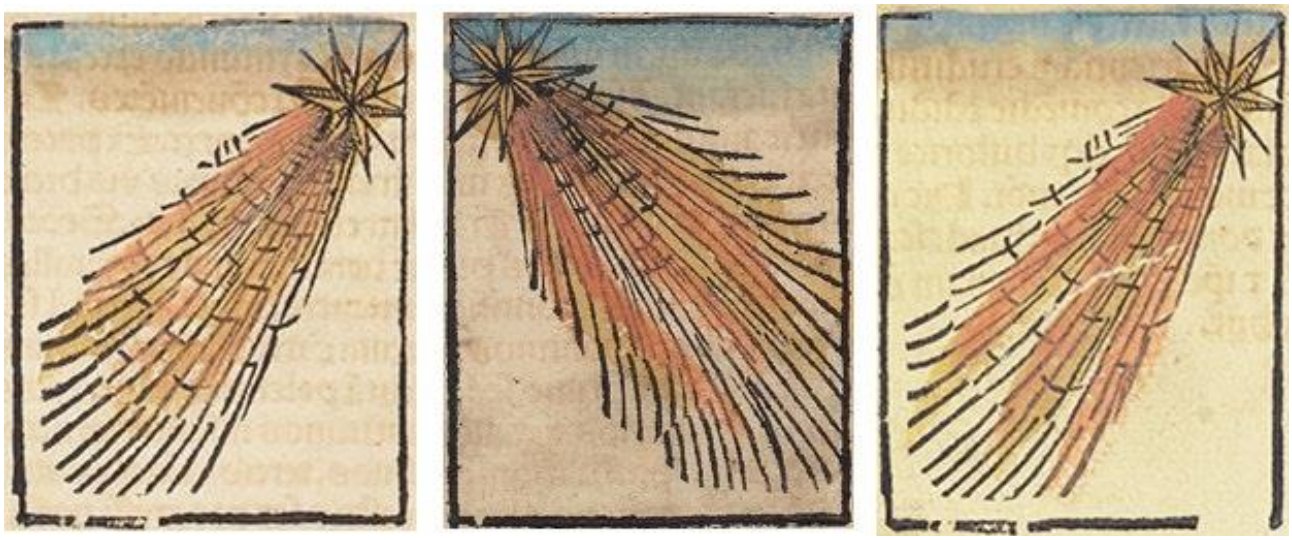

Woodcut from the Nuremberg Chronicle – 1493 (wikicommons)

THE COMET'S TALE

Comet Section – British Astronomical Association

Journal – Number 41 2022 June
britastro.org/comet

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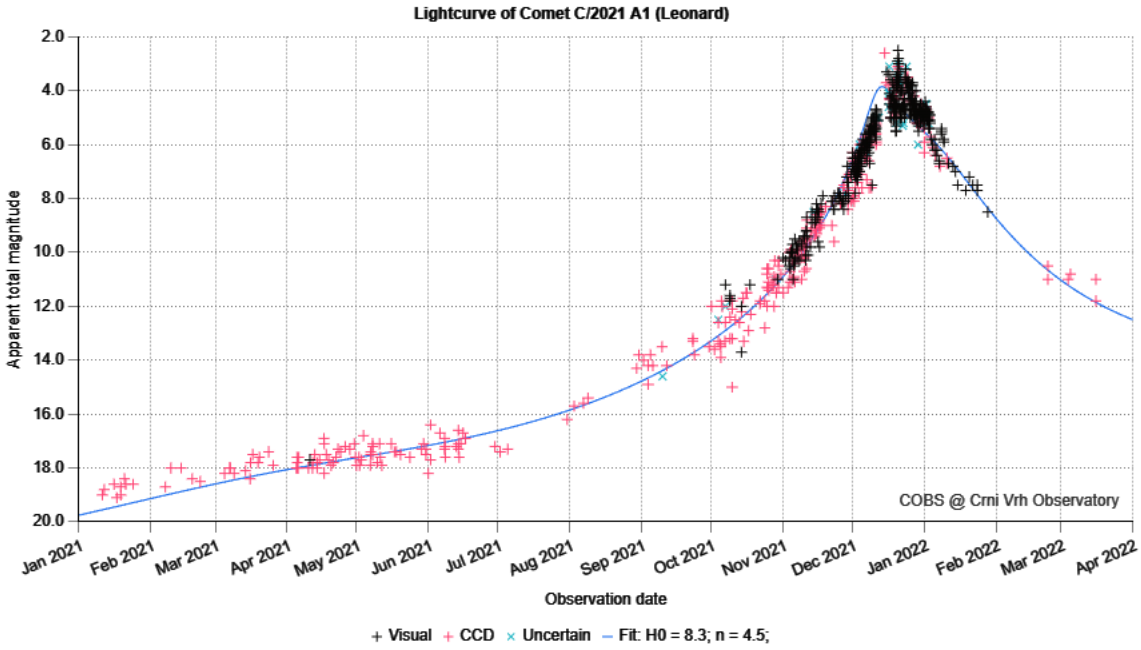

Welcome to another edition of the Comet's Tale, the BAA Comet Section's annual newsletter. After a couple of years of Covid restrictions things are beginning to get back to normal and BAA face-to-face meetings have restarted at various venues around the UK. We also have a Europlanet Comet Workshop coming up in Prague in June, which will be a hybrid meeting, so you have the choice to attend physically or remotely. This meeting will discuss how amateur observers can better cooperate with professionals and will cover a number of observational techniques, particularly comet photometry. It is a great opportunity to increase contacts between observers from Europe and around the world and I hope to meet a number of you there or online. Very many thanks to Helen Usher who has coordinated the organisation of this event.

I hope that the Comet Section will have its own meeting sometime in the summer of 2023. The venue is yet to be decided but Manchester has been suggested. Please let me know if you have any other suggestions.

It has been a busy year. A couple of years ago we were spoiled with the spectacular comet C/2020 F3 (NEOWISE) and things have been rather quiet since then. The best comet in the last year was C/2021 A1 (Leonard). This put on a good show for us in the north but it was a particularly nice object from the southern hemisphere and I published a short report in the BAA Journal[1]. The latest lightcurve from data on COBS shows that the comet had faded to around 12th magnitude in late March.

We receive observations from visual and electronic observers although the number of visual observations received is small. A number of observers report total magnitudes, either directly to the section or via the Comet Observations Database

[1] https://britastro.org/journal/baa-journal-volume-132-number-02-april-2022

(COBS) website. The visual observers help to maintain the continuity of historical records for periodic comets and they provide a reference which we use to check electronic estimates.

Early in my Directorship we transferred the entire BAA/TA ICQ archive into COBS so that it is available for analysis by other researchers. We also worked with COBS to help recover a large number of historical observations that had been submitted to the ICQ but which were no longer accessible. COBS has continued to expand and it is now a key source of data on current and historical comets. The website recently been updated so now is a good opportunity to browse the site if you have not done so before[2].

We have a core group of observers who submit comet astrometry to the Minor Planet Centre (MPC) and a number of observers use the Section's comphot software to extract total magnitudes from images. Jonathan Shanklin has continued to analyse quantitative data submitted by visual and electronic observers and he reformats the observations into the format that Guy Hurst uses for publication in *The Astronomer*.

The section receives a huge number of comet images and we maintain what is possibly the largest online comet image archive in the world. This is curated and updated regularly by Denis Buczynski[3]. The archive now contains 35,000 images and is expanding at around 4,000 images a year. Over the last few years we have scanned most of the photographic material in the section archive and placed it in the online archive. The archive now contains numerous images from famous comet observers such as Reggie Waterfield, Harold Ridley and Mike Hendrie and has images of comets dating back to the 1930s. Peter Carson provides valuable mentoring assistance to comet imagers and the Section now receives images from a very wide range of observers both in the UK and overseas.

Richard Miles continues to run the 29P monitoring campaign. This has expanded into a significant international effort and has successfully detected several significant outbursts of this enigmatic object. He maintains a webpage which logs observations and outbursts of this enigmatic object[4]

The last few years have shown the increasing ability of amateurs to produce comet spectra. These are lodged in the BAA spectroscopy database. Some particularly fine observations were made of bright comets such as C/2020 F3 (NEOWISE) but fainter comets are now coming within the range of amateurs as Robin Leadbeater describes in his article in this Tale starting on page 12.

Technology continues to advance and CMOS sensors are gradually taking over from CCDs. Large-format CMOS sensors are ideal for larger comets and, combined with fast telescopes at dark sites, they are able to produce spectacular results. Twenty-five years ago, in 1997, a comet with one of the largest nuclei known dominated our springtime skies. C/1995 O1 (Hale-Bopp) was an extraordinary object which came along just as amateurs were switching from film to digital. Our archive contains many images of this comet, most of them scanned from film or slides[5]. There are some CCD images but the field of view is small since the sensors were tiny.

[2] https://www.cobs.si/
[3] https://britastro.org/cometobs/
[4] https://britastro.org/section_information_/comet-section-overview/mission-29p-centaur-comet-observing-campaign
[5] https://britastro.org/cometobs/1995o1/index.html

Hale-Bopp was my second-best comet. It was beaten by C/1996 B2 (Hyakutake) which I saw from 1800 m altitude at Chipeque, Mt. Teide on 1996 March 25. The tail of that small, but close, comet stretched for more than 40° across the zenith with the naked eye and it was a truly awesome sight. I photographed it using TP2415 film which had been hypered by my great friend and keen comet observer, Glyn Marsh, who, sadly, died 2017. That film seemed like magic, since it had high resolution and much-reduced reciprocity failure. It probably had a detective quantum efficiency of 5%. Modern back-illuminated CMOS sensors are more like 80%. Old-time astro-photographers can sound like the characters in the Monty Python 'Four Yorkshiremen' sketch[6] but imaging comets really was tough in those days.

The late Ron Arbour (in 2015) with his upgraded 40cm

One of the great comet observers of the photographic era, Ron Arbour, died recently at the age of 79. Ron was best known for his supernova discoveries but he was also a keen comet photographer back in the tough days of film. He was the second person in the UK (after Alan Young) to detect 1P/Halley at its last return and he developed a cold camera and a special offset guiding platform for his comet imaging. At the request of Ron's wife, Pat, I had the honour of presenting a short tribute to Ron at his funeral in April. An obituary will appear in the Journal in due course.

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

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6 https://en.wikipedia.org/wiki/Four_Yorkshiremen_sketch

2 The Remarkable Apparition of Comet C/2021 A1 Leonard – Michael Mattiazzo

In my 35 years of comet observing, C/2021 A1 (Leonard) has to go down as one of the most fascinating to watch, with repeated outbursts at intervals of 3-5 days, eventually leading to disintegration of the nucleus. Below is my descriptive and photographic documentation of the apparition.

Gregory Leonard, a professional astronomer at Mount Lemmon Observatory near Tucson Arizona, discovered this comet on 2021 January 3. At the time, the comet appeared magnitude 19, located greater than 5 astronomical units away from Sun and Earth. Early calculations revealed that the comet was to become much more interesting; that in exactly a year, it would have a close encounter with the Sun, on 2022 January 3 at 0.61au. (91 million km). Even better, the comet was to have a very favourable approach to the Earth, on 2021 December 12 at 0.23au. (35 million km). Initial forecasts indicated the comet could reach 4th magnitude at this time, with potential further brightness enhancement due to forward scattering of dust particles. The comet also had an original 1/a = +0.000575 which indicated an approximate orbital period of 80,000 years, thus not a first timer. Its absolute magnitude of 8.0 however, was at the limit of perihelion survival.

Initially, the comet brightened quite steadily towards perihelion. However, during the first two weeks of December 2021, the comet had shown a significant slowdown in activity, leading to the suggestion that the comet was at risk of disintegrating. This slowdown may have been a result of the delta effect, where observers underestimate the comet's brightness due to the expanding coma as it approaches Earth. Other causes include poor weather, low altitude and moonlight but a true intrinsic fading was also possible.

C/2021 A1 Leonard rendezvous with globular cluster Messier 3. 2021 December 03 at 12:15UT. T68 New Mexico(remote). C11 RASA +CCD. 10 min. FOV 2 deg. North left.

Earth crossed the orbital plane of the comet on December 7, hence the sharply defined dust tail in this image.

On December 11th, estimates had the comet at around 5th magnitude, which was lagging behind predictions. Suddenly, on December 14th, reports of an outburst to 2nd magnitude were received. Some suggested that forward scattering was responsible, however this was a sudden rise in brightness, supported by photographic evidence of a parabolic dust hood, typical of an outbursting comet.

From my southern hemisphere location in Swan Hill, Australia, I recovered the comet on the evening of 2021 December 16, when only 3 degrees above the horizon (deep in twilight) and at approximate magnitude 4.0, indicating a significant fade post outburst. On 2021 December 18, the comet had an exceptionally close encounter with Venus at only 4 million km. On that night on 18.42UT, I made a visual estimate of 4.2, using 8 x 40mm binoculars, corrected for atmospheric extinction. On 2021

December 20.47UT comet C/2021 A1 Leonard was in outburst again! Easily visible to the unaided eye at magnitude 2.9, at an altitude of 12 degrees, corrected for extinction using the summer table, the coma appeared strongly condensed with a DC of 8.

2021 December 21 at 11:15UT. C11 RASA f/2.2 + Canon 6D. 3 mins. FOV 3 deg. North up. Swan Hill, Victoria, Australia. 1-day post outburst.

Although the comet has faded a bit (naked eye estimate of 3.5) the development was massive. Vivid streamers of ion tail had formed, as well as a parabolic dust hood.

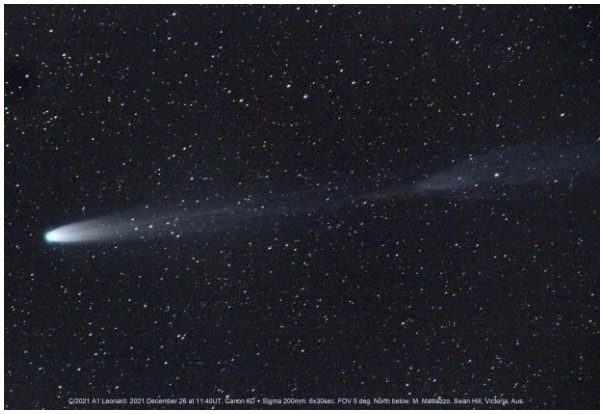
2021 December 22 at 11:40UT. using a Canon 6D + Sigma 200mm lens. 10x30sec. FOV 10 deg. North below. Image taken near Tailem Bend, South Aus.

Naked eye estimate was 4.0. Through 25x100mm binoculars, the comet was a superb sight, with a star like nucleus embedded in a parabolic hood. The first 1.5 degrees of tail (dust) was quite bright. In this image, the ion tail appears greater than 10 degrees long with a disconnection about 5 degrees from the head.

2021 December 23.49UT.
Naked eye observation:
Location: West beach South Australia. Although the comet was overall fainter, magnitude 4.3, the star like nucleus appeared significantly brighter than on night prior (using 25x100mm binoculars). This indicated an impending outburst.

2021 December 24.49UT.
Naked eye observation:
Location: Adelaide South Australia. Comet in outburst again! approximately +1 magnitude in amplitude. I estimated magnitude 3.1 using 8x40mm binoculars, observed through a narrow gap in the clouds.

2021 December 25.49UT.
Naked eye observation:
Observed through a narrow gap in the cloud, the comet had faded significantly post outburst, estimating 4.0 through 8x40mm binoculars.



2021 December 26 at 11:40UT. Canon 6D + Sigma 200mm. 6x30sec. FOV 5 deg. North below.

The comet appeared magnitude 4.3 naked eye. Through 15x70mm binoculars, the ion tail can be traced to over 10 degrees in length, with a bright feature located 4.3 degrees from the head. This feature was a disconnection of the ion tail. At 70mm focal length, the ion tail is traceable to >15 degrees.

2021 December 28 at 11:25UT. using a C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. North up. near Swan Hill, Victoria

Dark skies really helped with comet viewing. My naked eye visual estimate was 4.7. The comet displayed very active ion tail development, from a probable outburst on 27th. Through 15x70mm binoculars, the first 4 degrees of tail were bright, with a faint extension to about 9 degrees. Photographically, the tail appeared at least 18 degrees long, stretching towards Fomalhaut.

2021 December 29 at 11:25UT. C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. North up.

The ion tail was not as active tonight, when compared to 24 hours earlier. No visual estimate was made, but reported at magnitude 5.0

2021 December 30 at 11:25UT. PHOTO C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. North up.

And the surprises continued with comet C/2021 A1 Leonard. It was in outburst once again, albeit in a minor way. (+0.5 magnitude increase). The comet was estimated at naked eye magnitude 4.5. Through a 20cm reflector, the very bright nucleus was surrounded by a strongly condensed circular coma 9' across and 2-degree dust tail in PA90.

2021 December 31 at 11:25UT. C11 RASA f/2.2 + Canon 6D. 4 mins. FOV 3 deg. North up.

One day post outburst and the comet faded somewhat with a naked eye estimate of 4.9, however, it displayed a great deal of ion tail activity. It seems that an active region is rotating in and out of sunlight every 3 days

2022 January 02 at 11:30UT. A telephoto view of comet C/2021 A1 Leonard using a Canon 60Da + Sigma 200mm. 10x30sec. FOV 5 deg. North up

2022 January 02 at 11:25UT. PHOTO C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. North up. from Swan Hill, Victoria, Australia.

There is incredible detail showing up in the ion tail once again. My naked eye visual estimate was 4.8. The ion tail through 8x40mm binoculars is longer than 5 degrees. I made a m2 estimate through 25x100mm binoculars of mag 7.5, a possible mini outburst. Bright centre with a strongly condensed coma.

2022 January 03 at 11:25UT. Perihelion Day C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. North up. from Swan Hill, Victoria, Australia.

My naked eye estimate was 5.1, fading slowly. My nuclear m_2 estimate through 25x100mm binoculars was magnitude 8.5, significantly fainter from previous night.

2022 January 05 at 11:25UT. PHOTO C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. North up. Swan Hill, Victoria, Australia

The comet was now fading beyond naked eye visibility. My estimate through 8x40mm binoculars was 5.8, coma 5' and DC6. Nuclear m2 estimate through 25x100mm binoculars was magnitude 9.0, further fading from previous night.

2022 January 06 at 11:30UT. PHOTO C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. Magnitude estimate approximately 6.2.

2022 January 7.48UT.
Naked Eye observation:
My visual estimate through 8x40mm m_1= 6.7

2022 January 8.48UT.
Naked eye Observation:
Another significant outburst of comet C/2021 A1 Leonard! Visual m_1 estimate =

5.4 through 8x40mm binoculars, about 1.3 magnitudes brighter than 24 hrs prior. Through 20cm reflector, a bright star like nucleus of 7th magnitude appears inside a strongly condensed coma. In this telephoto shot, note the bright green head due to diatomic Carbon (which is short lived)

2022 January 09 at 11:25UT. 1-day post outburst. C11 RASA f/2.2 + Canon 6D. 5 mins. FOV 3 deg. North up. Swan Hill, Victoria, Australia.

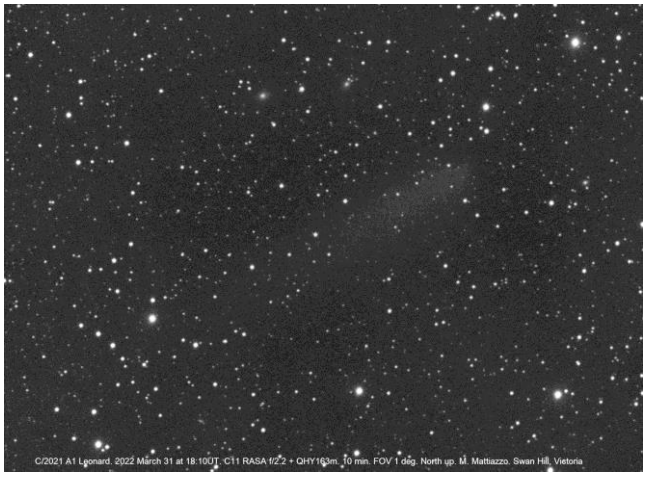
Note that the ion tail, which has been absent over the past couple of days has now grown into prominence after the January 8 outburst. Visual estimate through 8x40mm was m_1=5.8, coma 5' of DC7. The m_2 has faded by 0.5 magnitudes from previous night.

2022 January 14 at 11:15UT.
Naked Eye observation:
Visual estimate through 15x70mm binoculars = 7.0, moonlight and low altitude.

2022 January 15 at 11:15UT.
Naked eye observation
Visual estimate through 15x70mm binoculars = 7.5, moonlight and low altitude

2022 January 20 at 11:15UT. C/2021 A1 Leonard in outburst again! Canon 60Da + Sigma 200mm. 12x20sec. FOV 4 deg. North up. from, Swan Hill, Victoria, Australia.

The comet appears strongly condensed. Visual m_1=7.2 using 15x70mm binoculars. This was my final observation of the comet as it approached solar conjunction. The comet reappeared in the morning sky during late 2022 February, when reports started to appear on social media that the comet had disintegrated.



2022 March 31 at 18:10UT. C11 RASA f/2.2 + QHY163m. 10 min. FOV 1 deg. North up

At least it went out with a bang, rather than a whimper. It was certainly one of the most fascinating comets that I have observed in my lifetime.

Michael Mattiazzo

About the author:

I became a comet enthusiast after witnessing comet Halley from my hometown of Adelaide in 1986. I joined the Astronomical Society of South Australia in 1990 and had the privilege to meet one of the greatest visual comet hunters of all time, Bill Bradfield, who was my mentor and gave me much support. My only near success was making an independent discovery of C/2000 W1 Utsunomiya-Jones in 2000, but missed out by 24hrs. I gave up visual comet hunting in 2003 in favour of hunting for comets online using SWAN comet tracker maps. My first success came in 2004 when I was able to detect comet C/2004 H6 visually soon after spotting it on SWAN. As of 2022, I have a tally of 9 SWAN discovery credits. I am a past president of Astronomical Society of South Australia (2005-2006) and current member of ASSA and ASV. I now reside in Swan Hill, a regional town in northern Victoria, managing its pathology service requirement but also where I am able to pursue my astronomy interest

3 A Handful of Comet Spectra

Robin Leadbeater

On the night of 2022 March 6 a favourable placement of five comets allowed me to spend time on each with my faint object spectrograph, a modified ALPY 200 (Resolution approximately 45 Angstrom), http://www.threehillsobservatory.co.uk/astro/spectroscopy_20.htm ticking them off through the night as they crossed the meridian in turn. The table below summarises the observation details.

Comet	104P	C/2019 L3	67P	116P	C/2020 V2
Time (UT)	19:46	20:44	22:40	00:08	02:14
Exposure (sec)	4x 600	5x 600	6x 600	6x 600	6x 600
Magnitude (www.cobs.si)	11	9.7	11.6	13	14
Sun distance (AU	1.29	3.59	1.89	2.38	4.97
Earth distance (AU)	0.78	3.10	1.05	1.45	4.32

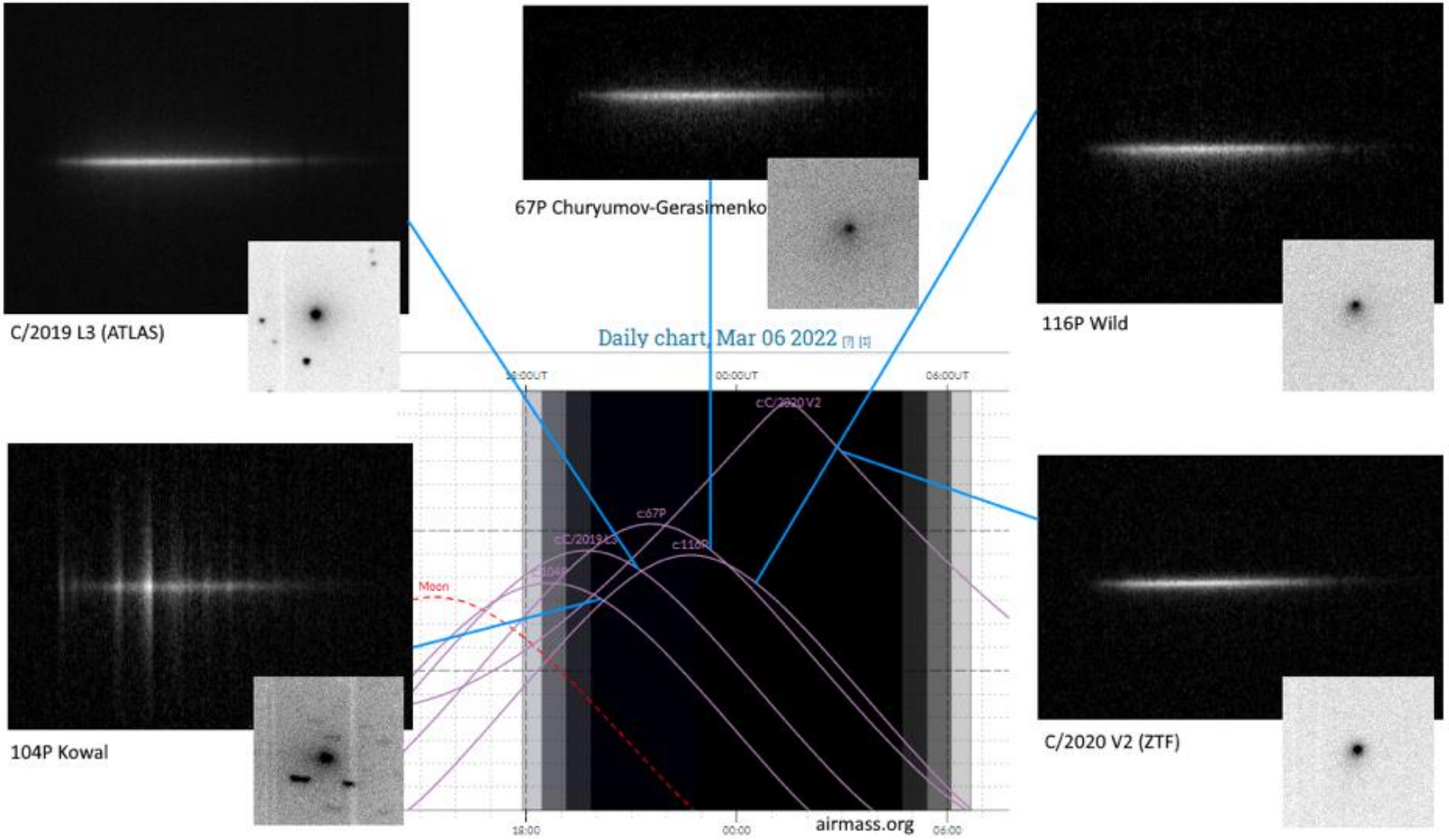
Slit spectroscopy of faint and/or diffuse comets brings its own particular challenges. Only a limited fraction of the available light passes the narrow slit and typical exposure times for the coma are of the order of an hour, even at low resolution.

Unlike imaging, where multiple images can be aligned and combined provided the individual exposures are kept short enough to avoid trailing, with a slit spectrograph the comet has to be kept centred on the slit throughout the observation. If the coma is bright and condensed enough it is sometimes possible to guide directly using the image on the slit.

This proved impossible with these targets however so the guiding had to be performed on field stars and the offset to the target continuously adjusted to keep the comet on the slit. This was achieved using the comet tracking feature in the PHD2 guider program https://openphdguiding.org/ which I use to guide the spectrograph. Provided the instrument and mount are precisely orientated and the plate scale of the spectrograph guider image is known, the rate of drift of the comet in RA and Dec can be entered directly into the program.

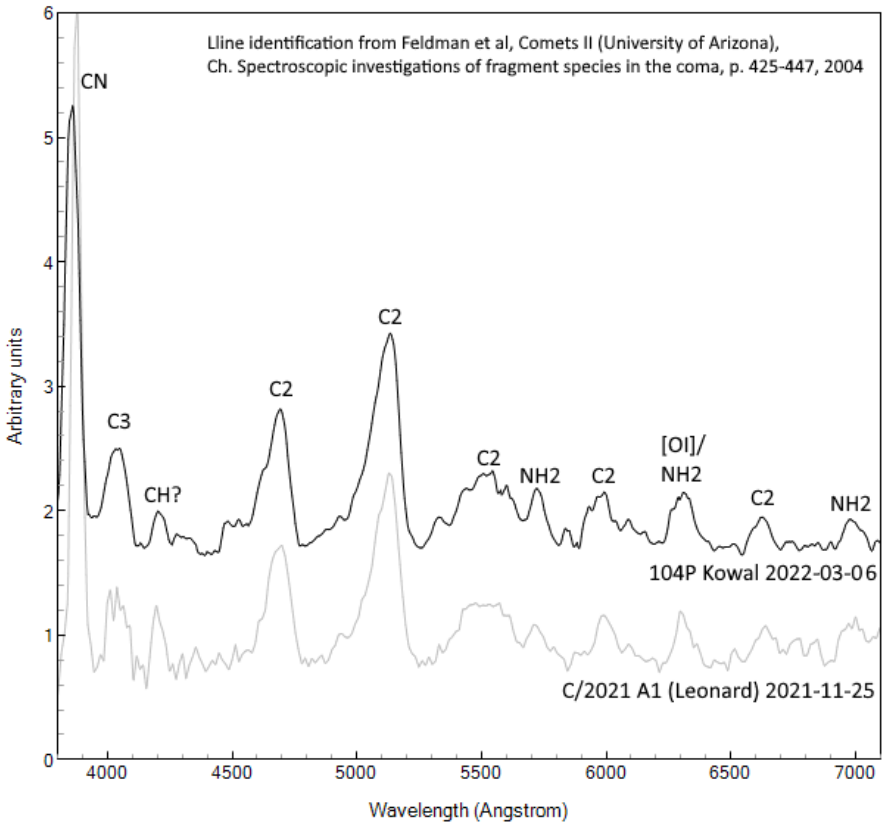
In this case however the movement was measured directly from two images taken 10 minutes apart. The rate of drift was then fine-tuned as necessary to keep the comet on the slit during the total exposure time.

The results are summarised in this figure which shows the position of the targets in the sky during the night from my location using https://airmass.org/ , the appearance of the comet as seen in long exposure (negative) images from spectrograph guider and the images of the raw spectra (sky subtracted but uncorrected for instrument response and atmospheric absorption) covering approximately 380-780nm.


C/2019 L3 (ATLAS)
67P Churyumov-Gerasimenko
116P Wild
Daily chart, Mar 06 2022
18:00UT
00:00UT
06:00UT
c:67P
Moon
104P Kowal
C/2020 V2 (ZTF)
18:00
00:00
06:00
airmass.org

Four of the five comets showed just the spectrum of sunlight scattered from dust, with no obvious sign of emission. 104P/Kowal however displayed clear emission features extending several arcminutes out beyond the dusty inner coma and so deserved a closer look. A further spectrum was therefore taken the following night and the two combined.

The result, now fully calibrated in wavelength and relative flux is qualitatively similar to a spectrum of C/2021 A1 (Leonard) taken using the same equipment on 2021-11-24 when 1.01 AU from the sun *https://britastro.org/observations/observation.php?id=20211128_183451_b1e498b4920861fe*



The digitised spectra can be downloaded from the BAA spectroscopy database. *https://britastro.org/specdb/*

Robin Leadbeater
robin@threehillsobservatory.co.uk

4 My Remote Observatory for Comet Observing Peter Carson

Part 2 – Success and Failure

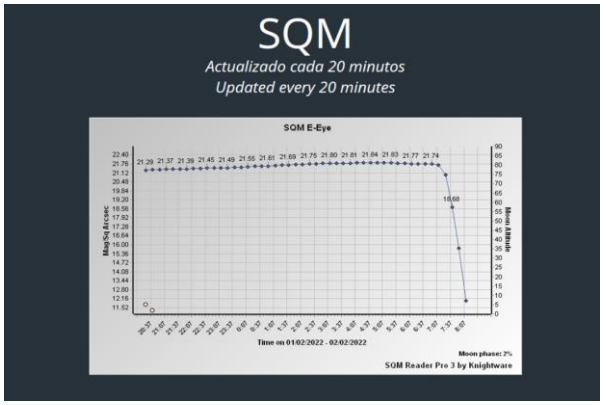
In the last edition of Comet's Tale, I described some of the reasons for moving my back-garden home observatory to a managed remote observatory hosting-facility in south western Spain. My remote observatory has been operational since December 2019 so has it been a success? The short answer is definitely yes. To answer the question in more detail I need to remind you of the criteria I used to select the remote site, they were:

- Dark location.
- No extremes of weather.
- Quality internet capable of supporting telescope operation in real time.
- Reputable facility with reliable utilities and good technical support.
- Reasonably priced all year-round transport links.
- Accommodation on site or nearby for visits or a holiday.
- Observatory building already erected on site.

I'll look at weather and dark skies together. The site all sky camera does reveal some light domes caused by the local small town about 5 miles away and also urban areas at much further distances.

My All-sky-Eye showing local light pollution

However, to put that in context the camera also regularly shows the Zodiacal light that sometimes extends along the ecliptic indicating the sky is actually very dark. The site sky quality meter reports that darkness improves throughout the night and is darkest, typically reaching magnitude 21.7 per arc sec square, a couple of hours before the start of astronomical twilight.



See above as an example. A single 60 second exposure with my 315mm aperture reflector can reveal magnitude 18.5 stars and a stack of 20 extends that limit to magnitude 20.

One aspect I didn't fully consider when selecting a remote site was seeing quality i.e. how stable the atmosphere is. To get good deep images the seeing needs to be stable enough to achieve good focus, images that make full use of the telescope's resolving power. On some nights I'm able to record nice tight star images with a FWHM of around 2.0 arc seconds, but on other nights it can be as bad as big blobby 4 arc seconds stars. I've not yet been able to properly ascertain if it's local factors or general weather conditions that are the major influence. Daytime temperatures in summer can reach over 40 degrees Celsius and during the winter it can be frosty.

Swings of temperature are more extreme than in the UK and obviously have a bearing on the stability of the atmosphere.

I've not kept records but estimate there to be about 200 nights a year where there is enough time to do a useful run of images, I imaged on 121 of them last year. In the first few months of operating my remote observatory I found I was trying to make use of every clear spell. I soon found my limiting factor was time available for image processing and analysis not the weather as is the case in the UK. From the UK I was lucky to get 100 clear nights a year. I now have a self-imposed rule where I don't collect more data until I've processed the majority of images from a previous session. If I was more IT savvy I would partially automate the post image acquisition process so there was not a bottleneck. Perhaps something I need to progress further.

Because of the often clear and better quality sky at my remote site I've found I've become more of a Moon hater! When imaging from my home observatory with its bright urban sky I regularly would image across bright Moon periods. The sky was light polluted anyway so the Moon only made a bad situation a bit worse. At my remote observatory the Moon has a massive detrimental effect to the dark sky and consequently I tend to concentrate my comet observing in periods when the Moon is near or below the horizon. I've also found the more southerly latitude of my remote observatory gives five hours of true astronomical darkness at the summer solstice, a benefit I'd not properly considered prior to the move.

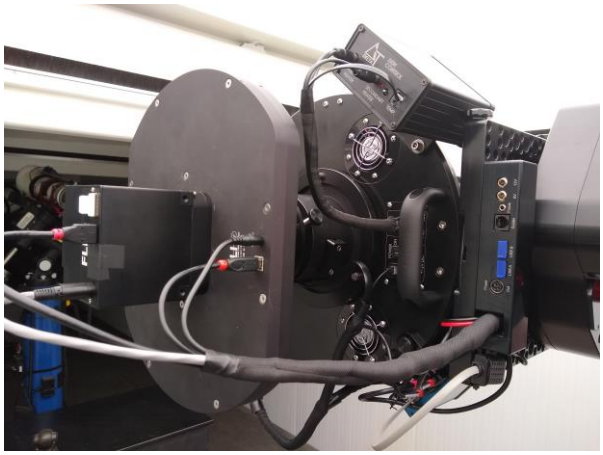
The other change to my observing habit is what drives me to start an observing run. From the UK it was without doubt the sky being clear. From Spain with its more frequent clear skies, I tend to plan an imaging run at intervals that are more regular or to observe some specific events. I can also better interweave my astronomy between my other interests on a more planned basis.

One of my site selection criteria was that the site internet speed should be sufficient to enable the use of my remote observatory in real time. Many remote hosting facilities require you to upload your night's observing instructions to your favourite robotic telescope software and allow the less internet hungry process do all the telescope and imaging control. I enjoy using my remote telescope in real time because it gives me the same "buzz" as sitting next to my operational telescope in my home observatory. Effectively nothing has changed to my observing experience except the wire to my telescope has got an awful lot longer. A fast internet connection is also very useful when needing to monitor or tinker with a piece of software or equipment. Seeing what the telescope is doing via the CCTV in response to an instruction can also be very helpful should there be an issue.

My telescope with its tube door partly open

That brings me on to reliability of utilities and my equipment. My remote observatory is in rural Spain so it's hardly surprising when there is an occasional loss of power or internet. Problems with utilities experienced so far have not been too frequent or inconvenient and my

observatory safety equipment, like uninterrupted power supplies (Battery back-ups) and safe shut down processes have worked just fine. It does seem to me the most vulnerable part of the whole system is the fibre optic internet cable that is supported on telegraph poles across 5 miles of farmers' fields to reach the nearby town. It has been known on more than one occasion a Spanish farmer has got his farm machinery tangled up in it causing an internet blackout. Fortunately, the Spanish telecoms companies are fast to react to the occurrences; perhaps it's the regular practice.



Rear end of the telescope set-up

My telescope, mount, camera and other equipment have been remarkably reliable. They have all performed superbly and not needed any on site intervention since installation some two and a half years ago….apart from a major camera issue I will mention further on. This is perhaps fortunate, as the Covid pandemic has prevented me from being able or wanting to visit my observatory since it's installation. I've therefore not had cause to test the on-site technical support offered by the hosts or the on-site accommodation. The roll off roof observatory provided as part of the rental package has performed well. The observatory construction is well insulated therefore avoiding excessive heat build-up under the blazing Spanish sun. I was careful to position the mount high up close to the underside of the roof thus enabling telescope access down to around 15 degrees altitude in all directions.
All the above confirms my new remote observatory is a great pleasure to use, is productive, reliable and most of what I'd hoped it to be when planning the move. However, I've not said what has gone wrong.

When planning any venture that relies on operation with minimal physical intervention planning and testing become very important. Everyone I spoke to and everything I read while contemplating the move said I should exhaustively test everything at home. I should ensure all the equipment, hardware, accessories, and software, even the interconnecting cables all function reliably and predictably. Then and only then should I dismantle the set up and re-erect it at the remote observatory exactly as it was previously. Unfortunately, I didn't follow that advice!!

My home observatory gear had functioned reliably and I had originally planned to relocate it just as it was. However, as the moving date got nearer I became concerned my old budget SBIG 8300 camera could be a weak point. My funds could just stretch to a replacement camera, so at the last minute I decided to change it. I upgraded it to a premium sCMOS camera that unfortunately did not perform as claimed by the manufacturer. My brief testing at home didn't reveal issues that only became apparent once the camera was used in anger at my remote observatory. The USB 3 transmission reliability and background flatness issues would have been noticeable if tested properly at home.

Eventually the issues could only be resolved by installation of a new camera from a different manufacturer, involving another visit to Spain. This wasted several months and really brought it home why it

is important to test everything properly before the move. A lesson for everyone! Over the last two years the observatory has performed splendidly and I'm pleased I made the move. Last year I took 606 comet images stacked from more than 12,000 individual images, with very few images ending up in the deleted bin. My contribution to the BAA image archive, COBS, and the MPC has improved considerably over previous years. I'm fairly sure I could not have achieved this performance from the same equipment at home.

Renting a hosted remote observatory is not cheap but if the alternative is to move house and observatory to a darker location then perhaps it's not so bad.

Peter Carson
CCD Imaging Advisor

5 My Comet Imaging Process – Deep Sky and Planetary Imaging Techniques

Dan Bartlett

Dan Barlett, the author, with his set up at June Lake California, USA.

How I came to observe Comets

We are all passionate about comets. Often a specific event or a set of images inspires you to follow these remarkable objects. Many are fanatical and passionate about observing and imaging these elusive objects. I am one of those committed individuals. For me, it was a series of events that solidified my desire to observe, image and search for these mesmerising fragments of space debris. As early as 1965 I recall my mother dragging my three siblings and me, early in the morning, in search of the great Comet Ikeya-Seki C/1965 S1. We had no idea where we were to look to see this great sungrazer. Soon, the darkness of the early morning hours gave way to bright daylight, and with no luck of seeing this visitor.

As I became an astronomer-outcast in my early high school years, I seemed to have missed all of the social norms. I wanted to learn as much as I possibly could about astronomy. The promise of comet Kohoutek C/1973 E1 was just the object I needed. To many people, Comet Kohoutek was projected publicly, to be the greatest comet of the time. I read as much information as I could about this comet and others. Knee surgery that year kept me from observing comet Kohoutek during the icy New England winter months, however my dreams of comets were heightened.

A few years later, observing comet C/1975 N1 (Kobayashi-Berger-Milon) in a pair of binoculars was highly exciting to me. It was a striking fuzzball, easy to see in a pair of 10x50s. Even more exciting were the first images published about this comet, taken with photographic film, showing a fine spike-like tail emanating from the fuzzball, a feature I did not see visually. This was my first introduction into the difference between visual observation and

the potential of imaging. Then in early March 1976 I chanced upon the news of a comet that could be seen by airline pilots during the daylight hours.

Comet C/1975 V1 (West) taken by author 1976 March 8 Calf Beach overlooking Narragansett Bay Rhode Island 50mm TriX film-1.tif

Grabbing a close friend and some very basic photographic equipment (a rickety tripod, an old 35mm camera and some black and white Tri-X film) we rushed in the early morning hours to the coast of Narragansett Bay (Rhode Island) to watch and hopefully photograph this comet. As we exited the car we were stunned by this beautiful sword like object, which had cleared the horizon, and was extending over the eastern side of the bay. This was the under-publicised comet C/1975V1 (West), and it was spectacular! Finally, I took my first images of a comet and followed it as it changed, evolved, fragmented, and finally disappeared from view, but not from memory, over the next several months.

Skipping forward 20 years, and avoiding mentioning a few hundred comets or so, to what is according to Wikipedia, the most widely photographed comet, (I think wiki may have overlooked C/2020 F3 (NEOWISE), the remarkable comet C/1995 O1 (Hale-Bopp), in April 1997. My first-hand experience of a visual cometary observation was very different from what I was able to photograph. Hale-Bopp was discovered a few years before perihelion, which gave me the time to make a pair of 4.25" F/4.5 binoculars for the event. (Large scope Dobsonians were an ongoing revolution, however I was still stuck in the 70's where an 8-inch scope was considered big and my recently completed 10-inch f/9.6 Newtonian was huge.) A 4.25" seemed quite the correct light gathering power for a pair of binos and wide enough field of view for this comet, or so I thought. I had no design plan for my project however I managed to make the twin objective mirrors and to design an alignment system and housing to make these hand-holdable.

Completing on time, I remember using them to see the nucleus of Hale Bopp from Los Angeles with remarkable success. On 1997 April 5, I drove up to the nearest dark site, Mt. Pinos, California, the moment the weather prediction proved favourable. What a night! What a sight, at 8,300ft in altitude with crystal clear dark transparent skies.

Comet C1995O1 Hale-Bopp 1997 April 5

I can remember staring at this ethereal body. Its tail flowed from its star like nuclear condensation, in two directions. Hale Bopp's nucleus was positioned about 5 degrees below Algol (Beta Persei) and a straight faint jet-like tail shot upward, into Mirfak's (Alpha Persei) field of bright stars. A much brighter broader tail, in a thicker broad expanse, curved to the upper right, aiming towards the double cluster of Perseus and in the direction of Cassiopeia. I pointed my newly created binoculars and scanned the comet-filled starfield to study as much of comet Hale-Bopp as I could, but with limited field of view (binos design flaw).

I continued to view this glorious sight as often and as long as I could hold the 4.25"s until the shaking in my arms made it too difficult. Then I stood in awe, just absorbing the view once again with my unaided eyes. I remember being fascinated, studying the tail separation between the dust and ion tail through the cumbersome binos, challenging myself to see how far I could see each of the tails extend upward as well as looking for striations in the ion tail. I didn't want to leave, but the earth's rotation took the comet, and I watched it pass through the gaps in the mountainous tree lined horizon.

Comet C1995O1 Hale-Bopp 1997 April 5 fading twilight

Somehow, on this first night, while visually observing, I was determined to see what I could capture on film. With no tracker, nor equatorial mount, I set up a 35mm Olympus OM2 SLR camera on a less than perfect tripod. I shot several rolls of colour film varying the length of exposures to obtain enough "comet" while limiting any type of trailing. Back in those days you would have to wait to process your film to see if you had anything useful. A lot of prayers/doubts/hopes went along with my limited photography experience. You were not only playing with the rotation of the earth but also the depth of changing twilight. The aperture setting was a guess, to say nothing about the length of the exposure, hoping you didn't over expose this bright comet yet spend enough time to bring out something exciting. I was using a typical 50mm lens, anything more without tracking and "forget about it". Filming was an expensive hobby, where you'd pay twice, once for the film and once for the

processing. You can see an example of my photographic prowess of Comet Hale-Bopp from this first night.

I drove the two-hour drive to Mt. Pinos three more times over the next working week, limited by weather and exhaustion. The weather was not as favourable as the first night, however I was able to film and observe again. Tiredness, weather and the moon entered into the comet field till I fell back into the normal lifestyle of raising a young family. Unlike Comet West which stayed easily visible, while its nucleus fragmented into at least four large segments, for well over a month, I don't recollect many reports of Comet Hale-Bopp as extensively. I know it stayed low to the horizon for a period. My daily distractions, led me to miss the aftermath of its post-perihelion splendour. But I was hooked and I have followed, observed and, more recently, with the purchase of CMOS cameras, imaged comets ever since.

Now for the technical bits

So, I have finally arrived at the purpose of this article. Which methods do I use to go about producing the comet images I enjoy publishing? First a sampling of what I've submitted;

https://apod.nasa.gov/apod/ap200606.html,
https://apod.nasa.gov/apod/ap211121.html,
https://www.astrobin.com/users/h2ologg/,
https://apod.nasa.gov/apod/ap211212.html.

In truth, I'm never quite happy with the results as I strive to render each comet as clear and clean as possible. I am always pushing to get it right for any particular comet imaging publication. I view comet imaging as a conjunction of both Deep Sky Object (DSO) imaging and planetary imaging processing. Notice my wording. I capture and process comet images as I would deep sky objects, tracking on the stars, taking exposures of the length where the cometary central condensation does not "trail" and processing the image as I would with two DSO images (comet registered and starfield registered). A simple mathematical recombination of both images using PixelMath in the PixInsight program finishes the outcome. Here the imager is free to select an appropriate timed-reference image to "quality" stack the remaining comet only images.

The comet only registered image is then processed much as one would process a planetary image, recovering as much hidden detail and reducing any artefacts produced in the process. In the planetary imaging toolbox, where an imager stacks perhaps thousands of images from a particular night, the resultant stacked image initially *isn't* impressive (regardless of stacking software such as AS!3/RegStax6). Generally, the stacked image is not more clear or clean than the single subframe taken of the object. It requires careful selection of processing techniques (wavelets, deconvolution, winjupos derotation etc.) in order to pull out the hidden details.

Processing done correctly can reveal impressive details of the Martian cloud shrouded volcanoes and Jupiter's interloping cloud patterns as examples. I follow this thinking for comet processing; stack the images, pull out the details, reduce the artefacts and avoid introducing biases that aren't present. My general plan of action on any given night and for any given comet, is to image for as long as possible. It is not uncommon for me to capture *hours* of say, 180 second (dependent on the comet's apparent motion) exposures on any particular comet in one night. Overall, extended imaging time helps in revealing fainter cometary details as well as the added benefit of improving the starfield only background. For me, it seems incomplete to leave the results of a stacked comet aligned image

without further investigation of potential details that are likely to be present. Meaning, complete the processing as you would a planetary image once the stacking is complete.

With that said, the plethora of cometary characteristics, including orbital positioning, comet nature and local environmental variability makes each comet imaging session a challenge and will dictate what can be accomplished. It is important to decide on the image collection process; time on target, angle of camera sensor, scope and camera choices etc. setup and use of equipment to perform the planned capture AND the processing nature of each comet image. Quite a handful!

I'll describe a few scenarios as examples: what adaptation would be possibly helpful in your imaging routine if you wanted to image a moderately bright comet passing a reasonably bright galaxy during bright moonlight? Shortened exposure times to 15 seconds or less subframes would certainly head the list. Alternatively, when time is against you as a comet sets in the west, decreasing its altitude or twilight may interfere as a comet rises, adjustments must be made for the low altitude (difficult even when using automatic focusing). For a very active comet (e.g. recently comet C/2021 A1 Leonard after perihelion) details can be blurred as knots, tail disconnects, and sudden brightening can happen. Long exposure times must be limited and equipment choices are critical.

My favourite scopes are my super-fast F/2 & F/2.2 Rowe Ackermann Schmidt Astrographs (RASA) 8"(203mm) and 11"(279mm). Their wide field large aperture and sharp flat fields matched with their imaging speed are ideal for comet imaging. When a bright comet exceeds the field of view of one of my RASAs I use my RedCat51 (fl = 250mm) or any of my DSLR prime lenses with my astronomy cooled camera combinations.

Although the merit of mono astronomical cooled cameras is widely known for their increased sensitivity over their one-shot camera (OSC) counterpart, I choose the 16bit OSC versions (settling for 14 -12 bit when merited) for my cometary imaging. RASA's don't work well with filter wheels and extra wiring blocks more of the central obstruction. I find that I have more time on target and less time in processing using OSC cameras. Obviously the wider the camera sensor the better for larger fields of view (the smallest sensor used to date being a 1-inch sensor with 2.4µm pixel size). Accurate tracking is paramount for longer exposures where at the present I'm using unguided 10 Micron gm1000hps and gm2000hps mount heads on stable portable tripods. Pricey, yes, however the simplicity of use and dependability of the mounts is extraordinary.

Rasa11 and RASA8 Usual Setup Cabin June Lake California USA.

Where do I image?

RASA11 F2.2 June Lake in California USA.

From a cabin in June Lake, California, USA, at nearly 7750ft (+2300m), and surrounded by lakes in a horseshoe shaped canyon. The cabin is perched 200ft on top of a granite dome overlooking a Bortle class 2 township. The air is thin, often dry and has very stable skies. I am strictly imaging in a backyard portable setting. I run the USB and ethernet cables out of my cabin windows, run the power cords from the walls to operate all data collection from the comfort of an interior office. Good thing too, the weather in the Eastern Sierra Mountains of California can quickly change and immediate disassembly is required when winds are predicted. I've learned the hard way when wind gusts of 78mph, recorded from my rooftop weather station, toppled both imaging rigs. Damage was severe.

How dark are my skies?

I have reached objects of magnitude 20.5 while taking 21 x 180 seconds with the RASA11 + asi6200mmP integrating with the Tycho synthetic tracking software, written by Daniel Parrott. I know the images can go deeper.

A final word on comet processing before I close. I only use PixInsight and NOTHING else for processing. This is the software I used to produce DSO images and am dedicated to it. There are a number of methods of separating the comet from the background starfield images; in PixInsight it is the comet alignment process. Usually, any star removal process will leave artefacts however some of the algorithms such as StarXterminator, StarNet Version2 and the native PixInsight integration process have been steadily improving. I prefer ESD integration algorithm using the Large-Scale Pixel Rejection typically using Layers=1 and Growth=6 for high structures only. Brighter comets and those with a large apparent motion work best during star removal. My end goal for comet publication is to reduce the noise, stacking more images when possible, and other aberrations introduced during capture. In processing I pull out any details that might be lessened from a purely stacked comet and starfield set of subframes (light frames).

From visual observations of comets, to filming, to imaging in different wavelengths of light, it has been exciting to see what delights a comet might reveal. My enthusiasm for cometary observation has ballooned into passions both in visual observation and in astro imaging. Visually there is no replacement, for me, to enjoy the beauty of the visitor through my own eyes. I love to watch the development of the potential of a comet's essence. There is often an emotional feeling, as if I alone, am

the only person witnessing this visitor travelling through time and space.

When I'm imaging, I'm watching the computer screen. I am as eager to see, for the first time, what a comet potentially has to offer. Imaging, in a sense, is collecting time, whereas visually my eyes see the comet in real-time. The sensitive sensors we use are able to collect more light, more information, more details than my eyes possibly can, over a specific range of time of my choosing. Imaging beautiful comets is no longer reserved for the brightest, but can offer spectacular observations even for a meagerly bright comet.

Taking the raw images to the next level through computer processing adds a bit more magic. Stacking a session's worth of comet images can reveal additional hidden cometary detail and beauty. A ready- to-publish, completed image, is an attempt to give its audience the satisfaction or feeling of looking at a comet as it naturally travels in space.

With their remarkable beauty, and ever-changing characteristics, never knowing what you're going to get, comets add an element of deep sky beauty. Deep sky objects, by themselves, can captivate one's imagination and intrigue. Adding a touch of a comet's variability to a chance alignment with a beautiful deep sky object, whilst observing and imaging, can inspire an even deeper moment and a memory of excitement. There is even the possibility of potential science discovery, revealing additional wonderment.

Dan Bartlett

Maybe of interest are some animations I've made:

Comet C/2021 A1 Leonard disconnects (a month prior to perihelion!)
https://youtu.be/Gg4-oquezKU

77mph vs telescope(s) - The worst happens.
https://youtu.be/vflgrWPQZ68

Forgotten data final night before moonlight Comet C/2020 F3 (NEOWISE) 2020 July 22
https://vimeo.com/449111706

A closeup rarely seen using a telescope on C/2020 F3
https://vimeo.com/454967417

My general archival Vimeo links are here https://vimeo.com/user89727684

And archival YouTube channel here: https://www.youtube.com/channel/UCY1lhSXKZ_rDDX_KQ0m3hig

6 Interview with Kacper Weirzchos Denis Buczynski

Kacper Weirzchos is a Senior Research Specialist at the Catalina Sky Survey https://catalina.lpl.arizona.edu/

I recently wrote to Dan and asked him a few questions about the observational procedures used at CSS for comet observing.

Denis
You mention that CSS incidental astrometry is carried out on comets you pick up as a result of the regular searches you perform. I assume your searches require you to return to successive fields to search for NEO's. Do you return to fields twice or more during a nights' run?

Kacper
Our nightly survey plan consists of about 14 to 20 survey sets of 12 fields each, with each field being visited 4 times. Each exposure is 30s. So, in total we take about 4x12x14-20 images each night. Of course, this depends on several things. In Summer our night is about 7.5hrs, now in winter it is 12 hrs. Bad weather can cut a night short or start it late so it depends. To answer your question: we take four images of each field during the night.

Denis
If so when you return to a field containing a comet (already known) how many astrometric measures of the comet do you make, and are these comet measurements automated or are they made manually.

Kacper
All comets, known or unknown are presented to us for validation. Each survey field contains 22 detections of potential new objects. That is, we are presented with 22 blinking detections to visually inspect and decide whether they are real or not. In the course of 2 years, a CSS observer visually inspects about 1 million of detections. Of course, the vast majority are not real, just artefacts, flat field issues, cosmic rays, artsats, etc. Comets, whether known or not are always presented for observer validation. Known main belt objects and any other asteroid that is known is not presented for validation. Sometimes a field close to opposition contains over 300 known main belters. If we see a comet, first we check whether it's known or not with an internal software that checks MPC and JPL ephemeris positions of known objects with a similar PA and rate and position. If the comet is

known and has a good centroid we just mark it as real with the "Y" key and keep validating.

1.5-metre Telescope: The 1.5-m survey telescope is an f/1.6 reflector equipped with a 111-megapixel (10,560 x 10,560 pixel) CCD detector mounted at prime focus. The field of view is 5.0 deg² with a pixel scale of 0.77"/pixel (unbinned). Covering 1,000 square degrees per night with a limiting magnitude V~21.5 images are obtained using a 2 x 2 binning mode with an exposure time of 30s.

That astrometry will go at the end of the night with the rest of thousands of positions of known objects. If we see that the software had some issue centroiding on the object then we do what we call "handcrafting a detection". Handcrafting consists on placing a crosshair on the object with the arrow keys on where we think the centre of brightness is and that will correspond to the astrometric measurement. This happens on a nightly basis at the 1.5m on Mt. Lemmon with new NEOs that are trailed. Software is not as good as the human eye at finding the centre of a trailed detection.
If the comet is new, we send the discovery observations to the MPC and CBAT immediately.

Denis
I assume that this is what you mean by incidental astrometry. In the case of targeted follow up astrometry, I assume this will be done on comets that you newly discover during the NEO searches. Are these astrometric measurements treated differently to the incidental astrometry measurements or are they treated in the same procedure?

Kacper
Yes, incidental astrometry is just astrometry of known objects that were picked up in the course of the survey. Tens of thousands of measures of this kind are sent at the end of the night. And with the exception of comets, the person is not involved in their validation (real/not real) or their measurement. It would not be possible to validate 10,000 objects in addition to the roughly 4,000 detections a night that we validate by eye. By the way, the fact that we are validating detections by eye is what lets us work with much lower SNR compared to other surveys. The brain is still better at pattern recognition than a computer!

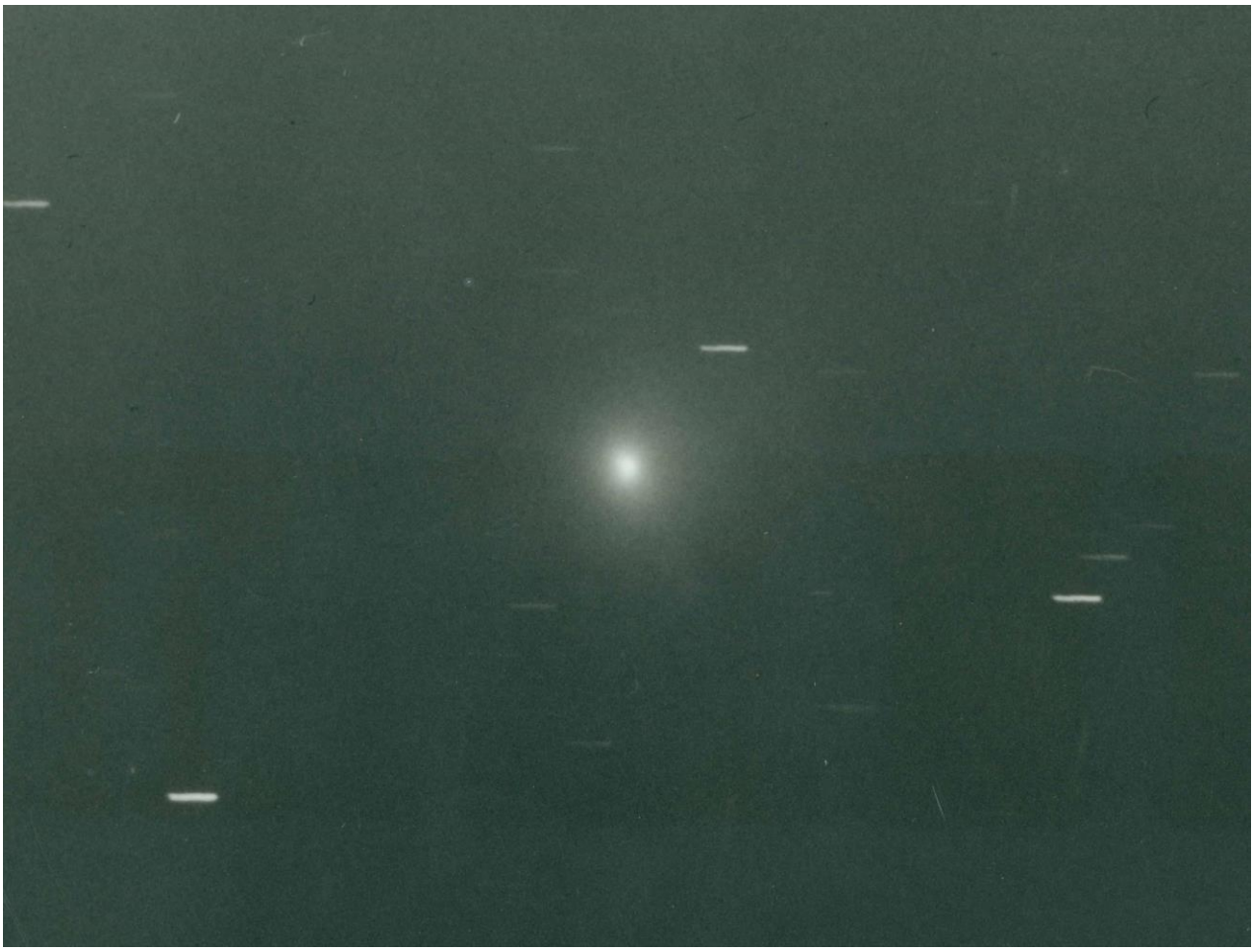
Denis
How many incidental comet astrometric measurements are made and submitted to MPC each night and where could I find listings of these measurements on CSS or MPC websites?

Kacper
On average, I would say that we run into 3-10 comets a night. So 3x4 to10x4 measurements amounts to about 12 to 40 comet positions/observations each night. Of course, this depends on weather, night duration, presence of the moon etc. You can find all of our comet astrometry at the MPC website, under Orbits/Observations Database. You just type the name of the comet that you want to look into and if the displayed observations have the G96 or 703 conde, that means those were made by our survey telescopes.

If you are interested in our night procedures, Rich Kowalski explains really well our method, software etc in this interview: http://www.skaw.sk/interview-with-richard-kowalski.html.

Denis Buczynski
Comet Section Secretary

7 Masani Nagata – The Farmer Who Discovered a Comet
Timothy K. Asamen



Nagata's Comet. Image courtesy of the Observatories of the Carnegie Institute for Science Collection at the Huntington Library, San Marino, California.

By July of 1931 the melon season was winding down in Southern California's Imperial Valley. With fewer runners from local produce companies wiring eastern wholesale markets, the Western Union telegraph office in the farming town of Brawley announced that it would reduce its business hours as it did each year when the harvest came to an end. But in the middle of the month a flurry of incoming telegrams caused quite a stir. The wires came from unheard-of sources – astronomical observatories across the country and scientists around the world. Causing even more disbelief was for whom they were intended – a diminutive Issei[7] farmer named Masani Nagata. The modest bachelor earned worldwide acclaim that summer by discovering a comet. On July 23, 1931, a headline on the front page of the *Brawley News* heralded:

AMATEUR ASTRONOMER OF BRAWLEY STARTLES WHOLE WORLD FINDING NEW COMET – GETS MANY WIRES

[7] *First generation immigrants from Japan.*

Masani Nagata peering through his Zeiss telescope, 1931. Courtesy of Japanese American Gallery Collection, Imperial Valley Pioneers Museum, Imperial, California.

Nagata was born in 1886 in Ibaraki Prefecture, Japan, where his father was also a farmer and amateur astronomer. And it was the elder Nagata who nurtured Masani's fascination with the stars, constellations, and planets from a young age.[8] Masani (also known as Masaji)[9] immigrated to the United States in 1907 at the age of twenty-one. Three years later he settled in the Imperial Valley where he grew truck crops on a small scale in the areas around Brawley and Westmorland.

[8] *Los Angeles Kashū Mainichi, "Nagata, Comet Discoverer, Prefers Lettuce to Fame," June 26, 1932.*
[9] *Nagata's personal name was Romanized as Masani on his passport and was therefore treated as his legal name. However, he preferred to spell it with a j, which undoubtedly reflected how he pronounced it (Los Angeles Kashū Mainichi). In Japanese, with surname preceding given name, his name was written as 長田政二.*

At the time of his important discovery, he was a ranch foreman for the Sears Bros. & Company, a Brawley-based grower-shipper. Later he was employed by the A. Arena & Company, Ltd. of Los Angeles. For both produce companies he oversaw the growing of vast acreages of lettuce and cantaloupes.

The California Alien Land Law of 1913 prohibited Japanese immigrants from owning farmland and limited leaseholds to three years, so Nagata continually moved from field to field. The discriminatory law gave rise to a distinctive transient lifestyle in the Imperial Valley. Issei tenant farmers – bachelors and farm families alike – lived in small, rickety, wooden shacks. They were built to be lightweight because when the farmers moved to a new field, they took their houses with them. The moveable houses were not equipped with electricity or indoor plumbing. Russell W. Porter, an associate of optics and design at California Institute of Technology (Caltech) in Pasadena, visited Nagata and was taken aback when he found that "his thatched roof home was made of sticks and burlap bags."[10]

While farming, Nagata continued his vocation and even encouraged several of his cronies to take an interest in astronomy. He convinced them that it was an ideal hobby because irrigation was a 24-hour task and they could gaze up at the stars while irrigating their crops at night. Astronomy was only a whimsical pastime for most of his friends, but Nagata studied the subject in earnest. What was described as his "library" consisted of a "rough table piled high with books and magazines, including the works of both Japanese and American scientists."[11] One of those books

[10] *Berton Willard, Russell W. Porter (Freeport, Maine: The Bond Wheelwright Company Publishers, 1976), 237-238.*
[11] *Lincoln Nebraska State Journal, "Japanese is Modest Over Finding Comet," July 25, 1931.*

was *Hokkyokusei sonohoka*, 'The North Star and other subjects' published in Tokyo in 1926. It may have been that book that inspired him to build a miniature planetarium that he called, 'A View from Your North Window'. He rigged the contraption with a light source that produced twinkling stars and it revolved to show the position of different constellations in relation to the North Star.

Zeiss telescope with which Masani Nagata discovered Nagata's Comet and other memorabilia on display in the Japanese American Gallery at the Imperial Valley Pioneers Museum, Imperial, California. Photo by author

Just after dark on July 15, 1931, the Issei farmer was looking at the planet Neptune through his five-foot long Zeiss telescope with a three-inch (80 mm) lens, mounted on a heavy, black tripod. At about 8:30 p.m. a nebulous star near the horizon caught his attention because he did not recognize it. Examining it again the next evening, he determined that it had moved approximately one degree to the northeast and suspected that it was a comet.[12] Unable to identify it from his charts or astronomical journals, he telegraphed an apologetic inquiry to Mount Wilson Observatory in Pasadena professing his own oversight. It was no oversight. Dr. Seth B. Nicholson of the observatory confirmed that what Nagata found was a previously undetected comet. It was positioned in the constellation Leo, near the star Rho Leonis, about ten degrees to the right of Mars.[13]

In the days that followed, requests for additional information and details about the comet were telegraphed to Nagata from the National Science Service, a scientific news agency in Washington, D.C. In accordance with its prerogative, Harvard College Observatory officially announced the discovery of the new comet to the world. Likewise, the International Astronomical Union conferred the name of the celestial object – C/1931 O1 (Nagata). As was customary, it was named for its discoverer.

Nagata became an instant celebrity. He was hailed as a genius and he received letters and telegrams of congratulations from around the United States and Europe for being the first Japanese resident in America to discover a comet. He was also inundated by local newspaper reporters and news correspondents from Los Angeles who wanted to learn more about the obscure Imperial Valley farmer who astonished the world by discovering, as the *Brawley News* reporter put it, 'what astronomers with high powered appliances have missed for years'. When the same newsman asked Nagata to comment on the naming of the comet, he displayed his

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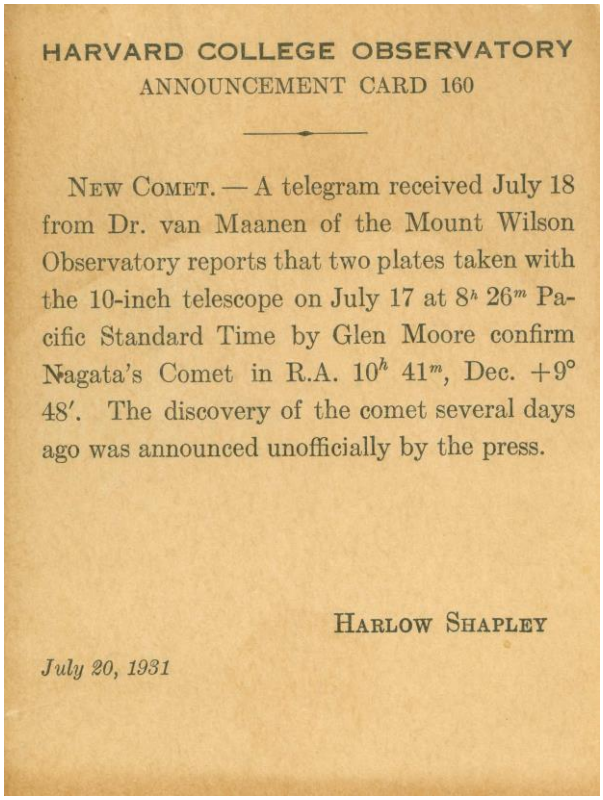
[12] *H. M. Jeffers, "Nagata's Comet," Publications of the Astronomical Society of the Pacific 43, no. 255 (October 1931): 356. The official date of the discovery of Nagata's Comet is July 16, 1931.*
[13] *Fitchburg (MA) Sentinel, "Lettuce Farmer Discovers the 'Newest' Comet," August 18, 1931.*

trademark modesty by replying that it should be named 'for some worthier person.'[14]



HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 160

NEW COMET. — A telegram received July 18 from Dr. van Maanen of the Mount Wilson Observatory reports that two plates taken with the 10-inch telescope on July 17 at 8^h 26^m Pacific Standard Time by Glen Moore confirm Nagata's Comet in R.A. 10^h 41^m, Dec. +9° 48′. The discovery of the comet several days ago was announced unofficially by the press.

HARLOW SHAPLEY

July 20, 1931

One of several Announcement Cards (postcards) sent to Masani Nagata from Harvard College Observatory. Courtesy of Japanese American Gallery Collection, Imperial Valley Pioneers Museum, Imperial, California.

The unassuming Issei was bewildered by all the hullabaloo made about him.[15] Initially he even resisted posing for photographs but his polite protests did little to thwart his rise to prominence. An Associated Press photo of him sitting beside his Zeiss telescope and stories of his extraordinary achievement were picked up by big-city and small-town newspapers from coast to coast. Fox Movietone News dispatched a camera crew to Brawley and on August 3, 1931, sound newsreel footage was filmed of the amateur astronomer. Being proficient in English, he made remarks in both English and Japanese for the talkie.[16]

In the wake of his discovery, a number of dignitaries from the scientific world, including the aforementioned Russell W. Porter, called on Nagata at his crude abode in the Imperial Valley desert, some six miles west of Brawley. Much to his consternation, a delegation representing the Astronomical Society of the Pacific showed up at his door on 10th September 1931. The delegation was led by Robert G. Aitken, the director of Lick Observatory near San Jose.[17] Aitken bestowed upon Nagata the society's Donohoe Comet Medal. Beginning in 1890, it was the 138th time that the prestigious bronze medallion was awarded to an individual for the discovery of an unexpected comet.[18]

Nagata joined the Citrus Belt Amateur Astronomers Club in Riverside, which was founded in 1933 by Dr. H. Page Bailey, a dentist and renowned amateur astronomer. Nagata was an active member and travelled to Riverside frequently to participate in the club's functions, such as its Spring Rally.[19]

Nagata's newfound fame made it possible for him to share his passion for astronomy with a wider audience. He arranged for Bailey to give lectures at the Brawley

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[14] *Brawley News, "Amateur Astronomer of Brawley Startles Whole World Finding New Comet – Gets Many Wires," July 23, 1931.*
[15] *Los Angeles Kashū Mainichi.*
[16] *Brawley News, "Lick Observatory Honors Astronomer Here," August 5, 1931.*
[17] *Los Angeles Kashū Mainichi. Both Willard's biography of Porter and the Kashū Mainichi article point out the difficulty in locating Nagata's residence. At the time, rural roads in the Imperial Valley were not named. The location of a farmstead was ascertained by the name and number of the nearest irrigation canal.*
[18] *R. G. Aitken, "One Hundred and Thirty-eighth Award of the Donohoe Comet Medal," Publications of the Astronomical Society of the Pacific 43, no. 255 (October 1931): 349.*
[19] *For photos of activities that include Nagata, see Bob Stephens, "History of the RAS: Part 1 – Roots . . . The Citrus Belt Astronomers," Riverside Astronomical Society, www.rivastro.org/ras-history-roots.php.*

Junior College library. Such events were always free to the public. In 1936 the Issei farmer was invited by the Astronomical Society of Los Angeles to give a radio address, which he conducted in English and Japanese. In Brawley, he would set up his telescopes in the city's parks so that local residents could gaze through them. On the night of August 7, 1937, he took several of his telescopes to Hawthorne Park and invited the public to view Fensler's Comet. Earlier that evening the *Brawley News* announced that 'residents of Brawley wishing to see the new Fensler Comet will have the opportunity tonight through the courtesy of Mr. Nagata, local astronomer'. The article continued, 'The telescopes used by Mr. Nagata in his exploration of the stars are of his own construction'.

At some point, Nagata presumably made a killing by producing a bumper crop when market prices were at their peak because he spared no expense in purchasing his Carl Zeiss refractor telescope. Zeiss optical and scientific instruments – manufactured in Jena, Germany – were reputed to be among the best in the world. Commercial telescopes in general were typically too expensive for amateur astronomers, especially during the Depression era. Consequently, the making of telescopes was a widespread activity among amateur astronomy clubs. Nagata became skilled at grinding and polishing lenses and mirrors for his own telescopes. It is likely that he possessed in his library the book *Amateur Telescope Making*, published by Scientific American in 1926, to which Russell W. Porter was a key contributor. And Nagata must have been thrilled to meet Porter who was regarded as the founder of the amateur telescope-making movement.[20] But it was Bailey from whom Nagata 'learned very much', and to whom Nagata was grateful for 'helpful suggestions and aid'.[21] Nagata discovered that the Imperial Valley's notorious summer heat had an adverse effect on the shaping of the mirrors, a problem he solved through trial and error.[22] Despite the setbacks, he was successful in building nine telescopes.[23]

As a result of the growing interest in astronomy, the Imperial Valley Astronomical Society was formed in March of 1938 with Nagata as one of its founding members. J. R. Hollingsworth was its first president. In recognition of his exemplary community service, Nagata was made an honorary member of the Brawley Rotary Club.

Nagata confided to his close friend and Ibaraki kinsman, Minekichi Kobayashi, of Westmorland, that he looked up at the stars because he suffered from headaches at night that prevented him from sleeping. When his headaches became unbearable late in the summer of 1938, he sought medical attention in Los Angeles. On September 8, 1938, he passed away at the Los Angeles County General Hospital. The cause of his death was recorded as chronic ethmoiditis (inflammation of the bones of the walls and septum of the nasal cavity), which led to a streptococcic bacterial abscess at the base of the brain.[24] The *Brawley News* sombrely reported:

'His demise comes as a distinct shock to this community, to his neighbours and friends in the Westmorland area where he has resided for many years, because of his kindly greetings to all with whom he came in contact and for the hospitality extended

[20] *Anthony Cook, e-mail message to author, May 4, 2021.*

[21] *Harry Minami, "U.S. Japanese Wins Fame as Astronomer," San Francisco Nichibei Shinbun, April 16, 1938.*

[22] *Willard, 237-238; and Anthony Cook, e-mail message to author, May 4, 2021.*

[23] *Minami.*

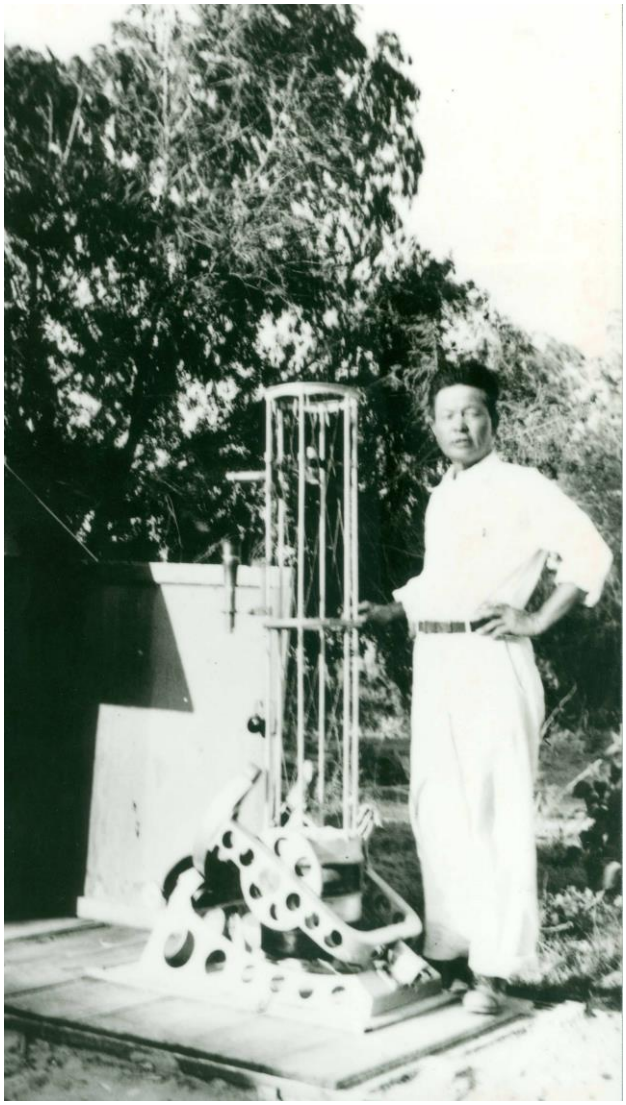
[24] *Certificate of Death: Nagata, Masaji. Filed September 10, 1938. State of California, Department of Public Health, Vital Statistics, District No. 1901, Registered No. 11702.*

to those who visited him at this ranch to survey the starry universe through his homemade telescopes'.[25]

An urn bearing his ashes was returned to the Imperial Valley and a funeral service was held on the evening of September 15, 1938, at the Brawley Buddhist Church. The church *hondo* (main worship hall) was not large enough to accommodate the enormous crowd that gathered to pay its last respects. Many attendees were required to stand in the back of the hall and outside on the church's veranda. Reverend Koyo Tamanaha officiated the service. Pallbearers were J. C. Archias, Yuzo Honda, Myron Howard, Minekichi Kobayashi, Ben Kodama, and Ralph Stilgenbaur. Brawley produce-shipper Tomosuke Uchizono delivered the eulogy. Remarks were also made by other community leaders in both English and Japanese. Those who spoke in Japanese included Reverend Susumu Kuwano of the Brawley Japanese Methodist Episcopal Church and officers of the Japanese Association of Imperial Valley. Among the English speakers were J. R. Hollingsworth of the astronomical society and G. K. Anderson representing the Rotary Club. In his tribute to Nagata, Anderson said:

'Perhaps no other person in Imperial Valley has been so widely honoured because of his way of life and his achievements in amateur astronomy. He placed service above self…The valley has lost a scholar and a gentleman'.[26]

Epilogue



Masani Nagata standing beside the truss-tube telescope supported by an equatorial split-ring horseshoe mount built by H. Page Bailey, circa 1932. Japanese American Gallery Collection, Imperial Valley Pioneers Museum, Imperial, California.

Nagata asked H. Page Bailey to build a telescope for him in 1932. The inventive designer and builder of telescopes did not disappoint his Issei friend. The telescope that he built was a truss-tube reflector supported by a novel equatorial split-ring horseshoe mount.[27]

To Bailey's mind, Russell W. Porter and his supervisor John Anderson, of California

[25] *Brawley News, "N. Nagata, Local Astronomer and Rancher Passes Away in Los Angeles General Hospital," September 9, 1938.*
[26] *Brawley News, "Many Local Residents at Funeral for M. Nagata," September 16, 1938.*

[27] *For descriptions and photographs of the telescope and correspondence related to the Hale telescope controversy, see Stephens.*

Institute of Technology, had ulterior motives when they made the trek to the Imperial Valley between 1932 and 1933 to congratulate Nagata and extend an invitation to visit Caltech. At the time, Porter was designing the 200-inch Hale telescope, then the largest telescope in the world, for Palomar Observatory in San Diego County, and Anderson was the overall project manager. Bailey was convinced that they wanted to see the telescope that he had built for Nagata, or, more precisely, the telescope's unique mounting.[28] The concept was not entirely new, but Bailey became consumed with the idea that his design was appropriated by Porter for use in the Palomar project. When the Hale telescope was dedicated in 1949, it essentially resembled the one Bailey had built for Nagata but on a mammoth scale. Bailey never overcame the dejection he felt after receiving no acknowledgment for contributing to the design of the Hale telescope.[29]

Nagata's Comet was the first comet given a Japanese name.[30] The Issei emigre did become known in Japan. A photograph of him with his Zeiss telescope appeared in the September 1931 issue of *Tenkai* (The Heavens) published by the Oriental Astronomical Association.[31] He also authored an article titled 'Chikyū to suisei no shōtotsu' (Comet collision with Earth) published in the 25th April 1933, issue of the same journal.[32] The Oriental Astronomical Association was founded in Kyoto, Japan, in 1920. In 1932 the association named Nagata as the representative of its North American branch.[33]

At the time of his death, Masani Nagata was in the process of constructing a large telescope to be mounted on the roof of the science building at Brawley Junior College. He was personally grinding the 12½-inch lens for the telescope.[34] The project was never completed. The unfinished telescope sat neglected in the school's storeroom for years until janitors eventually discarded it.

Nagata's Comet has an elliptical orbit near 357 years.[35] It will once again be visible from Earth about the year 2288.

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28 *Anthony Cook, e-mail message to author, April 12, 2021. Nagata's telescope was one of three built by Bailey that Porter examined (Anthony Cook, e-mail message to author, July 2, 2021).*

29 Anthony Cook, e-mail message to editor, Discover Nikkei, April 8, 2021.

30 Yamasaki Masamitsu, an astronomer in Japan, discovered a comet in 1928 but it was named Crommelin's Comet. Interestingly, Japan led the world in comet discoveries from the 1960s to the 1990s, including Comet Hyakutake (Anthony Cook, e-mail message to NHK World, May 7, 2021). Seki Tsutomu, one of Japan's greatest comet hunters mentioned Nagata, albeit in passing, in his blog, http://comet-seki.net/Gekijou/Gekijou10wa_en.html.

31 Kyoto University Research Information Repository, "007_Related Academic Societies/The heavens/Vol. 11 Vo. 125," Kyoto University, http://hdl.handle.net/2433/161712.

32 Kyoto University Research Information Repository, "007_Related Academic Societies/The heavens/Vol. 13 Vo. 145," Kyoto University, http://hdl.handle.net/2433/162352.

33 Los Angeles Kashū Mainichi, "Astronomical Society of Japan Opens Branch," June 4, 1932. Other foreign branches were located in Manchuria, Shanghai, Taiwan, and Brazil.

34 Minami.

35 Gary W. Kronk, Comets: A Descriptive Catalog (Hillside, New Jersey: Enslow Publishers, Inc., 1984), 125.

I wish to thank Anthony Cook, former Astronomical Observer of Griffith Observatory, for informing me of the connection between Nagata and the Hale telescope, providing background information on H. Page Bailey and Russell W. Porter, sharing other material, and reviewing my draft with an astronomer's eye.

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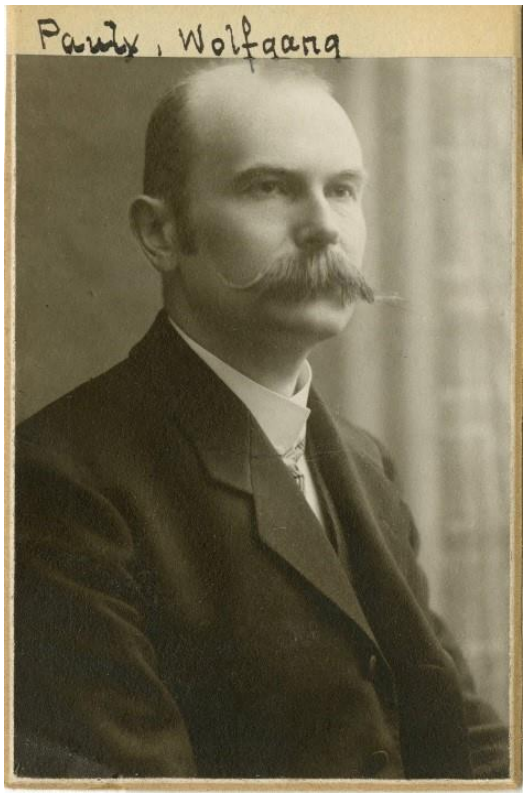
Tim Asamen

About the Author
Tim Asamen is the coordinator of the Japanese American Gallery, a permanent exhibit in the Imperial Valley Pioneers Museum. His grandparents, Zentaro and Eda Asamen, emigrated from Kami Ijuin-mura, Kagoshima Prefecture, in 1919 and settled in Westmorland, California, where Tim resides.

8 Wolfgang Pauly, The First Comet Discoverer of Romania
Mircea Pteancu

This is the story of Wolfgang Pauly, a gifted mathematician, creator of chess compositions and a keen amateur astronomer who discovered a comet (C/1898 L1) near Messier 4, which came to be credited to him and to Edwin Coddington.



Wolfgang Pauly 1876 - 1934

Wolfgang Pauly (August 15, 1876 - March 3, 1934): was born in Dohna, Germany, the son of Heinrich and Sabine (née Zillman). When he was four years old, in 1881, the family left Germany, as his father, who was a mining industrialist, lost his money in financial speculations and decided to seek his fortune in Bucharest, the capital city of Romania. Wolfgang, as a boy, studied at the Royal German College, and then at the University of Bucharest, showing a talent for mathematics and a decided interest in astronomy. He became a keen amateur observer. He was also a passionate chess player. [36]

In Bucharest, on 1898 June 14, Wolfgang Pauly discovered a comet whilst observing the globular star cluster M4 in the constellation of Scorpius. He used a 75mm aperture Reinfelder refractor telescope. The magnification used was ×28. At the time of the comet's discovery, Wolfgang was approaching the age of 22. His notes of the discovery of the comet, as recounted by himself, are quoted below. The quotation is taken from the article 'Weitere Nachrichten über den Cometen Coddington-Pauly/ Other news about Comet Coddington-Pauly' published in Astronomisches Nachrichten.

'*On June 14 [1898] at 22:30 I was observing with my Reinfelder refractor of 75mm aperture, at the magnification of 28x, the globular cluster GC 4183 (Messier 4) near Antares, when I noticed a small misty spot to the Southwest of it. Not having a complete catalogue of nebulae and not being able to determine if the object was a novelty, I made a sketch framed by the stars of the neighbouring area. On June 15, the sky was unfortunately overcast. Yesterday, on the 16th, from 10 pm to 11 pm, I found that the nebulous object in question could no longer be seen at the noted place, but, after a little searching, I found it to the southwest compared to the previous position.*

After 11 o'clock it was cloudy again but at 1 o'clock it cleared enough for me to do again observations. The nebulous object was visible again but with difficulty, and seemed

36 Provocarea unei moșteniri – Marian Stere , Gambit arhiSAH 9, 2001https://www.stere.ro/2001-m-stere-wolfgang-pauly-challenge-of-a-legacy-provocarea-unei-mosteniri-extras/

*to have moved a little to the Southwest. Based on the above, I considered that I was entitled to believe that the object in question was a comet, and I duly notified the Central Office by telegraph. * The comet appeared as a blurry foggy mass, being smaller and dimmer than the star cluster GC 4183 on the 14th, and on the 16th it appeared to have increased in brightness. '* [37]

The note (*) of the editors of the magazine, signed 'Kr.' (meaning probably Kreutz) states;

'*the telegram, which immediately revealed the identity of the discovered object with Comet Coddington, arrived here on June 17, at 8 o'clock. in the morning. Mister W. Pauly did not receive the telegrams of the Central Office and, as such, could not be informed of the comet's earlier discovery.'* [38]

The comet *had* been already discovered, by American astronomer, Edwin Foster Coddington of the Lick Observatory. This observatory is located at an altitude of 1300 metres on Mount Hamilton in the Diablo Range, California. It was the world's first high-altitude astronomical observatory to be permanently occupied. Coddington took a two-hour photograph of the area north of Antares on 1898 June 9, using the 152mm Crocker Photographic Telescope, but the plate was developed only on June 11. The comet was immediately noticed on the plate and confirmed in the evening of the same day and his position measured by Professor Hussey of the same observatory, using the 12-inch refractor. Comet C/1898 L1 (Coddington-Pauly) was only the third comet to be discovered photographically, according to the History of Astronomy. [39] From an analysis conducted in 1953 by Eric Sinding of the University of Copenhagen, Comet 1898 VII has an elliptical orbit and will remain in the Solar System. [40]

DISCOVERY-PLATE OF COMET CODDINGTON.
1898, June 9d 9h 30m to 11h 45m P. S. T.
[Comet is at intersection of arrows.]

In 1898 Wolfgang Pauly joined the Société Astronomique de France. He was introduced to the society by Mrs. Sylvie Flammarion and Bertaux, at the meeting of May 4, 1898, chaired by Vice President M. Fouche. Pauly was admitted at the June meeting and became member no. 2028. [41] Later, Pauly was working in an insurance company in which he subsequently advanced to the position of Vice President. Pauly continued to use his talent for mathematics to calculate astronomical ephemeris, for example for the asteroid 446 Aethernitas, for the variable star Mira Ceti or for the transit of Mercury over the

[37] Provocarea unei moșteniri – Marian Stere, Gambit arhiSAH 9, 2001https://www.stere.ro/2001-m-stere-wolfgang-pauly-challenge-of-a-legacy-provocarea-unei-mosteniri-extras/

[38] Weitere Nachrichten uber den Cometen Coddington-Pauly – "Astronomische Nachrichten", vol 146 Issue 20 p355, June 1898

[39] Comet C 1898 (Coddington) – E.F. Coddington, "Publications of the Astronomical Society of the Pacific" vol 10 no. 63 p.146 -148, August 1898

[40] The Future Orbit of Comet 1898 VII (Coddington-Pauly) – E. Sinding, " Dan.Mat.Fys.Medd. 27" no. 11 (1953)

[41] "Bulletin de la Société Astronomique de France" 1898, p.258 – SAF, Hotel des Société Savantes, Paris 1898

disk of the Sun on November 1, 1907 (Julian calendar) [42][43]

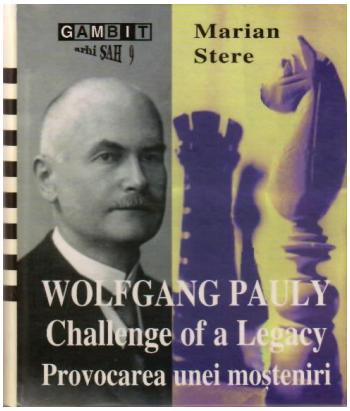
Comet.	Discoverer, and Date of Discovery.	Remarks.
I	PERRINE, . Mar. 20	Elliptic; with period of more than 300 years.
II	PERRINE, . Jan. 2	WINNECKE'S periodic comet; period, 5.8 years.
III	GRIGG, . . June 7	ENCKE'S periodic comet; period, 3.3 yrs. Independently discovered, June 11th, by TEBBUTT, from whom the first announcement of discovery was received.
IV	HUSSEY, . June 16	WOLF'S periodic comet; period, 6.8 yrs.
V	GIACOBINI, June 19	
VI	PERRINE, . June 14	
VII	CODDINGTON, June 11	By photography. Independently discovered visually by W. PAULY, at Bucharest, on June 14th.
VIII	CHASE, . Nov. 14	On meteor plates; announcement made Nov. 24th.
IX	PERRINE, . Sep. 13	Independently discovered by M. P. CHOFARDET, at Besançon, on Sept. 14th.
X	BROOKS, . Oct. 20	

January 9, 1899. R. G. AITKEN.

In 1907 Pauly joined the ''Flammarion'' Romanian Astronomical Society, founded in Bucharest in 1907 by Victor Anestin, with whom he worked closely. [44] He supported the fellow members of the ''Flammarion'' Romanian Astronomical Society by making his own observations and reporting those made with fellow members through his 135mm telescope (believed to be a Steinheil), [45] and by continuing to calculate astronomical ephemeris. [46]

During the First World War, because of his German nationality, the Romanian authorities interned Pauly in a camp, where he contracted an eye disease which then prevented him from further indulging his passion for astronomy. [47]. From now on, all his enthusiasm and creativity would go into the game of chess. In chess, Pauly's mathematical talent found a home. The Koninklijke Bibliotheek is a library in The Hague, Netherlands, that has a section dedicated to Wolfgang Pauly's life as a chess player and, in particular, as a creator of chess compositions. Here is what we learn about him as a chess player on the site of Koninklijke Bibliotheek:

'A chess problem consists of composing a chess position together with a creative solution to solve it. Along with Samuel Loyd (1841-1911) and William Shinkman (1847-1933), Wolfgang Pauly is considered one of the first three chess composers of their time. He composed about 2,500 chess problems during his lifetime. Meindert Niemeijer, one of the two founders of the Van der Linde-Niemeijeriana Library (himself a chess composer), was very impressed with Wolfgang Pauly. He corresponded with Pauly and sought inspiration from him. In 1948, Niemeijer published an anthology of Pauly's chess problems. In the introduction, he wrote of Pauly's archive, until then considered lost, 'maybe the archive will appear someday, but maybe it's lost forever.' [48]



The cover of the book "Wolfgang Pauly Challenge of a Legacy", M. Stere, 2001.

The latter prediction is very close to what really happened. In the late 1980s, Marian Stere found Pauly's archive in the attic of a building in Bucharest, scheduled for demolition to make room for Ceausescu's

[42] Ephemeride des Planeten (446) Aeternitas – W. Pauly, "Astronomische Nachrichten" Feb. 1901- p.297;
March 1902 – p.175; July 1903- p.323

[43] Trecerea planetei Mercur in dreptul Soarelui - "Orion" An I Nr. 2 Octombrie 1907 p. 25, SARF, București 1907

[44] Societatea astronomică din România - "Orion" An I Nr. 1 Septembrie 1907 p. 11, SARF, București 1907

[45] Noutăți astronomice - ''Orion' 'An I Nr.1 Septembrie 1907 p.16, SARF, București 1907

[46] Noua cometă - ''Orion" An II Nr.3, 1 Oct. 1908 p. 39-40, SARF, București 1908

[47] https://de.wikipedia.org/wiki/Wolfgang_Pauly

[48] https://www.kb.nl/en/wolfgang-pauly-archive

People's House. In 2001, after years of study, Stere published a comprehensive biography of Pauly. He then offered the archive for sale on the Internet. The Koninklijke Bibliotheek bought it for its chess collection in 2002. In the image above, we see the cover of Marian Stere's book about Wolfgang Pauly while that below we see an envelope with chess problems, bearing the name and address in Bucharest of a W. Pauly, which is in the possession of the Koninklijke Bibliotheek in The Hague, the Netherlands, since 2002.

Pauly co-authored, with Alain Campbell White, the chess book 'Asymmetry', published by Stroud Publishing in 1927. With Luigi Ceriani he collaborated in the study of the properties of orthopendular positions, the results being published in the magazine 'Italia Schacchistica' for April 1929. In chess, there is a 'Pauly Theme' [49], also called 'Perpetuum mobile', applicable in certain plays, to create blocking of an opponent.

Pauly's native penchant for mathematics naturally manifested itself in the realm of chess. Thus, he was particularly interested in the 'echo' as in recurring and symmetry problems. With Alain Campbell White, Pauly co-authored the books 'The White Rooks' (1910) and 'The Theory of Pawn Promotion' (1912). Problemist Meindert Niemeijer wrote a book about Pauly as the chess problemist and chess tournaments organiser entitled 'Zo sprak Wolfgang Pauly', a title that I would translate as 'So spoke Wolfgang Pauly'. [50]

Wolfgang Pauly died on March 3, 1934 from continuing complications of the illness that he had earlier contracted in the Romanian POW camp. He was and still is famous in the world of chess. According to Marian Stere, his passion for Astronomy was overshadowed only by his passion for chess. In his life, astronomy was his first love but in his adult years, all his energy and creativity manifested in chess, a wonderful intellectual kaleidoscope in which the infinite is reflected and which gave him the thrill of glimpsing the absolute, first sought among the stars of heaven.

Cornel Păcurar, editor of the 'Chess Problems. CA Bulletin' magazine issue 14 for July 2018 writes: '*This first-ever comet discovery from Romania was - strangely - forgotten, not recognized and not known until very recently.*' [51]

During the Marxist dictatorship, access to the archives was drastically limited, so we are less surprised that the comet he discovered, and indeed the man himself, are missing from the seminal textbook 'Moments and Figures of the History of Romanian Astronomy' by I.M. Ştefan and V. Ionescu Vlăsceanu. But how can a person so preoccupied with the progress of

[49] The theme of Pauli (Eng. Pauly theme), in a chess composition is an extended block task with twin positions in which the first move to solve one problem leads to the initial position of the other task and vice versa (perpetuum mobile, lat. Perpetuum mobile). Named after the famous Romanian chess composer Wolfgang Pauli (editor's note).

[50] https://it.wikipedia.org/wiki/Wolfgang_Pauly

[51] Pauly's Comet – Cornel Păcurar, ChessProblems.ca Bulletin, issue 14 (July 2014) p. 699

Romanian Astronomy, as is said to have been Nicolae Coculescu, the Director of the newly completed observatory of Bucharest, completely forget about Pauly? The ten-year interval between the comet discovery by Pauly and the subsequent establishment of the astronomical observatory of Bucharest, always suffering from a shortage of qualified staff, would have been too high a figure for the doctor in mathematics Coculescu? The answer can be only one: it was not about forgetting but about deliberate ignoring. For political reasons the less said the better.

In my research of Romanian astronomical literature, I found only two references to Wolfgang Pauly and his comet. The first mention is in the book 'Asteroids and Comets' by Victor Nadolschi, see Table III Chronological list of comet discoveries, p. 357, p. 276. [52] The second mention appears in an article by Dimitrie and Maria Olenici from the Planetarium of Suceava, an unpublished document, written around 2012. They were planning an exhibition of their institution. Their source on the subject originated from Cornel Păcurar. [53]

Life hit hard for Pauly when a disease severely affected his vision, taking him away forever from the much-loved world of the stars. But the loss to astronomy was the gain of chess. Let's break the wall of silence, forgetfulness and injustice of the past by remembering Wolfgang Pauly as the first astronomer in Romania who, in a brutally shortened period, discovered a comet. It was an achievement that, in more than a century, proved to be so difficult to repeat, either by professional or amateur astronomers of Romania. [54]

Mircea Pteancu

[52] Asteroizi și comete – Victor Nadolschi, Editura Albatros, 1971, pag. 276, poz. 357

[53] Pagini din istoria astronomiei românesti- Cornel Păcurar apud Dimitrie Olenici, Maria Olenici, "Plan tematic pentru expoziția de bază de la Planetariul din Suceava", "Comete cu nume de romani", p.9, Suceava, cca. 2012

[54] Românii și stelele în La Belle Epoque - Mircea Pteancu, p 37-55 see volume Marc Frîncu (editor) " Lucrările celei de a Treia Sesiuni Naționale de Comunicări Științifice a Societății Române pentru Astronomie Culturală", Editura Eurobit, 2020 https://www.academia.edu/44153135/Conferin%C8%9Ba_SRPAC_2019

9 Did 1P/ Halley have an outburst in 990 AD? Piero Sicoli and Roberto Gorelli

While examining old far eastern cometary records, Roberto Gorelli (Rome) found that observations reported for February 990 AD in the Chinese texts *Wénxiàn Tōngkǎo* (Comprehensive Investigations based on Literary and Documentary Sources) compiled between the late 13th and early 14th century by Mă Duānlín (1254 - c. 1324) and *Sòng Shǐ* or History of Song (c. 1345) could refer to 1P/Halley, five months after its perihelion passage which occurred on 989 September 5. Since the comet, on the date of the observations, should have been of total magnitude about 10 the only explanation that could confirm this hypothesis is that Halley's comet had an outburst that increased its brightness by 6 magnitudes or more. Such a 'star' could fit with 1P/Halley but owing too poor positional data available it cannot be excluded that could be another object. The last passage of Halley's Comet during the first millennium has been well documented in the Eastern, Middle Eastern and European chronicles. According to the Chinese, it began to be visible from 989 AD August 12th, between Gemini and Auriga. At first visible in the morning sky, it then moved into the evening sky passing from the Coma Berenices to Boötes and finally it disappeared, around mid-September, in Virgo (Ho 1962: 181; Kronk 1999: 165). Although not one of Halley's most spectacular returns, the comet may have reached negative magnitude around mid-August.

Observational records in 990 AD

According to the Chinese texts mentioned above on 990AD Feb 2, a guest star appeared at *Zhen* or *Chen* (28th Lunar Mansion) and it travelled in retrograde motion for 70 days until it reached *Zhang* or *Chang* (26th Lunar Mansion) where it disappeared after traversing 40 *du* (1 du = about 1 degree). A translation of the *Song shi* was made by Ho (1962: 181), and more recently by Pankenier et al. (2008: 114) as follows:

> *'AD 990 Feb 2. 1st year of the Chunhua reign period of Emperor Taizong of the Song Dynasty, 1st month day xinsi [18]; a guest star emerged in lunar mansion Zhen (LM28) [Carriage Box, Gamma CrV, 4 stars] and travelled retrograde to reach Zhang (LM26) [Spread, v^1 Hya, 6 stars] in 70 days, traversing some 40 du before disappearing.*

Almost the same of Mă Duānlín's text (Biot 1843: 66)

'990AD, 2 février (période Chun-hoa, 1re année, 1re lune, jour Sin-sse), une étoile extraordinaire parut dans la constellation ou division Tchin (déterm. Gamma Corbeau): elle rétrograda jusqu'à la constellation Tchang (déterm. v^1 Hydre, et χ, υ, φ). En 70 jours elle parcourut 40 degrés, puis on ne la vit plus'.

Here the term retrograde must be interpreted in the sense that the object was moving east to west, in reverse order of the lunar lodges (D.W. Pankenier, pers. comm. 30 June 2021). Among western and middle-eastern countries the only record reporting the year 990 AD is the *Chronicon* of Romualdus Salernitanus (Romuald Guarna), written in XII Century (Muratori 1725: col. 164)

'In the year 990, a bright star appeared on the northern side with a tail long 'one passus' facing south. A few days later it appeared again in the western sky with a light that tended to the east. And not many days later there was a violent earthquake that caused many houses to collapse in Benevento and Capua, killing many people and also in the city of Ariano many churches were destroyed'.

Romuald anyway certainly mixed up the year since the description of this apparition is clearly to refer to Halley's comet in the

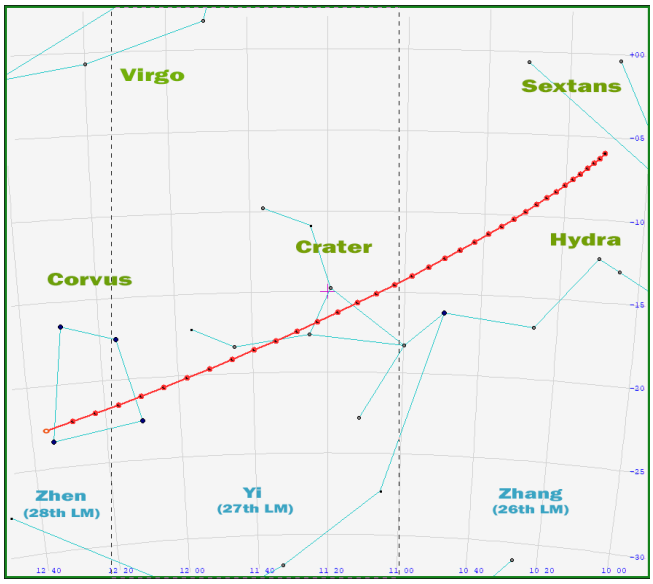
period 989 AD August - September. The earthquake mentioned that hit Benevento, Capua, and the town of Ariano Irpino in southern Italy, is elsewhere recorded as 989 AD October 25th.

Data on the possible outburst in 990 AD

Using the orbital elements computed by Yeomans and Kiang (1981: 643), in fig. 1 is shown the path of 1P/ Halley in 70 days, starting from 990 AD February 2nd. In this period the comet, in agreement with Chinese statement, crossed about 37 degrees of sky. Unfortunately, these texts, speaking of lunar lodges do not provide a specific asterism where this 'star' was located. The 28 lunar lodges (*xiu*), distributed along the equator, are represented by determinative stars, in this case are: 28th *γ Crv*, 27th *α Crt*, and 26th υ^1 *Hya*. We must consider that each position, within the lunar lodge, on one hand provides an approximation of its right ascension and on the other may be included in a large area in declination, distributed north and south of the determinative star. Notwithstanding the rough positions available, one element that may support the outburst theory could be found in the terminology adopted by the Chinese. In fact, the term *kè xīng* 客星 (guest star) instead of *huìxīng* 彗星 (broom star = comet with tail) seems to suggest the observation of a star like moving object.

Conclusion

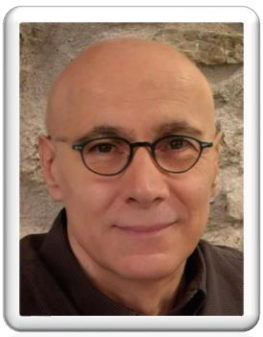
A possible outburst in Halley's comet is certainly not an uncommon phenomenon if we consider that in the last three returns there have been at least two outbursts. The first one at 1.44 AU, in late 1836 January, ten weeks after its 1835 perihelion (Sekanina 2008: 63-74). The second, in the last return, was detected on February 1991, exactly 5 years after its 1986 perihelion passage when the comet was 14.3 AU from the Sun (Meech 1991: 173; Hughes 1991: 26-29; Sekanina et al. 1992: 367-386). During the outburst, probably occurred on Dec. 1990, the comet increased its brightness of more than 5 magnitudes (Prialnik and Bar-Nun; L9-12).



Path of Comet 1P/ Halley from 990 Feb. 2, (blank circle) to Apr. 13 [step 2 days] according to Yeomans and Kiang's (1981: 643) orbital elements. Drawn using Osservatorio Sormano software Mappa2W (v5.7).

Acknowledgement

We thank Prof. David W. Pankenier (United States) and Augusto Testa (Italy) for their kind support.



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References:

Biot, E.C., Des Étoiles extraordinaires observées en Chine depuis le temps anciens jusqu'à l'an 1203 de notre ère, Additions a la Connaissance de Temps pour 1846, Paris, 1843, p. 66

Ho P.Y., Ancient and medieval observations of comets and novae in Chinese source, Vistas in Astronomy, Vol. 5, 1962, p. 181

Hughes D.W., Comet Halley's outburst, Monthly Notices of the Royal Astronomical Society, June 1991, 251(1): 26P-29

Kronk, G., Cometography, Vol. 1, Cambridge University Press, New York, 1999, p. 165

Meech K.J., Outburst of Comet Halley at 14.3 AU, NASA, Washington, Reports of Planetary Astronomy, Oct. 1991

Pankenier D.W., Xu Z.T., Jiang Y.T., Archaeoastronomy in East Asia: Historical Observational Records of Comets and Meteor Showers from China, Japan, and Korea, Cambria Press, New York, 2008, p.114

Prialnik D., Bar-Nun A., Crystallization of amorphous ice as the cause of comet P/Halley's outburst at 14 AU, Astron. Astrophys. 258, L9-12

Romualdus Salernitanus, Chronicon in Rerum Italicarum Scriptores, edited by L. A. Muratori, Tomo VII, Milano, 1723-1751

Sekanina et al., Major outburst of periodic Comet Halley at a heliocentric distance of 14 AU, Astron. & Astrophys. 263, 1992, p. 367-386

Sekanina Z., On a Forgotten 1836 Explosion from Halley's Comet, Reminiscent of 17P/Holmes' Outbursts, ICQ 30, Apr. 2008, p. 63-74

Yeomans D. K., Kiang T., The long-term motion of comet Halley, Monthly Notices of the Royal Astronomical Society, Vol. 197, Nov. 1981, p. 643

10 From Martin Lunn's Podcast Series - Great Comets Martin Lunn

Caesar's Comet (C/-43 K1)

Welcome to this transcript taken from a series of podcasts in which I talk about some of the great comets seen in the sky over the last two thousand years.

I'm going to look at comets in date order going back as far as is realistically possible, so I'm talking about objects classed as bright or great comets, and I'll start off in 44 BCE. By the way, BCE is a religiously neutral acronym which has been used for hundreds of years. It describes the same time period as BC, but means 'before the common era'. Many scientists prefer it, whether religious or not, because the date of the birth of Christ has been proved to be *before* the year zero, and therefore BC is seen as inaccurate.

Here's a departure into literature for you - 'Friends, Romans, countrymen, lend me your ears' - Shakespeare of course, from Julius Caesar; Mark Antony's speech at Caesar's funeral. Why am I mentioning this? Well, in 44 BCE Julius Caesar was assassinated by a group of Roman Senators. He was killed on the 15th of March. The time around the middle of the month was known as the 'ides', hence Shakespeare's oft-quoted soothsayer tells Caesar to 'beware the ides of March'.

Shakespeare probably knew about the comet and decided to use it in his play for dramatic effect, so on the morning of the murder, after a bad dream and a series of portents, Caesar's wife Calpurnia, trying to persuade him to stay at home, tells him:

'*When beggars die, there are no comets seen;*
The heavens themselves blaze forth the death of princes.'

In real life, the bright comet which was named 'Caesar's comet' appeared in May 44 BCE, and some Romans believed it to be the soul of the murdered Caesar. Comets have always been associated with disaster – death, drought, floods; so, for a bright comet to appear just after the death of Caesar must really have reinforced the belief that the astrologers knew what they were talking about.

Getting back to astronomy, the earliest report of Caesar's comet comes from China and is from 44 BCE May 18th. Many of our ancient observations of astronomical events come from Chinese records, which are pretty accurate. They were made for astrological reasons, to impress the Emperor with facts, but although the recording is *astrological*, the events they were recording were *astronomical*, so there is a bountiful record of information to tap into.

The comet itself was really very bright, and possibly appeared almost as bright as the planet Venus. Venus, in magnitude terms can reach about mag. - 4.5, which means nothing to most people, but if you've ever seen Venus you'll know it's that really bright white dot in the evening sky, or in the morning if you see it before the sun rises. The comet itself had a tail about 10 degrees long – and you may be thinking,

what the deuce is 10 degrees in the sky? Well, there are some simple ways of working it out, and one way is to use your hand. If you hold your arm at full length and look up into the sky, making a fist with your hand, then the width of your clenched fist covers an area of about 10 degrees. It is kind of crazy in these high-tech days that we can still use very basic methods to understand a complicated point, but I love simple ways.

Now, according to the Chinese records, the comet was visible until the June 16th, so we are talking about something that was visible for about a month, which must have made a huge impression on people looking into the sky at the time.

The Chinese describe comets as 'hairy stars' simply because if you look at a comet it is not a point source; if you look at a star it appears as a point in the sky, but if you look at pictures of comets you will see the wonderful giant tails they can have. And yes, that's what a massive wonderful giant comet can look like, but often comets look much smaller than that; sometimes just like a fuzzy patch in the sky, hence the Chinese description 'hairy star'.

You might be wondering why, if the Chinese saw the comet, it wasn't seen in the West if it was as bright as all that? This is often a mystery, but going back a couple of thousand years, the Chinese records are extensive, but the European ones are poor by comparison. We cannot conclude that the comet wasn't seen and recorded in the west because it could just be that the records haven't survived.

Comets have a complicated elliptical orbit, so when modern astronomers try to plot a path for this comet, working out how long it would take it to reach the outermost parts of the solar system and come back again is difficult. There have been tentative suggestions it may have had an orbital period of over 550 years, but it's a bit like holding a wet finger to the wind to determine which way it is blowing. It's almost impossible to say whether or not the comet has been back again since 44 BCE.

The comet clearly made an impression in Rome. Twenty years after the death of Caesar the Emperor Augustus had a coin minted which showed a comet on the reverse side, and during Roman times the comet was sometimes referred to a 'Caesar's star'.

Denar with the Sidus Iulium CC BY-SA 3.0

With a comet recorded so long ago it is hardly surprising we have little hard evidence to go on; we just have a small number of reports from the ancient Chinese astronomers and nothing from Europe to back these up, so that's all I can tell you about the comet of 44 BCE, Caesar's comet.

Comet 1106 (X/1106 C1)

Next, I'm going to take you back to the year 1106 CE. At that time, the sight of a spectacular comet could have a big psychological impact on people; back to Medieval times comets were often seen as harbingers of doom. They could sometimes be seen as bringers of good luck, but certainly for astrologers, the appearance of a comet meant that something was going to happen, and of course, in those days something always was going to happen; the death of a king, the birth of a future king, a battle to be won or lost, a flood or a drought. Astrologers were always ready to capitalise on seeing a comet.

A comet is a dirty snowball, or an icy dirtball, depending on which expert you want to listen to. When this dirty snowball gets close to the Sun of course it heats up and as it heats up the ice and dust is blown off and burnt off, producing a wonderful tail in the sky.

Early Chinese Astrologers…astronomers.

The earliest reports we have of the comet of 1106 are from February of that year. Interestingly enough it is not only reported by Japanese, Korean and Chinese astronomers, whose observations we tend to rely on, but it is also noted by European astronomers. This is interesting because in early medieval times there are not many references to events in the night sky from European sources. One possible reason for this of course is that at that time the most powerful institutions in Europe were the monasteries. The monasteries adhered to the belief that the heavens were perfect and therefore unchanging, so a comet appearing in the sky or a supernova star blowing up and suddenly being visible where nothing had been seen before, did not fit their view of the universe, and this may partly explain why there are so few peer reports of this sort of event. However, in the case of Comet 1106, we do have a report from Belgian historian Sigebertus Gemblacensis in his *Chronica*, written in 1111. He reports that on 1106 February 2 a star appeared in the daytime, about a cubit away from the sun.

Now, a cubit is approximately a degree, and you can get an idea of this distance with some very low-tech science. Hold your arm out, make a fist at arm's length and stick out your index finger. The width of that finger is about one degree.

Some of the reports of this particular comet indicate the length of the tail was about 100 degrees, which is absolutely enormous. To give you some idea of just how long 100 degrees is, let's go low-tech again. Take your hand and hold it at arm's length. If you stretch your little finger and your thumb away from each other and look up towards your hand and on into the sky, the strip of sky between your finger and thumb will be very roughly 25 degrees. Multiply that distance four times and you have approximately 100 degrees. This will give you some idea of just how huge this comet was, if we can believe what the records are telling us.

Early Chinese comet representations

This comet was seen very close to the sun, and clearly it was an impressive sight. The comet was seen in the south-west in the general vicinity of the constellation of Pisces on the 7th February, and by the 9th it had nudged into the constellation of Cetus the Whale.

Working out just how many days this comet was visible can be quite difficult. The European texts tell us it could have been any time from 15 to 70 days, although most of the references suggest it was between 25 and 30-days, which is still a respectable time for a comet to be visible.

Comet 1106 is a spectacular comet, so it has attracted the attention of modern-day astronomers, who like to try to work out the length of a comet's orbit, or in other words, how long it will take for it to reappear. One suggestion is that it could actually be the great comet of 1680 although evidence for this is quite slim because there is so little real evidence to use in the calculation. Having said that, some astronomers still believe it could be what's known as a Kreutz or 'sun-grazing' comet.

Flowers of the Sky Comet 1007

Sun-grazing comets are believed to be fragments of one very large comet which broke up hundreds of years ago as it passed close to the Sun, and are named after the German astronomer Heinrich Kreutz. He first demonstrated that these comets were actually all related. Some astronomers, basing observations on more modern comets, for example, the great comet of 1882 or comet Ikeya-Seki of 1965, think they could in theory be from the same family as the comet of 1106. We have the orbital measurements of the more modern comets, and even though we don't have those measurements for the comet of 1106, the suspicion is that it is one of the group of Kreutz comets.

When astronomers today use the sparse information, they have about the orbit of comet 1106 it seems to come back to the inner part of the solar system sometime in 1114 or 1116. Although this is not quite the same as 1106, given the difficulty of accurately working out these cometary parameters, it might be close enough. Even today shortly after a bright comet appears you may hear astronomers saying it is predicted to have an orbital period of 500 years, 700 years, 900 years, or even 2000 years. As it is so difficult to be precise it is quite possible that comet 1106 is related to comet Ikeya-Seki.

Time will tell, but assuming the calculations are correct comet 1106 should come around again in 790 or 800 years, so our generation will never know.

The Great Comet of 1264 (C/1264 N1)

In this third part of my series on great comets I will be travelling back about 750 years to take a look at the great comet of 1264. When we look at the records of bright comets like this one, we do have to remember that their orbits, or the periods of time they take to travel around the Sun, are very long – comet's orbits are referred to by astronomers not as circular but as elliptical, or egg-shaped. This means it can take hundreds or even thousands of years for a comet to return and be visible in the night sky again. I only mention this now because I'm going to talk about some predictions made by astronomers about the comet of 1264, but you will have to read on for that.

This particular comet was first seen on 1264 July 17 in the constellation of Hydra the Water Snake, which is the largest constellation in the sky. We see Hydra in the spring skies from Britain, but it is always very low down. The one reasonably bright star in Hydra is Alphard or 'The Solitary One'. As all the other stars in Hydra are fainter than Alphard, and with the constellation's position low in the sky, if there is any haze or moonlight they just

can't be seen. If you were further south, say in the Mediterranean, with a good dark sky, Hydra would be much easier to see.

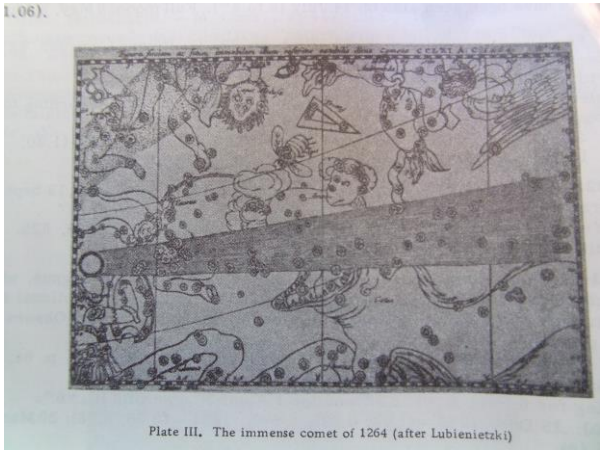


Plate III. The immense comet of 1264 (after Lubienietzki)

As I said, Hydra is a spring constellation so by the time we reach July it will be very low down in the south west. Back in 1264 by the 31st July, a few days after it was first spotted, the comet was seen to be moving northwards, getting a little higher in the sky, and visible in the constellation of Cancer the Crab. By this time the comet was seen not to have just one tail, but several.

With all the modern equipment that is available to astronomers today, it is not unusual to see more than one tail. I am sure that many people reading this will have seen incredible photographs taken by astronomers showing multi tailed comets. Here though, I am talking about a comet seen in 1264, and the astronomers, prior to the invention of the telescope, were able to see an incredible five tails. It must have been a fantastic sight, very low in the summer sky and something like a fan in shape.

By 1264 August 2 the comet had moved slightly west into the constellation of Gemini the Twins. It was then visible in the west until September when it moved behind the sun and changed from an early evening object to an early morning object. The early morning sky in 1264 September was about to become a sight of amazing beauty.

Nothing could have prepared the people for what they were about to see. Just imagine looking into the sky as the Sun rises and seeing a comet with a tail around 100 degrees long. This would mean that the tail of the comet would be directly over your head while the head of the comet was still below the horizon. What an absolutely massive comet this was turning out to be! I can only imagine that the astrologers of the day must have been beside themselves with predictions about what the future might hold.

Imagine going out in the 21st century and photographing a comet of this size. For a start you would need a pretty wide-angle lens! It would certainly be one of the astronomical sights of the century.

European records from this time are generally very poor so astronomers undertaking historical research often have to resort to the wonderful and detailed astronomical records from China, Japan and Korea. They record comets as 'Hairy Stars' because when comets are first seen, they are not points of light; they look like 'fuzzy' patches.

With comet 1264 astronomers have the luxury of having observations made from both China and Europe. This comet was visible for such a long period of time that astronomers were able to plot its path across the night sky.

Astronomers who saw a comet in 1566 speculated that they were seeing the return of the great comet of 1264. They predicted that this comet would reappear in 1848. There were searches but alas, no comet was seen. The conclusion was that the comets of 1566 and 1264 were not related.

We must not pour scorn on the mathematical skills of the astronomers of the 1560s. The methods they used to calculate orbits would have been exactly the same as those Edmund Halley used when he saw a comet in 1682 and, looking back at the orbits of the comets of 1531 and 1607, used maths to predict that it would re-appear in 1759. He was right of course, so although he did not discover his comet, his prediction meant that it would be named after him.

Getting back to the comet of 1264, I mentioned astrologers earlier on, who interpreted events in the sky and related them to the affairs of people. Astrology was powerful at this time, and astrologers were respected. Comets were often seen as the bringers of death, doom and destruction - the three 'D's.

We are told that when the comet of 1264 was first seen, the Pope, Urban IV, fell ill, and on the final day that the comet was visible, which is given as October 3rd 1264, he died. I cannot confirm this as fact, but this is what was reported at the time.

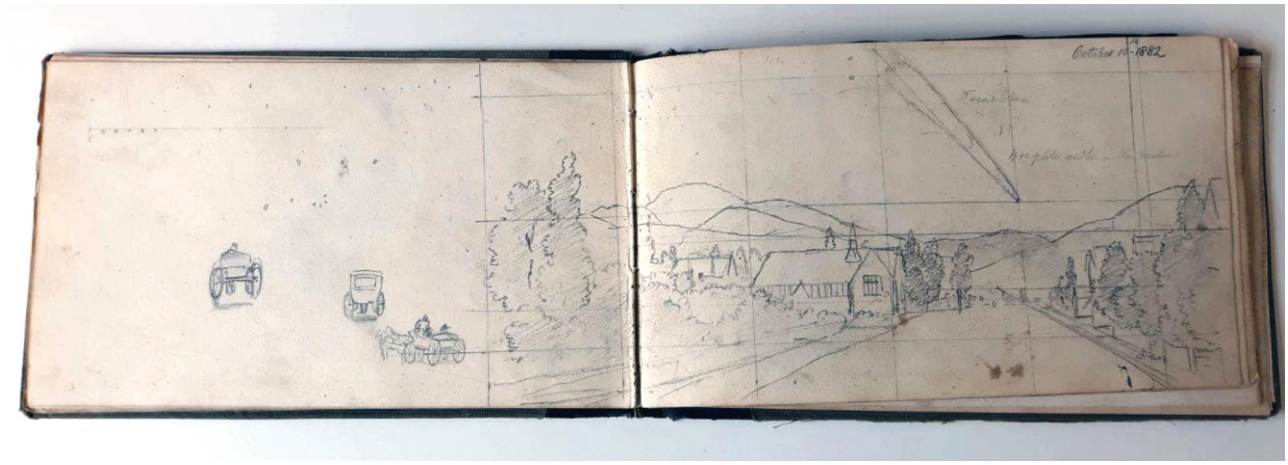
Another great story; another great comet!

Martin Lunn

Martin's original podcasts can be heard at www.theramblingastronomer.co.uk

11 The Great Comet of 1882 - A Kreutz Sungrazer sketched by Emily C. Harris

Denis Buczynski



The famous landscape artist Emily C Harris 1836 March 28 – 1925 August 5 sketched the view she had of this comet from her home in New Zealand.

She was one of New Zealand's first professional women painters, born in Plymouth, Devon, England but moved to New Zealand in about 1837. Her father was a competent artist and supported his daughter's artistic development. Harris spent most of her life teaching and although clearly a gifted artist she never made enough money from sales to devote herself entirely to her art.

She exhibited in New Zealand and abroad and was awarded a first degree of merit at the Sydney International Exhibition, and several other awards and prizes over the years.

Harris was mainly a painter of botanical subjects. This sketch, by a non-astronomer, shows the dimensions of the comet seen in the sky. She describes the scene as:

'October 10 1882. Street scene with a comet in the sky. Church on left hand side and mountains in background. Colour notes in sky next to comet: [fossil?] blue and four words: bright as the [nucleus?].'

Maik Mayer (comet-ml) said "I came across this by accident: Drawing of Kreutz group #comet C/1882 R1, ... by New Zealand based artist Emily C. Harris in her 'Edwin Sketchbook 2'.

THE COMET VISIBLE DURING THE DAY.

[BY TELEGRAPH.—PRESS ASSOCIATION.]

WELLINGTON, Tuesday.

THE comet was clearly visible at 2 o'clock to-day, and created considerable excitement. It was a most brilliant object, even to the naked eye, when seen from the shadow of any building shutting off the sun. Dr. Hector states that it was within five degrees of the sun, and rapidly approaching it. He has observed it nightly since the 11th instant, and expects that it will get round the sun to-morrow, when the sun also crosses the equator, being in the equinox (Libra). After getting round the sun, its course will be towards the northern hemisphere, and it will not be visible here after sunset. Dr. Hector says the head strongly resembles the engraving of Donati's Comet. The tail is short, but very fanlike.

DUNEDIN, Tuesday.

The comet was plainly visible all the forenoon here to-day.

Mr. Arthur Beaverley writes as follows to the Evening Star to-night concerning the comet:—"The great comet was in its perihelion last night, and is now receding from the sun in nearly the same direction that it approached him. It went very near the sun at its perihelion, and was twice in conjunction with him within a few hours, the eastern portions of its orbit being described in the interval. It approached its perihelion on the remote side of the sun, and is receding from it on the near side, hence it is much nearer the earth than before. At sunrise to-day it was 4 degrees west from the sun, and at 10 a.m. it was a little more than 4½ degrees west. It is exceedingly brilliant, and will probably be distinctly visible to the naked eye in the daytime for several days."

New Zealand Herald, Issue 6503, 20 September 1882, Page 5

Metrosideros tomentosa (pohutukawa) by Emily Harris

Other examples of her landscape and nature drawing and paintings, such as that above, can be seen at this link:

https://emilycummingharris.blogs.auckland.ac.nz/artandwriting/after-the-war/

Denis Buczynski
Comet Section, Secretary

12 Editor's Whimsy – The Book of Miracles Janice McClean

The Book of Miracles original Manuscript in the Mickey Cartin Private Collection
Folio 90 The Tiber Monster – translation – In A.D. 1496 in the month of January at the time the Tiber burst its banks high and wide near Rome: what wondrous creature appeared found dead where the raging and the might of the Tiber's waters had subsided, and was in this shape and form, as it is painted here.

Those of you with good memories may have noticed that last year the Comet's Tale frontispiece lead with an image I had found from a 16th manuscript called the Book of Miracles. It was an image of a comet observed in 1007 A.D. and which in this edition of the Comet's Tale is also referenced by Martin Lunn (see Page 45). Like all these things, when looking for images for the Comet's Tale or the BAA monthly newsletter, it is easy to get led down internet rabbit holes and a whole afternoon can go by when the garden gets neglected and chores ignored. Putting those hours to some practical use here is some more about the manuscript from which that image was taken, and presented in the hope it may interest you as readers, after all the serious stuff.

The surviving manuscript, made up of 123 folios, was a German renaissance-period series of illustrations created around 1550, depicting miraculous phenomena, freaks of nature and natural disasters. It also includes one of the largest collections of early comet illustrations of which there are around 26[55]. There are illustrations of meteor showers, eclipses, blood red moons (i.e. lunar eclipses), several parhelia and the occasional fiery shaft.

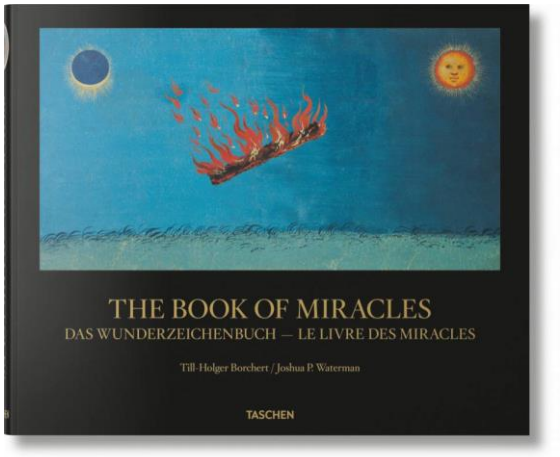
[55] The book is contemporary with the illustrated 'Treatise on Comets' produced circa 1587 in Flanders and housed in the Warburg Institute in London and also a copy believed an identical treatise by the same author University of Kassel and which was one of few books to survive an allied air raid in September 1941.

'In the year 1456 it rained real blood in Rome and in the region of Liguria it rained flesh which at that time was wondrous, even as it is painted here'

Books of portents were not a recent invention of the Renaissance, they date back to classical antiquity and this one exists beside a recently republished copy of Julius Obsequens's work, first written as a 'Book of Prodigies' in the fourth century. Another suspected influence was the 'Chronicle of Prodigies and Portents' by Conrad Lycosthenes. It is not known who commissioned the book/manuscript, or who was its original patron. Research into the watermarks and records of the last known disasters recorded within it, do help to date it, but has no introduction, no dedication or even a list of contents, and some pages have been lost over time.

The manuscript, originally known as the 'Wunderzeichenbuch' or 'Augsburg Book of Miraculous Signs', is currently owned by an American private collector with a particular interest in the Renaissance period, Mickey Cartin.

As I researched the story of the original manuscript of the Book of Miracles I found that it had been fairly recently re-discovered and had reprinted by Taschen in 2013 and I am grateful to the scholarship of the two experts who wrote explanatory text to explain the manuscript.



This edition has been researched and presented by Till-Holger Borchert and Joshua P Waterman. Borchert is currently the Scientific Director of the Bruges Museum in Belgium in Europe, and has written many books about the art produced in this period in art and biographies of artists of the time; an expert in his field. 'I remember that when I first saw the images in the flesh,' Till-Holger Borchert told BBC Culture in an interview soon after publication., 'I was awestruck by the very touching combination of simplicity and beauty in systematically depicting catastrophes of all times.'[56]

Joshua P Waterman holds an art history doctorate from Princeton University, and is currently a research associate at the Germanisches Nationalmuseum in Nuremberg, German. 'These stunningly vivid pictures must certainly have imparted to those readers first seeing them a sense of awe at the progression of disasters and wonders from the beginning of history to the end of time, as then understood'. [57] Both have contributed essays at the beginning of the Taschen

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[56] https://www.bbc.com/culture/article/20170421-the-eerie-historical-visions-that-predict-the-apocalypse

[57] https://www.bbc.com/culture/article/20170421-the-eerie-historical-visions-that-predict-the-apocalypse

publication which puts context and background to the collection.

The time span of the illustrations produced in the manuscript dates from the mythological and biblical stories of the creation of the world and stories of the Biblical Old Testament to the time of its production. It mentions disasters and natural events that were recorded over the centuries and would be known to contemporary readers. It finishes with a good dose of dire warnings of the consequences of leading a dissolute life, based on the Book of Revelations from the New Testament. In between are the many celestial phenomena. The growth of Christianity did nothing to stem identification of these portents as signs from a deity having a bad day and taking it out on the humans below, and the period of the Renaissance saw them become a staple from about 1500 onwards. 'A significant factor contributing to the concern for wonders was the growing contemporary interest in astrological prophecy. Authors such as Johannes Virdung von Habfurt (1463-1538/9) published yearly predictions of world affairs based on sightings of comets and conjunctions of celestial bodies.' [58]

The illustrations were painted originally in gouache and watercolour and often they referenced already well-known printed woodcuts and leaflets from the earliest days of mass printing; references or straight copies of contemporary engravings or other art works with which the audience would have been familiar. They were accompanied by an explanatory text, in German, below.

Waterman says, '... (This text) is important for what it reveals about the balance of priority given to text and image in the Augsburg manuscript. Originally, this (folio 110) was followed by another sheet, now detached (but repositioned in context), which treats the same event with the addition of bearded visages, daggers, spear-like streaks and flames in the surrounding night sky. [59]

Folio 110

The source was a 1528 pamphlet by the astrologer Peter Creutzer.

A comet sighting in 1527 was recorded by a well-known astrologer of the time Peter Creutzer, subsequently interpreted in the Book of Miracles manuscript with similar text.

The text overall makes the first illustration almost superfluous, and the illustration becomes secondary to the meaning in the text. The reader will be struck first by the vivid images.

[58] Miraculous Signs from Antiquity to the Renaissance, Waterman, The Book of Miracles, p10, Published Taschen 2013 ISBN 978-3-8365-6414-4

[59] Miraculous Signs from Antiquity to the Renaissance, Waterman, in The Book of Miracles, p38, Published Taschen 2013

Folio 111Dates recorded in the manuscript are sometimes inaccurate or a misinterpretation of records using other calendars. It is interesting to match the comets in the manuscripts with current contemporary records.

And what of the place where the original was produced? It is generally agreed that is was in the Swabian Imperial Free City of Augsburg. Swabia is one of the seven administrative regions of Bavaria in southern Germany. It is one of present-day Germany's oldest cities founded in 15 B.C by the Romans, then called Augusta Vindelicorum and remined a free imperial city from 1276 – 1803.

The Market square in modern Augsburg - Wikipedia

It is noted for having some of the earliest social housing (built in 1513). The city played a key role in the reformation, with the Augsburg Confession being the primary confession of the Lutheran church in 1530. The Peace of Augsburg, signed in 1555, technically allowed states to choose Lutheranism or Roman Catholicism as the official confession of their state. As Martin Luther (1483-1546) had a less than optimistic outlook on life, and had a somewhat similar attitude to Catholicism as the late 'Reverend' Ian Paisley MP, there was nothing to beat a good portent of gloom and doom. Repent ye all.

Against this background the rise of the illustrated broadsheet, woodcuts and printed pamphlets as the Instagram of the day, together with a surge of interest in miraculous signs especially within the Protestant reformed religion, led to the general proliferation of these books and Nuremberg and Augsburg became centres of production. It was important that the images produced were strikingly vivid and lavish, to create awe and fear. Landscape orientation was used in the Augsburg manuscript, along with an explanatory text or headline was particularly fitting for illustrating comets and also for situating the cityscape, about to be devasted, below. Augsburg was a banking city and trade helped spread these media. Nothing has changed in the world; the bankers needed to know about floods and disasters and obviously had a strong interest in futures.[60]

Who made these extraordinary pictures? Borchert proposes some may have come from a well-known workshop of Hans Burgkmair the Younger (1500-1561). [61] Only 12 documented commissions of his remain in existence, together with a few sketches and drawings, but it is known that he continued his father's workshop with some success for several years. 'His subtle handling of gold and silver in the illustrations of jousting scenes (he has signed elsewhere) recalls the carefully

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[60] The publication of the Fugger Newspapers referenced in the Book of Miracles provided much content

[61] The Book of Miracles – Genesis style and meaning – Till-Holger Borchert p88 Essay in The Book of Miracles, Published Taschen 2013 where Burgkmair identifies himself in the text, the only passage written in the first person.

applied gold and silver highlights in the present manuscript's comet pictures.'[62] Another possible contributor, or at least, collaborator mentioned is Heinrich Vogtherr the Younger (1513 - 1568) also known to have set up his workshop in Augsburg. Some of his work hangs in the British Museum in London. Ultimately the work must be a collaboration of various artists and scribes, as can be seen by the different styles of writing and finer drawings, although the captions look to be entered by one scribe.

Some illustrations relied upon engravings already in circulation by Albrecht Dürer (1495-1528) or engravings by Lucas Cranach the Elder (1472-1553) who is also believed to have based some of his work on other earlier popular artists.

The detail in some of the images is surprisingly realistic. Borchert thinks, 'the illustrations of celestial apparitions are particularly fascinating for the modern viewer since the vividness and care with which they are depicted manifest an almost scientific interest that looks ahead to the future'[63]..a movement away from the fantastical towards the scientific. In the picture below the light is shown refracting through to the main sun.

Folio 26

No attempt was made at classification of the comets and sometimes comets and meteors/fiery shafts of light, are confusingly described in the captions.

The first comet to appear in the manuscript is dated as of A.D.595 which I believe may be number 361 listed by I. Hasegawa in his 1980 catalogue of Ancient and Naked-eye Comets, Vistas in Astronomy[64]

Folio 23

There are at least five illustrations of the appearance of Halley's comet, the first wrongly dated as 1184 but actually 684 A.D.

[62] The Book of Miracles – Genesis style and meaning – Till-Holger Borchert p92 Essay in The Book of Miracles, Published Taschen 2013

[63] The Book of Miracles – Genesis style and meaning – Till-Holger Borchert p64 Essay in The Book of Miracles, Published Taschen 2013

[64] Hasegawa I. (1980) Catalogue of Ancient and Naked-eye Comets, Vistas in Astronomy, vol 24 pp59-102 Lunar and Planetary Science.

Folio 50

Then one in 1456,

Folio 79

and then several in 1531,

Folio 120

Folio 121

Folio 122

Appendix of the Identity of the Comets illustrated.

I produce all the comet captions as they are translated, dated and described beneath their illustrations. Each illustration has a date inscribed below it but then in the caption wording the occasionally a correction is given. Some seem to correspond with objects listed in the IAU MPC website. The more experienced comet observers amongst you may be able to identify more.

Folio 23: A.D. 595 – In the year A.D. in the time of Mohammad, something wondrous and fearsome appeared. At that time a bright comet was seen over Constantinople for a whole year. (see illustration in main text above).

Folio 34: 1007 – In the year 1007 A.D. a wondrous comet appeared. It gave off fire

and flames in all directions. As it fell it was seen in Germany and Italy.

Folio 37: 1103 – In the year A.D.1103 on the Friday of the first week of Lent an unusual star appears in the evening. It appeared in the south and in the west. It was visible for twenty-five days and always at the same hour. From the south a great shaft of light moved towards it. After this on Maundy Thursday two moons were seen, one of them in the east.

Folio 46: 1173 – In the year A.D. 1173 a great brightness was seen, like a fiery shaft of light climbing up into the height of the firmament in all parts of Italy.

Folio 50: A.D 1184 (but in fact 684) – In the year 684 A.D. a comet appeared for three months. This was followed by such heavy rain, storms, wind and thunder as had never been heard before. And this element acted as if it wanted to destroy the city of Rome completely, and a great many livestock died in terrible ways. And people died from the lightening in the sky they saw. (see one of Halley's, reproduced in main text)

Folio 58: 1293 – In the year A.D. 1293 a notably large comet appeared for three months, rising in the east and climbing to the middle of the sky, with its rays in the west. And when Pope Urban died, it disappeared again. (This might possibly be an appearance of 153P/Ikeya-Zhang)

Folio 61: 1300 – In the year A.D. 1300 a fearful comet appeared in the sky. And this year on St Andrew's day, the ground was shaken by an earth quake so that many buildings collapsed. At this time, the first jubilee year was established by Pope Boniface VIII.

Folio 62: 1304 – In the year A.D.1304, three moons and a comet appeared - seen around midnight for three months, in the German lands and in Italy, just as it is painted here. (possibly as listed in the IAU MPC)

Folio 64: 1338 – (but in fact 1438) – In the year 1438 in the time of King Albrecht, Duke of Austria and son-in-law of Emperor Sigmund, a great darkening of the sun was seen in the daytime. And also, a great comet with a tail was seen in the city of Liege. This was followed by great bloodshed.

Folio 65: 1347 – In the year A.D. 1347 a comet appeared in Italy for two months. After this Emperor Louis IV, a Bavarian monarch died.

Folio 67: 1351 – In the year A.D.1351, in the month of December, a comet was seen in the sky around midnight. Afterwards heavy winds sprang up and a fiery shaft was seen to fall from the sky, which then presaged great disagreement between the pope and the emperor. (see as listed in IAU MPC)

Folio 74: 1401 – In the year A.D. 1401 a large comet with a peacock tail appeared in the sky over Germany. This was followed by a most severe plague in Swabia. (Could be mistaken for the Great Comet of 1402)

Folio 79: 1456 – In the year 1456, in the month of June, a comet appeared and within a year of that a yet bigger one, which looked really terrible, and was seen

in Germany, just as it is painted here. (see another depiction of Halley's comet reproduced in main text)

Folio 83: 1462: (in fact 962) - In the year A.D.962 a great and wonderful comet appeared in the sky in Italy. This was followed by a great famine, so that many people perished and were found dead in alleys. (Listed in IAU MPC)

Folio 92: 1506 – In the year 1506, a comet appeared for several nights and turned its tail towards Spain. In this year a lot of fruit grew and was completely destroyed by caterpillars or rats. This was followed with and nine years later in this country and in Italy by an earthquake, so great and violent that in Constantinople a great many buildings were knocked down and people perished. (Listed in IAU MPC)

Folio 100: 1519 - In the year 1519, on the 14th day after the death of His Serene Highness, the mighty Roman Emperor Maximilian, of glorious remembrance, this comet was seen over the city of Mainz for two whole days, so positioned in relation to the Rhine that the star pointed upstream and cross downstream.

Folio 101: 1519 – In the year after Christ, our Saviour, around the time of his birth, the comet drawn here was seen in the middle of the night near Krafnitz turned towards Strasbourg.

Folio 110: 1527 – In the year 1527, on the 11th October at four o'clock in the morning, this comet was seen in Westrich for five quarters of an hour and then is disappeared again. It was extremely long and yellowish red, like a diluted blood in colour. At the front the head was like a bent arm, as if it had a sword in its hand and was poised to start striking with it. And at the point of the sword there were three big stars and form the stars and form the stars there issued a cloud coloured stream, which was longer than the comet's tail, just as it is painted here. (see reproduced in main text)

Folio 111 1527 – In the year 1527 several streaks like long spears were seen next to the comet, with several faces and small swords in amongst them, all intermingled in a pale red colour. Between them could be seen several large flames that blazed very brightly and with a fiery light. And the faces with hair and beards the colour of grey clouds were seen here and there to be flickering through each other as fi they were lying in water that was flowing in rivulets of blood and as if everything was mixing up together, which looked so terrifying that many who saw it died. (see reproduced in main text)

Folio 120: 1531 – In the year 1531 on St Bartholomew's Day (24th August) a comet

was seen for some time in the sky every night in Strasbourg and in other places just as is painted here. (see reference to Halley's comet reproduced above.)

Folio 121: 1531- In the year 1531 four comets appeared in the sky opposite another, such that they could be seen in certain places in the Netherlands, just as they are painted here. (see reference to Halley's comet reproduced above.)

Folio 122: 1531- In the year 1531 a comet was seen in the Netherlands which showered fiery flames like a blacksmith making sparks from iron - quite fearsome to see, just as is painted here. (see reference to Halley's comet reproduced above.)

Folio 125: 1531 – Of the comet or comet' tale as it first appeared in certain of the High German districts around the 10th day of August and then for many nights – more than a lance in length (c.5M) one and half shoes wide, was seen in the sky, 1531 years after the birth of Christ. (see reference to Halley's comet reproduced above.)

Folio 128: 1533 – In the year 1533 on the 27th July at two o'clock after midnight a terrible comet appeared and as also seen for many days after this which the astronomers interpreted when unrest later broke out in Germany etc. (This may refer to Comet Apian, IAU MPC)

Folio 142: 1542 – In the year 1542 on St Rupert's Day the 27th September, a comet was seen in the sky not far from the moon for many days, just as is painted here.

Folio 146: 1543 – In the year 1543 on the 4th May a terrible comet was seen in the sky over Pforzheim and in the village called Zaisenhausen with many fiery flames falling from it. And after this there followed some strange things.

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Picture Gallery

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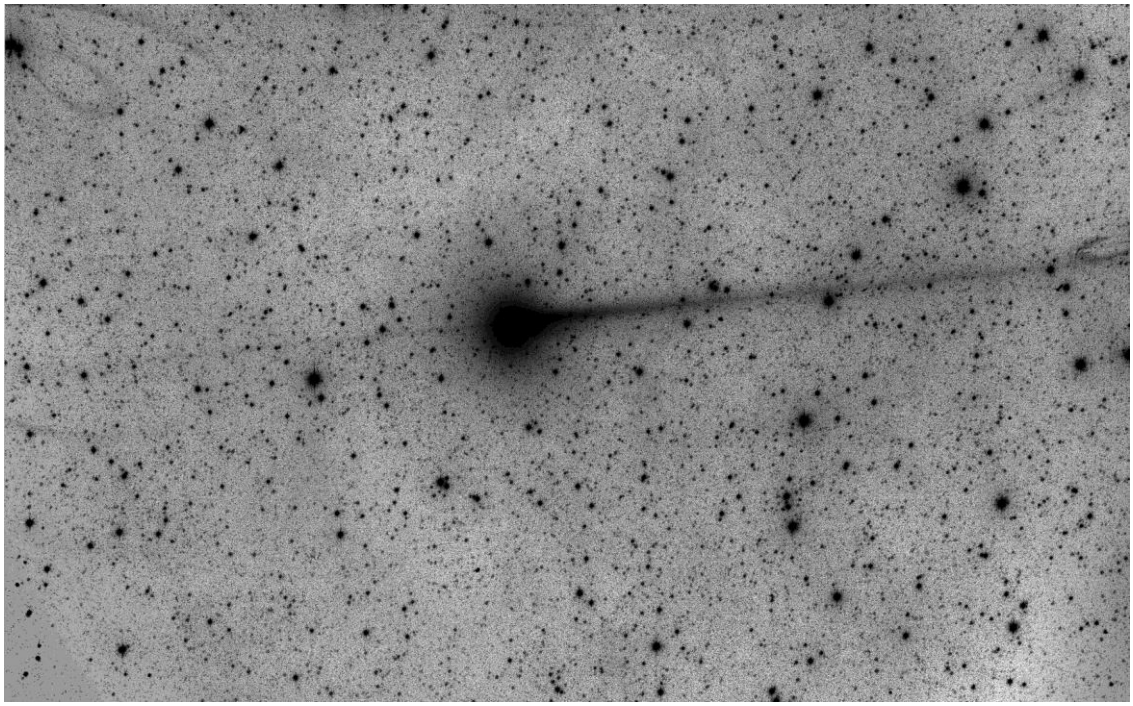

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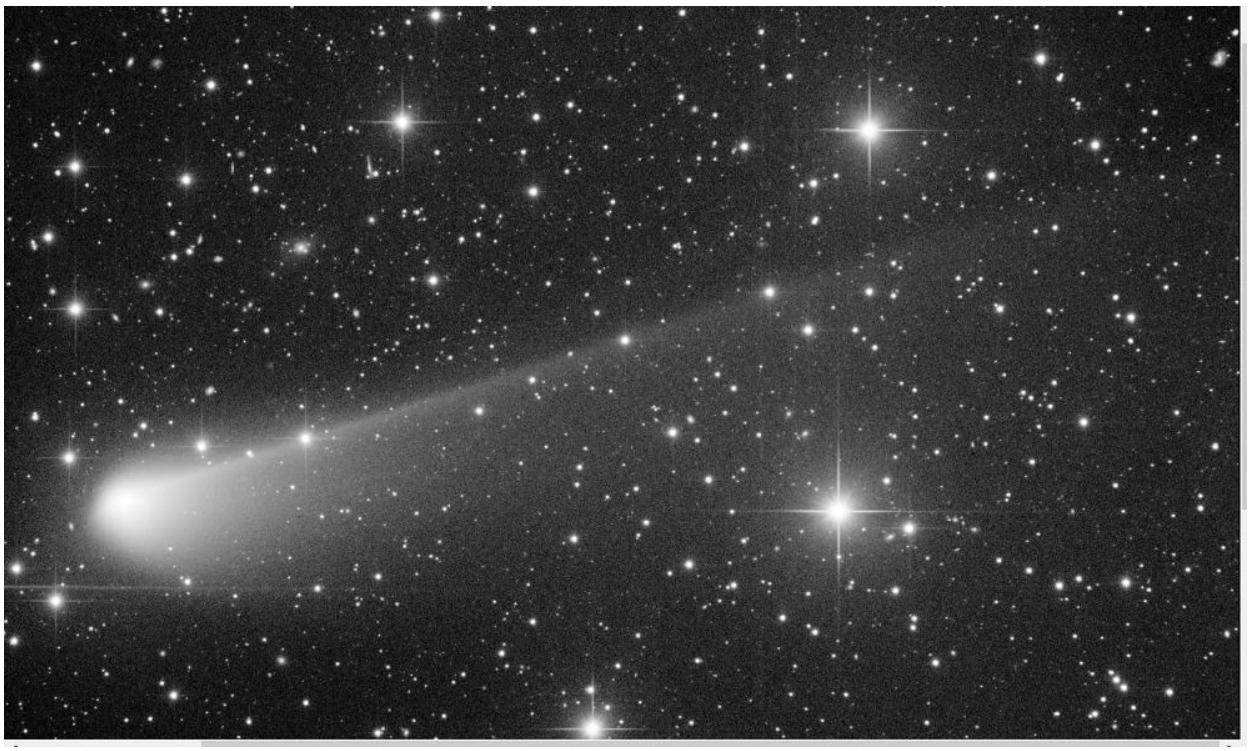

67P/Churyumov-Gerasimenko exp 5x5min, 2022-01-06 22_51_54 UT SW 2001 (D 204mm, F 1003mm), 0,95x CC Altair Hypercam 1600 PRO TEC, Gain 600, -20C. Darius Gasiunas.

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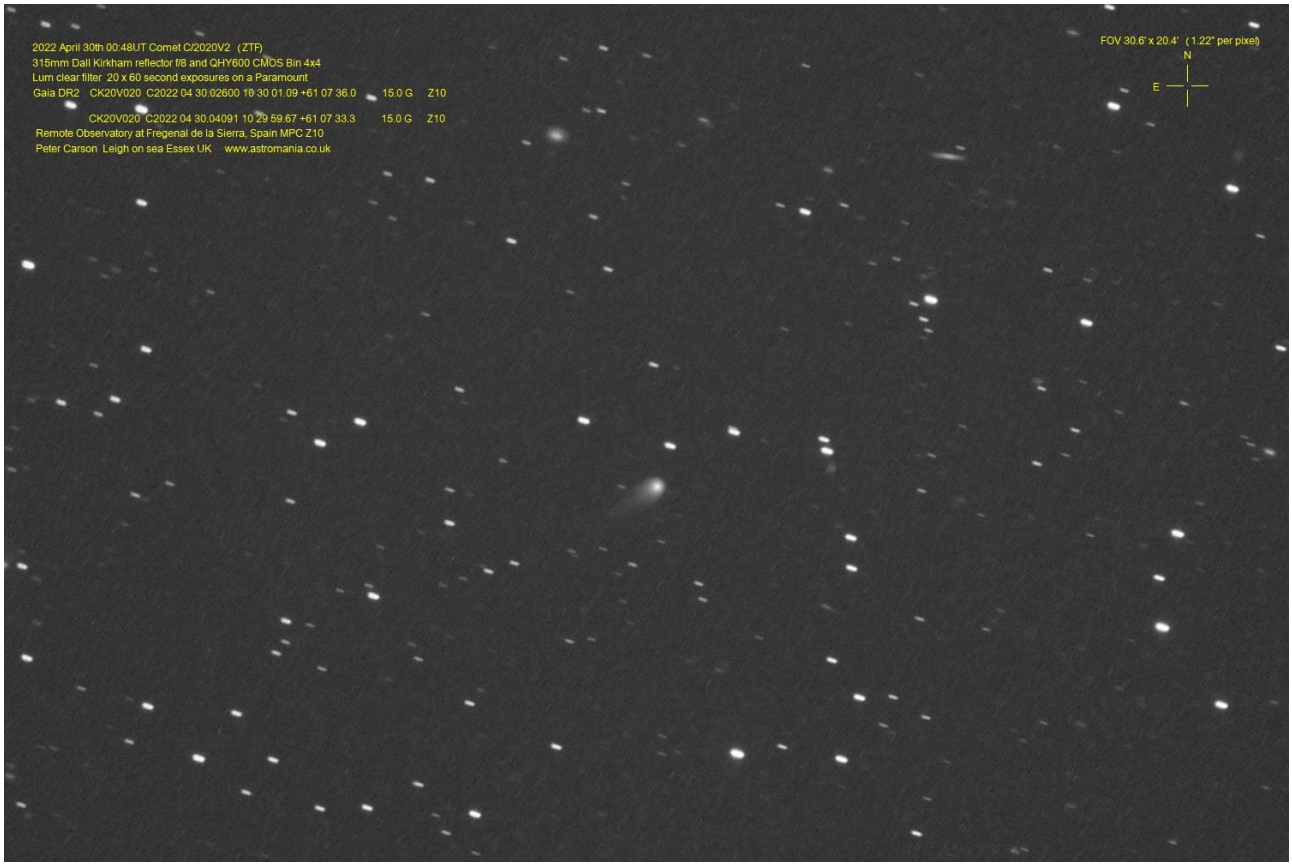

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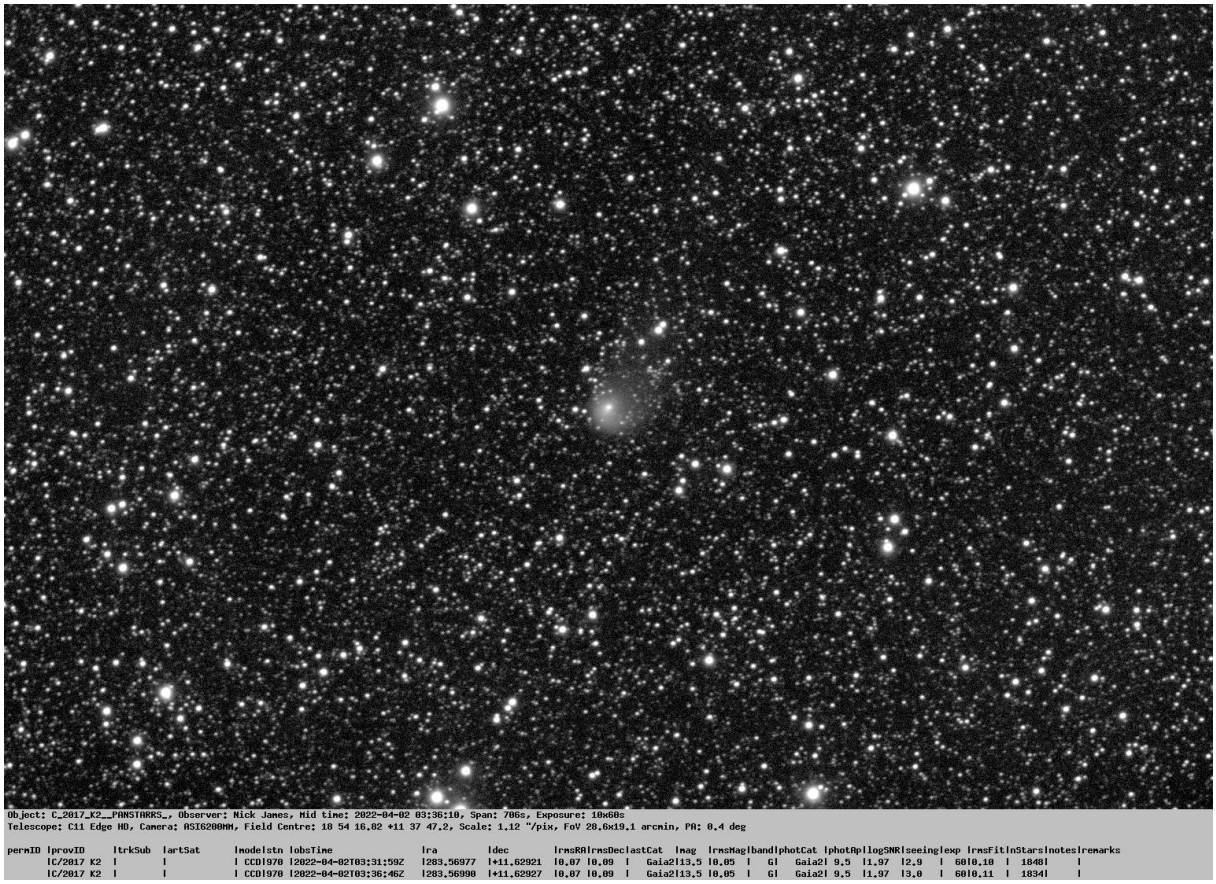

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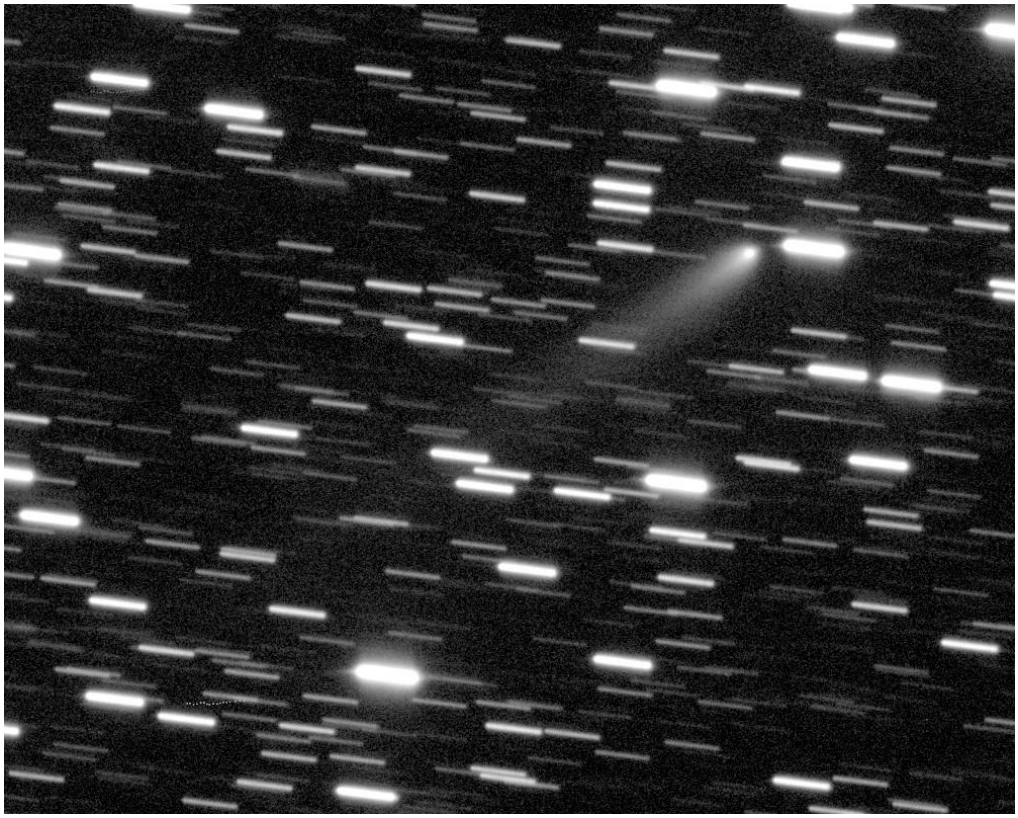
2017k2 20220402 033610 ndj

2017 K2 Panstarrs March 16 with 12“ f 3.6 ASA Astrograph and ZWO ASI 6200 MM Pro, LRGB 18/12/12/12 min. Farm Tivoli/Namibia 2017k2 20220316. Gerald Rhemann



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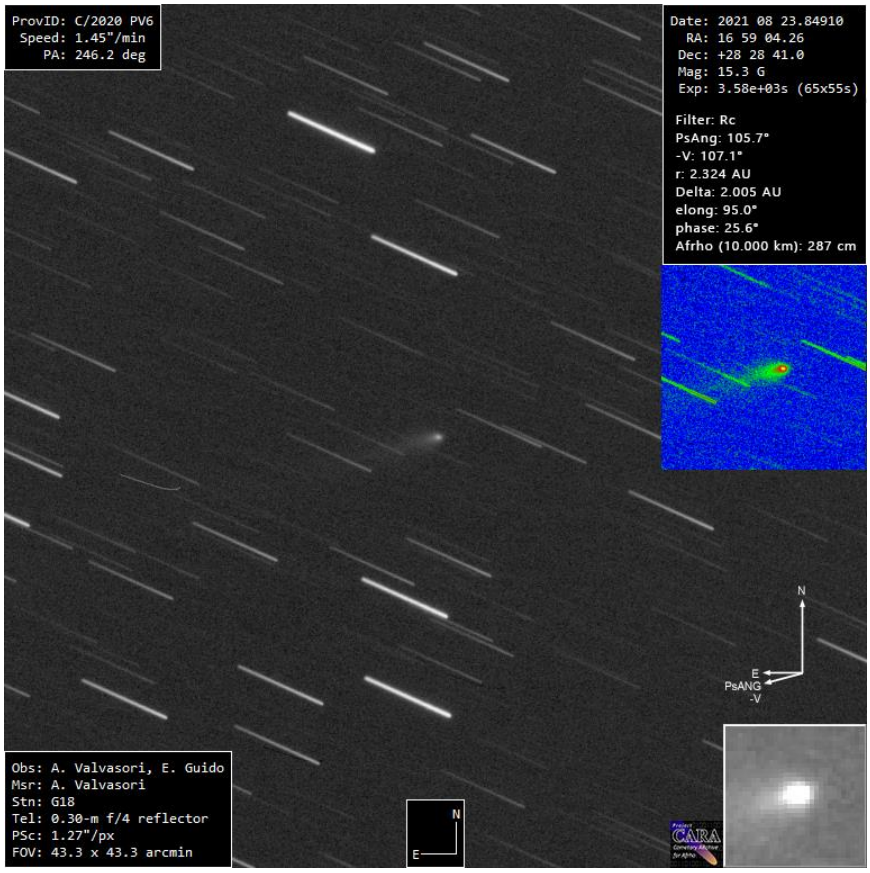

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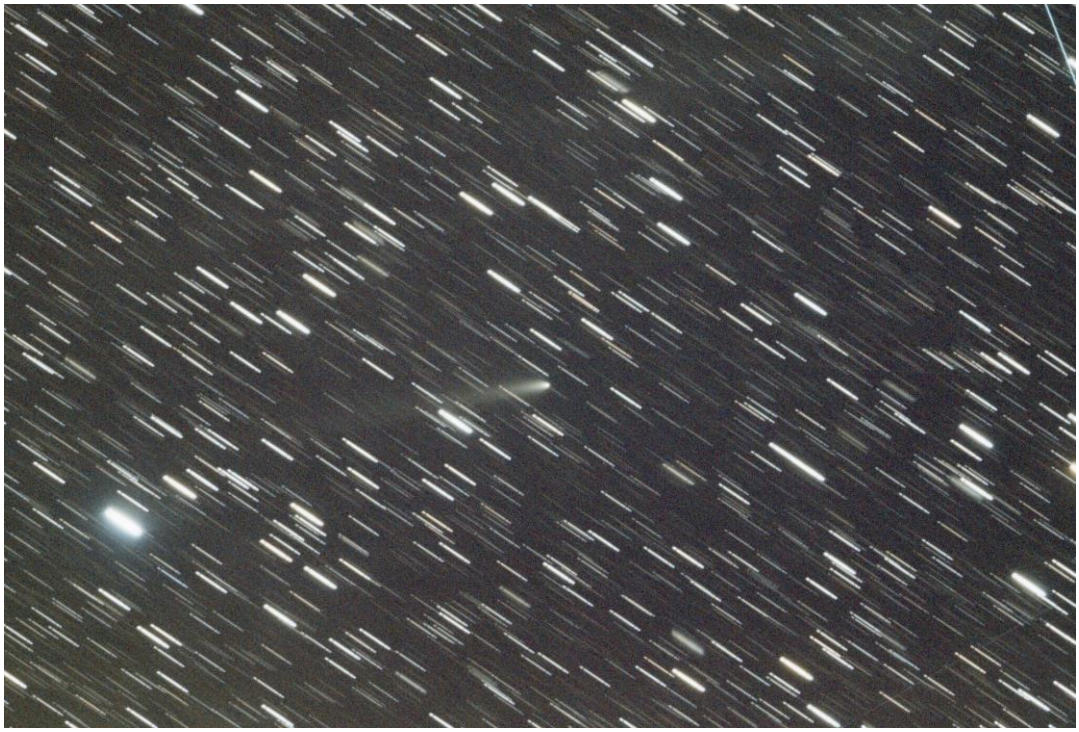

C/2020PV6 PanSTARRS RASA11 ASI2941mcP 33x180sec 20210907 211415_DEBartlett June Lake California, USA
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2021A4 NEOWISE 08 04 2021 12" f3.6 4x4min. FLI ML16200, Farm Tivoli Namibia 2021a4 20210408 Gerald Rhemann

C/2019 U5 PANSTARRS, 2022.05.08, 23.50 UT 10" / 4.0 Newton, CCD Moravian G2 8300, 10 x 180 s. 2019u5 20220508 N Mrozek

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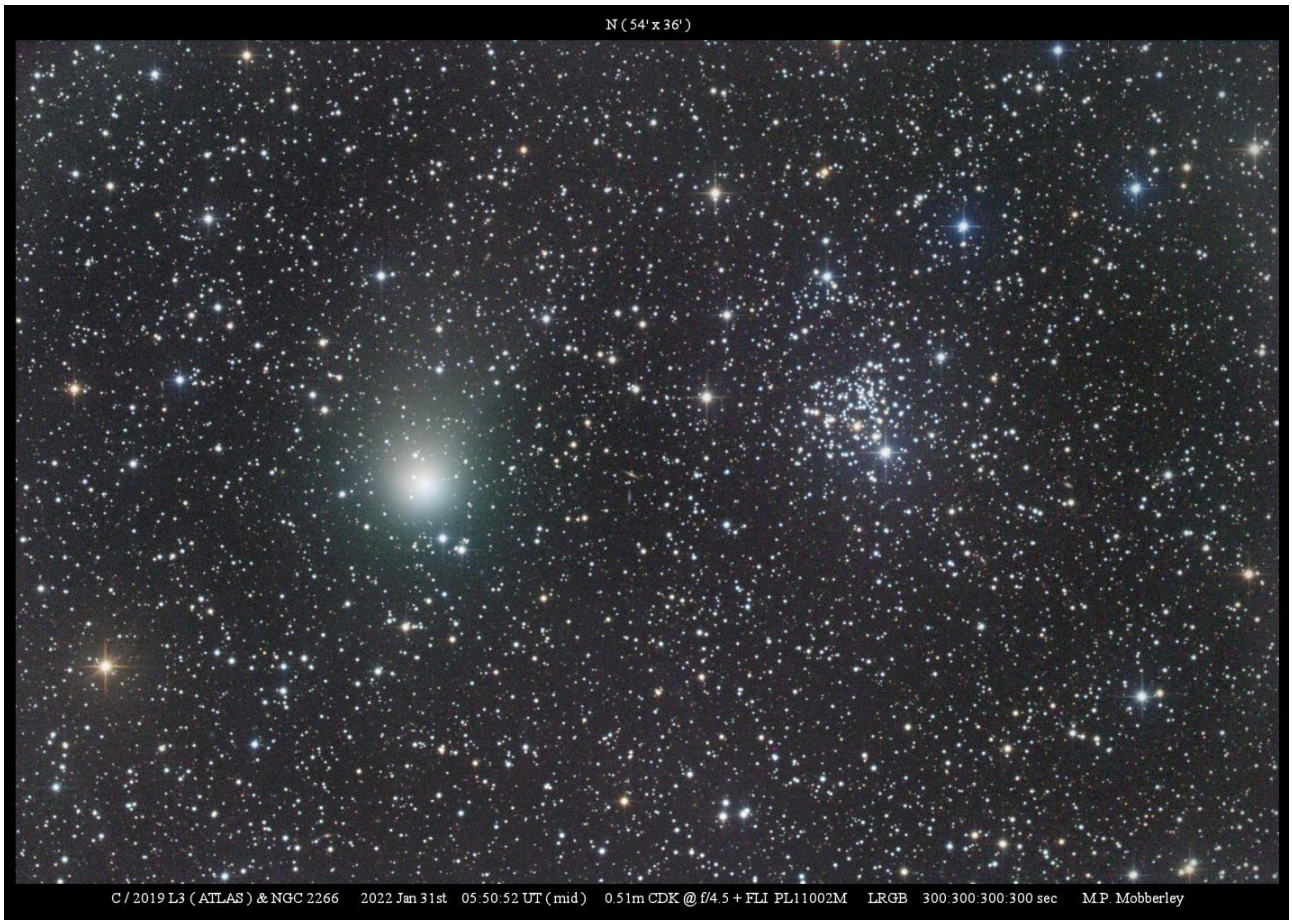
2019l3 20220327 212600 Nick James

C/2019 L3 (ATLAS) exp 3x5min 2022-03-20 19_57 UT Crop (Full Size: 63.5 x 48 arcmin) Pixel scale: 0.821 arcsec / pixel SharpCap 4 SW 2001 (Newton - D 204mm, F 1003mm), 0,95x CC Altair Hypercam 1600? PRO TEC (No Filter), Gain 600, -20deg 2019l3 20220320 Darius Gasiunas



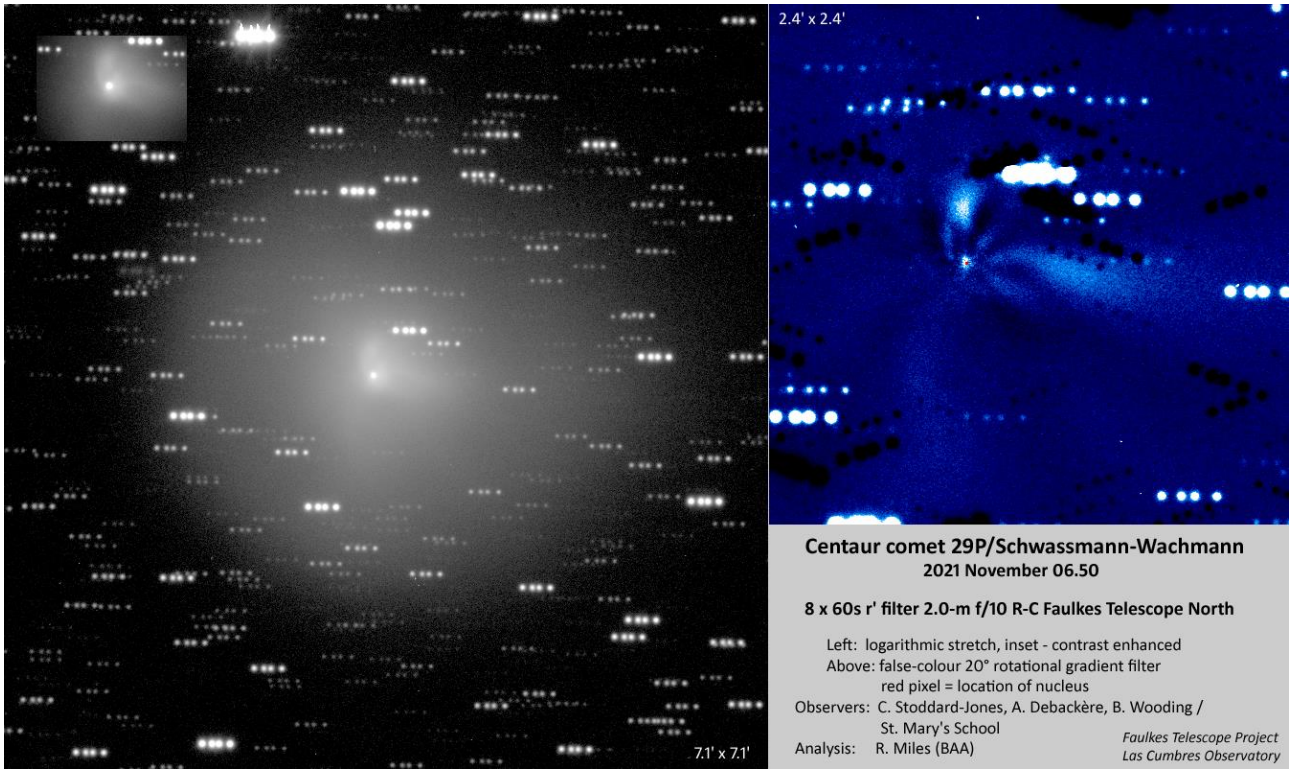
2019l3 20220131 0551 Martin Mobberley

The dust trail of comet 19P - 3.5° on this mosaic image taken on November 27 19p 20211127 Gerald Rhemann

19p 20220501 0314 Jose Chambo

29P/Schwassmann-Wachmann 1 2022 jan. 1 20.25 UT 10x2min 11" RASA QHY 600 Michael Jäger 29p 20220101 2025 Michael Jäger

*****29P/Schwassmann-Wachmann **On 2022 Jan 21 18h56 UT TEL 0.4-m f/2.8 reflector + CCD Atik460ex 27x60s zoom 40% 29p 20220121 Francois Kugel***



29p 20211106 1200 Richard Miles

110p 20220111 0256 Denis Buczynski

116P 2022 April 21 UT 20.36 10x90 16"/f-3.2 and QHY600 116p 20220421 2036 Michael Jäger

116P Wild 2022 April 28 UT 20.38 10x3min 16"/3.2 Nikon Z50mod Michael Jäger

https://britastro.org/cometobs/67p/67p_20220225_dbartlett.html
Observational data: RASA11 620mm ASI2600mcP June Lake California, USA
54x 240 seconds of images were stacked. Dan Bartlett