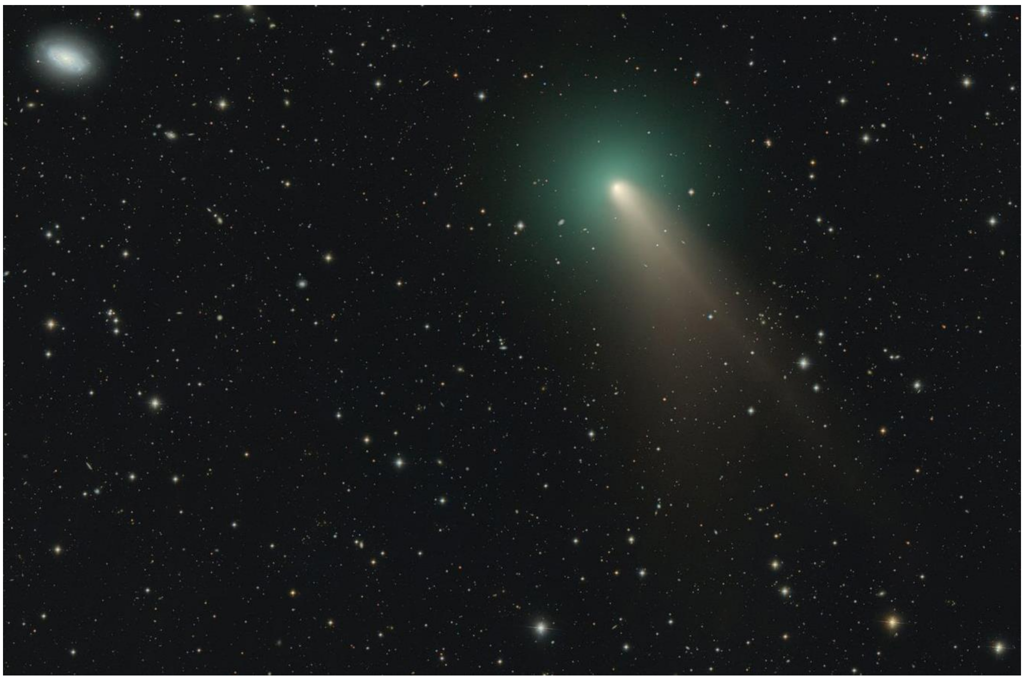
The "Book of Miracles" includes 26 examples of comets, including this one: "In the year 1007 A.D., a wondrous comet appeared. It gave off fire and flames in all directions. As it fell to Earth it was seen in Germany and Italy. [Augsburg Book of Miraculous Signs]()

THE COMET'S TALE

Comet Section – British Astronomical Association

Journal – Number 40 2021 July

britastro.org/comet



C/2020 R4 (ATLAS). 2021 May 8, 0600 UT by Dan Bartlett, June Lake, California USA (North left)

Table of Contents

Frontispiece Image by Dan Bartlett

Celestron RASA 11" (0.28-m, f/2.2 Rowe-Ackermann Schmidt Astrograph), ZWO ASI294MC Pro, 10MICRON GM2000 HPS mount. Software: Pleiades Astrophoto, S.L. PinInsight 1.8 Sequence Generator SGPro. Date: 2021 May 8, 06:00 UT Focal length: 0.62-m, Seeing: 4, Transparency: 8.
https://britastro.org/cometobs/2020r4/2020r4_20210507_dbartlett.html

1 From the Director – Nick James

Another year has passed and another issue of the Comet's Tale has arrived. What a very strange year it has been. The Covid pandemic has changed many aspects of our lives and things that we took for granted were no longer allowed. Within the BAA we have not held a physical meeting since 2020 February and I really do miss them. As a replacement the BAA implemented a set of webinars which have been well received. These are available to watch on YouTube and there have been a number which are relevant to comets. I've listed these at the end of this editorial. No matter how good virtual meetings are they can't replace face-to-face meetings and I've really had enough of Zoom, Webex, Skype and all the rest. I hope that we can get back to a more normal life soon. In particular I would like to organise a physical Comet Section meeting sometime in the spring of 2022. If you have any suggestions for a venue, please let me know.

From an astronomical point of view 2020 was a good year. We had an excellent run of good observing weather in the late spring and the Covid restrictions meant that there were far fewer aircraft in the sky with a consequent reduction in man-made cirrus cloud. We also had one, very nice, comet.

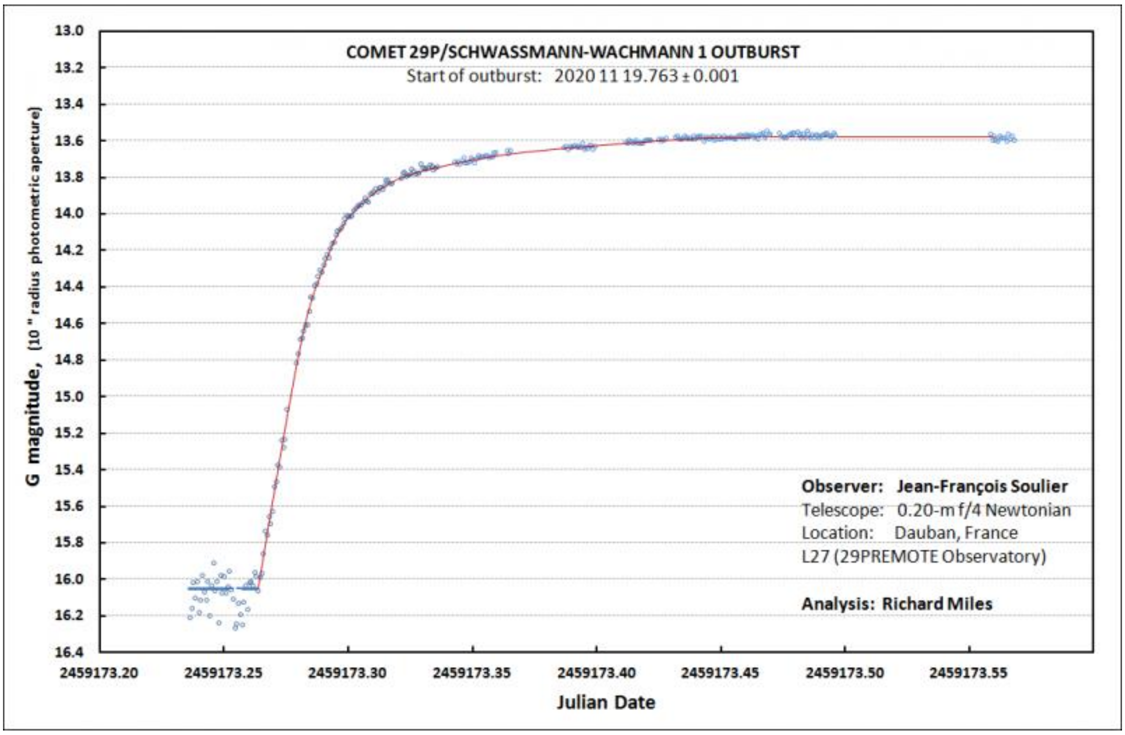
Of course, a year ago we had no idea that C/2020 F3 (NEOWISE) was going to turn out to be the impressive object it was. The comet had been discovered in late 2020 March as a southern hemisphere object and it finally emerged as a northern hemisphere morning object after its July 3rd perihelion. My first view of it was on the July 6 and it was far brighter than I had expected. Over the following few weeks, it blossomed into a mini-Hale-Bopp with a wide, curving, structured dust tail and a very long, blue ion tail. It was so exciting to have a naked eye comet in the sky. My best night was Friday 10/11 July when it was clear from dusk to dawn. The comet was a beautiful sight in the peaceful, deep blue, midsummer twilight and it was joined by a very active noctilucent cloud display on the northern horizon.

The Section received a huge number of excellent images of this comet, all of which are lodged in the section online archive. Thank you to everyone who sent in material. I am currently working on a full paper for the JBAA but, in the meantime, I wrote a summary which appeared in the 2020 October edition.

https://britastro.org/system/files/jbaa_pdf/v130i05j_0.pdf

This was one of the brightest comets we have seen from the northern hemisphere in the last couple of decades and quite a few non-astronomer friends commented that they had seen it. Surprisingly though, for those of us who thought it was a really prominent object, a lot of people couldn't find it. I expect that many people really had no idea what they were looking for and probably expected to see something as prominent as the views in images. Local light pollution is a problem for many as well.

Over the last year we've also had some very exciting observations of 29P/Schwassmann-Wachmann, the huge Centaur comet that orbits outside the path of Jupiter. Richard Miles runs the Mission 29P programme for the section and many observers now have this object high on their list of priority targets. The comet has fairly frequent small outbursts and a few larger ones each year. On 2020 November 19 I started observing after getting home from work and got my first image at 18:46 UT. On examination it showed the comet at magnitude 14.5, two magnitudes brighter than the previous night. I emailed Denis Buczynski and Richard and, a few minutes later, Denis responded that he had observed the comet at 18:02 when it was magnitude 16.2. I initially thought that I must have made a mistake so I checked for field stars but there were none. As the images were appearing on screen it was obvious that the comet was brightening fast so I reported the outburst to the section mailing list at 18:58. Many observers managed to catch this outburst but the most impressive sequence was from Jean-François Soulier. He has an automated 0.20-m telescope which monitors the comet continuously and he caught the entire outburst. These observations show that the outburst started around 25 minutes before my first image. The outburst lightcurve that Richard generated from his observations is extraordinary and it shows how rapidly the comet brightens.



Many thanks to all the observers who continue to contribute to this important programme. The comet is in conjunction at the moment but if you are interested in joining the 29P project please have a look at the webpage here:

https://britastro.org/node/25120

Brightish comets are a bit thin on the ground at the moment although C/2020 R4 (ATLAS) has been around 10th magnitude and it is very well placed for those of us in the UK. We also have C/2020 T2 (Palomar) which has been brightening recently and has taken over from C/2020 R4 as the brightest comet in our skies. In terms of future prospects C/2021 A1 (Leonard) might become a naked eye object in the morning sky in late November but it is too early to tell.

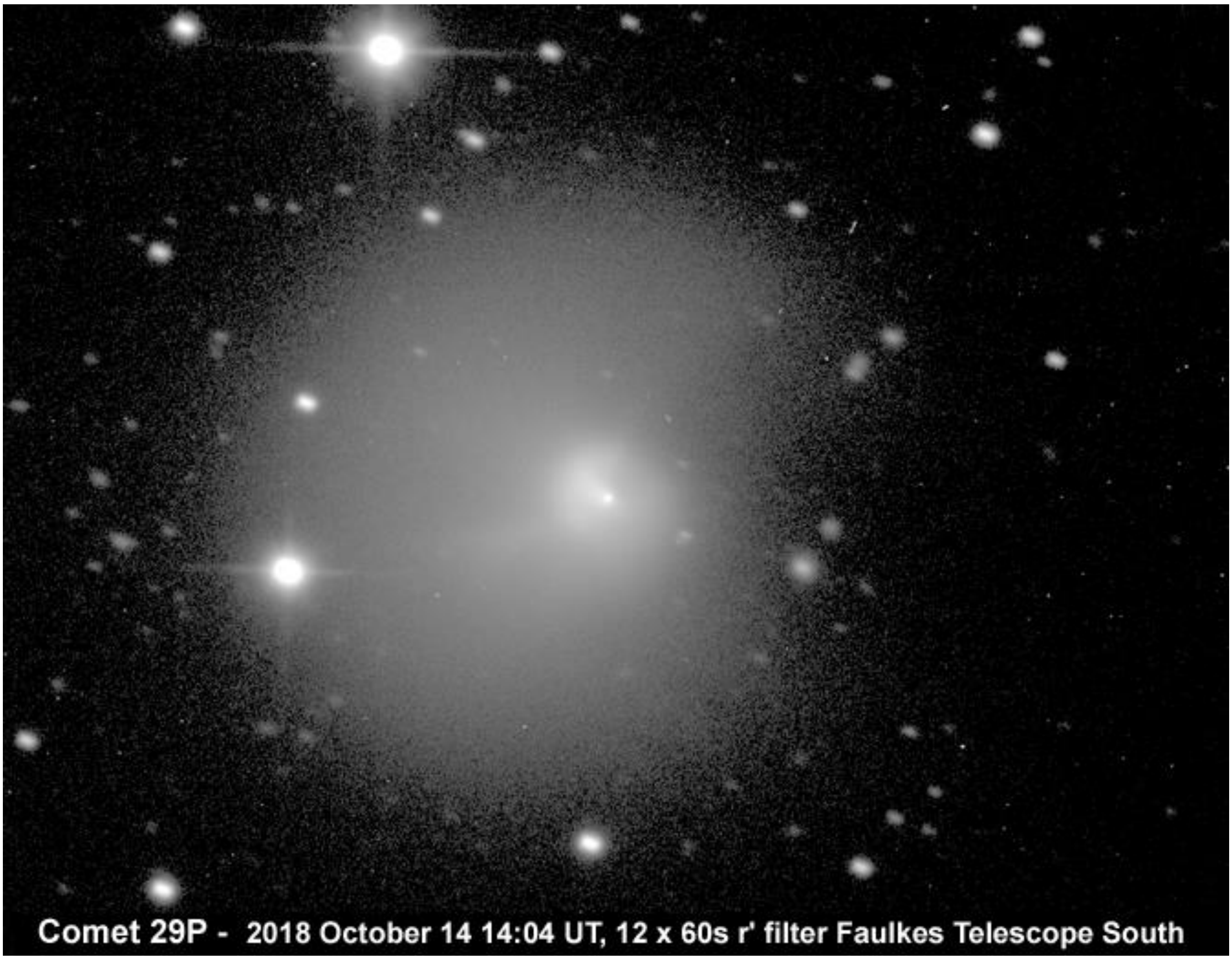
I hope you enjoy reading this issue. Many thanks to our editor, Janice McClean, for putting it all together and to Denis Buczynski who has collected a lot of the contributions. My thanks also to the section committee for supporting me through the year, and particularly to our former Director, Jonathan Shanklin, who continues to perform detailed analyses of cometary activity. There is plenty of material in this edition. I hope that you find something that will interest you and that you will be encouraged to go out and observe these fascinating objects.

Nick James Section Director

BAA comet-themed webinars

C/2019 Y4 (ATLAS) - https://www.youtube.com/watch?v=N2d_t_fDndo
C/2020 F3 (NEOWISE) https://www.youtube.com/watch?v=G6xlpvxJTYQ
29P/Schwassmann-Wachmann - https://www.youtube.com/watch?v=oZciIMau3_4
The Comet Section archive: https://www.youtube.com/watch?v=JgaJ_NRv-uI

2 MISSION 29P Help Needed! Richard Miles



Nowadays, as well as being a dedicated observer there are other avenues that folk interested in Science and Astronomy can explore: one of which is Citizen Science. This type of investigation is where there are large amounts of data available via the Web and software is provided whereby anyone with a keen interest in the subject and a suitable computer, can become involved with relatively little effort.

Take the '***Zooniverse***' initiative. They have a number of space-related projects but nothing specifically on comets since these do not lend themselves to making a quick discovery or two. However quite a few amateurs have discovered new comets by looking for interlopers in SWAN imaging of the region of sky close to the Sun. Michael Mattiazzo comes to mind in this respect, his latest success of which was Comet C/2021 D1 (SWAN) first found on February 19 of this year. Well done, Michael!

Discovering comets is one activity but not one with any guarantee of success these days. Instead, as members of the BAA Comet Section, we are also interested in better understanding the nature of comets and in this vein, we have launched a project to study one particular comet in much greater detail namely, **Comet 29P/Schwassmann Wachmann 1.**

Entitled '**MISSION 29P**' the details can be found on a dedicated webpage:

https://britastro.org/node/25120

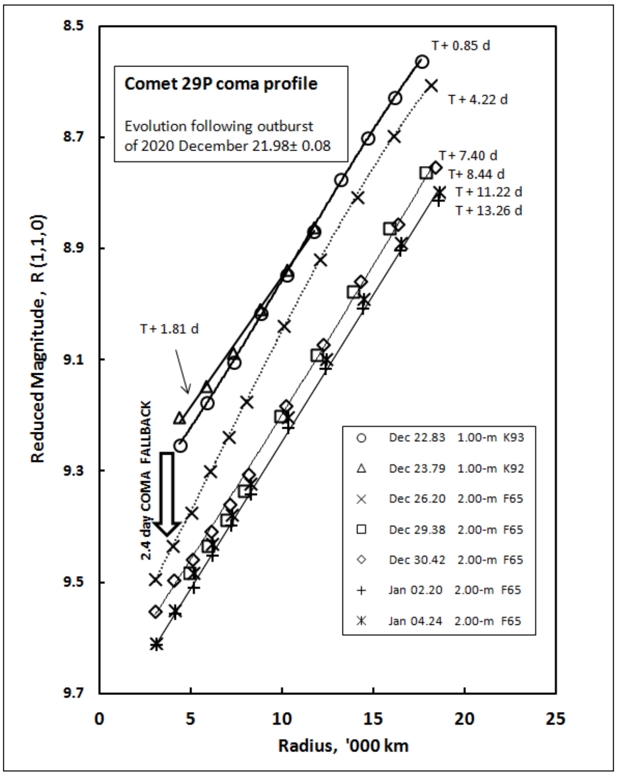
Nick James and I would like to enlist the help of a few people to analyse images of the comet captured via the ***Faulkes Telescope Project / Las Cumbres Observatory*** (LCO) network of telescopes. All of these images are available online in a couple of data archives. Of these, the most valuable are those taken using 1.0-m aperture, and more especially, 2.0-m aperture telescopes. The latter, when obtained under good seeing offer the prospect of studying changes to the innermost coma following its well-observed outbursts. Regular observations of 29P with these telescopes began around 2014 but apart from reporting inner coma brightness using a fixed size measuring aperture, and stacking frames to highlight changes in the morphology of the coma, we are yet to exploit these very fine images to any great extent.

One area which we would like to study in more depth involves measuring the inner coma with smaller and smaller photometric apertures (down to 3 pixels radius, equivalent to a mere 0.9 arcsec radius in the 2.0-m images). This task may sound straightforward but the problem is that we have to determine the brightness on an absolute scale and because the comet is always appearing to move across the sky and the fields of view are small it is more difficult to derive absolute magnitudes. At least we now have the Gaia photometry and so this opens up the prospect of doing this with considerable accuracy.

But what can we discover by way of this analysis? Here are three topics for starters:

1. When the comet is relatively quiescent, we can extrapolate the multi-aperture photometry to quantify the brightness of the 'bare' nucleus. If the nucleus is significantly elongated we might 'see' its rotational signature in the data obtained.

2. After the comet has outburst, we often see an asymmetric coma developing sometimes having the 'Pac-Man' ᗧ shape. Performing multi-aperture analysis of a well-developed outburst coma with and without centroiding provides a measure of the direction of motion of the expanding coma relative to the nucleus. Knowing this may help locate the approximate position (especially latitude) of the source on the nucleus.



3. The accompanying plot illustrates a key objective of multi-aperture analysis, namely monitoring the nature of coma fall-back following weak outbursts. Here you can see how the intensity of the reflected light from the (inner coma + nucleus) drops by about 0.2 magnitudes some 2–5 days after a weak outburst. This discovery late last year is a watershed moment in that it is the first time such a phenomenon has been observed. Other examples of this fall-back process have now been found in other image data but there are many such weak outbursts in recent years and the image data following each such outburst

needs to be analysed in a systematic fashion, preferably based on Gaia photometry.

It is anticipated that a two-pronged approach will be followed to accomplish the analysis: One will be a largely manual activity using various software to perform measurements and plot the results. The second will attempt to automate some of the more laborious steps in that analysis. Both require dedication to the cause; the first by someone prepared to put in the time to carry out a repetitive analytical procedure step by step; the second by someone having the necessary programming skills who could automate the procedure once the approach has been standardised.

Do get in touch if you might be interested in joining this type of citizen science project. You might not be an observer (for whatever reason) but you might nonetheless be in a position to help and to make a new discovery hidden in the data. To register your interest in this project please send an email to cometobs@britastro.org with the subject line "29P image analysis". Further details and a step-by-step guide to the analysis method will be posted on the section's Mission 29P webpage. We will contact you when this guide is ready to discuss the contribution you can make to this important project.

Richard Miles

3 Spectroscopic Observations of Sodium in C/2020 F3 (NEOWISE)

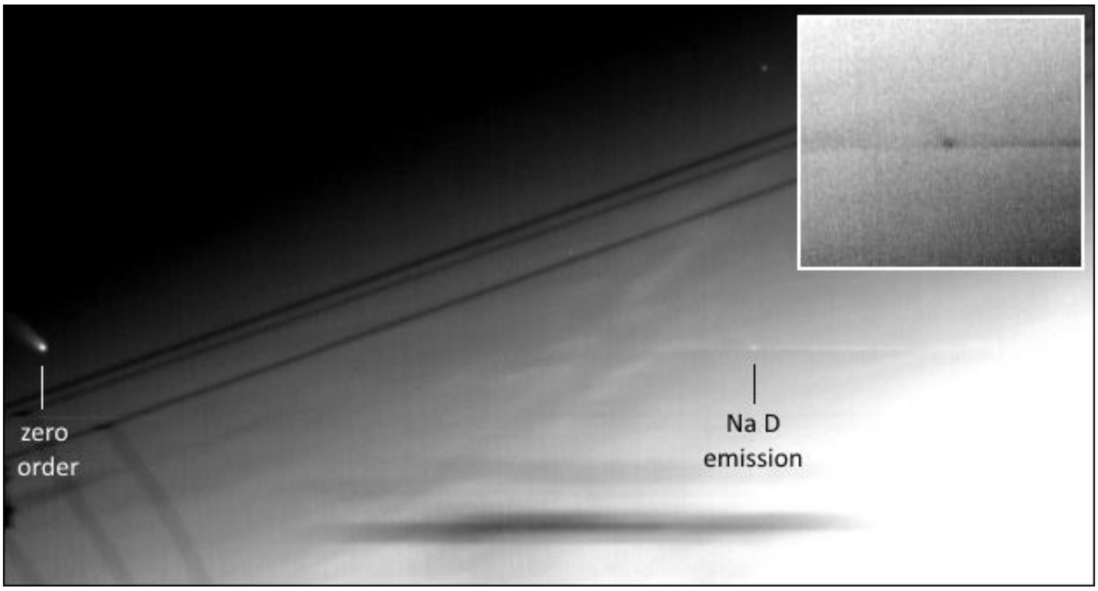
Robin Leadbeater

If a comet passes close enough to the Sun there is the potential for sodium atoms to be liberated from the nuclear material and associated dust. Once free these neutral atoms strongly absorb photons in the sunlight at specific wavelengths and re-emit them in all directions, a process known as resonant fluorescence. This produces a characteristic orange emission, seen in the spectrum as the close double sodium D line at 589.3 nm. The momentum of the absorbed photons gives a kick to the sodium atoms causing them to stream away from the nucleus forming a "sodium tail". (Note this mechanism is different from that producing the ion tail, where electrically charged ions are accelerated by the magnetic field caused by the solar wind).

Examples of comets which showed sodium tails include C/1995 O1 (Hale Bopp), C/2011 L4 (Pan-STARRS) and C/2012 S1 (ISON). The strength of the emission depends not only on the quantity of sodium released and the amount of sunlight but also on the velocity of the sodium atoms relative to the Sun. (The resonance mechanism depends on there being photons of exactly the right wavelength in the sunlight and since the solar spectrum contains strong absorption lines (from sodium and other elements) in this region of the spectrum, the amount of light available, of the right wavelength, varies depending on the Doppler shift of the sunlight (The Swings and Greenstein effects) This also affects the accelerating force felt by the atoms which propels them away from the source.

One of the simplest and most definitive tests for the presence of sodium emission in comets is to image the comet through a diffraction grating placed in front of the camera lens. Some of the light passes straight through the grating producing a conventional image of the comet (the zero order) but the rest is spread out into a low-resolution spectrum, effectively producing overlapping images of the comet in each wavelength. While the continuous spectrum of the sunlight scattered from the dust smears the spectrum image, the narrow sodium D emission produces a sharp image of the sodium component of the comet.

I did this with C/2020 F3 (NEOWISE) at the earliest opportunity (2020 July 7). Despite thin cloud, low altitude and bright sky background, the presence of sodium was confirmed by an image in the spectrum of the comet at the sodium D wavelength, complete with a just discernible tail, shown in the larger scale negative cut out.

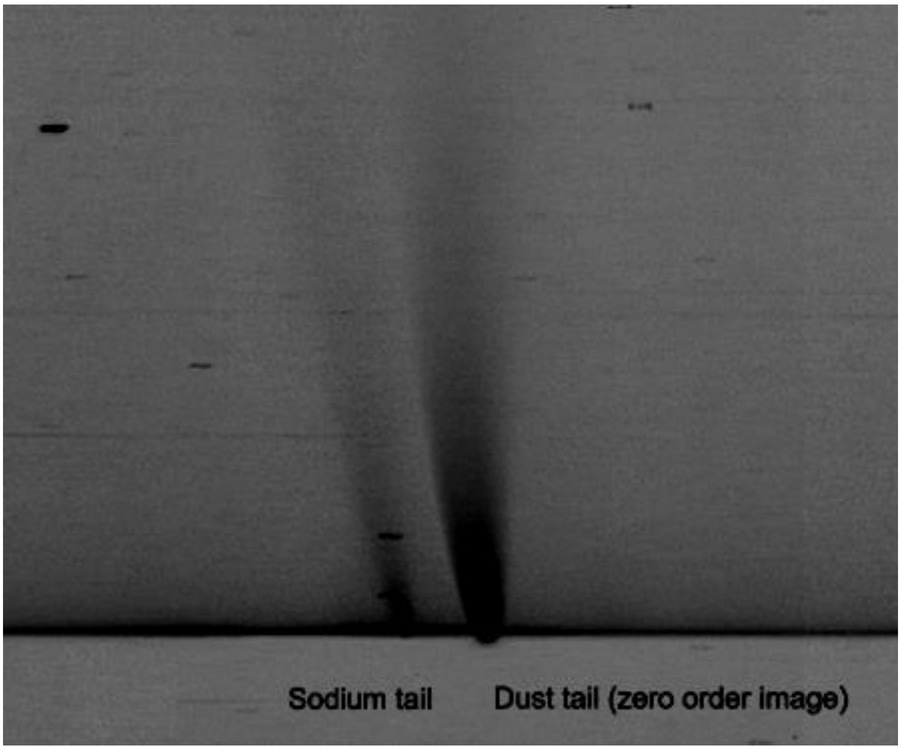


The sodium tail was confirmed the next day in an image using a narrow band Na D pass filter by Jeff Morgenthaler (Planetary Science Institute) and Carl Schmitt (Boston University) who repurposed IoIO, an observatory normally used to monitor the sodium cloud around Jupiter's moon, Io). https://psi.edu/news/neowisesodiumtail

In the following days a number of other amateurs took further objective prism and grating spectral images showing the sodium tail more clearly. Perhaps the clearest was that taken by Torsten Hansen on 2020 July 13 using a Star Analyser 100 grating in front of a DSLR camera.

Credit: Torsten Hansen

Placing high contrast negative images of the zero order and the sodium emission alongside each other we can see the diffuse sodium tail extending approximately 1 degree in the image and continuing straight where the dust tail (which dominates the zero-order image) curves away to the right.

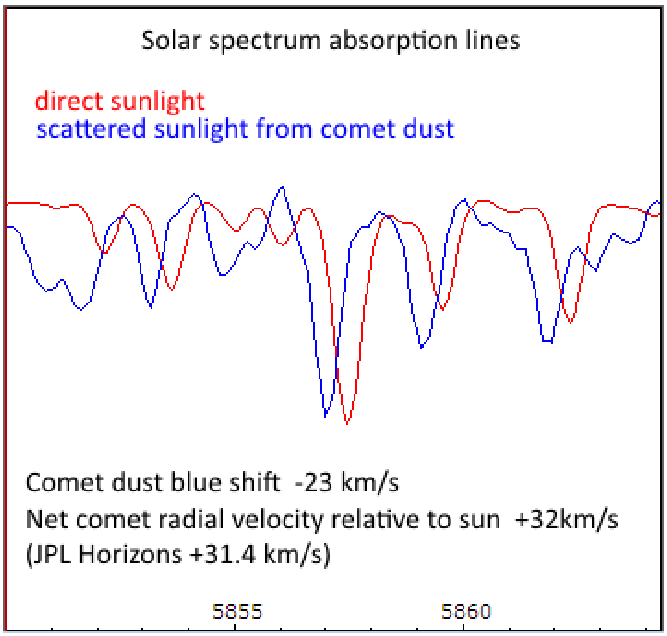


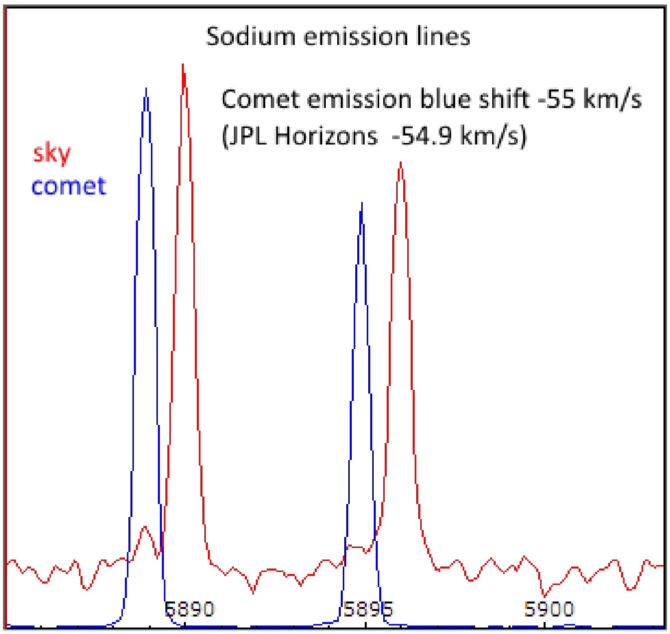
Enhanced from the Torsten Hansen original

Meanwhile the comet had moved into the field of view of my main observatory telescope so I switched to using telescope mounted slit spectrographs, first at high resolution showing clear Doppler shifts in the absorption lines in the sunlight scattered from the dust and in the emission lines from the cometary sodium.

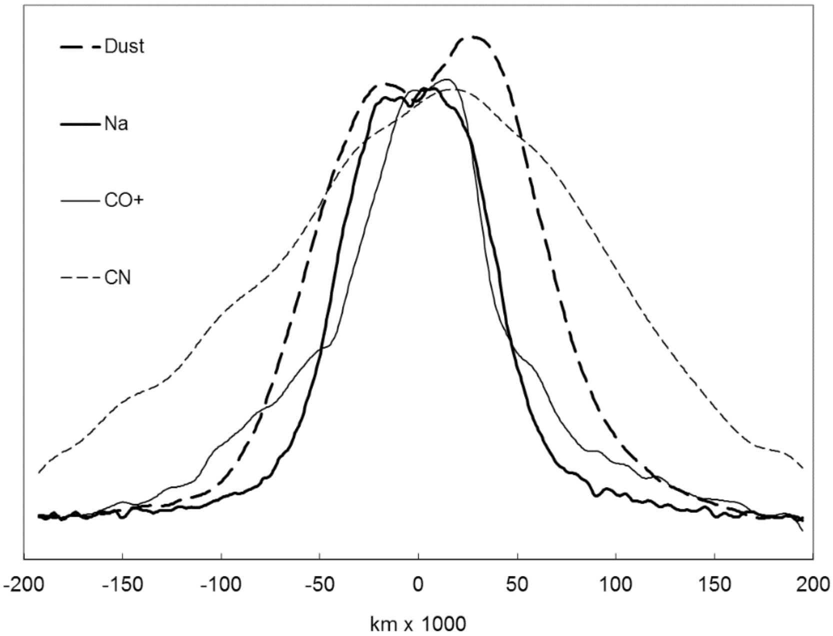
https://britastro.org/observations/observation.php?id=20200710_225300_18b30a0a785a7ab3

Measurement of these shifts relative to the daylight sky and local sodium light pollution confirmed the velocity of the comet both relative to us and the Sun.





I then turned to a lower resolution instrument to measure the distribution of the various constituents of the comet, including a cross section through the tails close to the coma. https://britastro.org/jbaa/pdf_cut/jbaa_24438.pdf This showed sodium streaming away from the coma at a small angle anticlockwise relative to the dust and narrower, confirming the observation of Morgenthaler and Schmidt, though the measurements were too close to the coma to predict with any accuracy the direction of the tails further out.



By then stunning wide field images were appearing showing the tails in detail several degrees long. Some showed a narrow reddish colour component within the predominantly blue ion tail, as in this image by Thomas Lehmann on 2020 July 12.
https://britastro.org/cometobs/2020f3/2020f3_20200712_tlehmann.html

Others though did not, such as this one by Gerald Rehmann on 10th July
https://britastro.org/cometobs/2020f3/2020f3_20200710_0124_grhemann.html

Some observers attributed this reddish tail to sodium, for example in this image published as an APOD
https://apod.nasa.gov/apod/ap210308.html

However, the reference given in the APOD in support of it being due to sodium is not relevant as the paper cited refers only to sodium in the central coma. (The description in the APOD of the mechanism of sodium emission and tail formation is also incorrect). There is some debate as to the origin as the colour better matches the red emission expected from H_2O+ ions also present in the ion tail, seen in this image taken by Stefan Zeigenbalg through a sodium D blocking light pollution filter on 2020 July 14.
http://www.simg.de/comets/neowise-2020.html#j14i1p3

In discussions with Carl Schmidt, he is not convinced that the reddish tail seen in the wide field images is sodium. His view is any sodium would be expected to be found between the dust and ion tails and limited in distance due to eventual photoionisation of the sodium atoms which would switch off the D line emission. The analysis of their observations is not yet complete however and hopefully will clarify the matter.

The sodium emission diminished as the comet moved further from the Sun and was last detected in the coma on 2020 July 28 when 0.75 au from the Sun, in high resolution spectra taken by Christian Buil. http://www.spectro-aras.com/forum/viewtopic.php?f=6&t=2574&start=20#p14507

Comets showing significant sodium emission are relatively rare. If I get an opportunity to observe another, I plan to try more wide field spectral imaging to better see the distribution of the sodium, perhaps adding short and long wavelength blocking filters to isolate the D line region of the spectrum, enhancing the contrast against the sunlit dust and sky.

Robin Leadbeater

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4 Video Astrometry of Comets Alex Pratt

Astrometry of a comet is usually performed by taking a CCD image and using software such as Astrometrica to determine its RA and Dec with reference to a field of stars whose positions are given in an astrometric-quality star catalogue. This article describes the technique of video astrometry, where an integrating video camera is used to obtain a series of GPS-timestamped images over a brief period and they are analysed in Tangra to measure the position of the comet.

[Note: Hristo Pavlov initially designed Tangra to perform video astrometry of asteroids and comets. [1] Its photometry module is used to analyse video recordings of asteroidal occultations to reduce their light curves and determine the times of disappearance and reappearance]. [2]

The development of video astrometry

In 2009 Dave Herald wrote an article about video astrometry of asteroids, [3] in which he proposed a method to record a video of an asteroid, convert the frames into FITS image files and process them in Astrometrica to derive its RA and Dec. During that year Hristo Pavlov developed Tangra - to streamline the process that would have involved converting the video and using Astrometrica - by performing its own plate solving and reduction of each video frame.

Typically, in a recording of 60seconds duration, an integrating video camera outputs about 200 separate images, depending on its integration setting. Tangra plate solves and analyses each video image and derives the positions of slow-moving asteroids or comets (sky motion <2.0”/min) from the median values of these RA and Dec coordinate pairs. Faster objects, such as Near-Earth Asteroids or swift-moving comets, are measured by motion-fitting their movement in RA and Dec. Tangra can produce O-C astrometric residuals smaller than 1” for bodies with sky motions of 600”/min.

Recording a video

I use a Watec 910HX mono video camera with an IR/UV filter on a Celestron 11 f/10 SCT with a Meade f/3.3 focal reducer on a Losmandy G11 mount and Gemini GoTo. This setup has an effective focal length of 900mm, giving a field of view 30’ across the diagonal and an image scale of ~1.7”/pixel. It gives a reasonably flat field and telescope collimation is maintained using a set of Bob’s Knobs. The output from the camera is fed into a video time inserter [4] which embeds accurate UTC (received from GPS satellites) into the video stream recorded onto a laptop computer.

Analogue video cameras generate frames at a fixed rate of 25 per second (for the PAL video standard. The NTSC standard gives 29.97 fps). [5] At an integration setting of 8 frames etc. they produce large numbers of repeated frames. Hristo Pavlov’s OccuRec video recorder software [6] saves a single averaged image from each integration period, slightly improving the signal-to-noise ratio and creating a much smaller output video in its AAV (Astronomical Analogue Video) format. It uses Lagarith Lossless Codec compression. I run OccuRec on my Windows 10 laptop with a 256 GB SSD.
[Note: OccuRec also supports timestamping using NTP Internet time servers].

The Minor Planet & Comet Ephemeris Service webpage of the MPC is used to obtain the current position of the asteroid or comet and its magnitude. [7] C2A planetarium software is employed to identify the star field. [8] Depending on the apparent motion of the object and its brightness, I adjust the camera's integration setting to minimise its motion per pixel, maximise the number of field stars and avoid image saturation. A setting of x16 (8 frames, 0.32s exposures) reaches magnitude 14 and produces approximately 180 images in a 60s recording. The half-degree field occasionally has a paucity of reference stars.

In suburban NW Leeds my light-polluted skies are Bortle 7 with a Sky Quality Meter reading of almost 19.0 at best. [9] My observing conditions are even further degraded when my neighbours' PIR (in)security lights are activated, flooding my garden and observatory (Z92) with the beam from one - and sometimes two - intensely bright photon torpedoes. Then Bortle 9? Despite this local environment I record and measure asteroids to mag. 15; I follow the brighter comets but rarely make total magnitude estimates. If a comet isn't too faint and has a good degree of condensation it can be a candidate for video astrometry.

Reducing a video recording

To analyse and reduce a video Tangra needs to determine the pixel width and height with reference to the effective focal length, to calibrate the star field and to perform precision astrometry on the target object. A recording with a good distribution of stars across the field should be used for calibration. Tangra uses the UCAC4 astrometric star catalogue for this and for plate solving, and Gaia DR2 is also supported via an online link to gaia.aip.de. The calibration steps will not be described here, they are documented in A Guide to Video Astrometry. [10]
[*Note: This guide was last updated in 2015 and is due for revision, but a lot of the text is still valid]*.

As an example, the potentially hazardous asteroid (52768) 1998 OR_2 was monitored in March and April 2020, resulting in 90 GPS-timestamped video astrometric measurements from 22 nights being submitted to the MPC. Tangra support for Gaia DR2 was implemented during this time, but for continuity I used UCAC4 for all reductions.

On 2020 March 20 the object was about magnitude 14 and had a sky motion of 0.5"/min. A 66 second recording at 0.64 s integration setting gave 105 frames and these were plate solved and analysed using Tangra's Slow (<2"/min) multi-frame astrometry option (Figure 1). The mini-plot displays these individual RA and Dec measurements, their median values, the estimated magnitude and the mid-time (to 5 decimal places) for submission to the MPC. Tangra uses all stars in the field to determine the magnitude of the object and it offers Cousins V and Johnson R output bands. I use Johnson R with my Watec 910 video camera.

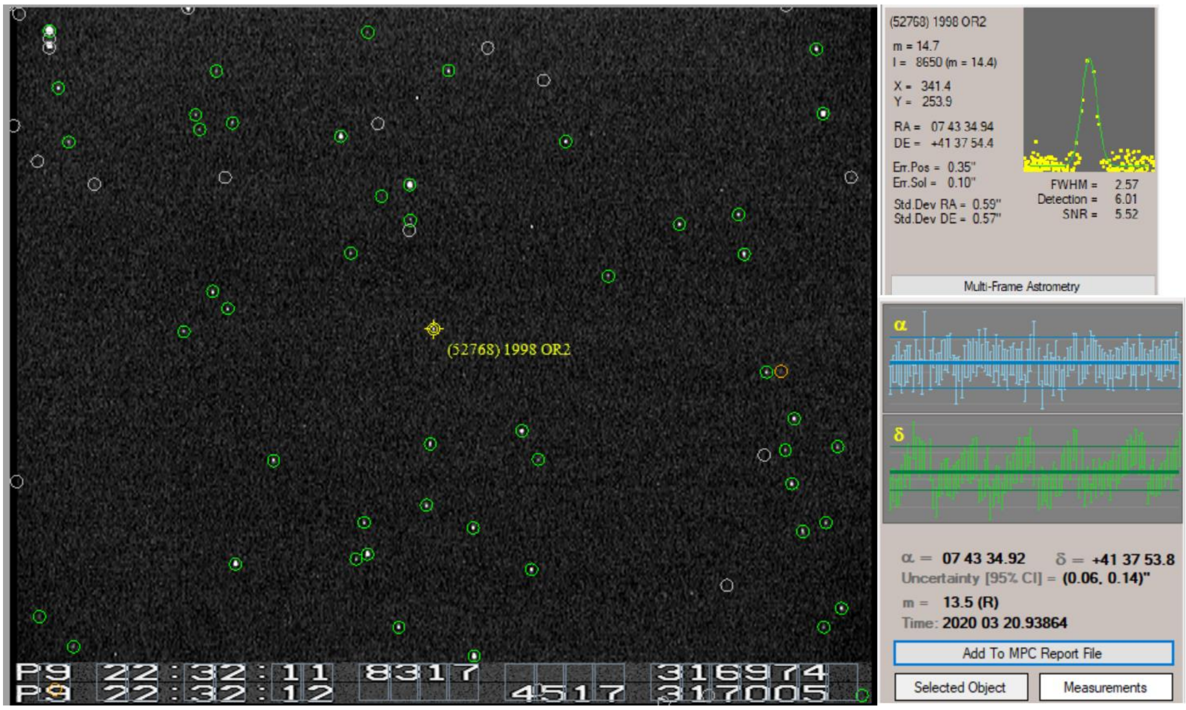

Figure 1 – Video astrometry of (52768) 1998 OR$_2$ on 2020 March 20

A month later, on 2020 April 19, the asteroid was magnitude 12 with a sky motion of 7”/min. A 70 second recording at 0.32 s integration gave 221 frames. Tangra’s Slow Flyby (2”/min -> 200”/min) option was selected to analyse 201 frames. In this case it motion-fitted the RA and Dec values and in its Fast Motion Astrometry page it gives the time to 6 decimal places (Figure 2). The ‘n’ preceding the date indicates that the astrometry is a mini-normal place to micro-day precision interpolated from GPS-timestamped video frames. [11] I now use Tangra’s Flyby (motion-fitting) options for all my astrometry, finding they give better results than the Slow (median values) option.

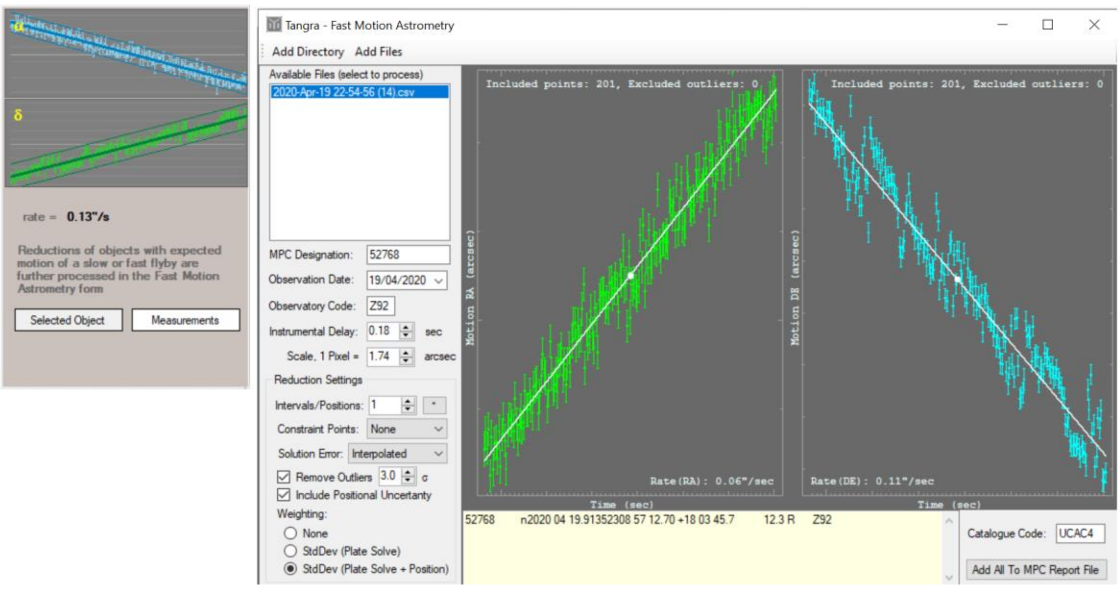

Figure 2 – Motion-fitted video astrometry of (52768) 1998 OR$_2$ on 2020 April 19

Tangra exports data to an observation file for submitting to the MPC. Figure 3 shows an example of 5-figure and 6-figure timed astrometric measurements, currently in 80-column format. Tangra will be supporting the ADES format. The text 'GPS-tagged video' confirms that high-precision timestamping was used in the reductions. The observation report files are sent to the MPC using the 'Submit astrometric observations via a web form' link. [12]

```
COD Z92
OBS A. R. Pratt
MEA A. R. Pratt
TEL 0.28-m f/10 Schmidt-Cassegrain + f/3.3 focal reducer + CCD + GPS-tagged video
NET UCAC4
NUM 2
52768         C2020 03 20.93864 07 43 34.91 +41 37 53.8          13.5 R      Z92
52768         n2020 04 19.91352308 57 12.70 +18 03 45.7          12.3 R      Z92
```

Figure 3 - An extract from data submitted to the MPC

Comparing CCD astrometry and video astrometry

NEODyS (Near Earth Objects - Dynamic Site) [13] automatically collects MPC data to compute the orbits of NEOs and publishes (amongst other data) their astrometric and photometric residuals. Figure 4 compares observers' CCD and video measurements of (52768) 1998 OR_2, showing the RA, Dec and magnitude residuals, and a chi-squared data quality assessment. The magnitude residuals are derived from the tangle of G, R and V magnitudes submitted by observers. In the chi-squared results, values nearer to 0 are considered to be better quality. Z43 is another video observer, Christophe Ratinaud (France).

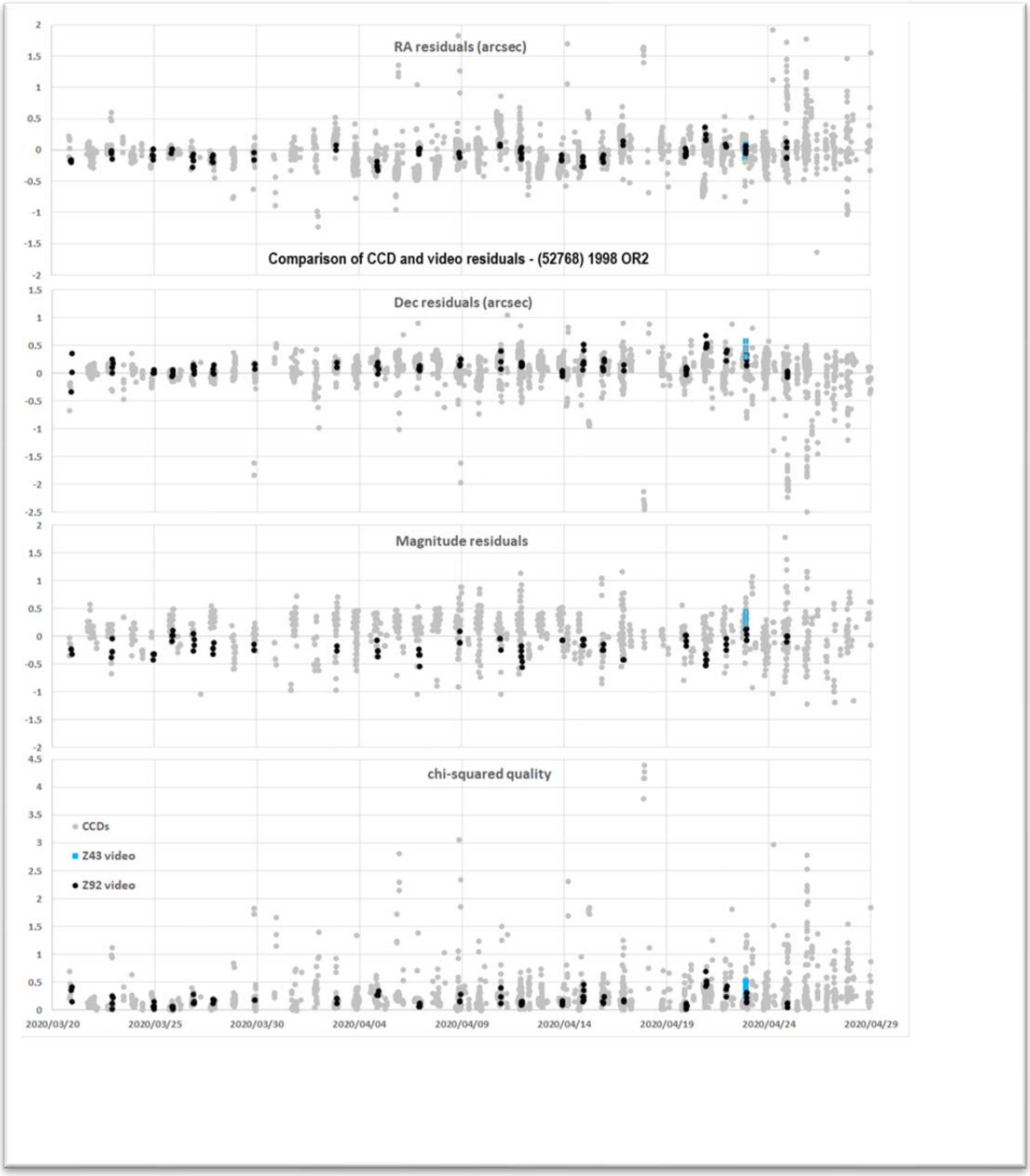

Figure 4 – Comparing the CCD and video residuals of (52768) 1998 OR_2

Video astrometry of Comet C/2017 T2 (PanSTARRS)

This nice comet was visible for several months, staying relatively bright (between mags. 8 - 11) and well condensed, so I was able to follow it from October 2019 until July 2020, measuring 110 positions and magnitudes on 38 nights. Figure 5 shows a video image of the comet on 2020 March 10 taken with an integration setting of 0.64s which recorded its central condensation and avoided saturation. Looking like a slightly fuzzy asteroid, it was ideal for video astrometry. The recordings were analysed as outlined above but the magnitude estimates were nuclear, not total, so it was necessary to change R in column 71 in the observation file to N before submitting the results to the MPC. I have a COBS account but I don't submit any observations because they want total visual magnitudes, not estimates of the nuclear condensation.

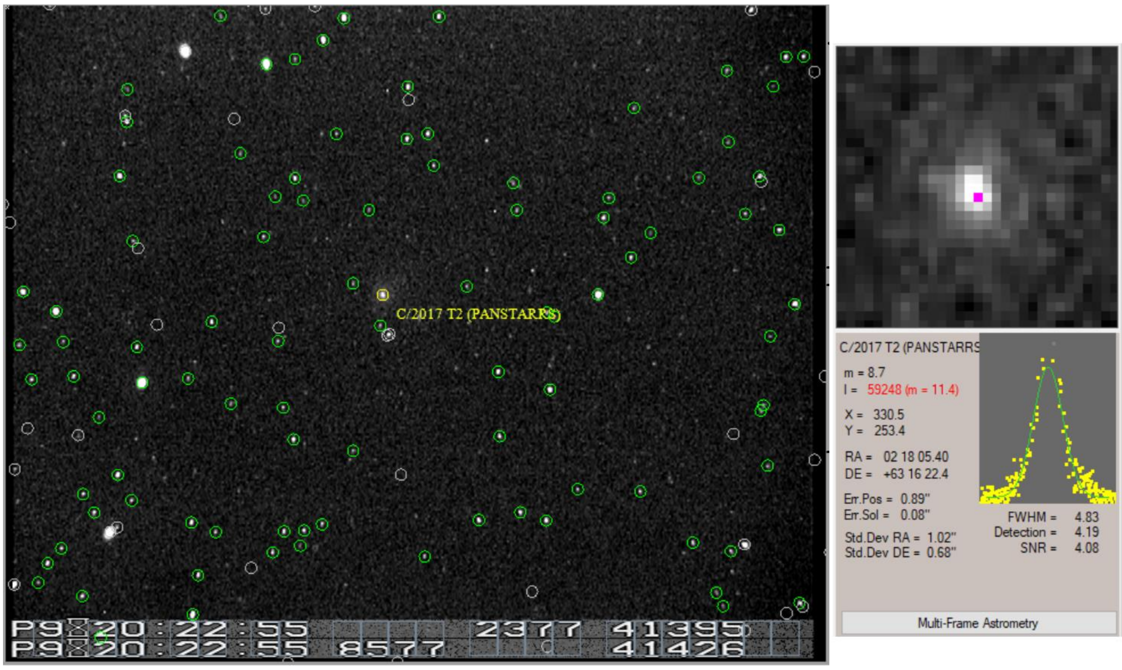

Figure 5 – Video image of comet C/2017 T2 (PanSTARRS) on 2020 March 10

To compare CCD and video astrometry of the comet, all observations during this period were downloaded from the MPC and processed with Windows Find_Orb [14] to determine their residuals in RA and Dec. From 3,145 observations out of 4,869 entries it obtained a mean residual of 0.49”. Find_Orb reported that 6 of the measurements were taken in daylight, a few had discrepancies of ~50 degrees in RA and some stations had many residuals of tens of arcsec. Did they use Hipparchus' original catalogue or the Almagest instead of UCAC4 or Gaia DR2, or an inaccurate time source? This problem of data quality was discussed with Bill Gray (developer of Find_Orb) who suggested that confusion with time zones and/or Daylight-Saving Time could explain most of the erroneous data. [15]

Figure 6 shows the astrometric residuals, excluding the larger values, but there’s still a lot of scatter in the positions. Even the professional surveys aren’t immune from contributing the occasional outlier. Perhaps some amateur observers took relatively long exposures (or stacks) to record the comet’s splendour and to measure its total magnitude, then used the same images - of an over-exposed amorphous blob - to measure the position of the brightest part of its coma.

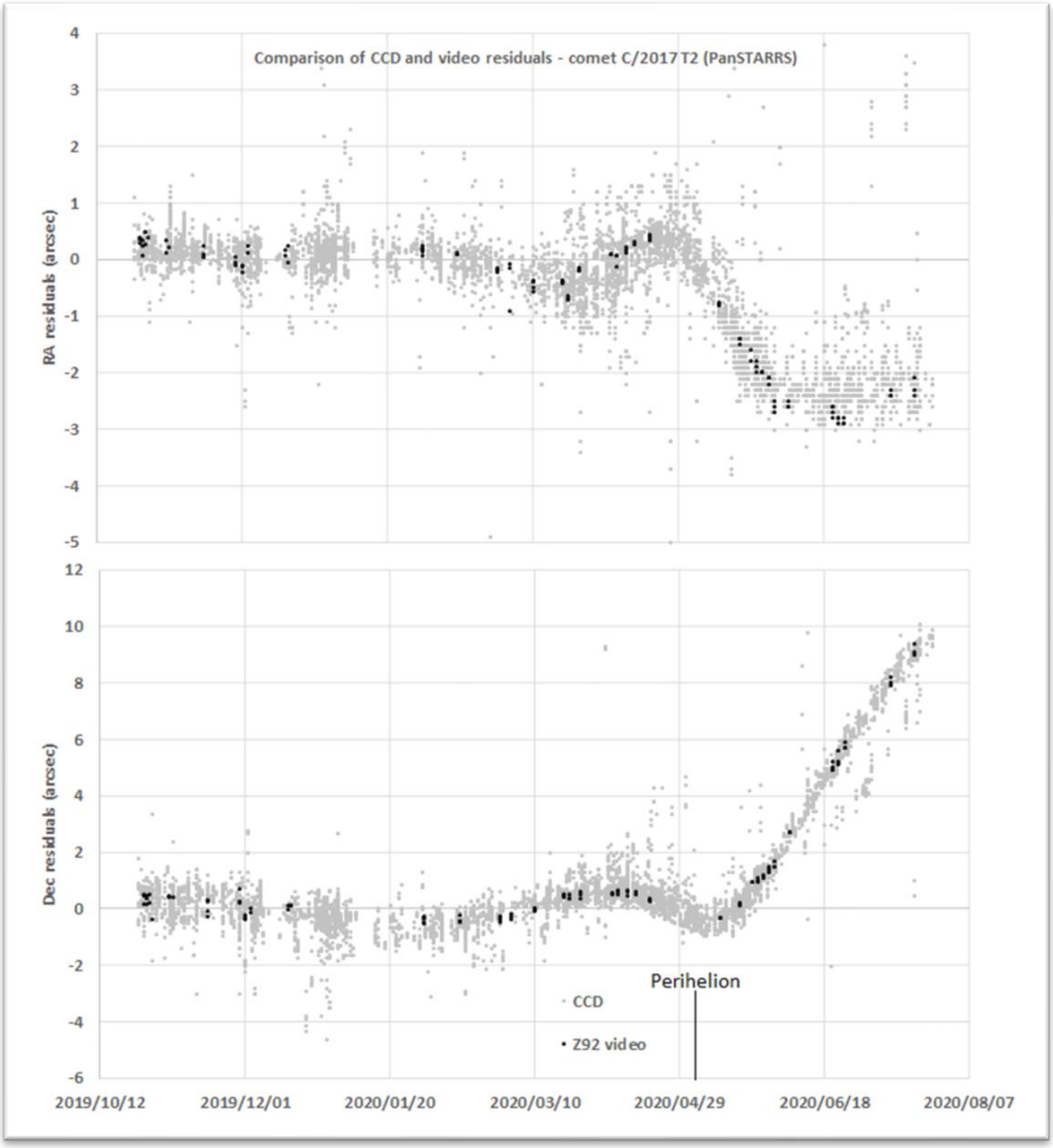

Figure 6 - Comparing the CCD and video residuals of comet C/2017 T2 (PanSTARRS)

The comet was magnitude 8 at perihelion on 2020 May 4 when it was 1.6 au from the Sun and during that month Nick James captured detailed structure in its coma. [16] I leave it to the dynamicists to comment on the comet's meanderings in RA and Dec, particularly after perihelion.

Concluding remarks

Cometary video astrometry can give results as good as the traditional CCD method as long as the comet isn't too faint or diffuse.

It's not suggested that CCD observers convert to video astrometry, because 16-bit CCD camera image stacking is much better suited for a faint comet and for estimating its total magnitude and recording fine details in the coma, dust and gas tails, but it might encourage video occultation observers to try astrometry.

It is recommended that CCD observers avoid using an over-exposed image of the coma for astrometry. Consider a shorter exposure or a smaller stack for this purpose.

A number of observations of C/2017 T2 (PanSTARRS) were rejected from the Find_Orb solution because of duplicate entries, time zone confusion and/or erroneous positions. With care these problems can be avoided.

Alex Pratt

References

1 http://www.hristopavlov.net/Tangra/Astrometry.html
2 http://www.hristopavlov.net/Tangra/Tangra.html
3 https://minorplanetcenter.net/iau/info/VideoAstrometry.pdf
4 https://www.videotimers.com
5 https://en.wikipedia.org/wiki/PAL
6 http://www.hristopavlov.net/OccuRec/OccuRec.html
7 https://minorplanetcenter.net/iau/MPEph/MPEph.html
8 http://www.astrosurf.com/c2a/english/index.htm
9 https://en.wikipedia.org/wiki/Bortle_scale
10 https://minorplanetcenter.net/iau/info/AGuidetoVideoAstrometry.pdf
11 https://www.minorplanetcenter.net/iau/info/OpticalObs.html
12 https://cgi.minorplanetcenter.net/cgi-bin/feedback_submit_obs.cgi?S=Observation%20submission%20via%20website&D=0
13 https://newton.spacedys.com/neodys/
14 https://www.projectpluto.com/find_orb.htm
15 Gray, B., Project Pluto, *pers. comm.*, 2021 April 15
16 https://britastro.org/observations/observation.php?id=20200528_214100_dc153a18e98c0a8a

5 Estimating Coma Diameter Using Comphot – Nick James

The Comet Section has a computer program which was designed to determine comet Visual Equivalent Magnitudes (VEMs) from images. The VEM of a comet is the total integrated magnitude of the coma excluding the tail and any stars in the coma. The approach adopted by comphot is described in section 7.3 of the Section Observing Guide which is available on our website. In summary, comphot attempts to compute the VEM by estimating the total detectable coma diameter using a specific criterion and then integrating median pixel counts in annuli centred on the photocentre. The estimated coma diameter can have a significant impact on the estimated magnitude.

The recent appearance of C/2020 R4 (ATLAS) raised some questions about the accuracy of the coma diameter measurement and this was discussed on the Section email list. The following presents some results for this comet and some tests done using a standard target (the galaxy NGC 3147).

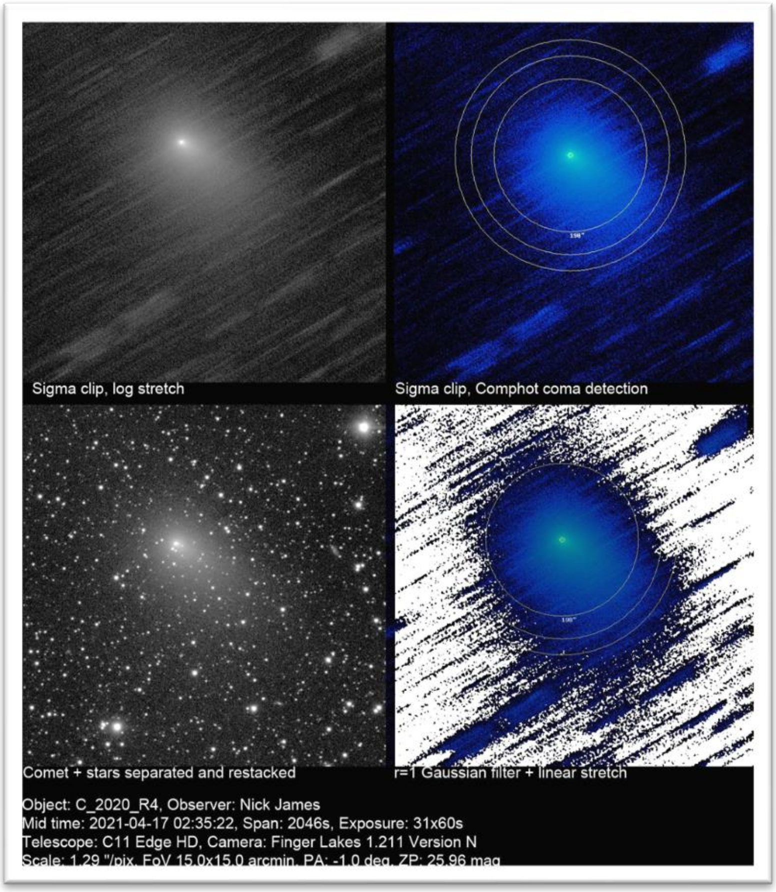

Figure 1 Coma diameter estimate for C/2020 R4 on 2021 April 17

Figure 1 shows some results from my observation of C/2020 R4 on 2021 April 17 taken in good conditions with the sky about as dark as it ever gets from Chelmsford. The frames used are sigma-clip stacks of 31x60s subframes which are then plate solved against Gaia DR2. These are 15x15 cut-outs from my 33x22 arcmin field. The magnitude zero point (25.96) is derived from ensemble photometry against around 100 Gaia G magnitudes. The sky background based on this ZP is 18.97 mag/arcsec^2.

Comphot attempts to calculate the coma diameter by estimating the RMS sky noise, σ, and then moving out in circular annuli until the coma brightness drops to below 0.8σ. In this case the 1σ threshold is 5.5 ADU and the sky background is 1035 ADU so the coma cut-off is at around 0.5% of the sky level. That kind of sensitivity requires very close attention to calibration frames, particularly flat fields as described below.

Figure 1 shows the estimate that comphot makes using this method (top right) compared with a manual hard linear stretch overlaid with the comphot result (bottom right). The estimate in this case appears to be about right at 190 arcsec radius. As a check, comphot outputs a log of the intermediate estimates. That can be used to plot a coma profile or a magnitude growth curve as shown in figure 2.

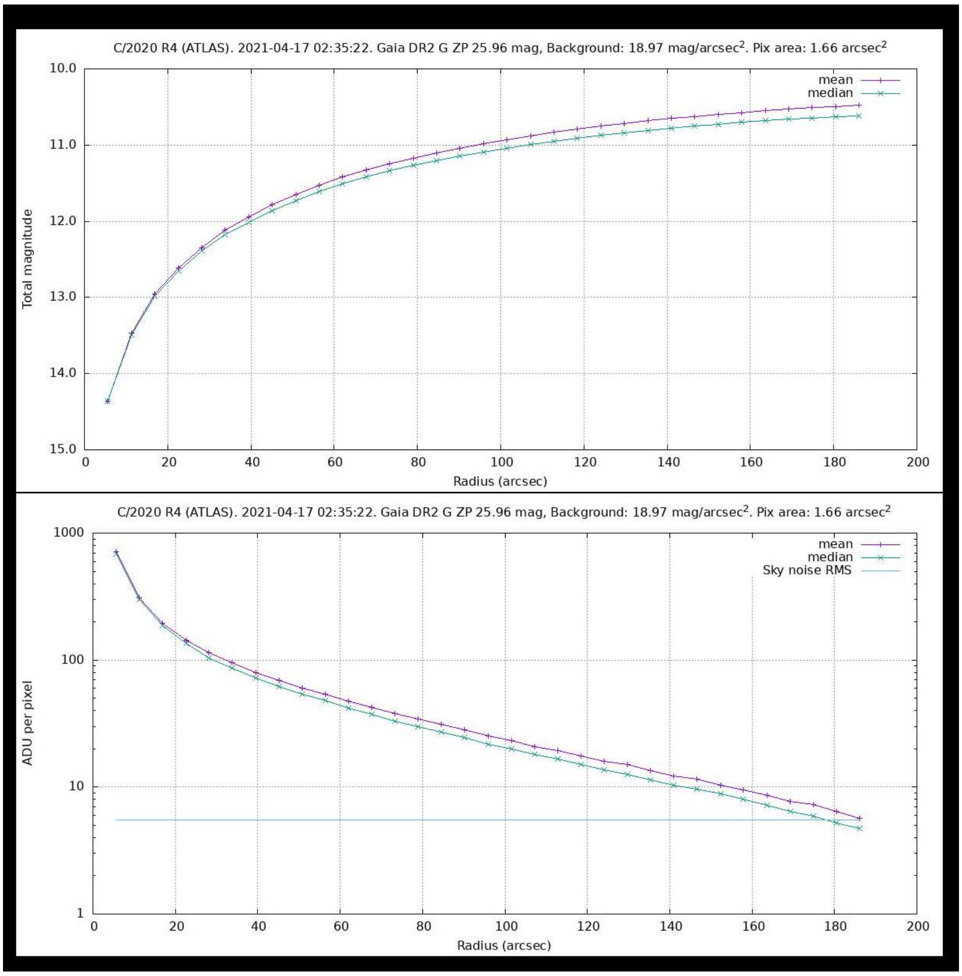

Figure 2 Coma brightness and magnitude growth curve for C/2020 R4 on 2021 April 17

The magnitude is calculated by integrating the pixel counts within the 190 arcsec radius assuming that the coma is circularly symmetric around the photocentre. This should avoid any contribution from the tail. The sky background is taken from the sigma-clipped mean of the outer annulus shown on the plot.

The results of this analysis for 2021 April 17.1 are a magnitude of 10.6 and a detectable coma diameter of 6.3 arcmin. Looking at corresponding results on COBS the coma diameter is on the large side (though I think, reasonable) but the magnitude is probably 0.5 fainter than most other people are getting. This is something that we are still trying to understand.

The coma diameter is estimated by determining the RMS sky background noise, σ, and then moving out from the photocentre until the median level at a given radius falls below 0.8σ. This estimate is critically dependent on a good estimate of sky level and so it is necessary to ensure that there is no significant gradient across the image. Comphot produces a skycheck image which shows areas where the local median is above the skylevel in blue and areas below the sky level in red. The intensity shows how far the local sky is above or below the overall median level normalized to the RMS noise, σ. An example skycheck plot is shown in figure 3

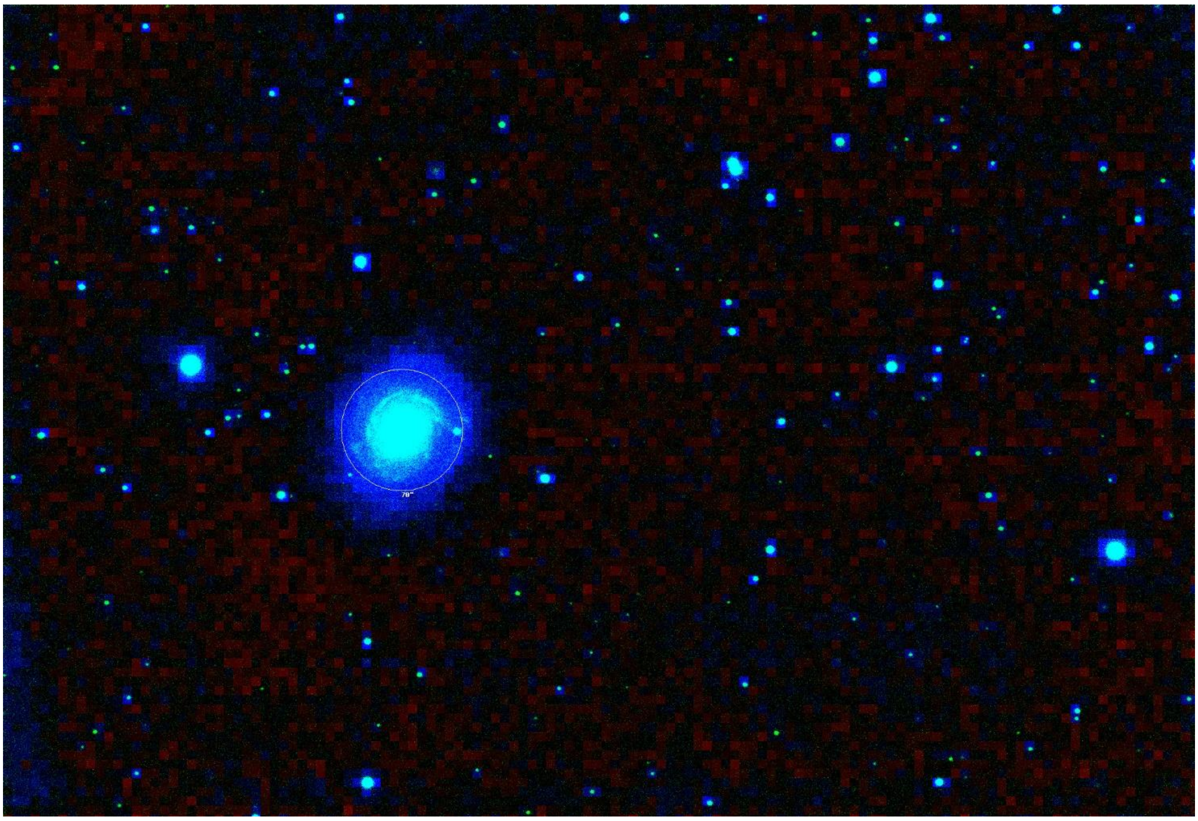

Figure 3 Skycheck frame from comphot for the field of galaxy NGC3147

The image in figure 3 is not a comet but the face-on galaxy NGC 3147. Peter Carson, Denis Buczynski and I used this field as a way of calibrating comphot's coma diameter and magnitude estimates on an object with a known size and brightness.

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The catalogue values for NGC 3147 are magnitude 10.6 with a size of 3.9 x 3.5 arcmin. Table 1 shows the results that we obtained with comphot using Gaia DR2 G magnitudes and unfiltered sensors

Observer	Instrument	Sensor	Location	Magnitude	Diameter (arcmin)
James	0.28m, f/10	KAF-6303E	Chelmsford	10.44	3.00
James	0.28m, f/10	IMX294CJK	Chelmsford	10.58	2.44
Carson	0.32m, f/8	IMX455ALK	Fregenal	10.28	3.95
Buczynski	0.35m, f/6	MN34230	Tarbatness	10.52	3.38

Table 1 – Comphot results for NGC 3147.

These results seem quite reasonable given the diversity of instruments, sensors and observing conditions. The larger coma diameters are detected at darker sites as expected and the magnitude range of 0.3 magnitudes probably reflects different observing conditions. Other observers using comphot should image this galaxy and see what they get.
These results seem to confirm that comphot is doing its job correctly as long as a suitably flat sky background is obtained.

For comphot to work correctly the background sky needs to be as flat as possible. That is the case for any observation where you are trying to detect something that is 1% or less of the sky brightness. I think this is the main area where people are having problems.

Comphot is available for download from the Section's website.

Nick James Section Director

6 Observing Comets in Brazil

José Guilherme de Souza Aguiar

The author with his 25x100 binos

I believe that my beginning in astronomy is not much different from that of other observers of my generation. I started observing comets in 1982, when comet C/1982 M1 (Austin) appeared. At the time it was using a 60 mm f/11 refractor. I recall that the biggest problem was getting better equipment and up-to-date information about comets. Typically, information on the discovery of new objects and their ephemeris was obtained from Sky & Telescope magazine, but it could take 40 to 60 days to be delivered. Difficult times.

Time was advancing and with the proximity of the appearance of comet 1P/Halley (1985/86), observation activity began to increase, as well as accessibility to information. It was now possible to obtain the ephemeris of comets not only from magazines, but also from Latin American entities (Liada) and from circulars such as COMET NEWS SERVICE. The passage of 1P/Halley was quite favourable and allowed me to advance a lot in terms of knowledge and observation techniques.

Access to other (larger) instruments, appropriate maps and computers have helped a great way in this development.

In January 1988 I moved to São Paulo to start my university course and today I am making my career as a lawyer. I had access to the astronomy library of the University of São Paulo (USP) and it was like getting into paradise. Now I had full access to the most important publications on comets, and the much desired circulars of the IAU. Information was no longer a problem.

Around the same time, I started sending my observation reports to The International Comet Quarterly (ICQ), and was nominated by Daniel Green, as the local coordinator for Brazil and neighbouring countries.

Dan Green and me in August 2004

The '90s came and brought a revolution in access to astronomy information.
With the arrival of general availability of the internet in 1994/5 I had a new accessible tool (still in a rudimentary way),

and now could have access, almost in real time, to the announcement of comet discoveries, could send the records within hours after they were made to the IAU, ICQ, BAA and others. It was a tremendous qualitative leap. The number of comets observed became higher, the observation sessions more productive... and that continues to this day.

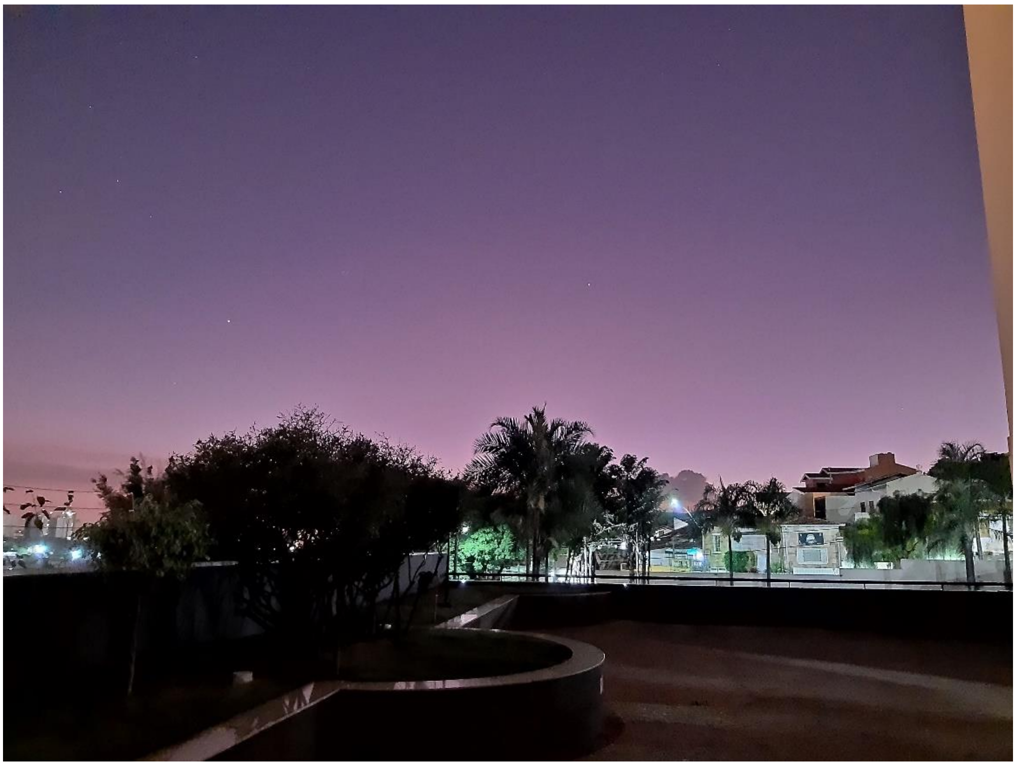
Let's talk a little bit about my modest setup: the equipment I use for the observation of comets consists of binoculars 20x50, 11x80 and 25x100. I also use a 270 mm f/5 Dobsonian (since 2002), which I use to register comets of up to 14 magnitude. As an indispensable tool, I use the GUIDE V.8 program to make the search maps and get the comparison stars. It is important to mention that there are several pages on the Internet with up-to-date information and maps available for this work.

I have three favourite observation sites, 2 urban and one rural.
The rural site is far from my house, about 35 kms and 45 minutes driving, in the district of Joaquim Egidio, near Campinas/SP where I live. The sky there is quite dark and allows me to spend the night busy all night.

My rural observing site - Joaquim Egidio, near Campinas/SP – view 1

My rural observing site - Joaquim Egidio, near Campinas/SP view 2

Urban observation points are quite reasonable, which doesn't stop me from observing some brighter comets.



My Urban view - South/West direction

Finally, in recent years, in addition to the systematic observations of comets, I have allocated part of my free time to help organise and participate in astronomy

congresses, all related to the area of comets. The most representative for me was the Third Ibero American Symposium on Comets of LIADA, an opportunity in which we jointly held the Fifth International Workshop on Cometary Astronomy (http://www.icq.eps.harvard.edu/IWCA5.html), on August 8, 2009, at the Planetarium of Rio de Janeiro, Brazil, of which I was a member of the Organising Committee.
On this occasion I met personally the director of ICQ/IAU, Daniel Green

Since then I have collaborated and participated in congresses held by various countries in South America (Argentina, Uruguay, Brazil and Bolivia), aimed at the observation of comets, and always with the objective of disseminating this area of work, teaching the main techniques of visual observation, as well as supporting the creation of groups of local observers. The job never ends...

José Guilherme de Souza Aguiar

7 My Remote Observatory for Comet Observing

Peter Carson

Part 1: Why and where.

Remote Observatories in Spain

When I upgraded my home observatory back in 2014 and was considering what equipment to procure, I had its possible remote use in mind. The mount that I chose was a Paramount ME2 partly because of its well-tested widespread use at the telescope rental sites such as the iTelescope network. My experience in the last 7 years has been very favourable, with the ME2 earning my respect for accuracy and reliability. Riding on the Paramount I selected a 315mm Dall Kirkham reflector, being the largest good quality telescope my budget would stretch to at the time.

My home observatory is a short walk across the garden from the back door but gradually as my confidence and skill improved I found I was quite often using it semi remotely from inside the house. I could set the telescope, mount and camera to work taking a series of faint comet subs and wander off to do some visual observing or nip inside for a cup of tea.
My home observatory site is near Southend on Sea, County Essex, in southeast UK. It is a fairly urban location close to an ever expanding and very bright regional airport. I was producing comet observations of good quality from my home site despite the bright night sky, so why go to the trouble of moving my observatory site? I was even championing comet imaging from a light polluted site as those who heard my talk at the June 2017 Comet Section meeting in Northampton will be aware. However, I knew that the home light pollution situation would only get worse and I was becoming increasingly paranoid every time a new offending light source required some additional mitigation effort from me.

Gear nearly packed..

My home observatory's excellent reliability starting me thinking that a move to a fully remote site might actually be a practical proposition. A remote site with better weather conditions could open up possibilities to observe when convenient to me and not have a rare break in the UK clouds dictate when I observe. A remote site at a dark location could also relieve me from the burden of light pollution enabling me to get the best from my telescope, mount, and camera and not have to fight with the limitations of my bright light polluted home night sky.

For several years I faint heartedly investigated various remote sites around the world noting their advantages but probably more heavily focusing on all the many possibilities of failure. I dabbled with the iTelescope rental network thinking that might give the feel of observing at a remote site, which in hindsight it did not. I even seriously (nearly) convinced my wife we should move from our home of 29 years to a site with a darker night sky.

Whilst a dark sky home location is ideal it is a very hard thing to achieve if where you currently live is perfectly suitable for your needs apart from the light pollution. Thoughts of a remote observatory lay at the back of my mind for a few years until I got chatting to a fellow BAA comet observer who operates a remote observatory on La Palma in the Canary Island. The observatory was located on land belonging to another BAA member who subsequently offered to rent me the use of an unused observatory base on same the site. This event promptly spurred me on to evaluate properly a number of remote telescope hosting sites around the world.

I chose to evaluate prospective remote telescope hosting facilities based on the following criteria:

Dark location, Bortle 3 or 2 with low humidity
No extremes of weather, which excluded high mountain locations
Quality Internet link fast enough to enable telescope controllability from home in real time
Good reputable facility with good security, reliable utilities and on site personnel for technical support
Good reasonably priced all year round transport links preferably via a scheduled airline
Nearby or on site accommodation suitable for a short holiday (My wife's requirement!)
An observatory building already on site to minimise the initial set up time and cost.

I finally found a site called Entre encinas y'estrellas near Fregenal de la Sierra in rural Extremadura, Spain which fitted my requirements the best.
https://www.entreencinasyestrellas.es/en/en-home/

Onsite accommodation

E-Eye, as the site's name is shortened to, is about two hours' drive northeast of Seville at an altitude of 560 m. The small town of Fregenal is around 5 miles away. The town does cause a minor light pollution nuisance but its close proximity delivers the provision of good quality utility services together with a nearby base for support staff.

The hosting facility is well run, professional and lives up to its advertising claims. Its night sky is SQM 21.5 -21.9 Bortle 2 or 3, so dark! E-eye hosts about 70 remote user telescopes making it one of Europe's largest hosting facilities and in the summer of 2019, they were building a further block of eight observatories.

Workshop in Spain

I put my name on the waiting list and contacted Rupert Smith of Astrograph Ltd in the UK who provided me with the additional equipment necessary to transform my home observatory into full remote operation. I had many questions about the site, the roll off roof observatory building, on site system resilience etc. that Rupert and Jose, the Spanish site owner, patiently answered. A roll off roof observatory could limit access to the low altitude sky, however detailed pier design indicated I could achieve better than 15 degrees in most directions. This gave me the confidence that I did not need to make a pre-inspection visit to the remote site and that I was ready to make the move.

So, in the autumn of 2019 I packed my telescope, mount, some new imaging equipment I'd purchased and all the other observatory paraphernalia into two crates ready for shipping to the observatory in Spain which by then was complete and ready for my or rather my equipment's occupation. I was very pleased to discover that shipping equipment to Europe was easy and cheap, albeit this was just before the UK departed the EU. The total cost of shipping two crates of equipment with a total weight of over 260 kg was £160 including insurance for specialist glass components. The less than expected shipping cost and the modest set up costs in Spain gave me confidence that I could give the venture a go and return everything back home if it didn't work out without costing me a fortune.

The completed installation

A four day visit to Spain completed the installation and commissioning of the observatory. It's fast and the completed installation was a credit to the assistance of Astrograph Limited. I managed to time my visit with one of their own maintenance visits.

Having returned home with a completed working remote observatory how was my experience of using familiar equipment from afar? The detailed answer to that question will have to wait for part 2. In summary though, I made some big mistakes, however now more than a year on it's a pleasure to use and most things I hoped it would be.

Part 2 will follow next year. I hope you enjoyed this.

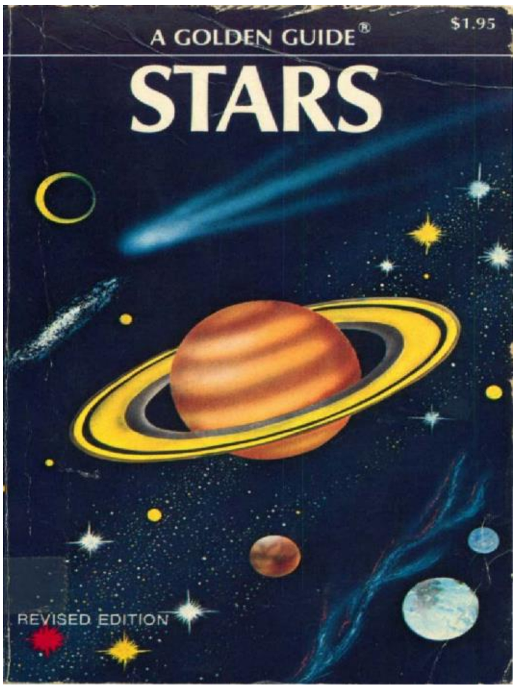
Peter Carson
CCD Imaging Advisor

8 My First Comet

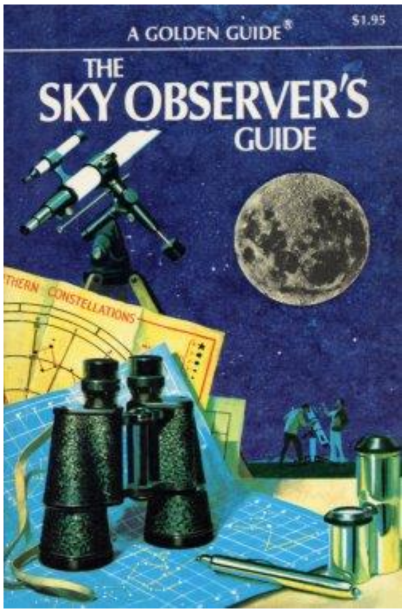
Tim Printy

As I enter my 49th year of amateur astronomy, my memories go back to those first years of that cemented my interest in the hobby. I grew up in Jacksonville, Florida, USA, which was only 150 miles from Cape Canaveral. I saw several Saturn V rocket launches from my front yard during the Apollo moon program.

The most memorable was Apollo 8. I quickly became fascinated by the space program and, naturally, became interested in the stars. My baby steps into the subject happened when I got my first telescope for Christmas in 1971. It was an awful instrument that was more toy than telescope. It was a draw tube type that promised 40X but only delivered about 2.5X. I was deeply disappointed in the performance.



Fortunately, I also received several "Golden Guide" books on astronomy. One was "The Stars" and the other was "The Sky Observer's guide". The "Stars" was an excellent book for learning the constellations and the "Sky Observer's Guide" was a primer on astronomy.



With "The Stars", I quickly familiarised myself with the constellations. While I lost my original copy, I loved it so much, I picked up a copy in a used book store. Here is the page showing Ursa Major:

URSA MAJOR, THE GREAT BEAR (BIG DIPPER) The familiar Dipper is only part of the Great Bear. The Dipper's seven stars are easy to find if you face north on any clear night. The two outer stars of the bowl point to the North Star, Polaris, which is about 30 degrees away. The distance between the pointers is 5 degrees. Both measurements are useful in finding your way around the sky. The middle star of the handle (Mizar) is a double star. Its 4th-magnitude companion is faintly visible, if you look carefully. The rest of the Great Bear spreads as a curve ahead of the pointers and in another curve below the bowl.

"The Sky Observer's Guide" was equally helpful in learning about the subject. It mentioned a magazine for sky watchers called "Sky and Telescope". On my birthday, I convinced my mother to buy me a subscription. I was enthusiastic about the first issue, which described the solar eclipse in July of 1972. I watched the partial eclipse from my home using pinhole projection.

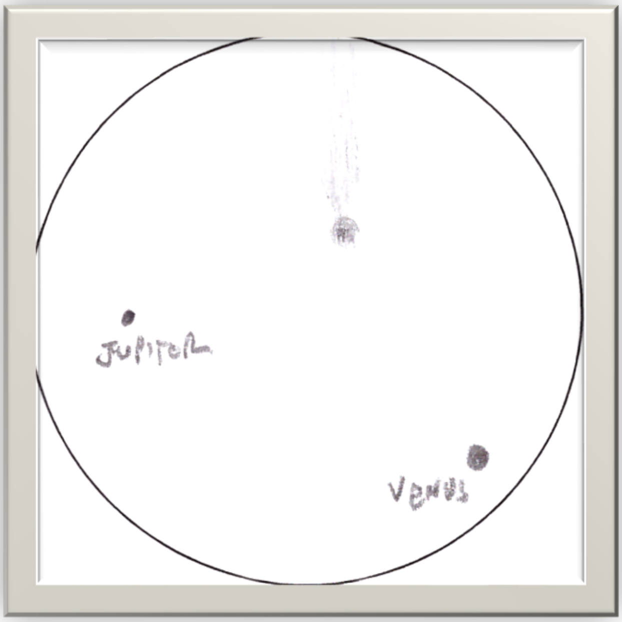
In December of 1972, I joined my local astronomy club. The "*Astro Gator Astronomy Club*", like most astronomy clubs, contained a diverse group of amateur astronomers with various types of telescopes and interests. They all shared my fascination with the space program and the night sky. One, by the name of Richard Sweetsir, was particularly helpful in improving my education on the subject. I was distressed to hear of his passing in the 1990s. He was a teacher by trade and an excellent mentor.

The Christmas of 1972 presented me a JC Penney two-inch refractor, which promised magnifications of 150X.

While it was one of those inexpensive department store refractors, it did deliver satisfactory views of the planets and moon. This was a significant improvement over the previous year's gift. Coupled with what I had learned in the past year, I was ready to become an amateur astronomer.

Because of all these events that happened in 1972, I consider that my astronomical 'birthyear' and count my experiences in amateur astronomy from that point.
In the summer of 1973, the news broke that a new comet had been discovered and it was going to be a bright one. That comet's name was Kohoutek. I had never seen a comet before and my excitement grew with wild predictions stating it could be as bright as the full moon! Sky and Telescope was more reserved in its estimate but still estimated it to be as bright as Venus. Needless to say, I was excited and could hardly wait for the month of January to arrive.

My first chance to see the comet was on January 4th, when the comet was supposed to have been low in the sky in bright twilight. I remember the date because the astronomy club met on the first and third Friday of the month and we went to the meeting after the comet had set. My friend and I searched in vain with our binoculars but could not see it. Something that was supposed to be negative magnitude should have been easy to find.



My sketch of Kohoutek made from memory – after 50 years!

What was frustrating was that some of the more experienced observers reported seeing it. The next time I recall looking for it was on January 8th. On that evening, the comet was to be positioned to form a triangle with Venus and Jupiter. I remember using my 8X30 binoculars as twilight began to fade and eagerly scanned the area where the comet was supposed to be. Once it got dark enough, the comet jumped out in my binoculars. My memories are that it was around magnitude 4 and the tail was about five degrees in length. I don't even remember seeing it with the naked eye.

No wonder I could not find it in bright twilight four days previously. With such a disappointing performance, I suspect that many budding amateur astronomers quickly lose interest in the hobby. The opposite happened to me as I became fascinated by the comet's appearance and how it changed from night to night. My sketches from the time period would have been something I considered to be a treasure now but they were lost with time. I did not think of preserving those blue folders with lined notebook paper that contained my astronomical observations/sketches from my teen years. All I have are my memories but that experience taught me about how comets behave and what to expect the next time a comet appeared.

My US Navy days

After I became an adult, I joined the United States Navy and spent many years moving about. Wherever I went, I had a telescope or binoculars of some kind so I could look at the stars when the opportunity presented itself. My interest in the subject never waned and I was quite active when I was not aboard ship. In 2000, I retired from the Navy and moved to Manchester, New Hampshire in the USA, with my wife, Pollyann.

Pollyann and me with Comet Neowise July 2020

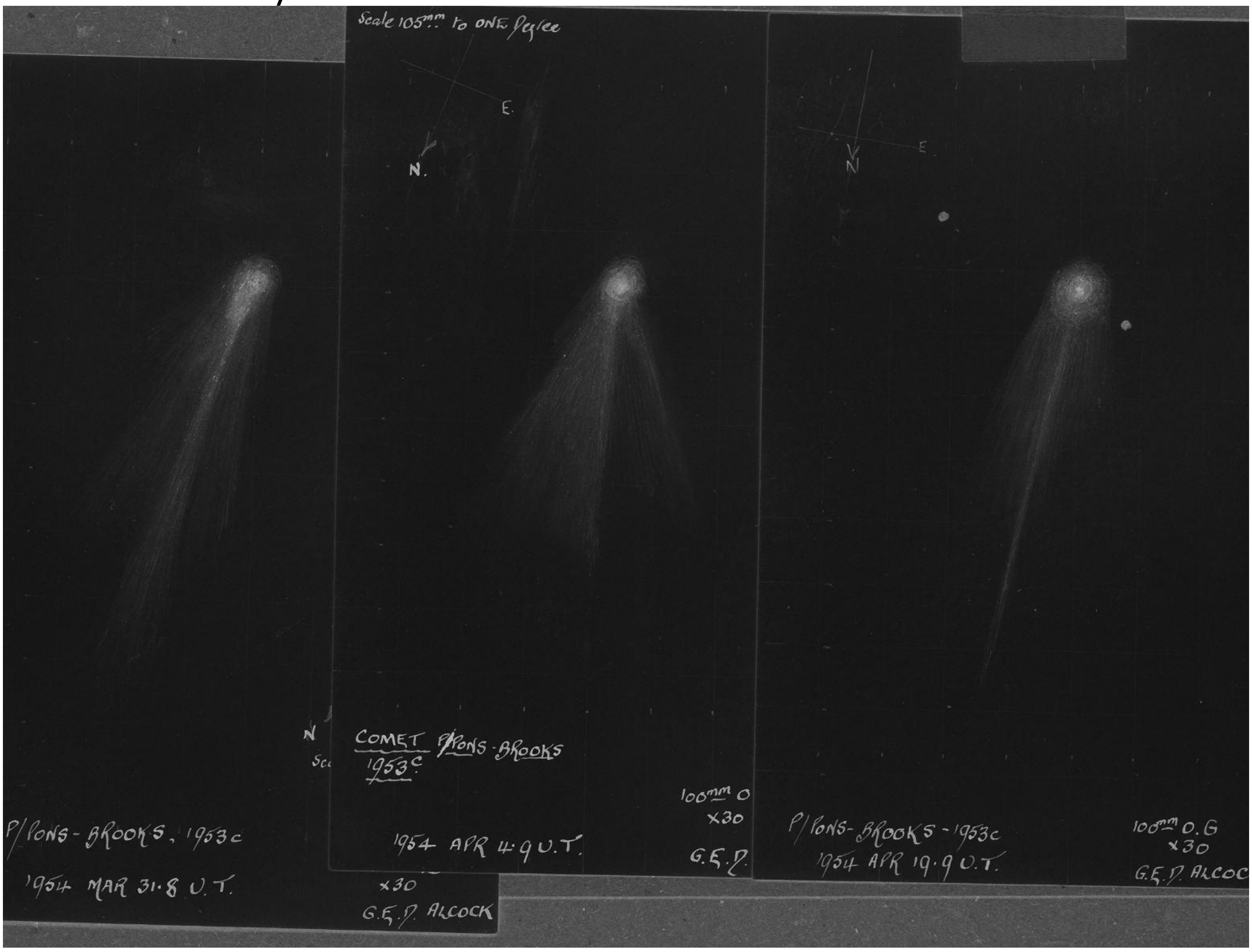
The two of us make quite the astronomical pair and we enjoy going to public sky watches together so we can share the night sky with others. I have to wonder how many young amateurs had their interests sparked by looking through one of my telescopes? One can only hope that astronomy is contagious.

Over all of these years, I have seen many comets. Some were faint, some were bright, and a few were spectacular. While Comet Kohoutek was considered a dud by the media, it has a special place in my memories as a glorious gem that cemented my love for amateur astronomy that has lasted almost fifty years.

I have come a long way since that 2-inch refractor! Here I am with my 10-inch Dobsonian, which is one of many telescopes I currently own.

Tim Printy

9 Comet 12P/Pons- Brooks **Neil Norman**



12P/Pons-Brooks belongs to a group of comets called Halley-type comets, that is to say the comets within this group share several characteristics with that of comet 1P/Halley in that they have periods ranging between 20 and 200 years and inclinations anywhere from 0 - to 90 degrees. The family, as of last year, comprises some 91 members and is getting bigger each year with more of these type comets being discovered. Still a while before the family becomes as big as the Jupiter family comets, which now exceed 690 members.

Comet 12P/Pons-Brooks was initially discovered on July 21,1812, by the great comet hunter, Jean Louis Pons (Marseille, France) as a magnitude 6 object near the borders of the constellations Camelopardalis and Lynx. Pons was a self-taught French astronomer who made 37 visual comet discoveries, a record still unsurpassed by this method. 28 of these comets were on parabolic orbits 3 did not have enough observations to determine an orbit, however many of his discoveries fuelled the discovery or recovery of what we relater recognised as periodic comets, including 12P/ Pons-Brooks and 7P/Pons-Winnecke.

He noted its appearance as “shapeless” and having “no apparent tail”. The comet at this time was situated some 1.28 au and 1.78 au from the Sun and Earth respectively. The comet continued to approach the Sun and Earth, and on August 13 it had become a naked eye object in the constellation of Lynx and with an angular separation from the Sun of 40 degrees. The comet was positioned 1 au from the Sun and 1.5 au from the Earth respectively. As August drew to a close it was then at magnitude 4.5 with a two-degree long tail. As September began, the comet was drawing towards perihelion and the declination began to rapidly drop as it moved southwards in the sky.

On the 15th it attained its maximum brightness of magnitude 4 and was displaying a split tail, with each branch extending for over 3 degrees in length. The comet was at perihelion at this time at a distance of 0.77 au and also a day away or so from the closest approach to Earth at 1.21 au. The comet was last observed, at this return, on September 28 as the comet moved south, but when last seen on that date it was still holding a magnitude of 4.

Jean-Louis Pons 24th December 1761-14th October 1831

As with all new comets, the next step was to ascertain an orbit. After several calculations, Johann Franz Encke (1791-1865 born Hamburg, then in the Holy Roman Empire, now Germany) arrived at a figure of 70.68 years for the orbital period. With this in mind astronomers planned to begin searching in 1883 for the returning comet in an area predicted in an 1882 ephemeris by L. Schulhof and J.F. Bossert. They gave a perihelion passage of 1884 September 4.14 (+- 4.5 years)

Before the searches began William Robert Brooks, 1844-1921 (a British born astronomer living at Phelps in New York State, USA) found a comet during one of his systematic searches on 1883 September 2.1. This comet was identified as being a return of Pons's comet of 1812 by C. W. F. Peters (Kiel, Germany) and would arrive at perihelion more than 7 months earlier than predicted. Brooks gave the magnitude as 10 at discovery. At that time the comet was 2.4 au and 2.36 au away from the Sun and Earth respectively.

William Robert Brooks 11th June 1844 - 3rd May 1921

After discovery the comet was extensively observed throughout September, being described by many observers as a small tailless nebulosity. On September 22 the comet experienced an outburst and H.Struve and G.V.Schiaparelli estimated the comet as bright as magnitude 7-8. S.C. Chandler noted a central condensation of around 0.5' and a coma of 1.5'. After September 30 the outburst subsided and the coma expanded to around 5' and appeared non-symmetrical, with the central condensation situated to the north on the coma. Some bright points of light were seen within the coma by G. Abbetti and he suspected a tail was present. The comet was still over 2 au from the Sun and Earth and beyond the orbit of Mars. This outburst was a well observed and was typical of what we now see in many comets as they approach perihelion.

The comet seemed to stabilise and on November 20 it reached naked eye visibility of around 6th magnitude whilst located in the constellation of Hercules and some 1.4 au and 1.3 au from both the Sun and Earth. By December 1, it was at 5th magnitude with a coma some 6' in diameter and a tail of 1 degree in length.

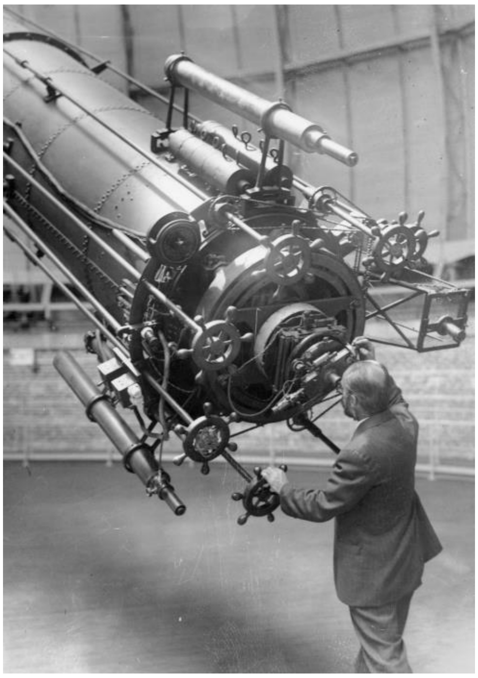
As 1884 began the comet was racing towards both perihelion and closest approach to Earth in mid-January. The early days of January saw the comet at magnitude 3 with a coma 10' in diameter and sporting a narrow tail of some 5 degrees in length. The closest approach to Earth occurred on the 10th at a distance of 0.66 au with the comet still at third magnitude and all seemed stable with the comet, until January 19th when three distinct zones were noted within the coma. A sharp nuclear region was evident that was surrounded by two jets and as the comet passed perihelion on the 26th at 0.78 au, the nucleus appeared to be surrounded by a halo of material with a tail of 20 degrees in length as seen through binoculars, and magnitude of 3.

Thereafter the comet gradually faded, still being 4th magnitude at the start of February, 6th magnitude at the beginning of March. The final observation was made on June 2nd when the comet was magnitude 9.5 and within the southerly constellation of Carina. The comet was then 2.2 au and 1.76 au from the Sun and Earth respectively. Using more positions, the orbit of the comet was refined and the following return was set for 1954 with a perihelion date of May 27th.

Elizabeth Roemer of the Lick observatory began searching in 1953, a full year before perihelion. (For an excellent account of the life of Elizabeth Roemer, see Denis Buczynski's article in the Comet's Tale June 2019) On June 6th she found the comet just 25' from its predicted position at a magnitude of 17.5 on a photographic plate.

Elizabeth Roemer 4th September 1929 - 8th April 2016

At this time the comet was 4.5 au from the Sun and located within the constellation of Draco. With more powerful telescopes and imaging equipment plus a greater understanding of the orbit, the comet was monitored on a regular basis-and odd things were noted.



Georges-Achille Van Biesbroeck 21st January 1880 - 23rd February 1974

Georges-Achille Van Biesbroeck, the Belgian astronomer, later of the Yerkes Observatory imaged the comet on 1953 July 1st, and was surprised to see the comet shining at magnitude 13, an outburst which was to last for two weeks. Normality returned and was not to change until September 28 when Van Biesbroeck again noted that the magnitude had risen from the expected magnitude 16 to 12th magnitude.

This outburst was to last just 5 days with the comet dimming back down to magnitude 15 on October 3rd. The comet at this point was located at 3.48 au from the Sun. At the start of December, the magnitude was the expected 15.5 but on the 7th yet another outburst occurred this time taking the comet to 11th magnitude with the comet still at a heliocentric range of 2.7 au and five months before perihelion. The comet again faded back down to its predicted magnitude and on Christmas day was magnitude 13.5 within the constellation of Lyra and 2.5 au from the Sun.

Moving into 1954, the comet approached both the Earth and Sun and remained at a steady, as-to-be-expected, magnitude and late April saw the comet reach naked eye visibility but this was short lived as the comet soon moved into solar conjunction and its perihelion passage. It eventually reappeared in early June in the constellation of Orion at magnitude 6 but was followed through until September 4th when it was located in Centaurus at magnitude 13 and at a heliocentric range of 2 au.

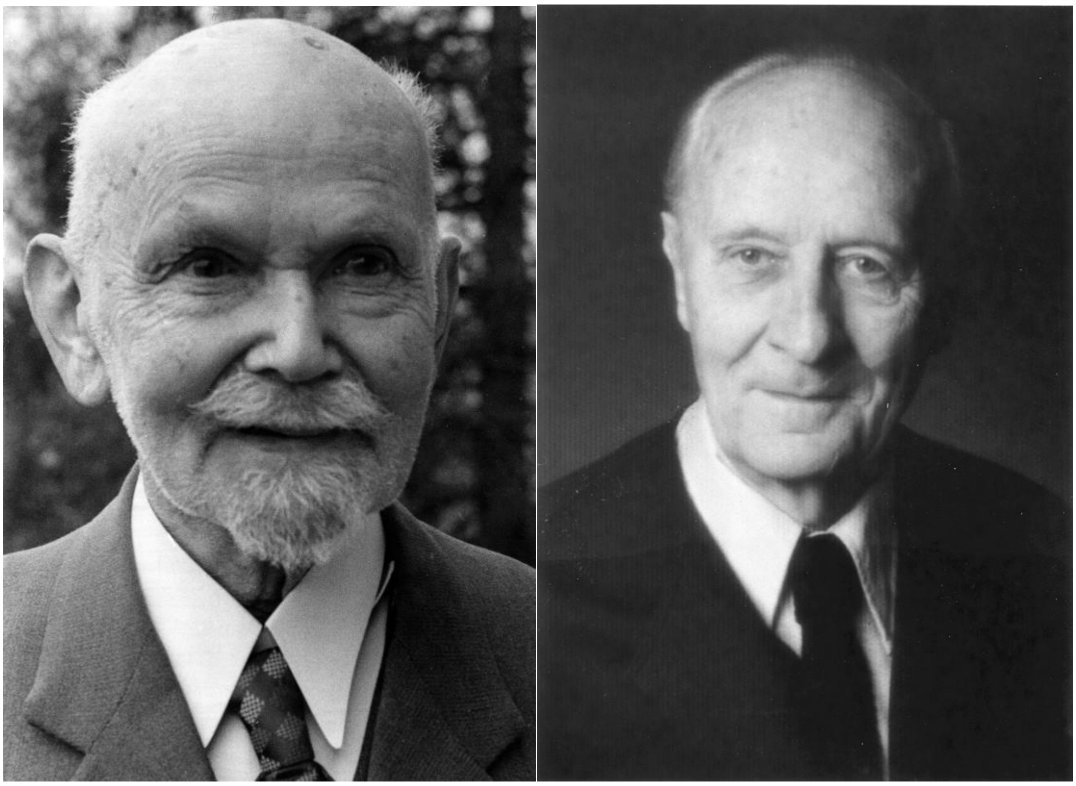
4.3-m Lowell Discovery Telescope at Happy Jack, Arizona.

With technology moving ever onward and the sensitivity of the equipment becoming far greater, astronomers began to try and find the comet as quickly as possible in preparation for the April 2024 perihelion pass and in late June of 2020 the comet was recovered just about 4 years away from perihelion. It was recovered using the 4.3m Lowell Discovery Telescope at a heliocentric distance of 11.9 au and with a magnitude of 26! The surprising thing also is that the team who discovered it say that given the state of the coma, that far out, the comet was very likely to have become active at 30 au from the Sun or in other words, the orbital distance of Neptune! Research work by Maik Meyer has found that the comet was observed twice before discovery in the years 1385 and 1457 which given the comet's absolute magnitude is 5 is no surprise.

The comet should become visible to amateur observers around early 2023 and it is an object worth monitoring very closely as outbursts are likely. If Halley-type comets are a subject of yours do also remember that in the Summer of 2024, comet 13P/Olbers will also be on the scene, though that's a subject for another issue.

Neil Norman

10 The Schwassmann-Wachmann Comets: A review Denis Buczynski



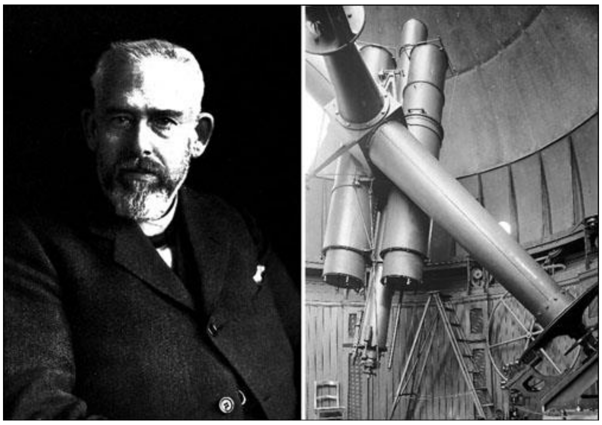
Fredrich Karl Arnold Schwassmann (1870-1964) and Arno Arthur Wachmann (1902-1990)

Introduction

Every comet observer will be aware of the comets that were discovered by the two great German astronomers, Karl Fredrich Arnold Schwassmann and Arno Arthur Wachmann at Hamburg Observatory in Bergedorf Germany in the 1920's and 1930's. To English speakers their names are tongue twisters and linger in the memory. The comets they discovered are important ones, and all three of them have an interesting history. Before I describe the comets themselves it will be interesting to examine the circumstances of the discoveries and the men who found them as a by-product of their regular professional work.

Although both their names are inextricably linked via their comet discoveries, their careers were also closely linked. Both men worked on the same programme of stellar spectral classification of 180,000 stars in the 115 Kapteyn calibration fields of the northern celestial sphere, carried out from 1925 to 1934 and published from 1935 to 1953 at the Bergedorf-Hamburg Observatory.

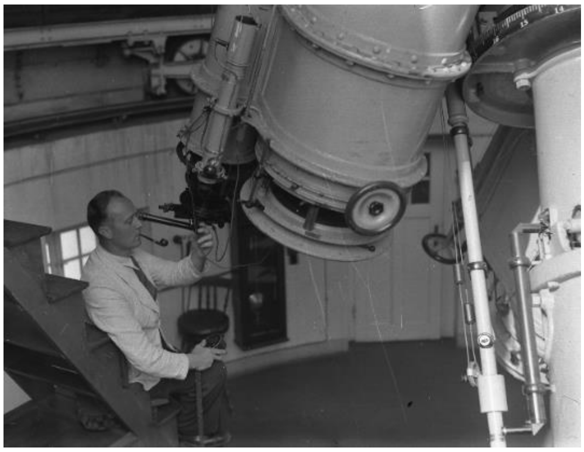
Karl Schwassmann (born March 25, 1870 in Hamburg, Germany) was the senior scientist and had a distinguished record of minor planet discoveries when he worked as an observer with the German pioneer of astrophotographic techniques, Professor Max Wolf, at the Heidelberg observatory on the Königstuhl from 1897. Here he discovered (with Wolf) 22 minor planets using the Bruce double astrograph up until 1900. From 1902 he moved to the Hamburg Observatory, in whose new building in Bergedorf he was involved. He stayed at the Bergedorf observatory until his retirement in 1934. He also taught astrophysics at the Hamburg University, which was newly founded after the First World War.


Max Wolf and the Bruce Astrograph

Arno Wachmann (born March 8, 1902 in Hamburg) studied astronomy at the University of Kiel. In 1926 he completed his studies with a dissertation on the proper motion of stars. From 1927 he worked at the Observatory, Bergedorf near Hamburg. With Schwassmann he used the Lippert astrograph which comprised a 34-cm-astrograph (Zeiss Triplet, long focal length) and a 30-cm-double-astrograph (Zeiss Triplet K and Petzval, short focal length) with objective lens prisms for spectrographic investigations.

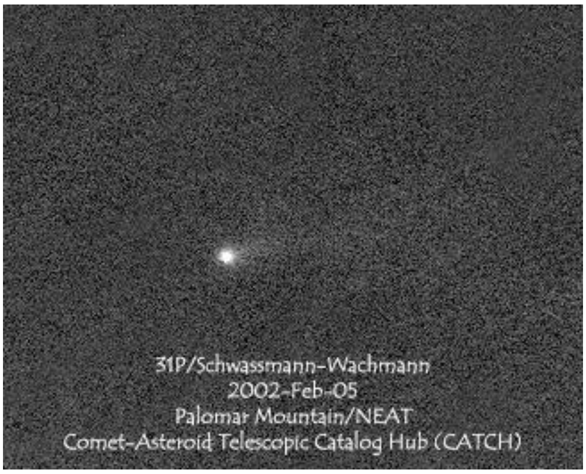

Lippert Astrograph and Dome

It was with this instrument that they discovered the three comets now credited to their names. The two men were close and when Schwassmann died, aged 94 on 19th January 1964 Wachmann wrote a warm obituary detailing his achievements and commented that, "He was of heart-winning kindness towards colleagues and students. In the dealing with the youth he keeps himself young." Wachmann continued working at the Bergedorf after Schwassmann retired and is credited with the discovery of 3 minor planets. He retired in 1969 and died in Hamburg in 1990.

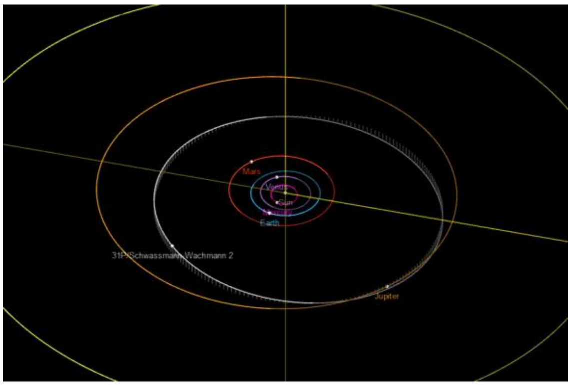

Wachmann at the Lippert Astrograph

The three comets that carry their names were discovered between 1927 and 1930 on photographic plates taken with the 30cm astrograph. All three of the comets eventually had pre-discovery observations by other observers ascribed to them. At discovery the magnitude of the comets was 13 (29P), 11 (31P) and 9.5 (7P).

31P



I shall now examine some of the history and changing aspects and appearances of these comets. The least well known, in terms of continued observations in later years, of the comets was 31P. This periodic comet, whose elliptical orbit is contained between Mars and Jupiter, has the current following values: Eccentricity 0.1928, Orbital period 8.705, Inclination 4.5487°.



Discovery of this comet happened after examination of plates taken on 1929 January 17 by Schwassmann and Wachmann. Other observers found pre-discovery images on plates reaching back to 1928 December 8, thereby extending the arc of observations.

American Astronomer, Anne Sewell Young 1871 – 1961

A curious story related to a possible pre-discovery was the announcement in June 1929 by the American astronomer, Anne Sewell Young, who had been searching for the lost minor planet 525 Adelaide (which had been discovered in 1904 by the American amateur astronomer Joel Metcalf) was in fact identical with newly discovered comet 31P.

Long 'Lost' Planet Found Masquerading as Comet

BERKELEY, June 21. — Adelaide has been found—at least Dr. Anne S. Young, of Mount Holyoke Observatory, thinks she has—after a 25-year search.

Adelaide, gentle reader, is not a girl but a minor planet, at least the astronomer who discovered her in 1904 and then lost her again almost immediately said she was.

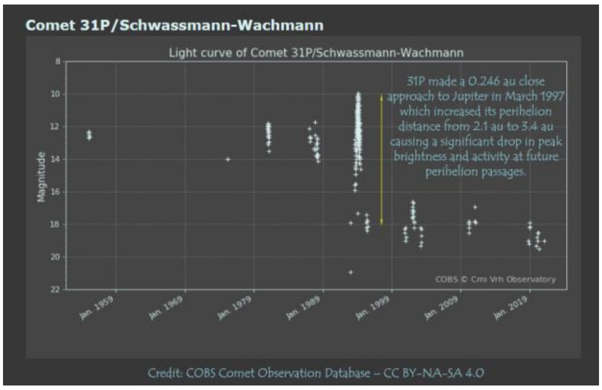
But Dr. Young, who has been tracing Adelaide at the University of California here, told astronomers attending the conference of the American Association for the Advancement of Science today that she believes she has discovered Adelaide masquerading as a newly discovered comet and under the ponderous name of "Schwassmann-Wathmann 1919-A."

"I have discovered that the orbits of Adelaide and of the new comet are identical and believe that the discoverer of Adelaide wrongly classified her as a minor planet and not a comet," Dr. Young declared.

"This leads me to believe that Schwassmann-Wathmann 1929-A is none other than the long-missing Adelaide."

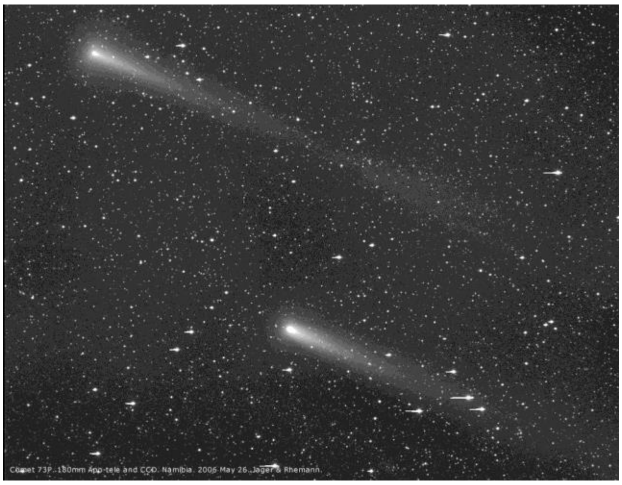
Dr. Young declares she will continue her search in the hope to definitely identify the new comet as Adelaide. She is being assisted in the search by J Ueta, of Kyoto Observatory in Japan.

The comet was regularly observed during the discovery apparition and the comet has been observed at all subsequent apparitions. As the comet has frequent close approaches to Jupiter its period is altered between 8 and 9 years. An attempt to measure the size of the nucleus was made by J.X. Luu and David Jewitt at near aphelion in 1992. In a summary of their paper they state "CCD photometry of comet P/Schwassmann-Wachmann 2 obtained at 4.58 AU. The observations reveal cyclic variations in the comet brightness about a mean apparent red magnitude mÄ = 21.05 ±0.06 mag and a range of approximately 0.5 mag.



We find a best-fit lightcurve period P0=5.58 ±0.03 h, which we interpret as the rotation period of the nucleus. No coma was seen in the individual exposures, but a faint coma extension toward the west was observed in a summed image. The derived upper limit to the radius of the nucleus is 3.1 km (assuming a value 0.04 for the geometric albedo). This renders Schwassmann-Wachmann 2 one of the smallest comet nuclei yet studied." A revised estimate of the doubling the diameter of the nucleus to 6.2km is given by Lamy et al in 2004. In 1997 the comet made another close approach to Jupiter which increased its perihelion distance and resulted in the comet appearing fainter at future apparitions.

73P

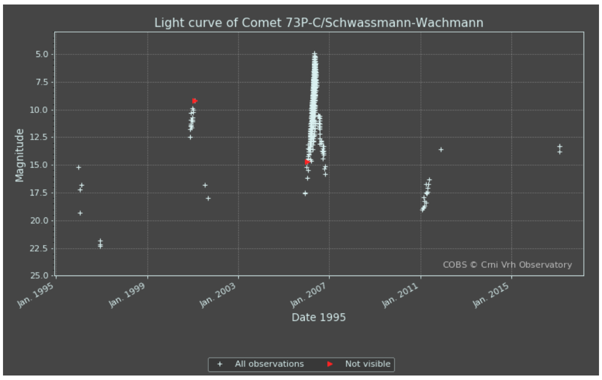


Comet 73P imaged in Namibia 2006 May 26 by Jager and Rhemann

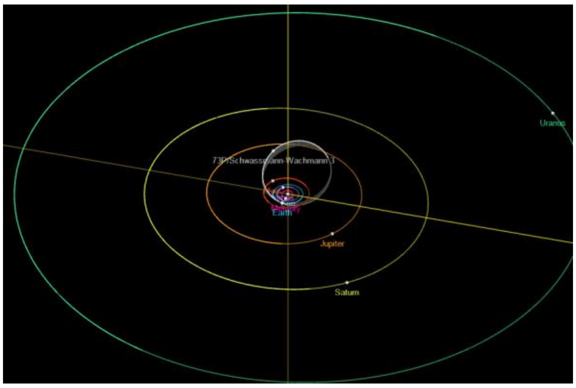
The last comet discovered by S-W was 73p. It was found on plates exposed with the 30cm astrograph on 1930 May 02 at magnitude 9.5. This periodic comet of the Jupiter Family has an elliptical orbit with the following values; semimajor axis 3.063 au, orbital inclination 11°.4, eccentricity 0.692 and a period of 5.4 years.

Hubble image of 73P. 2006 April 18, Credit: NASA, ESA, H. Weaver (APL/JHU), M. Mutchler and Z. Levay (STScI)

This is a comet that is in the process of disintegration and is intrinsically faint. It has been the subject of many investigations by some of the leading comet scientists.



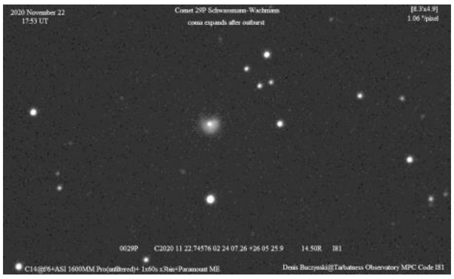
At the discovery apparition, observers reported seeing multiple tails and at least two central condensations with the coma. In some of the later apparitions the comet was poorly placed for observation and the comet was subsequently lost from 1930. It was recovered in 1979 and seen again in 1990. The apparition of 1995 was significant in that the comet brightened to mag 6 and multiple components were seen.



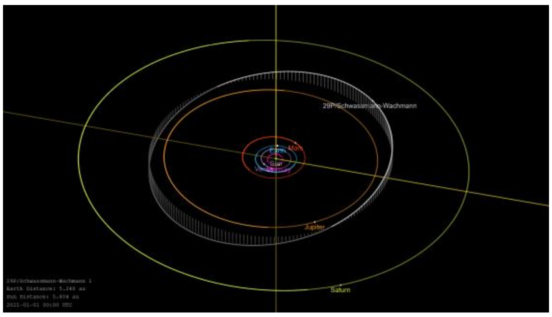
Two of the same components were identified at the 2001 return and in 2006 further disintegration was seen and this time more components were observed. The latest apparition in 2017 saw the disintegration continue.

29P

The most famous of the three discoveries is comet 29P. It was discovered on 1927 November 15 on plates taken with the 30cm astrograph.

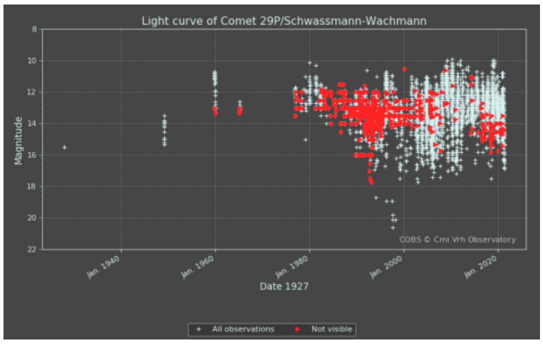


The comet was around magnitude 13 at discovery and 2 years past its closest approach to the Sun and Earth. The current orbit gives the following values: eccentricity 0.0441, period 14.65 years, inclination 9.3903°.

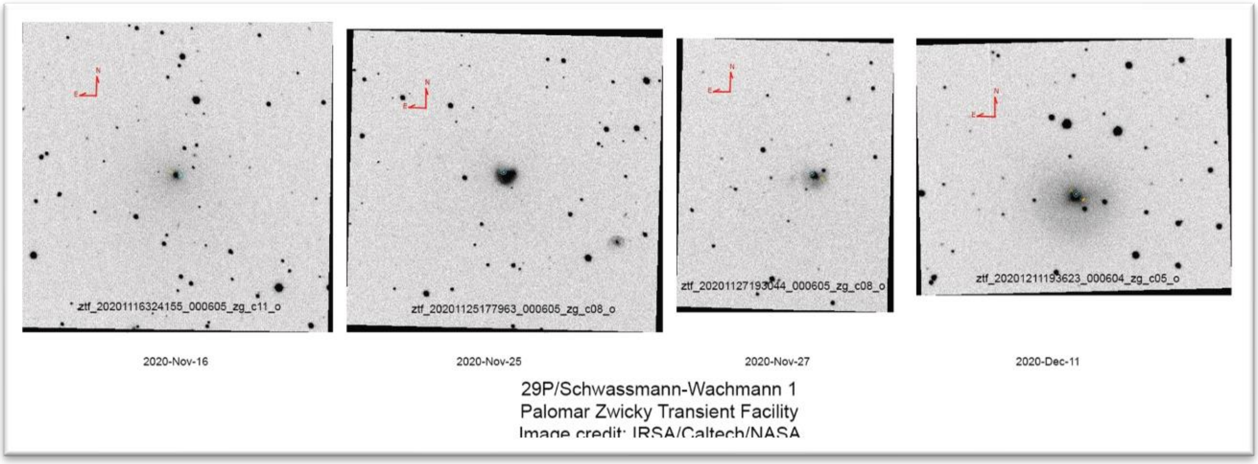


This means it resides between the orbits of Jupiter and Neptune and is classified as a Centaur. It is a large object over 60km in diameter and is subject to frequent outbursts. It is probably the most enigmatic of the solar system comets that have been observed. Not surprisingly, considering the regular outbursts the comet has, it was actually recorded on photographic plates more than 20 years before its 1927 detection.

In 1902 March 04 Karl Reinmuth found the comet at magnitude 12 then in 1931 Leland Cunningham in the USA linked the positions of the 1902 comet with the recently discovered 29P and showed they were the same object. Immediately after the 1927 discovery the leading comet observers around the world, Van Biesbroeck in the USA and Walter Baade in Germany, followed the comet photographically for the next few years and found that the comet faded then went in outburst.



The comet usually resides around or below magnitude 17 when in quiescence, consequently is not often observed visually. When outbursts occur they first appear as a starlight point of around mag 13, then they develop an expanding coma which has the nucleus eccentrically situated in the coma. As the comet never comes significantly closer to the Sun at any part of its orbit of (around) 5 AU, this outburst activity was somewhat baffling. No tail is reported although jets appear within the coma. This has remained an unsolved mystery despite many investigations by comet researchers over almost 100 years. No consensus has been found as to the causes of the outbursts. The comet is under constant observation and during every apparition there have been outbursts and fades recorded. Presently there is an on-going collaborative programme (Mission 29P, coordinated by Richard Miles of the BAA) by amateurs and others to image and measure the nuclear magnitude of the comet in a controlled and systematic procedure to gather enough data to support an investigation of the underlying physical causes of the regular outbursts of this enigmatic comet.



A sequence of images of an outburst of 29P/Schwassmann-Wachmann 1 from the 5th data release of The Zwicky Transient Facility ZTF archive in IRSA/IPAC plus les cometes magnitude plot. The leftmost image shows typical appearance during quiescence. The outburst occurred between the time of first and second image. The second image shows typical post outburst shape, an irregular expansion coma. Over time the nuclear magnitude tends toward the pre-outburst level while coma expands outward.

Palomar Zwicky Transient Facility
Image credits: IRSA/Caltech/NASA and Les Cométes

The three comets discovered by Schwassmann and Wachmann are amongst the most interesting of comets. Numerous investigations resulting in scientific papers to describe the motions and physical characteristics of these ever evolving solar system bodies have been published. These comets were discovered as a by-product of other astronomical observational programmes and it is noteworthy that there seem to be hardly any follow up observations published of their discoveries by either Schwassmann or Wachmann. However, those finds have been significant in the realms of cometary science. Those three discoveries have placed the names these two early 20th Century German astronomers large in the lexicon of comet discoverers. Their comets will continue to be observed and studied for many more years to come.

Denis Buczynski Comet Section Secretary

For those readers who may be interested in the detailed observational history of these comets, between 1927 and 1997, then the accounts in the Cometography Series of books by Kronk, Mayer and Seargent volumes 2, 4 and 5 are the best places to look.
Online the following sites are recommended:
https://cometography.com/pcomets/029p.html
https://cometography.com/pcomets/031p.html
http://cometography.com/pcomets/073p.html

11 The Comet Section Image Archive

Nick James

The Comet Section has been building an online archive of images for many years. It contains images of recent comets and images scanned from our section archive stretching back to the 1930s. We currently have almost 33,000 images in the archive and it is a tremendous resource for anyone interested in comets.

New images are collected by Denis Buczynski either from our email address (cometobs@britastro.org) or from other sources. We ask that images be annotated with key details and named in a particular way so that image submission is automated but Denis does spend quite a bit of time renaming files if needed. This can delay the incorporation of the image into the archive, particularly at busy times. The submission guidelines are here:
https://britastro.org/node/16839
Please try to follow them!
The archive has a very simple front-end available here:
https://britastro.org/cometobs/
This is a static HTML list of comets with a link to each one as shown in fig 1.

BAA/TA comet image archive

This is the joint comet image archive of the British Astronomical Association and The Astronomer. If you wish to subm

Object	Name	Last Observation	Number of images
1p (gallery)	1P Halley	1987-01-31T0421	206
2i (gallery)	2I/Borisov (=2019 Q4)	2020-07-06	129
2p (gallery)	2P Encke	2020-09-09	205
4p (gallery)	4P Faye	2021-03-27T0938	116
6p (gallery)	6P d'Arrest	2021-04-22	41
7p (gallery)	7P Pons-Winnecke	2021-05-09	46
8p (gallery)	8P Tuttle	2020-09-17	62
9p (gallery)	9P Tempel	2021-04-03T210228	143
10p (gallery)	10P Tempel	2021-04-02	85
11p (gallery)	11P Tempel-Swift 11P Tempel-Swift-LINEAR	2021-01-17T2146	48
12p (gallery)	12P Pons-Brooks	1954-04-19	4
14p (gallery)	14P Wolf	2017-10-24T185042	4
15p (gallery)	15P Finlay	2015-04-10T195002	55
16p (gallery)	16P Brooks	2021-01-17	16
17p (gallery)	17P Holmes	2020-11-12	399
19p (gallery)	19P Borelly	2016-05-08	52
21p (gallery)	21P Giacobini-Zinner	2019-08-20	634
22p (gallery)	22P Kopff	2021-04-03T234521	84
23p (gallery)	23P Brorsen-Metcalf	1989-09-03T0319	4
24p (gallery)	24P Schaumasse	2018-04-27T0640	55
26p (gallery)	26P Grigg-Skjellerup	2017-12-25	6
29p (gallery)	29P Schwassmann-Wachmann	2021-04-25T2044	1271
30p (gallery)	30P Reinmuth	2018-05-18	52

Fig 1 – The basic front-end to the Comet Section image archive

If you follow the links you are presented with another table containing links to each image. This works but it is not very pretty and it is not possible to search on specific observers or date ranges.

Recently Dominic Ford has written a much nicer front end to the archive as part of an overall update to the BAA webpage image gallery. You can get to this by going to the BAA image gallery homepage here: https://britastro.org/observations/index.php

Images from the Comet Section archive are imported into the BAA gallery once a week and they then become available through this interface.
This front end allows you to search on particular comets, observers and date ranges. The example in fig 2 shows a search on comet C/2021 D1 (SWAN).

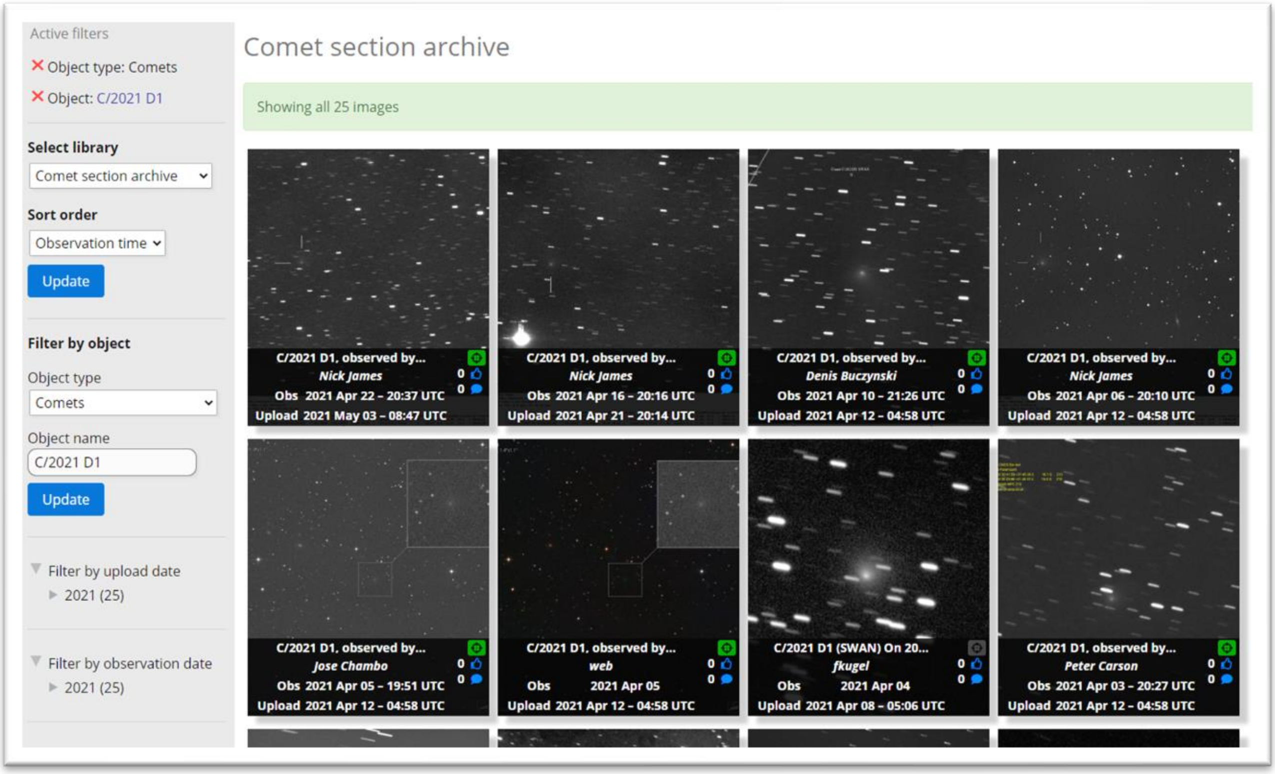


Fig 2 – The new front end, searchable by object, observer, date and field position

Remember to select "Comet section archive" as the library and then enter the name of a comet. Images can be sorted by observation time or submission date. A particularly useful aspect is that the images are platesolved where possible, as shown in fig 3.

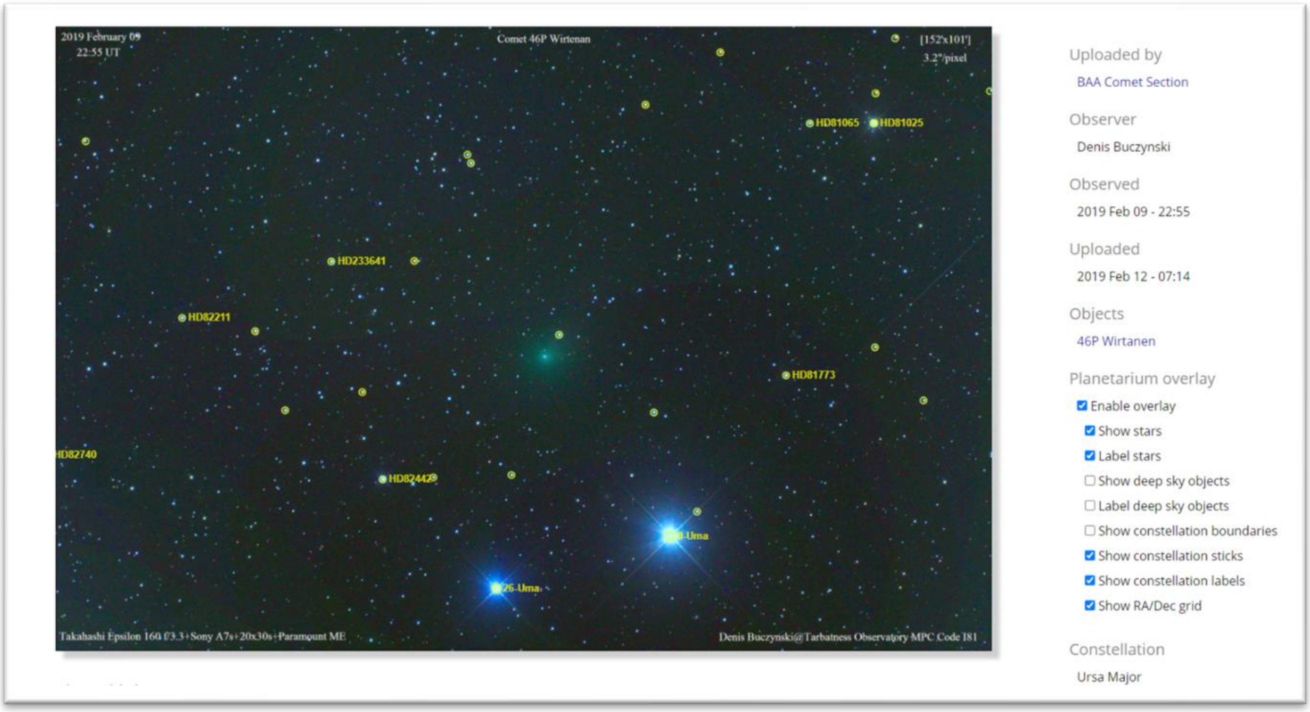


Fig 3 – A platesolved image of 46P/Wirtanen from the archive

This allows the fields to be plotted on a chart as shown in fig 4.

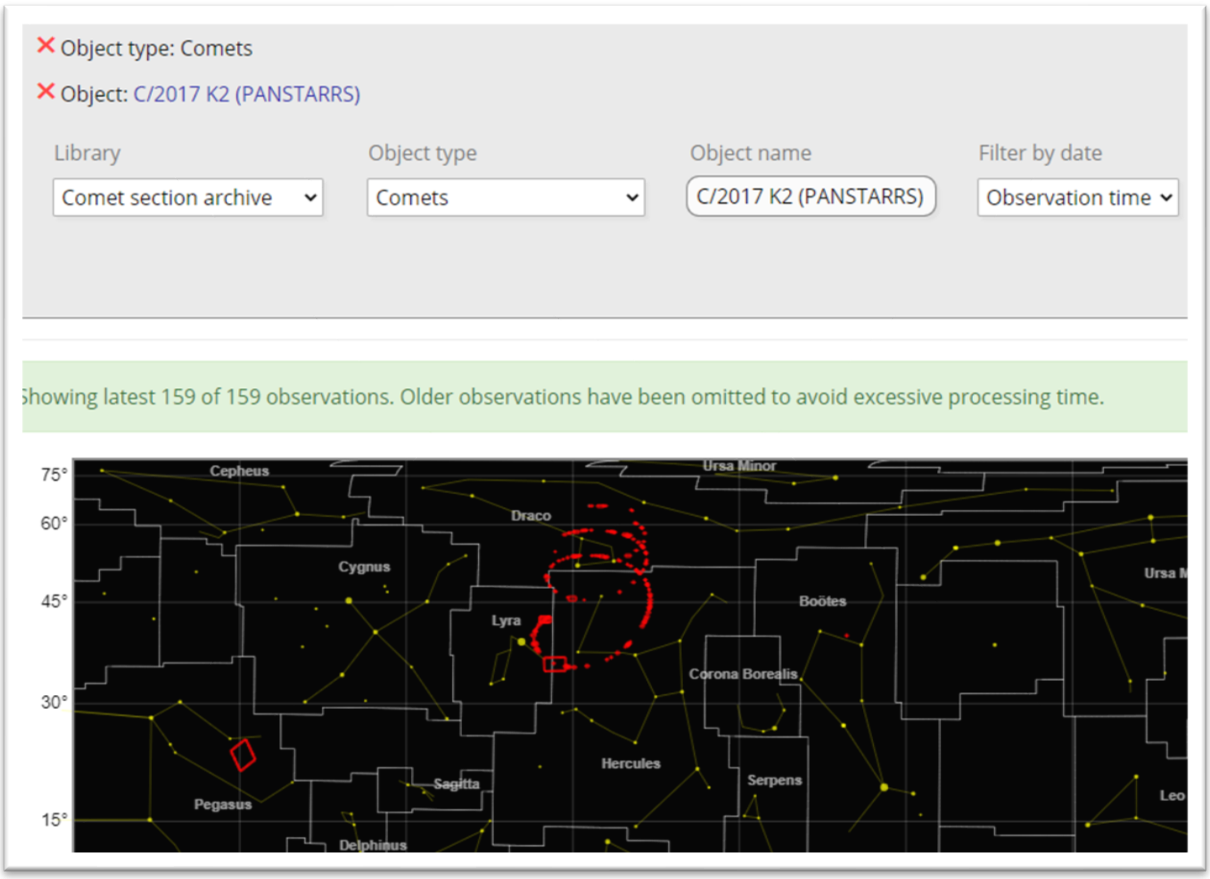


Fig 4. All the platesolved image fields for C/2017 K2

In this case, these are all of the images of C/2017 K2 (PanSTARRS) that are in our archive. The looping motion on the sky as this comet slowly approaches perihelion following its discovery in 2017 is nicely shown. There are a couple of images that are clearly in the wrong place and these are where the platesolve has failed. These can be reported by following a link on the image page (I've already done that for the examples here!).

It is also possible to search the archive by date as shown in fig 5.

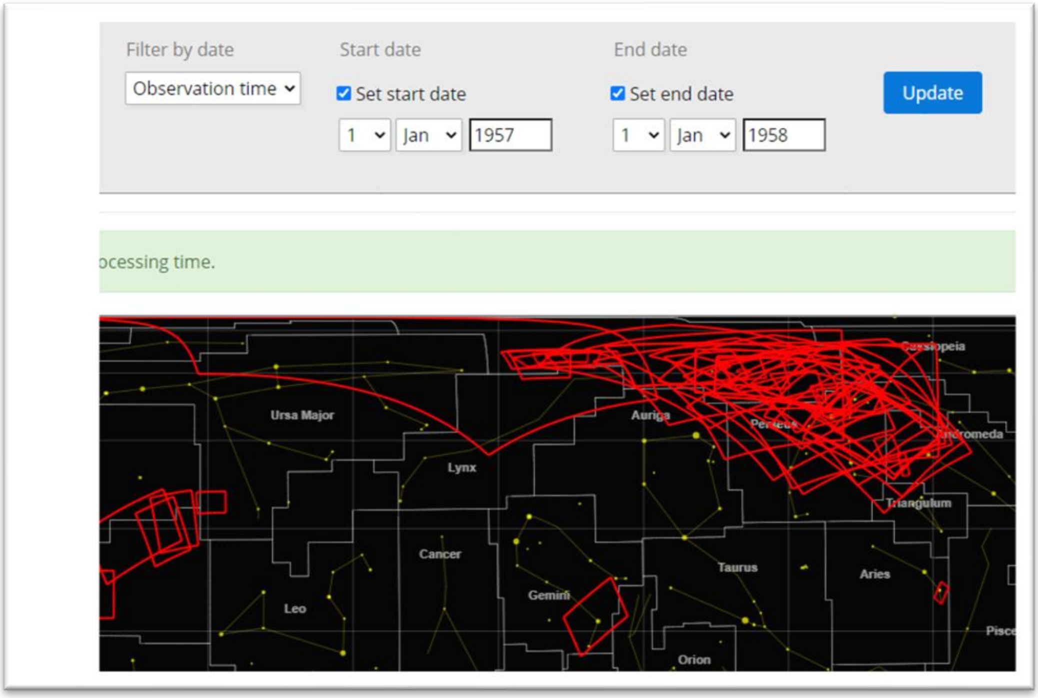


Fig 5 – All the images taken between 1957 Jan 1 and 1958 Jan 1

This example is for 1957 and so it includes a lot of images of C/1956 R1 (Arend-Roland) including the one by Reggie Waterfield shown in fig 6. What would he have made of an automatic, blind astrometry solver I wonder? In Reggie's day obtaining a few astrometric positions involved a night's work at the guiding eyepiece followed by hours developing the plate, using a measuring engine and computing the results.

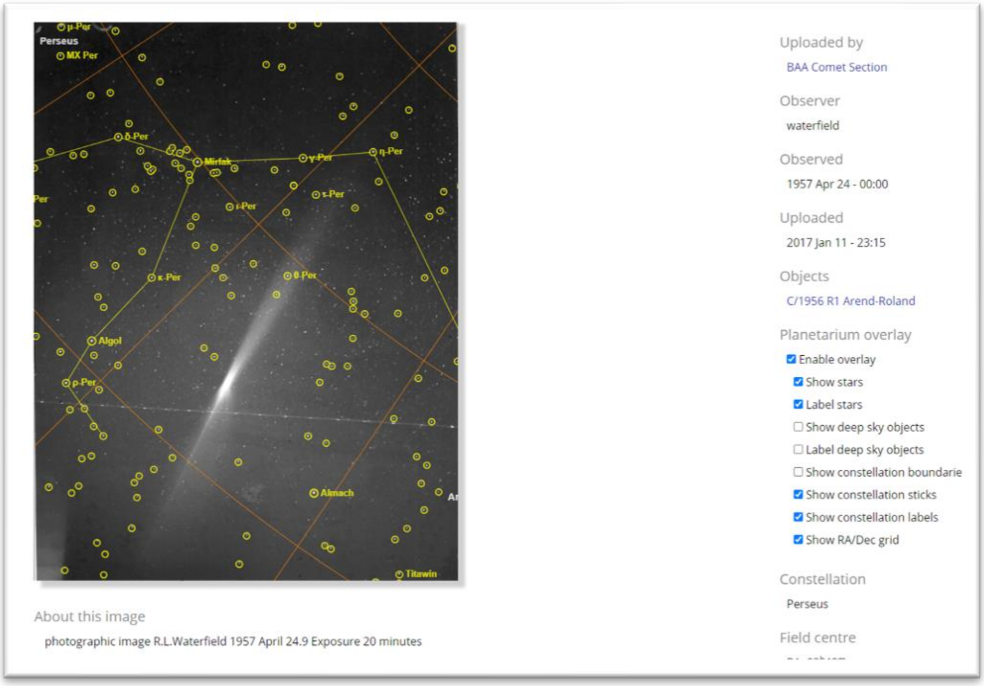


Fig 6 – A platesolved image of C/1956 Arend-Roland

This new web interface is a fantastic window on the fascinating contents of our image archive. You can check up on what other observers are seeing in recent comets and research images that have sat in archive boxes for decades. I am extremely grateful to Dominic for implementing this front-end and to Denis for the tremendous work that he does in collecting and preparing images for the archive.

Nick James

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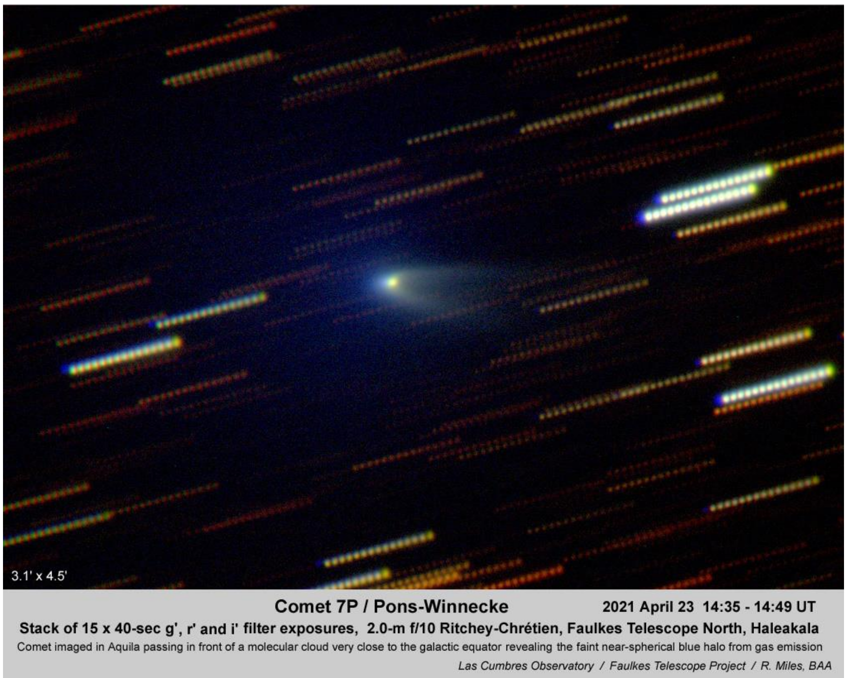
Comet's Tale and Newsletter Editor	Janice McClean events@britastro.org

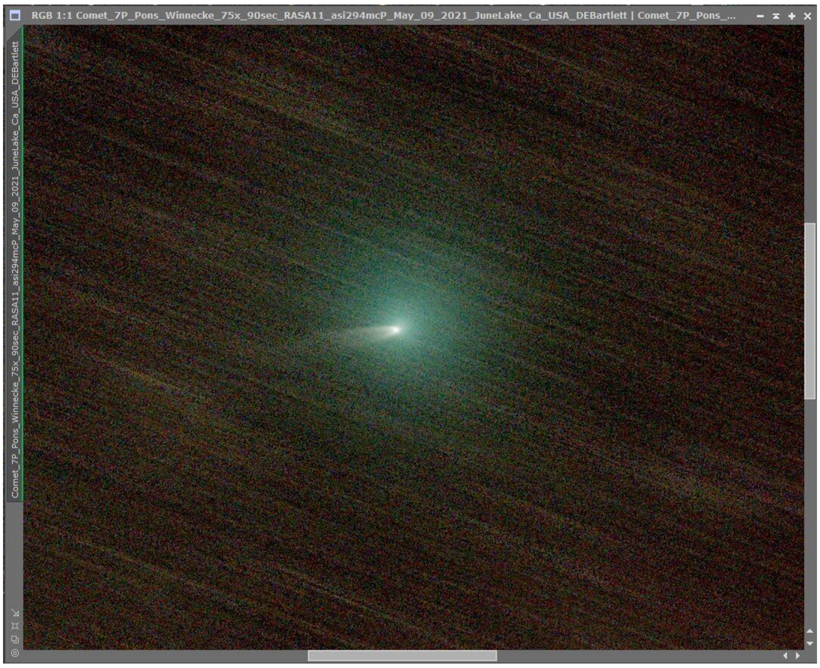
Picture Gallery
Copyright of all images belongs to the observer

7P / Pons-Winnecke

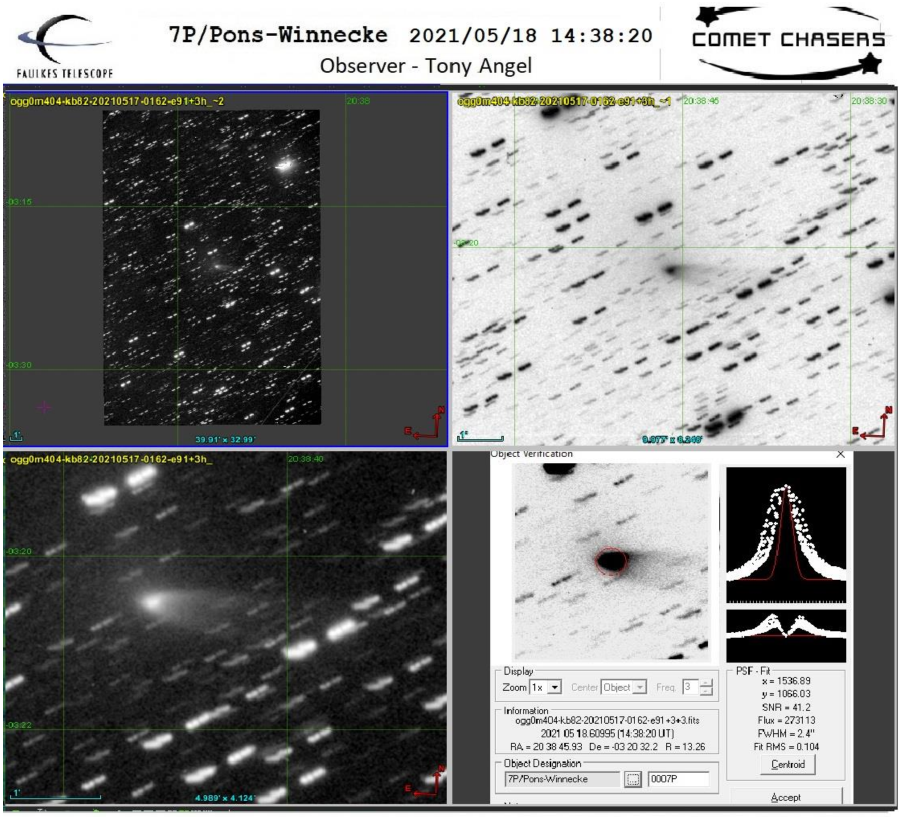


Comet 7P / Pons-Winnecke 2021 April 23 14:35 - 14:49 UT
Stack of 15 x 40-sec g', r' and i' filter exposures, 2.0-m f/10 Ritchey-Chrétien, Faulkes Telescope North, Haleakala
Comet imaged in Aquila passing in front of a molecular cloud very close to the galactic equator revealing the faint near-spherical blue halo from gas emission
Las Cumbres Observatory / Faulkes Telescope Project / R. Miles, BAA

[***https://britastro.org/cometobs/7p/7p_20210423_1435_rmiles.html***](https://britastro.org/cometobs/7p/7p_20210423_1435_rmiles.html)



[***https://britastro.org/cometobs/7p/7p_20210509_dbartlett.html***](https://britastro.org/cometobs/7p/7p_20210509_dbartlett.html)



ogg,clma,0m4c, Haleakala-LCO Clamshell #2,SBIG 5303,T03,156.2580W,20.7071N,3037m 4x180 secs

Gaia DR2

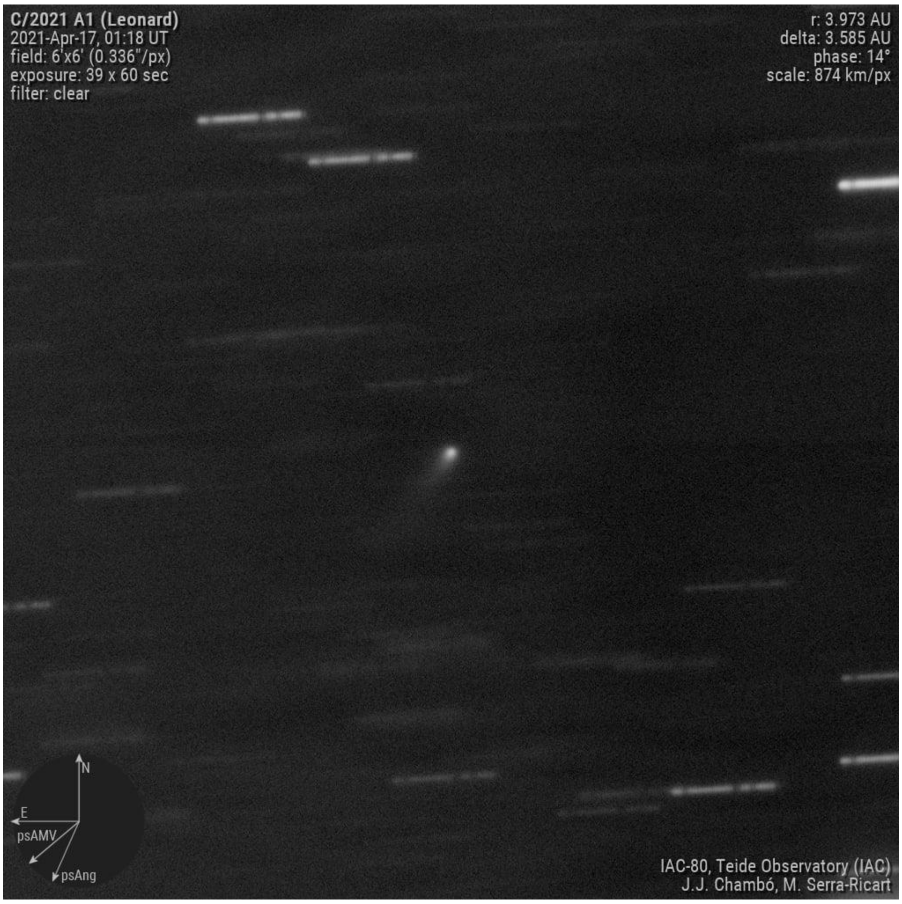
0007P KC2021 05 18.60995 20 38 45.93 -03 20 32.2 13.26R T03

https://britastro.org/cometobs/7p/7p_20210518_143820_angel.html

7P Pons-Winnecke. 2021 June 3 at 11:23UT. ITEL T24 0.61-m f/6.5 reflector + CCD. 5 mins. FOV 10'. North up. M. Mattiazzo.

https://britastro.org/cometobs/7p/7p_20210603_mmattiazzo.html

C/2021 A1 (Leonard)



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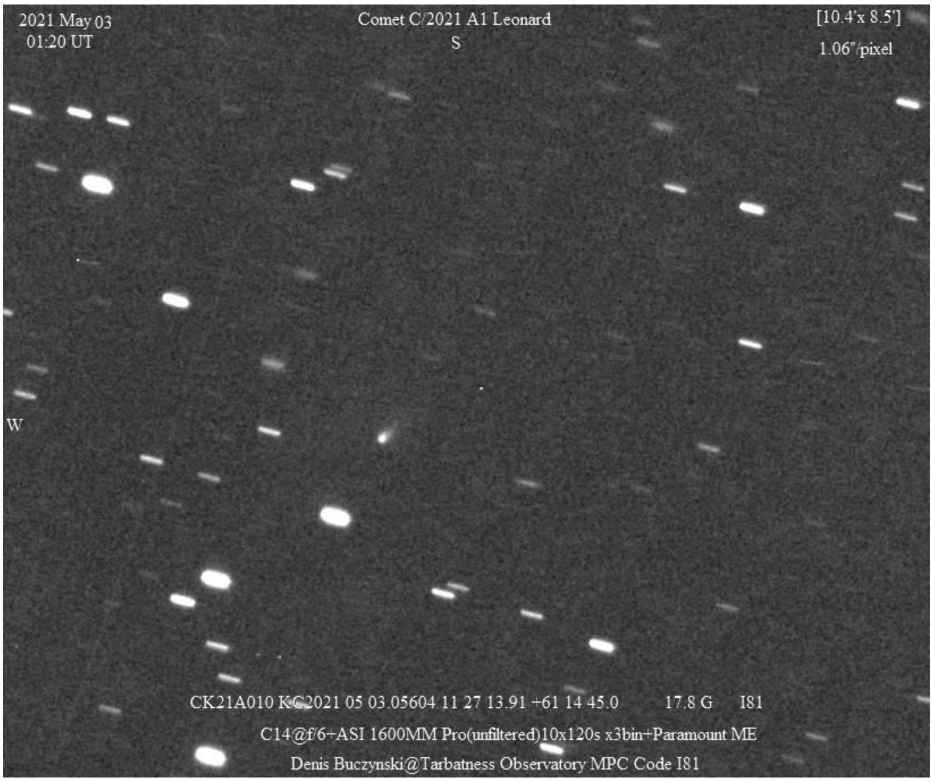


https://britastro.org/cometobs/2021a1/2021a1_20210503_0120_dgb.html

https://britastro.org/cometobs/2021a1/2021a1_20210506_2147_pcarson.html

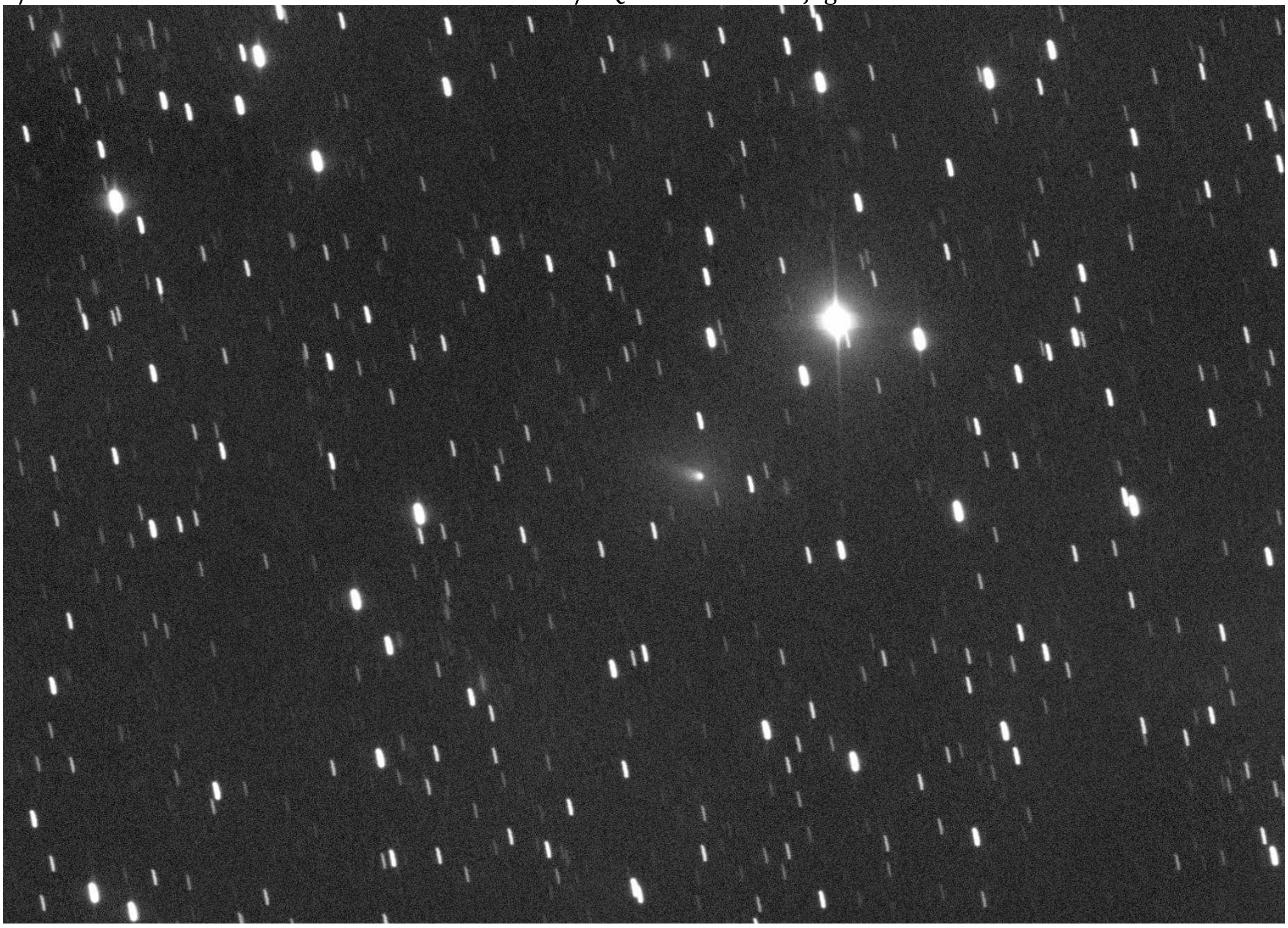
C/2021 A2 (NEOWISE)

C/2021 A2 (NEOWISE) near IC2162 2021 Feb. 14 UT 18.34 RGB 180/750/750sec Halpha 1500 sec 11"/2.2 RASA QHY600 Michael Jäger

https://britastro.org/cometobs/2021a2/2021a2_20210214_183400_mjaeger.html

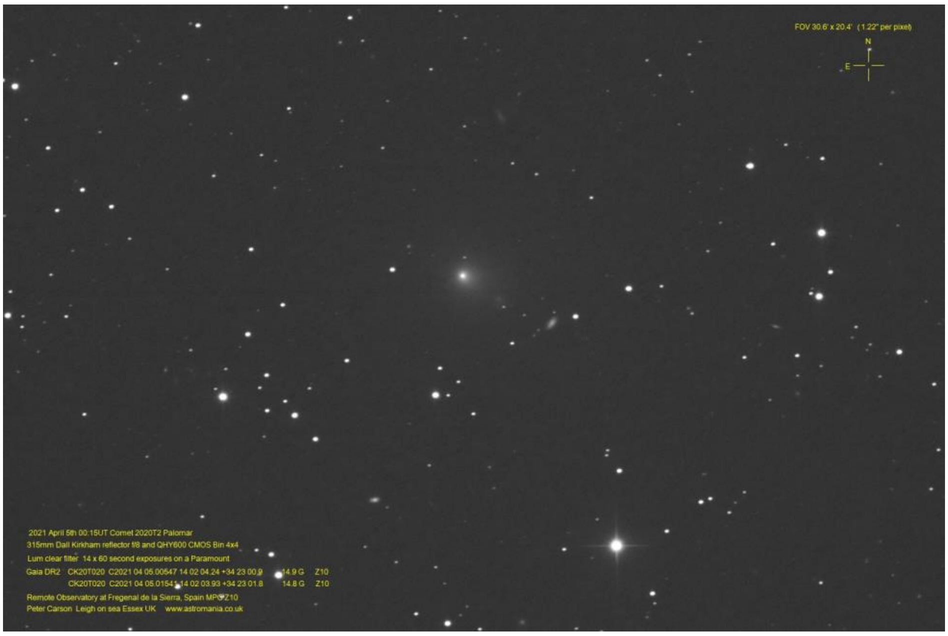
C/2021 A4 (NEOWISE*)*

C/2021 A4 2021 march 16 UT 18.22 6x150sec 12"/4 QHY600 Michael Jäger



https://britastro.org/cometobs/2021a4/2021a4_20210316_mjaeger.html

C/2020 T2 (Palomar)



https://britastro.org/cometobs/2020t2/2020t2_20210405_0015_pcarson.html

C/2020 T2 (Palomar) 2021 May 31 UT 22.25 18x2 min. 8"/4 Newton, Canon Ra

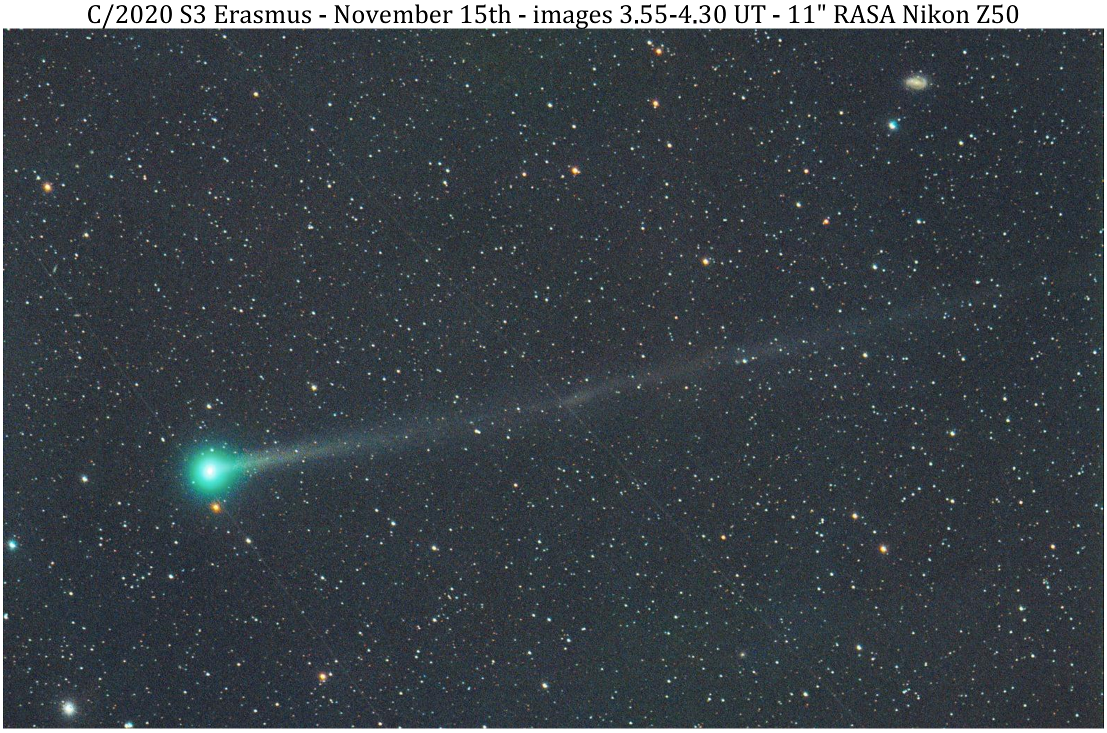
https://britastro.org/cometobs/2020t2/2020t2_20210531_nmrozek.html

https://britastro.org/cometobs/2020t2/2020t2_20210517_0647_jchambo.html

C/2020 S3 (Erasmus)

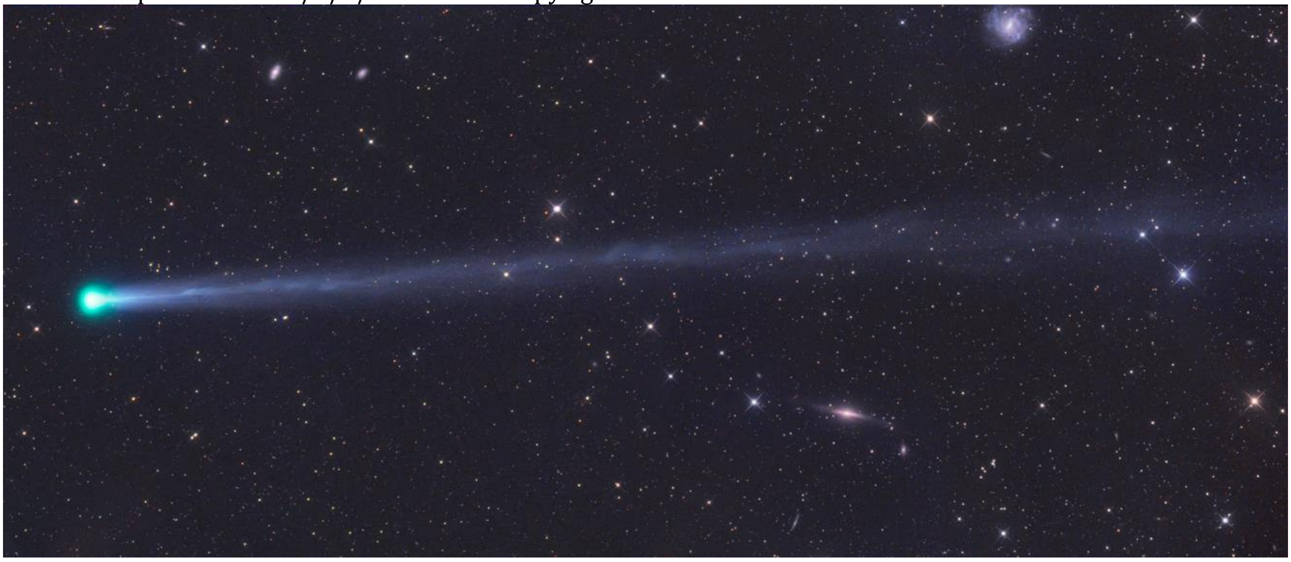
https://britastro.org/cometobs/2020s3/2020s3_20201027_0428_pcarson.html

C/2020 S3 Erasmus - November 15th - images 3.55-4.30 UT - 11" RASA Nikon Z50

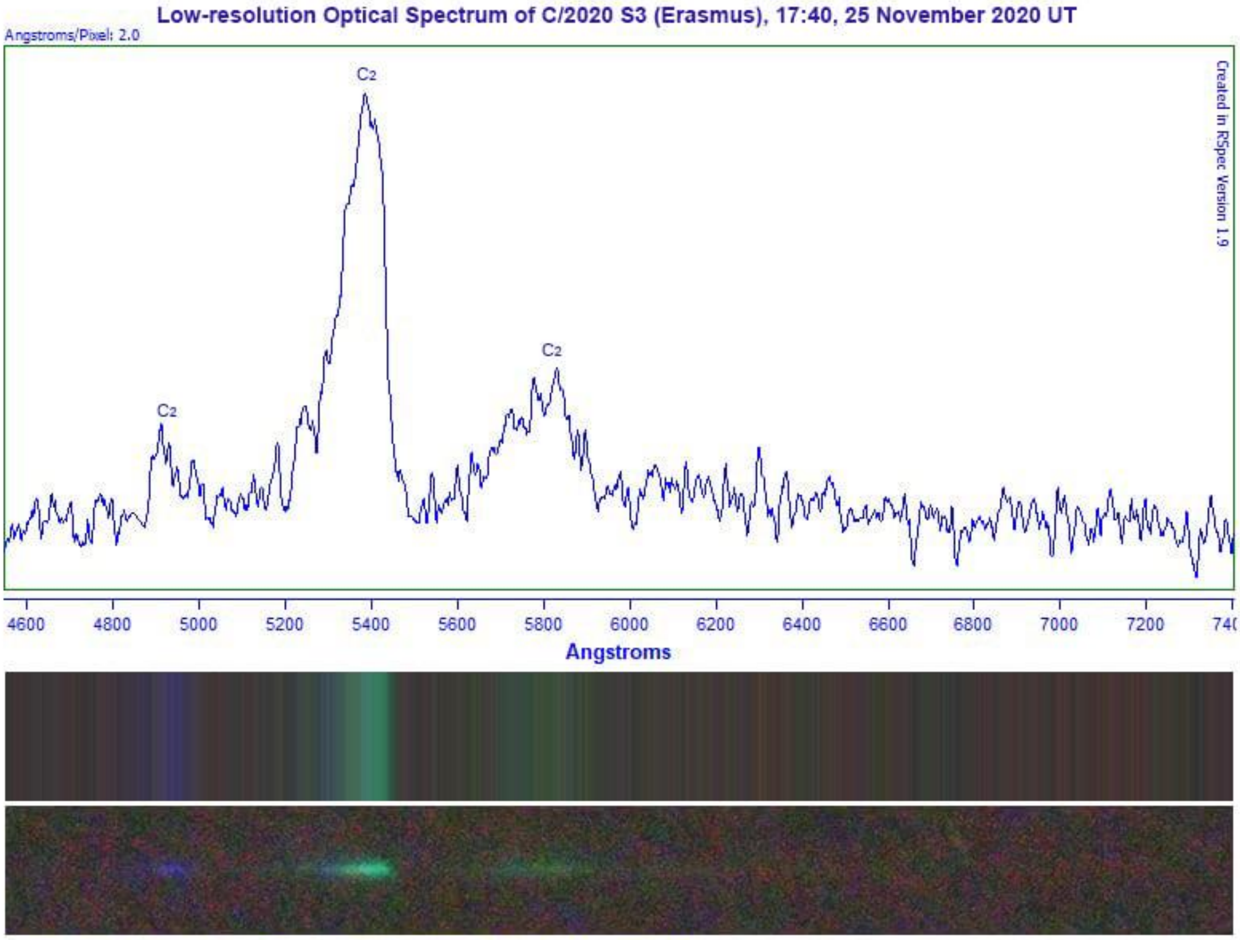


https://britastro.org/cometobs/2020s3/2020s3_20201115_mjaeger.html

Comet C/2020S3 Erasmus 24 11 2020 and NGC5084 NGC5068 Date: 24 11 2020 UT 01h01m Location: Farm Tivoli, Namibia Telescope: ASA Astrograph 12" f 3.6 Camera: FLI ML 16200 Mount: ASA DDM 85 Exposure time: Mosaic of 2 panels LRGB 9/4/4/4 min. each Copyright Gerald Rhemann



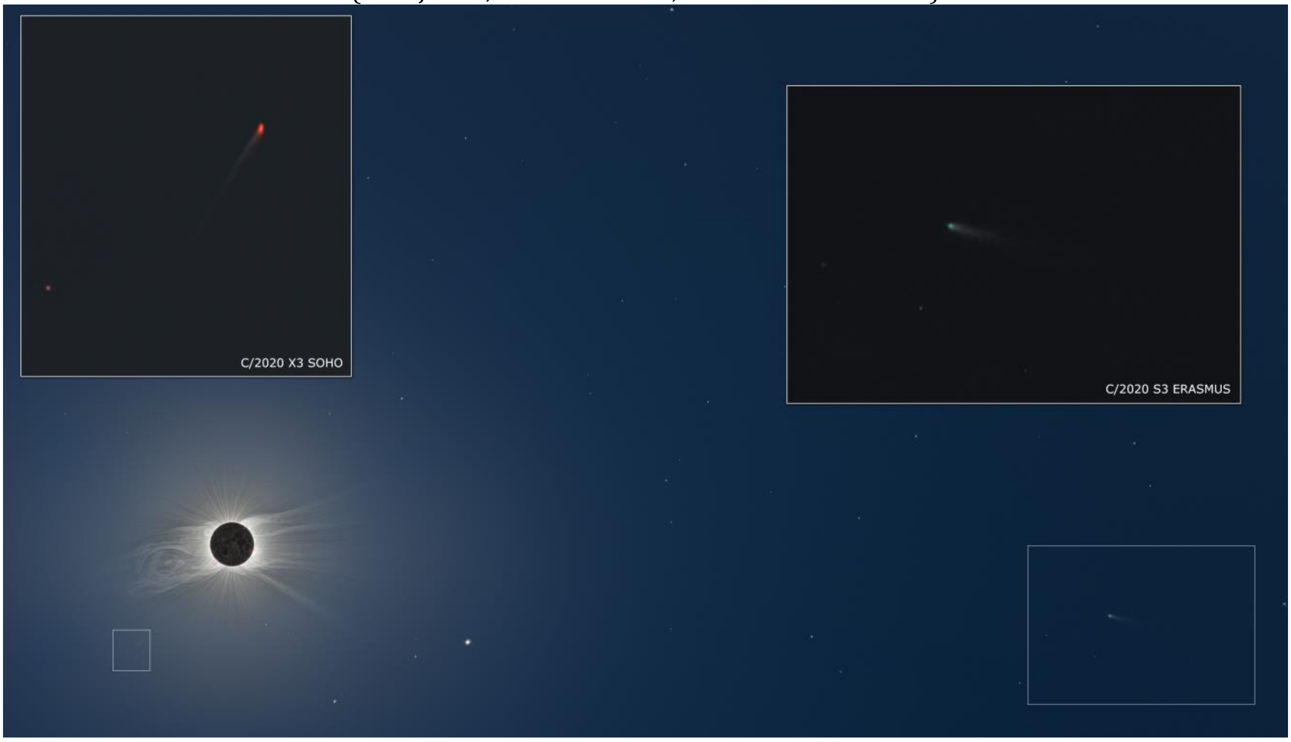
https://britastro.org/cometobs/2020s3/2020s3_20201124_0101_grhemann.html



Canon 800D on Vixen Polarie, 200mm lens, SA100 grating, 5 x 90 sec, ISO 12800, F/3.5.
Early morning twilight; comet altitude 10 degrees. Imaged from White Cliffs, NSW, Australia (31.0 S, 143.0 E).

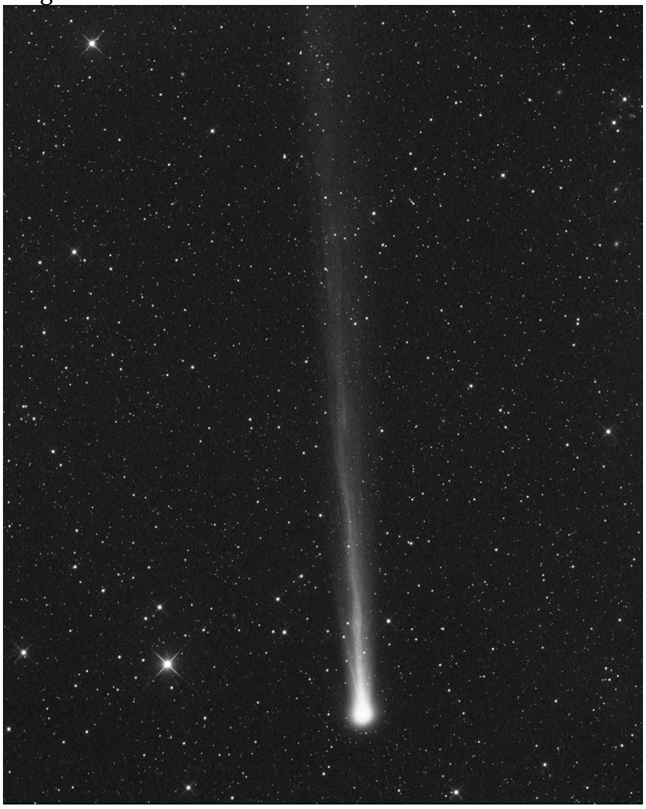
https://britastro.org/cometobs/2020s3/2020s3_20201125_rkaufaman.html

C/2020 S3 and C/2020 X3 during the total solar eclipse of 2020 December 14 (approx. S up)
(Nick James, Andreas Moller, Miloslav Druckmuller)



https://britastro.org/cometobs/2020s3/2020s3_20201214_161000_ndj.html

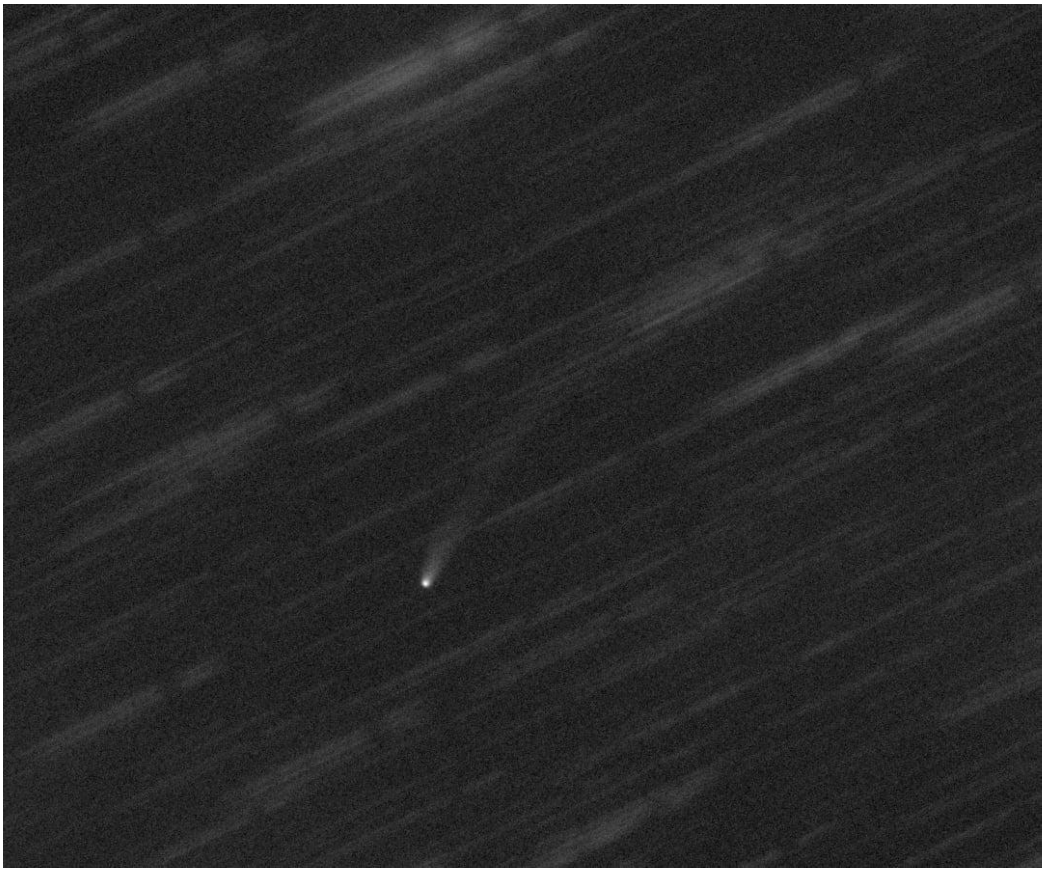
C/2020 S3 This image was taken November 27 12"f3.6 and FLI ML 16200 3x 140 seconds



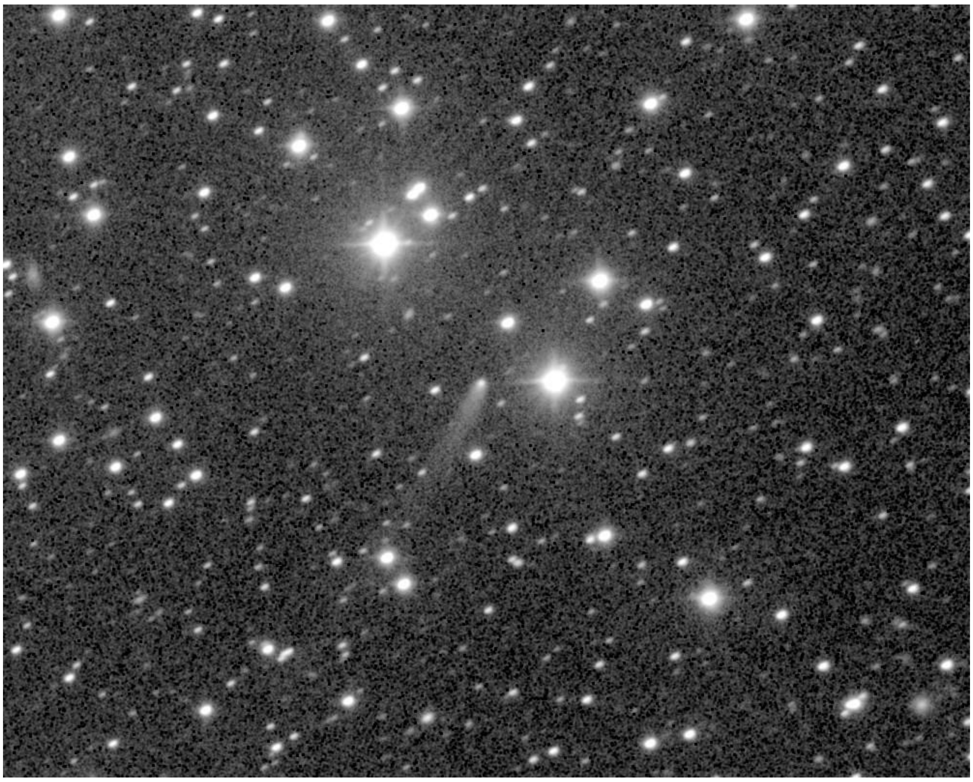
https://britastro.org/cometobs/2020s3/2020s3_20201127_grhemann.html

https://britastro.org/cometobs/2020s3/2020s3_20201116_mmattiazzo.html

C/2019 K7 (Smith)

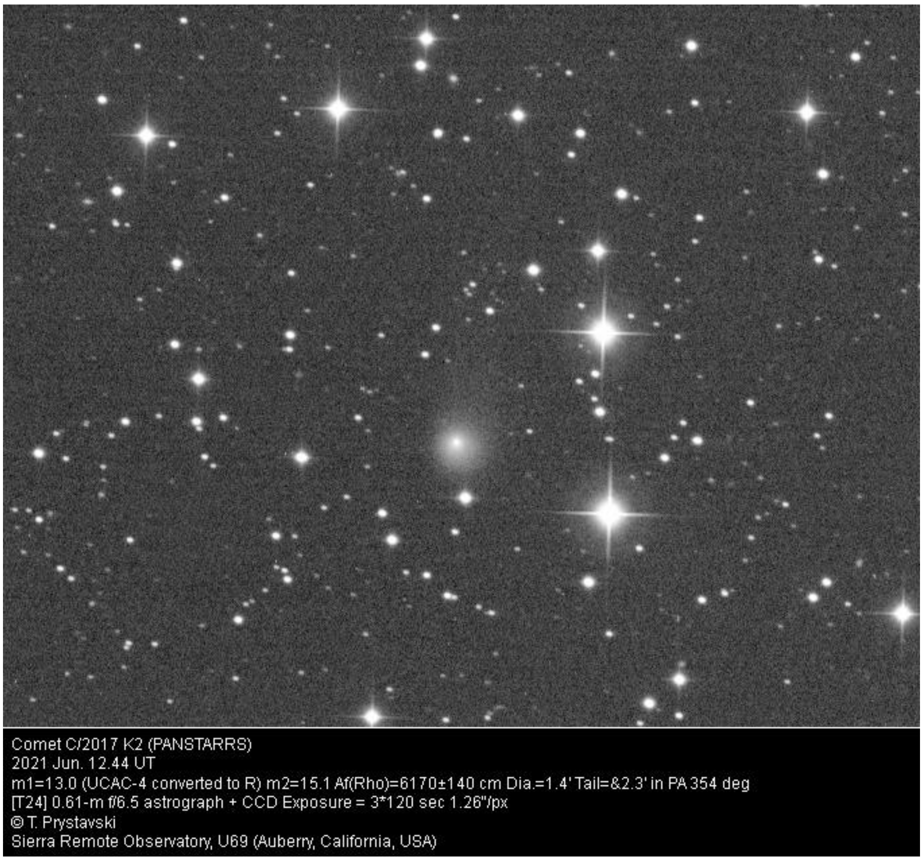


https://britastro.org/cometobs/2019k7/2019k7_20210613_nhaigh.html



https://britastro.org/cometobs/2019k7/2019k7_20210608_fkugel.html

C/2017 K2 PANSTARRS



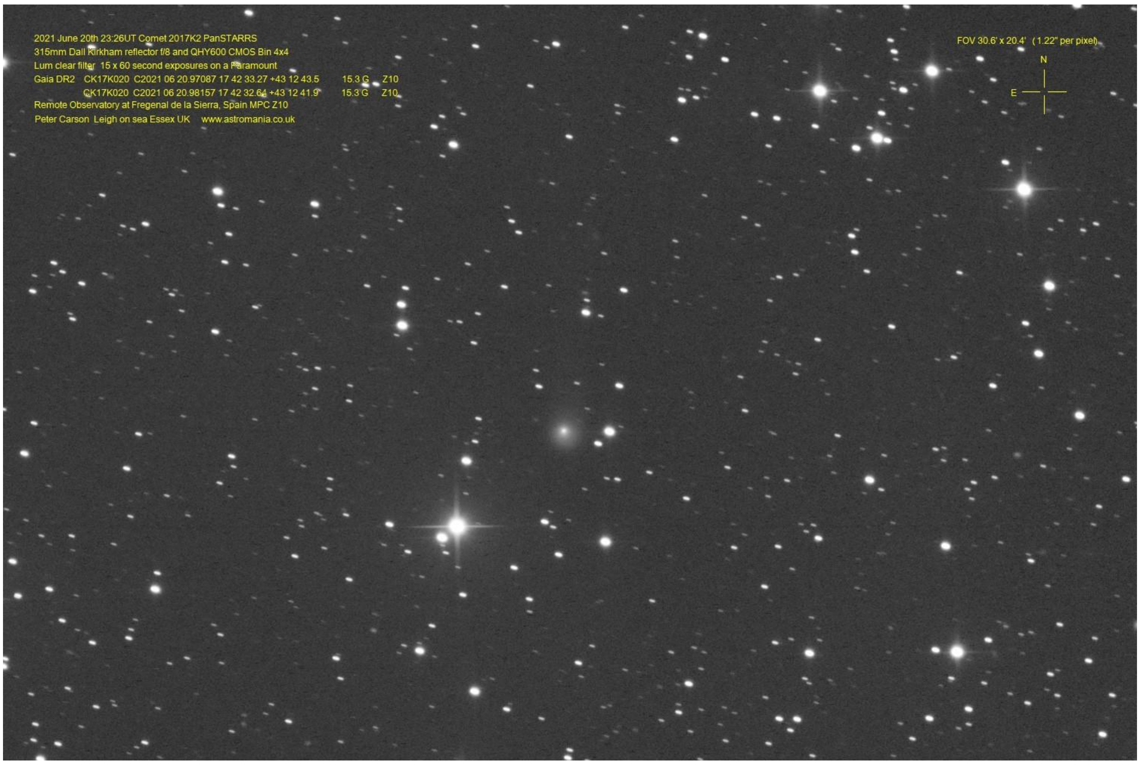
https://britastro.org/cometobs/2017k2/2017k2_20210612_tprystavski.html

C/2017 K2 (Panstarrs) 2021 June 3 UT 23.30 8x150sec 12"/4 Z50mod Michael Jäger

https://britastro.org/cometobs/2017k2/2017k2_20210603_mjaeger.html

Foto di oggi dal NM USA DK 450/1950 ccd PL6303e 300sec

https://britastro.org/cometobs/2017k2/2017k2_20210311_rligustri.html



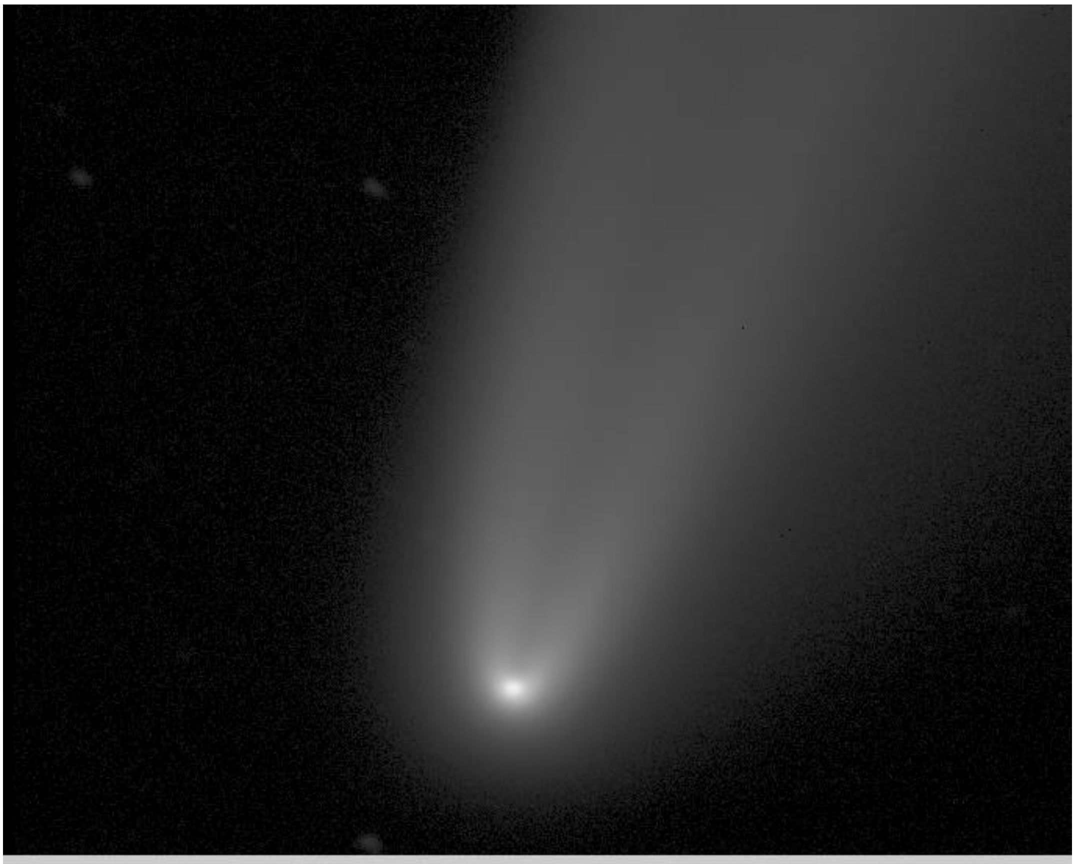
https://britastro.org/cometobs/2017k2/2017k2_20210620_2326_pcarson.html

C/2020 F3 (NEOWISE)

https://britastro.org/cometobs/2020f3/2020f3_20200711_0045_ndj.html

https://britastro.org/cometobs/2020f3/2020f3_20200710_2354_ids.html

https://britastro.org/cometobs/2020f3/2020f3_20200708_mmckenna.html

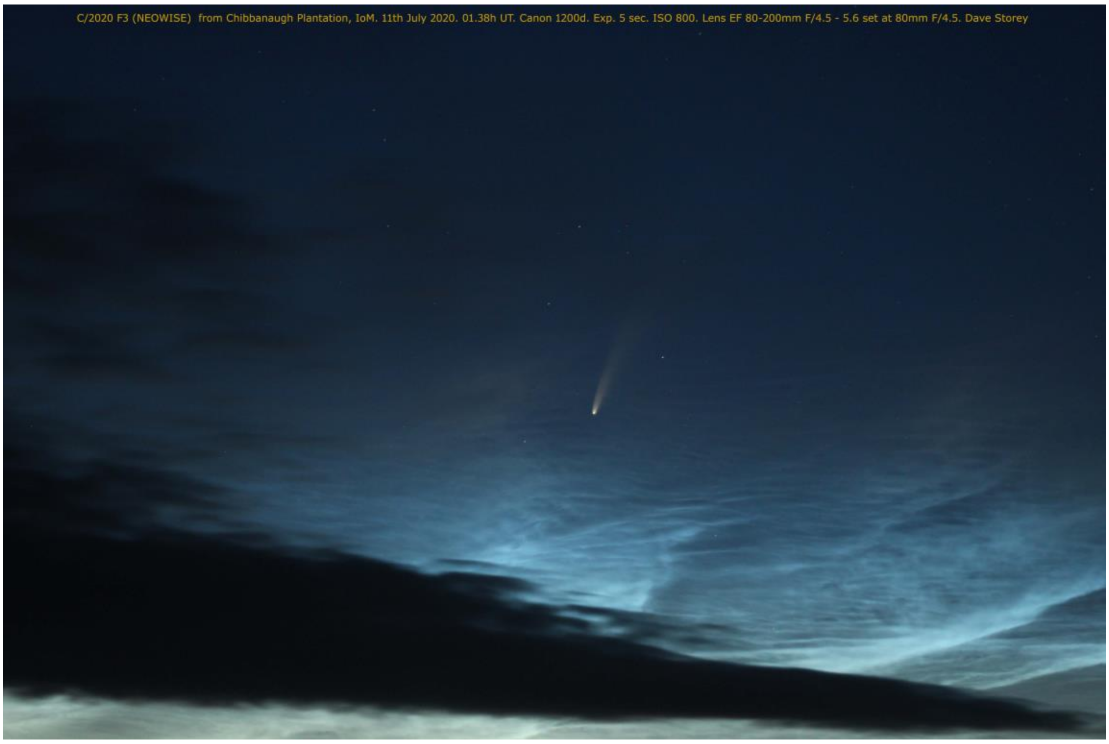


Comet C/2020 F3 (NEOWISE) on 2020 July 11 00:53-00:55 UT

10 x 10 sec, SDSS-i filter (700-850 nm), 0.35-m f/8 Schmidt-Cass.

Field of view: 12' x 15' *R. Miles, Golden Hill Obs., Dorset, UK (J77)*

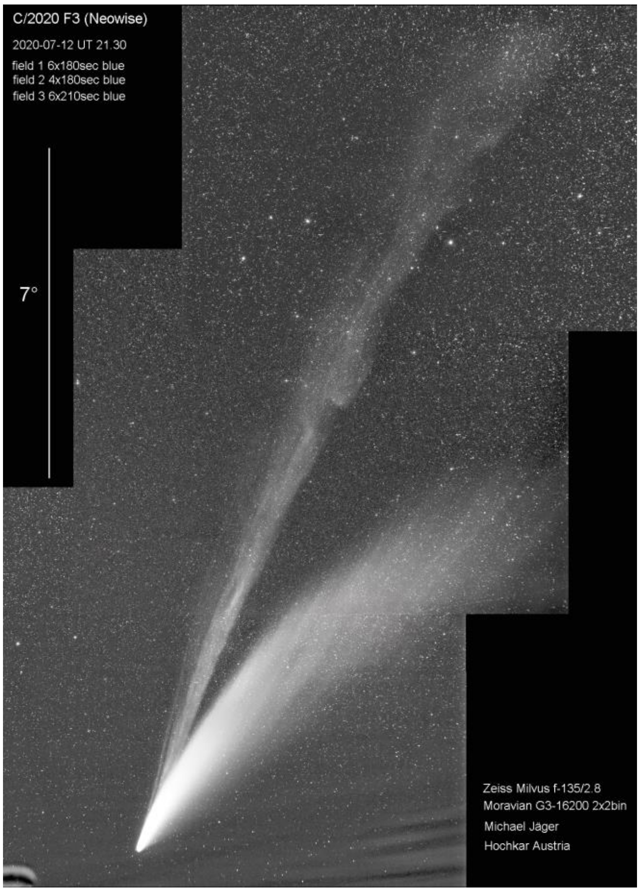
https://britastro.org/cometobs/2020f3/2020f3_20200711_0054_rmiles.html



https://britastro.org/cometobs/2020f3/2020f3_20200711_0138_dstorey.html

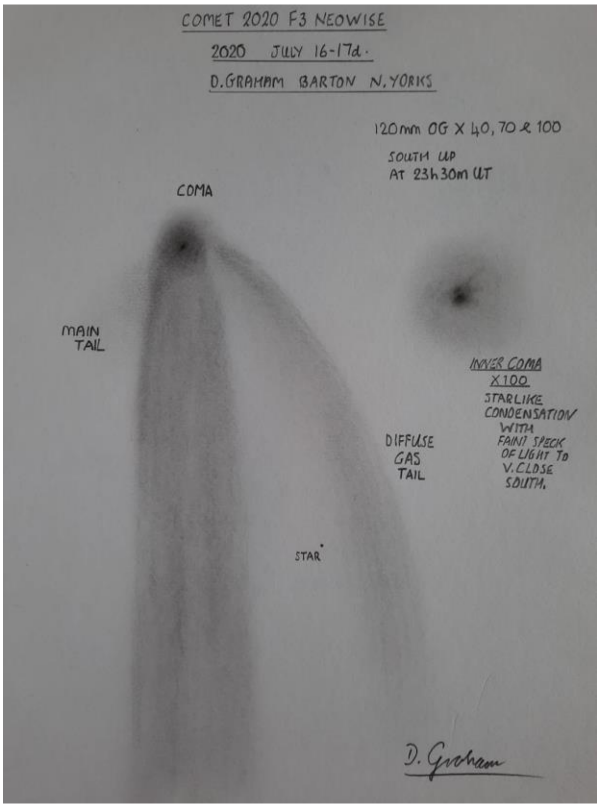
https://britastro.org/cometobs/2020f3/2020f3_20200711_0210_pabel.html

https://britastro.org/cometobs/2020f3/2020f3_20200711_isharp.html



https://britastro.org/cometobs/2020f3/2020f3_20200712_213000_mjaeger.html

Comet 2020 F3 NEOWISE sketched at the eyepiece of my 120mm f8.3 refractor at approximately just after local midnight on 16th July 2020, from near Richmond in North Yorkshire



https://britastro.org/cometobs/2020f3/2020f3_20200716_drgraham.html

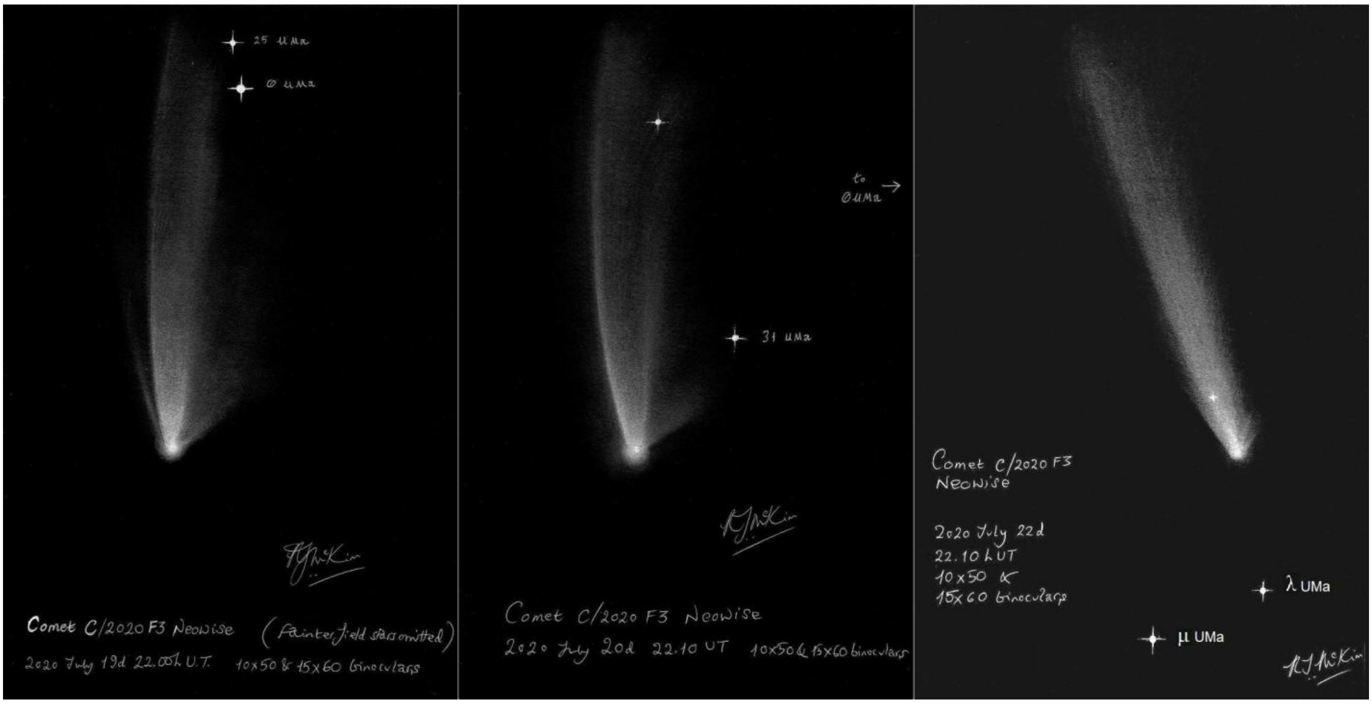
Here is a close-up of the nucleus region of the comet obtained last night. Various shells and streamers can be seen. Takahashi 250mm Dall-Kirkham with ASI290MM + R filter at 0.1"/pixel. 18k frames.

https://britastro.org/cometobs/2020f3/2020f3_20200717_dpeach-isharp.html

Comet C/2020 F3 (Neowise) July 19 UT 23.00-00.00 widefield f-50mm & CCD, RGB & mosaic filter blue

https://britastro.org/cometobs/2020f3/2020f3_20200719_2300_mjaeger.html

https://britastro.org/cometobs/2020f3/2020f3_20200719_dpivato.html



https://britastro.org/cometobs/2020f3/2020f3_20200719_rjmckim.html