced for comets with a bright, prominent dust tail, where the tail's extended structure can contribute to

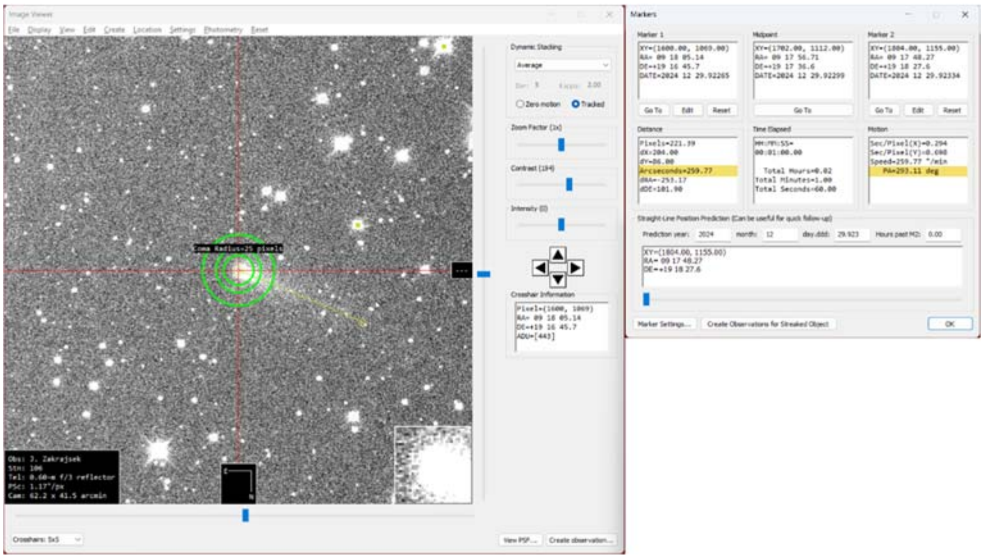

Figure 9 - Tail measurement in the Image Viewer with the ruler markers. Tail length and PA highlighted. Tail PA: N = 0°, E = 90°, S = 180°, W = 270°

additional flux, further skewing the photometric results and making it more difficult to accurately isolate the true brightness of the coma.

Tycho Tracker provides an effective solution for addressing this issue. It assumes that the comet's coma is circularly symmetric around its centre. This allows it to estimate the expected brightness distribution in the absence of stars. Star removal is performed using a threshold setting. A similar approach is also employed by the KOPR software, which uses an Average Circular Filter to mitigate such effects and improve the accuracy of the photometric measurements [8].

The effect of the star removal filter in Tycho Tracker is immediately displayed in the Image Viewer, allowing users to visually assess the impact of the filter. This real-time display helps ensure that the filter has effectively removed unwanted star contributions without compromising the comet's natural brightness.

The effect of different threshold coefficient settings is displayed in Figure 8, where pixels that exceed a certain brightness threshold (likely due to stars) are identified and then replaced with the median value of the corresponding concentric ring centred on the aperture's centre, thus reducing the impact of bright sources on the background estimate.

Users should adjust the threshold settings thoughtfully to balance star removal with the preservation of the comet's true brightness distribution.

Extinction correction

Since version 12.2, the Comet Photometry Module in Tycho Tracker includes the ability to apply magnitude corrections for atmospheric extinction. Atmospheric extinction, which results from the scattering and absorption of light by Earth's atmosphere, can significantly impact the measured magnitudes, particularly when a comet is observed at low altitudes. This effect becomes even more pronounced if there is a substantial altitude difference between the comet and the comparison stars used for photometry. The correction procedure implemented in Tycho Tracker follows the methodology outlined by Daniel W. E. Green in Magnitude Corrections for Atmospheric Extinction [9].

Generating a photometry results report

Tycho Tracker generates a text-based report that includes detailed photometric measurements, and an

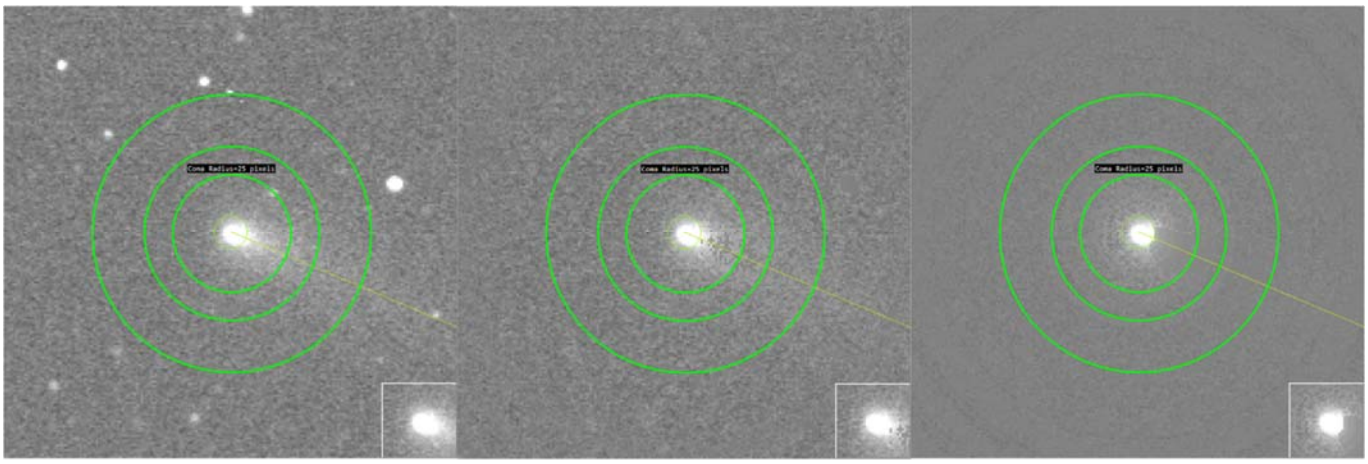

Figure 8 - Star removal filter with different coefficient settings: no filter (left), coefficient 3 (middle) and coefficient 1 (right)

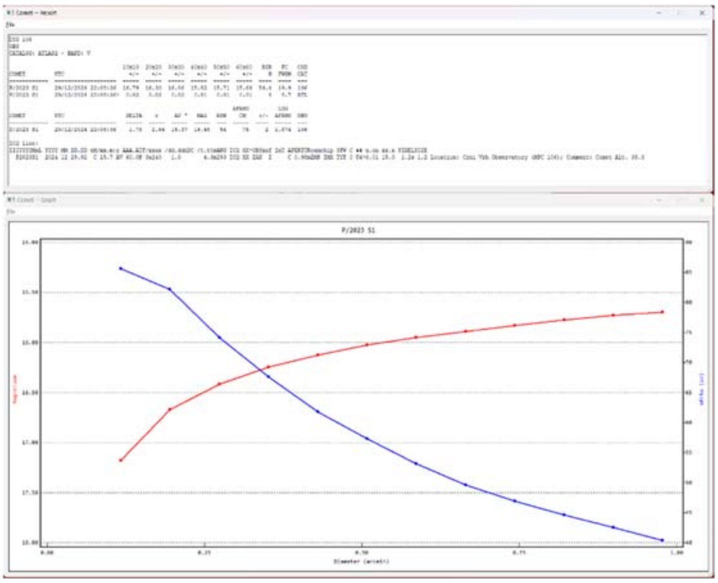

Figure 10 - Comet – Text Report (top) and Comet - Graph of magnitude growth curve (bottom)

ICQ (International Comet Quarterly) formatted report line [10]. The ICQ line ensures compatibility with standard comet observation reporting practices, allowing users to easily share their results and submit them to the Comet Observation Database (COBS) [11].

The text report presents magnitudes calculated using various aperture sizes, offering insight into how the brightness changes across the comet's coma. Additionally, the report includes key parameters such as the heliocentric distance (r), geocentric distance (Δ), and the calculated Afρ value.

Alongside the text report, Tycho Tracker also generates a visual plot, including the magnitude growth curve and the Afρ curve. The magnitude growth curve illustrates how the comet's total brightness increases with aperture size, providing valuable information about the extent of the coma.

Photometry examples

To demonstrate the photometry process, we present results for four different comets with varying characteristics. All images were acquired at Crni Vrh Observatory, using Cichocki telescope, a 0.6m f/3.3 Deltagraph and a ZWO ASI6200MMPro CMOS camera equipped with a clear filter.

Comparison of photometric results obtained by KOPR, Comphot and Tycho Tracker

All images were plate-solved and aligned using Tycho Tracker. Two stacked images were saved and subsequently analyzed for photometry using KOPR and Comphot software. For consistency and comparison, the same reference stars from the APASS V catalog were selected in both Tycho Tracker and KOPR, and identical photometry aperture sizes were used across all three tools.

An additional measurement was conducted with Comphot's automatic coma detection feature [12], which allows the software to determine the best aperture size for measuring the coma brightness.

To assess the importance of the star removal filter two measurements were conducted with Tycho Tracker, one with the star filter enabled and one with star filter turned off.

Comet 29P/Schwassmann–Wachmann

Images of Comet 29P/Schwassmann–Wachmann were acquired on 2024-12-31, a total of 12 images were captured, each with an exposure time of 60 seconds.

The comet had an expected magnitude of 12.6 (reported magnitudes 11.3 – 13.3) [13]. Comet features a large, diffused coma and was located in a dense star field, making the photometric analysis challenging due to the presence of numerous stars within the coma.

A coma aperture of 120 pixels was selected and applied consistently across all three software programs. The Tycho Tracker star removal filter was used with a coefficient setting of 1. This successfully eliminated all stars visible in the comet's coma, as well as part of the dust tail extending to the lower right. This effect is clearly visible in the right panel of Figure 11.

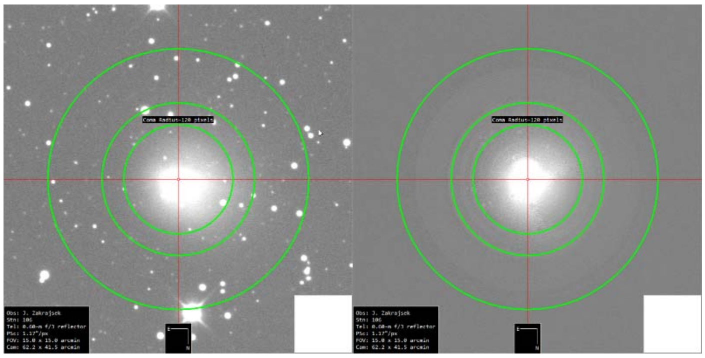

Figure 11 - Stacked image of comet 29P/ Schwassmann–Wachmann opened in Image Viewer with selected coma aperture displayed. Left image: no star removal, right image: with star removal coefficient = 1

The results presented in Table 1 (page 34) demonstrate that all three software tools yield comparable magnitudes, differing by less than 0.2 magnitudes when a star removal filter and manual coma aperture were used for the measurement. Comphot's automatic coma detection provides a slightly brighter measurement, due to the larger coma diameter estimate. Additionally, the effect of the star removal filter is evident. When the filter is turned off, the magnitude estimate increased by 0.1 magnitude, highlighting the importance of removing contaminating stars flux for accurate photometry.

Comet C/2023 A3 (Tsuchinshan–ATLAS)

Images of C/2023 A3 (Tsuchinshan–ATLAS) were acquired on 2024-12-29 during evening twilight, which introduced a notable sky brightness gradient across the images, making the selection of the comparison stars and sky background region particularly challenging to ensure accurate measurement. A total of 8 images, each with an exposure time of 60 seconds, were captured.

At the time of observation, the comet had a predicted brightness of magnitude 10.3 (reported magnitudes 9.4 – 10.8) [14]. The comet was located in a dense star field, with numerous stars visible within its coma. Additionally, the comet featured a bright dust tail extending across the photometry aperture.

A coma aperture of 65 pixels was selected and applied consistently across all three software programs. The Tycho Tracker star removal filter was used with a coefficient setting of 1. This successfully eliminated all stars visible in the comet's coma, it also eliminated the bright section of the comet's dust tail extending to the lower left of the coma aperture. The effect can be seen in the right panel of Figure 12.

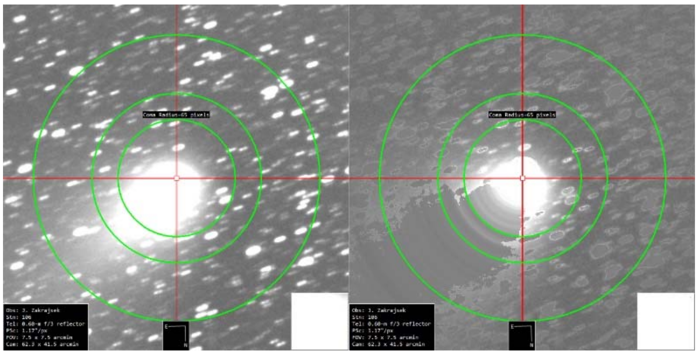

Figure 12 - Track stacked image of comet C/2023 A3 (Tsuchinshan–ATLAS) opened in Image Viewer with selected Coma Aperture displayed. Left image: no star removal, right image: with star removal coefficient = 1

The results presented in Table 2 (page 34) demonstrate that all three software tools yield comparable magnitudes, differing by less than 0.1 magnitudes when a star removal filter and manual coma aperture were used for the measurement. Comphot's automatic coma detection performed reasonably well for this comet, with its estimated coma diameter only 10 arcseconds larger and the corresponding magnitude estimate 0.1 magnitude brighter. The effect of the star removal filter was significant, with the magnitude estimate increasing by 0.5 magnitude when the filter was disabled. This discrepancy is attributed to the inclusion of a bright section of the comet's tail within the coma aperture.

Comet P/2023 S1

Images of P/2023 S1 were acquired on 2024-12-29. At the time of observation, the comet had a predicted brightness of magnitude 16.0 (reported magnitudes 14.8 – 16.1) [15]. The comet featured a notable tail extending across the photometry aperture.

A total of 12 images, each with an exposure time of 60 seconds, were captured.

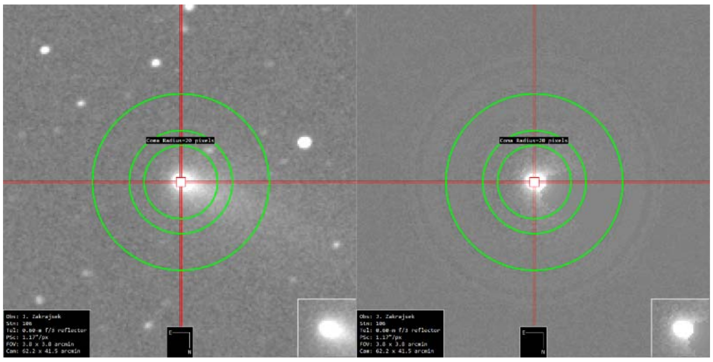

Figure 13 - Track stacked image of comet P/2023 S1 opened in Image Viewer with selected coma aperture displayed. Left image: no star removal, right image: with star removal coefficient=1

To maintain consistency, a coma aperture of 20 pixels was manually selected and applied across all three software programs used for the analysis. The Tycho Tracker star removal filter was used with a coefficient setting of 1. This successfully eliminated the section of the comet's dust tail extending to the lower right of the coma aperture. This effect is clearly visible in the right panel of Figure 13.

Table 3 (page 34) demonstrates that all three software tools yield comparable magnitudes, with differences of less than 0.1 magnitude when a star removal filter and manual coma aperture were used. However, Comphot's automatic coma detection underestimated the comet's coma diameter, resulting in a magnitude estimate that was 0.4 magnitudes fainter. The impact of the star removal filter was also notable; a 0.2 magnitude increase was observed when the filter was disabled. The observed magnitude difference can be attributed to the inclusion of a section of the comet's tail within the coma aperture, which was removed by the star removal filter.

Comet C/2022 U1 (Leonard)

Images of C/2022 U1 were acquired on 2024-12-29. A total of 10 images, each with an exposure time of 60 seconds, were captured. At the time of observation, the comet had a predicted brightness of magnitude 18.5 [16]. The comet was very faint, making the photometric analysis particularly challenging. A careful selection of the sky background region is critical for comets close to the limit of detection to avoid significant measurement errors.

A coma aperture of 7 pixels was selected and applied consistently across all three software programs. The Tycho Tracker star removal filter was used with a coefficient setting of 1; however, no significant effect was observed within the coma aperture (right panel of Figure 14), suggesting that the use of a star filter could be omitted in this case.

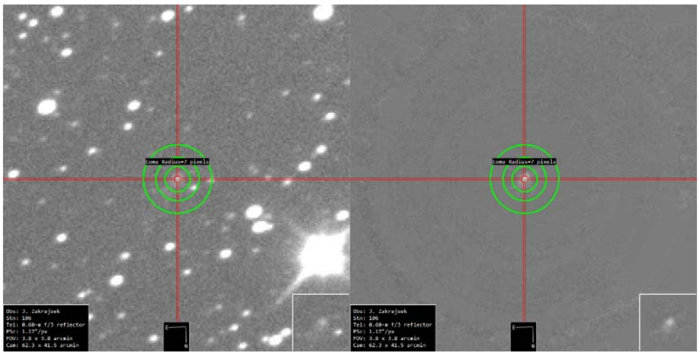

Figure 14 - Track stacked image of comet C/2022 U1 (Leonard) opened in Image Viewer with selected Coma Aperture displayed. Left image: no star removal, right image: with star removal coefficient=1

The results presented in Table 4 (page 34) demonstrate that KOPR and Tycho software tools yield comparable magnitudes, differing by less than 0.1 magnitude when a star removal filter and manual coma aperture were used for measurement. In contrast, Comphot, even with a manual coma aperture, underestimated the comet's magnitude by a whole magnitude. This discrepancy persisted when Comphot's automatic coma detection was used. The discrepancy in Comphot's measurements is likely due to two factors. First, is the way Comphot estimates coma brightness by computing medians within a set of concentric annuli. While this approach works well for brighter comets with relatively large comas, it does not work as well for small coma diameters. Second, Comphot might overestimate the background values, as it measures the sky background across the entire image. In contrast, Tycho and KOPR use a sky annulus positioned close to the coma aperture, allowing for a more localized and precise background estimation.

The effect of the star removal filter was negligible, with the magnitude estimate changing by only 0.1 magnitude when the filter was disabled. This was due to the small comet aperture used to measure this faint comet, and no stars were noted in the coma aperture.

Conclusion

A comparison of photometry results from Tycho Tracker, KOPR, and Comphot shows that all three software tools deliver comparable results, with deviations from the predicted magnitudes typically within ±0.1 magnitudes for the four analyzed comets.

One of Tycho Tracker's standout features is its visual star removal filter, which allows users to fine-tune the settings while immediately assessing the filter's effect directly on the image. This enables efficient adjustment for the accurate removal of contaminating star flux, a critical step for analyzing comets in dense star fields or those with low surface brightness.

A comparison of Tycho Tracker's results with and without the star removal filter demonstrated the significant impact of contaminating star flux. For comets in dense star fields, neglecting the star removal filter led to overestimations of magnitude by up to 0.3. This highlights the importance of using the star removal feature to ensure precise measurements, especially for comets with low surface brightness. A starting coefficient of 1 has proven to be a reliable default for the star removal filter, successfully removing the flux of stars and bright sections of the comet's tail, providing a balanced baseline for most observations.

Furthermore, it is important to note some considerations when using Comphot's automatic coma detection feature. Accurate flat fielding and gradient removal are essential to ensure that the sky background in the measured image is flat, as this is critical for obtaining reliable results. Comphot's unique and comprehensive automatic coma detection feature stands out in its capabilities; however, in our examples, even though the images were properly flat corrected, the procedure tended to overestimate the coma diameter for brighter comets, resulting in the comet's magnitude being overestimated, likely due to vignetting, which could be mitigated by cropping the images. Additionally, since the software determines the background value from the entire image, excessive background value correction led to an underestimated comet magnitude for fainter comets. This was observed in the cases of comets P/2023 S1 and C/2022 U1, with the latter having a particularly low signal-to-noise ratio (SNR). Further analysis is required to evaluate Comphot's automatic coma detection feature in greater detail.

In conclusion, Tycho Tracker v12 proved to be a reliable tool for comet photometry, offering a seamless integration of image calibration, alignment, and analysis, all within a single platform. Unlike other software such as KOPR and Comphot, Tycho Tracker eliminates the need for external preprocessing tools, significantly simplifying the photometry workflow. Its ability to adapt to different comet conditions, from bright comets with large coma to faint objects on the edge of detection, ensures accurate and reproducible results, setting a new standard for cometary observations.

Acknowledgements

We would like to thank Herman Mikuž from the Črni Vrh Observatory for providing the image sets of the comets used in this study.

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Observation date	Total Visual Magnitude (Coma diameter in arcmin)				
Software	KOPR	Comphot		Tycho	
Coma detection	Manual	Manual	Automatic	Manual	Manual
Star removal	On	On	On	On	Off
Star Removal Coefficient	Default	Default	Default	1	N/A
2024 12 31.14	11.6 (4.80)	11.45 (4.7)	11.20 (6.4)	11.6 (4.65)	11.5 (4.65)

Table 1 – 29p/Schwassmann-Wachmann

Observation date	Total Visual Magnitude (Coma diameter in arcmin)				
Software	KOPR	Comphot		Tycho	
Coma detection	Manual	Manual	Automatic	Manual	Manual
Star removal	On	On	On	On	Off
Star Removal Coefficient	Default	Default	Default	1	N/A
2024 12 29.71	10.4 (2.60)	10.31 (2.63)	10.23 (3.00)	10.3 (2.54)	9.8 (2.54)

Table 2 – C/2023 A3 (Tsuchinshan-ATLAS)

Observation date	Total Visual Magnitude (Coma diameter in arcmin)				
Software	KOPR	Comphot		Tycho	
Coma detection	Manual	Manual	Automatic	Manual	Manual
Star removal	On	On	On	On	Off
Star Removal Coefficient	Default	Default	Default	1	N/A
2024 12 29.92	15.9 (0.80)	15.81 (0.94)	16.21 (0.56)	15.8 (0.74)	15.6 (0.74)

Table 3 – P/2023 S1

Observation date	Total Visual Magnitude (Coma diameter in arcmin)				
Software	KOPR	Comphot		Tycho	
Coma detection	Manual	Manual	Automatic	Manual	Manual
Star removal	On	On	On	On	Off
Star Removal Coefficient	Default	Default	Default	1	N/A
2024 12 29.72	18.3 (0.28)	19.42 (0.38)	19.42 (0.38)	18.4 (0.27)	18.3 (0.27)

Table 4 – C/2022 U1 (Leonard)

EVOLUTION OF A COMET OBSERVER

Owen Brazell

Over 50 years or so I have observed over 100 comets visually. My interest in comets started in 1965 when I failed to observe C/1965 S1 (Ikeya-Seki), although I was only 8 at the time! It took until 1975 before I found my first comet in C/1975 N1 (Kobayashi-Berger-Milon). My interests in observing comets since then have always been visual and I have followed comets with apertures up to 55 cm. The way I observe comets has, of course, changed significantly over time from plotting tracks on Norton's star atlas to the computer-aided techniques of today.

Figure 1 – The 22-inch Obsession at Kelling Heath Star Camp, Norfolk

When observing with smaller instruments such as my 16×70 binoculars I tend to star hop using a mobile planetarium such as SkySafari Pro on my tablet/phone to be able to find them. When using larger instruments, I tend to plan in a different way. My smaller Alt-Az mounts have encoders and initially these were powered by using the Wildcard ArgoNavis system. The advantage of this system is that you can load comet elements and it will then compute the position of the comet at the time you are observing. This, of course, depends on both the accuracy of the elements and the accuracy of the calculation of the orbits, something that was a problem in the early days. The comet elements could be loaded manually but I preferred to use a program called SkyTools which not only produced a monthly list of bright comets but directly connected to the ArgoNavis to load these elements. It was limited to nine sets of elements but there were rarely more than nine bright comets available anyway. The author of SkyTools tried to improve the magnitude predictions by incorporating current observations. However as in the case of C/2025 F2 (SWAN) which appeared and disappeared in a month you could load the MPC data as well to get more current predictions. SkyTools also had the advantage of making very good finder charts, including eyepiece views which enabled me to confirm from the star field if I had found a comet or not.

The original Alt-Az mount I used was a Discmount DM6 with encoders and this carried my Tak Mewlon M210 or the Mirage STF 7. I found however that there were always instabilities with the encoders on this mount and it has been replaced by a Rowan AZ100 mount with much more accurate encoders. The very high-resolution encoders on this mount however have required a shift to a different type of Digital Setting circles (DSC) in the AstroDevices Nexus DSC. The two larger telescopes (an Obsession 15 UC and an Obsession 22 UC) both use lower resolution (10,000 tick) encoders and initially, as with the smaller mount, these telescopes also worked with the ArgoNavis system. This system was good for finding comets but its accuracy depended very much on how well the two-star alignment process worked. In general, however it mostly put the comet near the centre of the field. There were limitations with this system in that it did not work well when the comet was at low altitude, I assume because of refraction.

My main interest is in finding deep sky objects with these telescopes and, although you could star hop, it became quite time consuming when going for fainter and more obscure targets. The next stage evolution in finding these faint objects was to add Keith Venables' eFinder system to both telescopes. This system used a small camera to take an image of the sky that was then plate solved on a Raspberry Pi system and a pointing correction was sent to the Nexus system. I had to move completely to the Nexus DSC system to support the eFinder. There are a number of other similar systems on the market now. The main change here was the way the comet elements were loaded. The Nexus DSC has most of its catalogues on a microSD card and this loaded the comet elements in the MPC format. Initially this was a problem as you would have to edit the file to only include the comets you were interested in but the author of SkyTools made a modification so his Current Comets list could be output in that format and then copied onto the microSD card so I had the advantage of a much smaller list to play with.

Figure 2 – C/2023 A3 2024 October 19

The accuracy of the eFinder system meant that I was sure where in the sky I was looking and if I could not see the comet then there was either an issue with the elements or the comet was fainter than I expected. This type of eFinder system has become very popular with the users of Dobsonians although most are simply designs which you have to make for yourself.

Unfortunately, because of my location I cannot use the 55 cm telescope as the back garden only has a good view to the north. There have been occasions where there have been three northern comets visible from the garden so usually then the 35 cm is deployed. Otherwise, to see any comets I have to do a road trip which, at the early times in the morning that comets seem to appear, means loading the car with equipment and going to a site where I can find them. Luckily for evening occurrences I can go to a friend's house not far away that has excellent horizons.

Taking an expensive telescope out at 3 a.m. has its downsides as I found when, half asleep, I did not attach the Mewlon to its mount correctly and turned only to hear a loud crash as the Mewlon hit the ground. Luckily the optics were not damaged although the tube now has a dent. For larger comets I also have a APM 130 mm refractor that fits on the standard mounts as well. Over the years these systems have allowed me to find numerous comets.

The 55 cm has been used mostly at star parties. I have combined the experiences with the use of some of the comet filters. I initially used the Lumicon comet filter as that was all that was available and, as noted by all users, this filter works well on gaseous comets but not at all on dusty ones. Two years ago, I purchased the new Baader C2-Swan band comet filter and found this to be also an excellent filter for gaseous comets. It is also of somewhat newer technology than the Lumicon one. It may be the only comet filter available now as I believe that Lumicon has gone out of business. The only issues with these filters are that you really need both the 1.25 and 2" versions for the larger comets so the cost becomes a significant factor. Most of the recent comets have been dusty ones so the filter has not been of much use. I tend to use the hyperwide field (100°) Ethos eyepiece range for my comet observing as the wide field of view means that it is easier to initially locate the comet. I can then scale up or down the magnification depending on the size of the comet. The field of view may also be a personal preference as when observing comets with a group people sometimes prefer a different magnification for the best view.

As time went by however, I felt I needed another tool so at the 2024 Kelling spring star party I bought a ZWO Seestar S50 smart telescope and this has spent most of its time imaging comets. There are a number of restrictions with the telescope as you have to take short exposures so the comet does not move as it does not have the ability to track on a comet's motion. The latest evolution of the software/firmware allows for the official support of the telescope in equatorial mode. The telescope is set to take 10 second exposures and then stack them, it can also do 20 or 30 second exposures but I understand that the longer ones don't work as well. If you ask it to then it also saves the subframes as FITS files on the telescope which can be taken off for further processing.

Figure 3 – 29P on 2025 March 31

The telescope stores images in a folder with the name of the object which works well for a single session but, if you do multiple sessions, all the images get stored in the same folder which makes it difficult to disentangle them later. The telescope can be connected to a computer using a USB cable and then it appears as a disk drive so it is easy to get the images off. The bult-in camera is a colour camera so the data comes off as image cubes. For fainter comets if you extract just the green plane and do photometry on it the results are surprisingly accurate, although for larger ones the results are not so good. The Seestar also can have an issue in that if the comet moves too quickly or if the telescope jerks for any reason it then starts stacking on a different point so you end up with a double nucleus. I found that, even with 6-minute exposures, I could find comets down to about 14th magnitude. Last year the S50 spent a lot of time following 12P and 13P and I got some quite nice images The power of this system was brought home to me at the 2025 Kelling Spring Star party when I set it to image 29P and was surprised to find it relatively easily. However, when looking for the comet through the 55 cm telescope visually I could not see anything, even using the image from the Seestar as a guide. I must admit I have now bought a Seestar S30 while they were at the old price in case a bright comet comes along and I need a wider field of view.

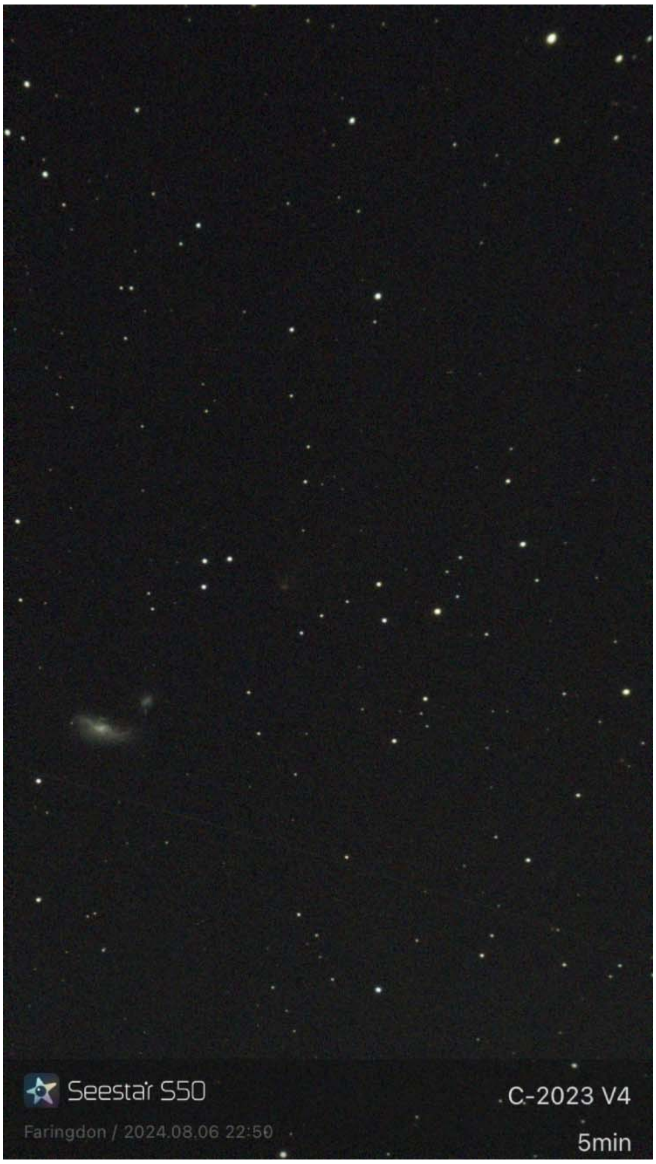

Figure 4 – C/2023 V4 on 2024 August 6

There is a problem with these telescopes when you have a fast-moving comet as I found with C/2025 F2 as with two exposures only 15 minutes apart the comet had moved considerably. I see now that many people are using the S50 for comet work so I guess the BAA will get different types of images to play with. There is a rumour of an ZWO Seestar S70 which, if true, will make a very interesting system for comets. The Seestar telescopes are driven from mobile devices, either a tablet or phone running iOS or Android, and ZWO update the object data very frequently so normally the comet you are interested in is already in the database. The portability and quick setup time mean that early morning road trips to find comets are not quite as stressful as they were. The one issue however that needs to be made aware of is the system needs to know where it is. This is not really a problem with a phone but Apple iPads for instance do not always have GPS capability so either you have to enter your location manually or hotspot it to a phone, or more usually in my case just use the phone.

A lack of drawing ability means that I have not been able to reproduce comets as much as I would like and a lack of confidence in doing magnitude estimates means that again, visually, I have not perhaps have contributed as much as I would have liked so the ability the use the Seestar to get an image has been a boon. I do not however see this supplanting visually following comets.

In terms of software evolution although I professionally worked with Linux, all my astronomical work is done on Windows. I used to use Megastar V5 and various versions of Project Pluto's Guide software, now at version 9.1, for comet work and although I still use Guide occasionally for plotting comet tracks, I primarily use SkyTools 4 Visual Pro for my comet work because of the integration it has with the tools I use. Megastar and Guide both allow you to download the current observable comet data, as does SkyTools if you want to work on a comet that is not included in the Current Comets list. SkyTools also provides a useful amount of information on comet data as shown in the supplied image. There is also an Imaging version that shows a lot more comets.

There may soon be a version of SkyTools 4.1 coming out that will support Electronically Assisted Astronomy (EAA) and smart telescopes and it will be interesting to see how this fits in with the comet work I do. I also understand that ZWO will produce an ASCOM/Alpaca module for the Seestars, which will allow them to be driven from other software apart from the Seestar app. I don't expect this to make much difference to the comet work but it will allow for a wider range of deep sky objects to be found. On the mobile devices I usually use SkySafari Pro 6, although I do have version 7 for comet work. The makers of that software update their comet data frequently from the MPC so you can get the latest data quite easily which helps when comet elements are rapidly evolving.

I also find the various Facebook forums dedicated to comets a useful source of information on what a comet may look like and Gideon van Buitenen's website at https://astro.vanbuitenen.nl/home a useful source of information on current comets.

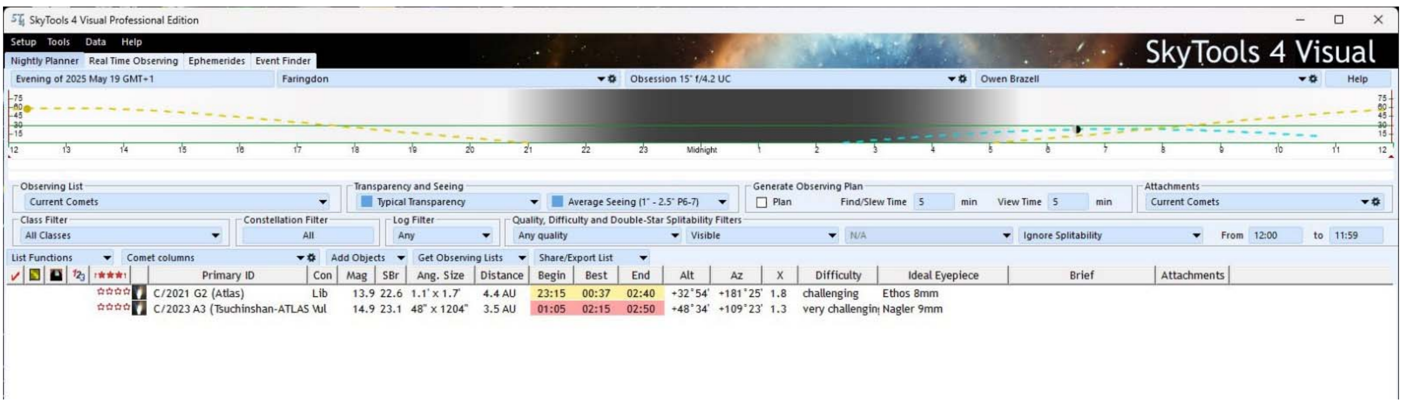

Figure 5 – Skytools comet listing

DONATI'S COMET – A WHODUNNIT MYSTERY

James Dawson, Nottingham

Figure 1

A friend of my father's knew that I was interested in astronomy and, when he found a painting of a comet in 2015 whilst undertaking a house clearance in the West Midlands, he passed on to me (Figure 1). The writing on the back of the frame and the year 1858 next to the artist's initials allowed me to deduce it was Donati's Comet, C/1858 L1. I posted on the BAA Forum at the time:

https://britastro.org/forums/topic/donatis-great-comet-of-1858

On the reverse of the painting, it was credited to 'Clementina Heathcote (afterwards Hon Lady Tryon)' and I was keen to find out more about the artist and potentially where it had been painted.

I'd taken the picture out of its frame and mounting card and identified the asterism of the Plough, and Arcturus near the head of the comet (Figure 2). Charts from 1858 (Figure 3) showing the position of the comet on various dates in September and October indicated if the painting was accurate, it was a study on the evening of 4th or 5th October 1858, looking north west.

Clementina Charlotte Heathcote (1833-1922) was born in Rutland, England, and went on to marry Vice Admiral Sir George Tryon (1832-1893) in 1869 and became Lady Tryon. My initial research in 2015 was wrong in that I mistakenly thought Clementina was living at Drummond Castle in Perthshire in 1858, but more thorough research has clarified matters.

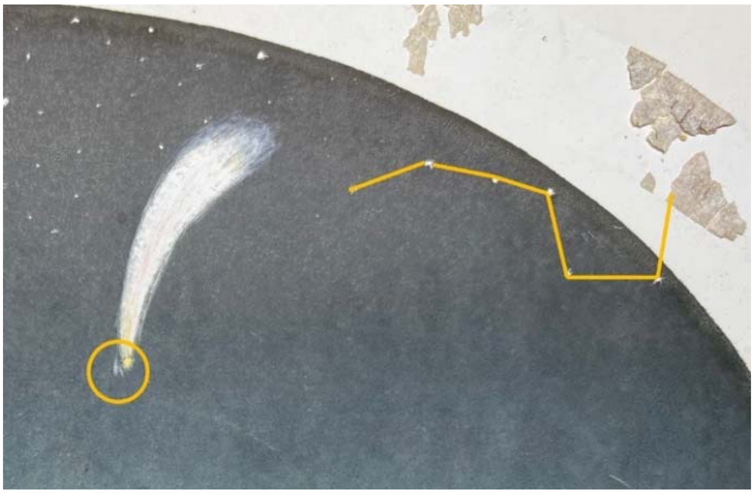

Figure 2 – The comet and the Plough asterism

As was common at the time, and especially within the aristocracy, names were handed down to successive generations. Clementina Charlotte's mother was also a

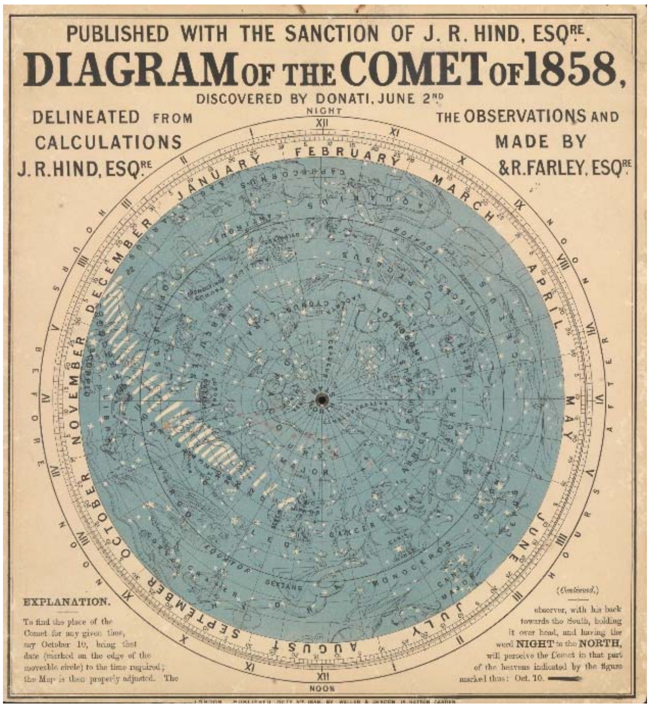

Figure 3 – 1858 chart

Clementina [Clementina Elizabeth Drummond]. It was Clementina Elizabeth (1809-1888) who had lived in Perthshire; she married Clementina Charlotte's father, Gilbert John Heathcote (1795-1867) in 1827. The Heathcote family owned a great deal of land, notably in Lincolnshire and Rutland, and Clementina Charlotte was born at Normanton Hall in Stretton, Rutland which appears to have been the family's principal residence. Normanton Hall was demolished in the 20th century and much of the Normanton Park Estate now sits under Rutland Water, the largest reservoir in England which was completed in 1975. I've managed to find old maps online (Figure 4), and photographs of the buildings and grounds of Normanton Hall.

Normanton Hall was built with its long axis northeast to southwest, and the grand views from the property look northwest (see insert). Fortunately, the photographs I've found show the grounds, the stone statues and sculptures, and these match those in the painting.

Figure 6, looking north with Normanton Hall on the east, and the garden statues to the west, with and insert of the painting looking northwest. Figure 9, looking east towards the hall, showing a low wall on the northwest edge of the garden studded with stone urn-like ornaments, as seen on the painting.

Figure 8 shows the initials on the front of the painting, seemingly etched through the paint are CHD. The assumption is that this must represent Clementina Heathcote Drummond. In 1858, Clementina Charlotte would have been 25 years old and still living at home, and her mother aged 49.

Whilst both women appear in historical records with their many surnames and inherited titles, only Clementina Elizabeth (the mother) ever appears as Clementina Heathcote Drummond. Both eventually became Baroness Willoughby de Eresby (23rd and 24th Baronesses), a title which today is held by the 28th Baronesses, Honourable Nancy Jane Marie Heathcote-Drummond-Willoughby. I've contacted the current Baroness and, unfortunately, she can't shed any

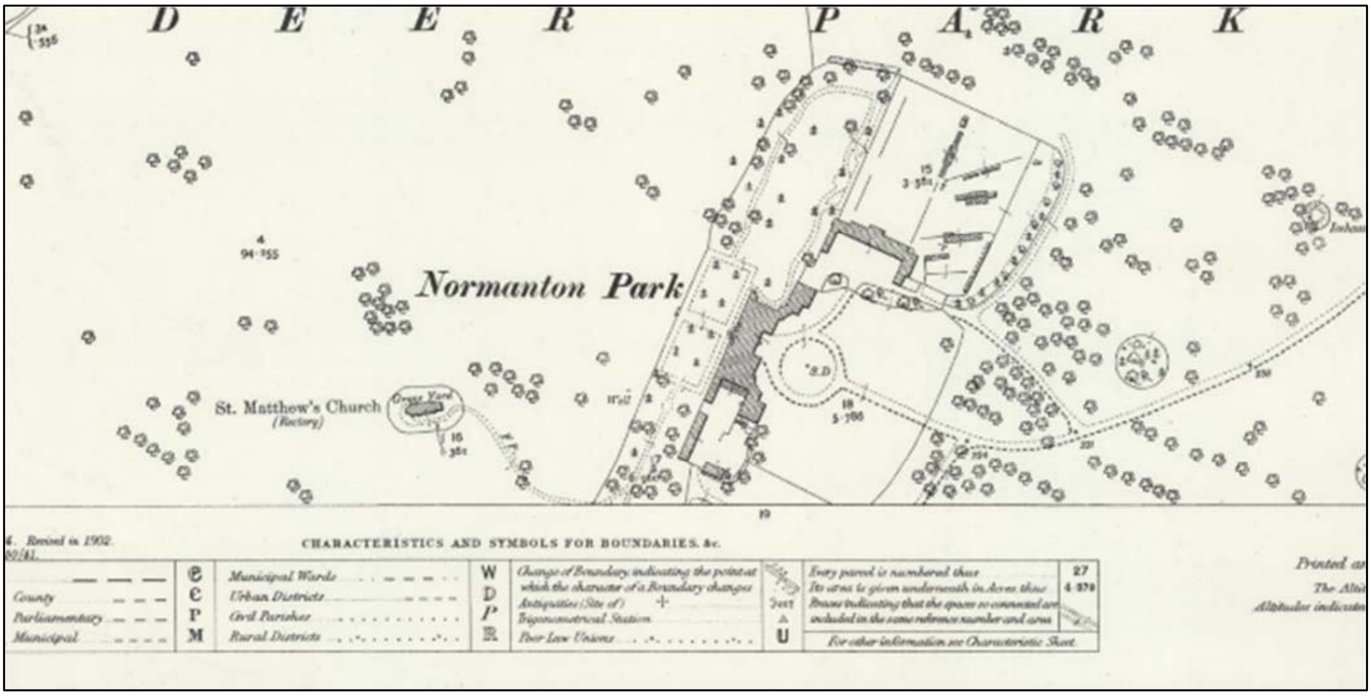

Figure 4 – Normanton Park

further light on the potential artist but is fascinated by the story. However, given the initials on the painting and the information I've discovered, I am 99% sure it was by Clementina Elizabeth Heathcote Drummond, the mother. I have found photographs of both of these women; Clementina Charlotte (Figure 5), and Clementina Elizabeth (Figure 7). I've enjoyed my amateur sleuthing and found it fascinating to learn more about this painting and the two Clementinas.

Figure 5 - Clementia Charlotte Drummond

Figure 6 – Normanton Hall looking north

Figure 7 – Clementia Elizabeth Drummond

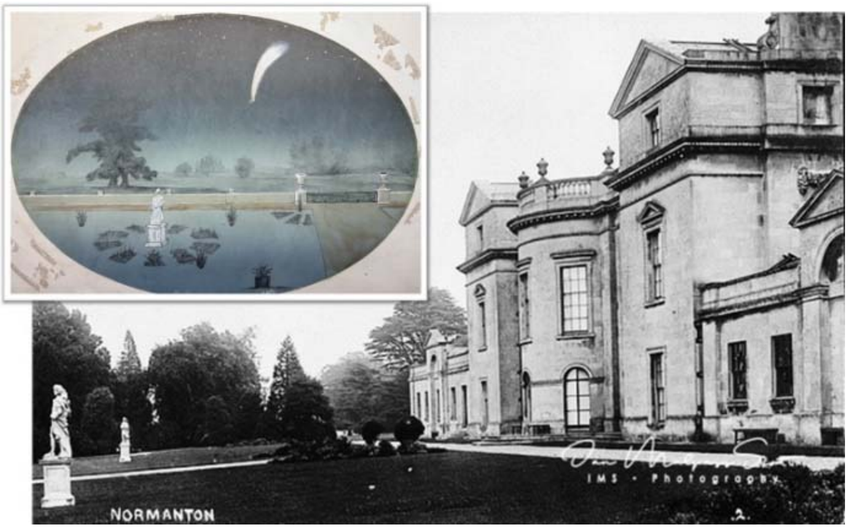

Figure 9 – Normanton Hall looking east

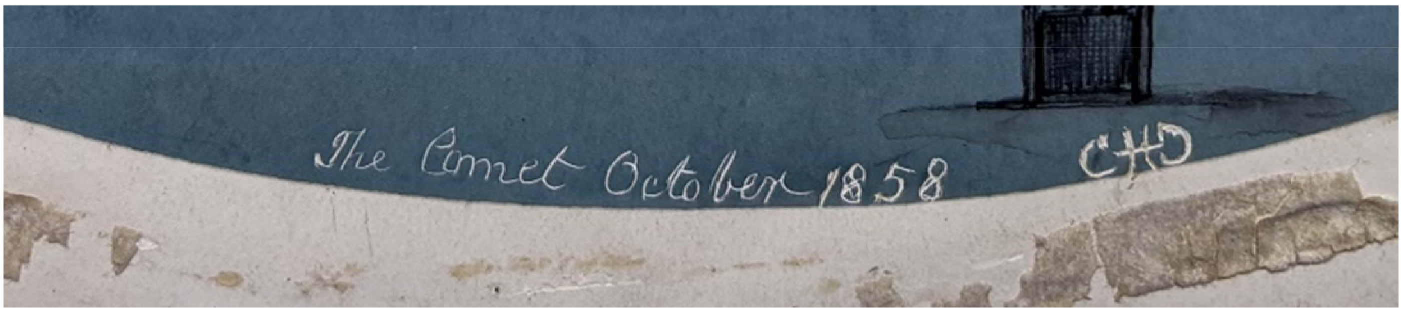

Figure 8 – Initials on the painting