Comets in Art - Panel from Bayeux Tapestry, 11th century (Wikimedia Commons)

THE COMET’S TALE

Comet Section – British Astronomical Association

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britastro.org/comet

Comet 252P LINEAR: conjunction with M14: Alan Tough 2016 April 05

Table of Contents

1 From the Director –Nick James

Welcome to the first issue of the new-style Comet's Tale. In the future I hope to publish the Journal twice a year; as near to the equinoxes as possible, although that might change. I look forward to receiving all your contributions and a special thank you to those who made their submissions for this first edition. Please let me know if you have any suggestions for future material.

This issue is my first as Director of the Comet Section. I took over from Jonathan Shanklin at the BAA AGM last October and became the 12th Director of the BAA Comet Section continuing an unbroken line going back to W.F. Denning, who was the first Director, appointed in 1891.

Becoming the Director of a BAA Section carries a great responsibility. I know that I have a very hard act to follow and it will take me a while to get used to the new role. I would like to thank Jonathan for the dedication he has shown to the Section as Director. His directorship lasted 25 years so he certainly deserves a break! This duration is second only to Crommelin's second directorship, a monumental 32 year stint between 1907 and 1939. Jonathan's knowledge of matters related to comets is more extensive than anyone else I know and I am very pleased that he has agreed to stay on the section committee as visual observations and analysis coordinator.

We all know that comets are wonderfully unpredictable objects. This is what makes them so much fun to observe. You never quite know what you are going to see when you go out to observe. Since the last Comet's Tale we have had two bright comets: C/2014 Q2 (Lovejoy) and C/2013 US10 (Catalina) and plenty of interesting faint comets. In particular, the amazing images of 67P from Rosetta have shown us how much we don't know about the physics of comets and how important amateur observations can be. I've tried to observe as many comets as possible using the 0.28m SCT at the bottom of my garden (pictured here) and remotely using iTelescope and Sierra Stars.

Although astronomy can be a solitary hobby I strongly feel that we get the most out of it through discussion and cooperation with others. The BAA Comet Section can be a significant part of this but there are also major hubs of comet observing going on elsewhere, particularly online in social networks, see the note from Neil Norman later in this issue. I feel strongly that cooperation between observers and organisations will improve things for everyone.

Last summer Jakub Černý organised a conference on comet observing at the famous Ondřejov Observatory in the Czech Republic. I attended on behalf of the Comet

Section and Richard Miles was also there. This was a very enjoyable and productive weekend and I came back with lots of thoughts about how to improve the efficiency of our comet observing programme and how to increase co-operation with other European groups. There is a lot that we can learn from each other.

My main focus since I returned has been how to improve the CCD comet Visual Equivalent Magnitude workflow by implementing some software to do most of the work automatically. I'm still working on this and you will find a summary of the current status in this edition of the Tale.

Another important aspect discussed at the Conference was the archiving of comet observations. One of the key motivations for people when they submit their observations is the knowledge that the data will be available for use by researchers. This function used to be performed by the ICQ but that archive now appears to be effectively defunct. Our conclusion was that the COBS database was the best option and that this would have a long-term future.

The BAA has a considerable archive of ICQ format observations curated by Jonathan Shanklin and, through the hard work of Jure Zakrajsek, many of these have now been imported into COBS. Over 30,000 observations of 370 different comets made by 170 observers have been imported so far. Please consider signing up to COBS to submit your data. You can find the COBS database here:

http://www.cobs.si/

If you register as a BAA member we can get a monthly report on observations made by our members. Complementing the data held by COBS the BAA maintains a huge archive of comet images on our website here:

http://www.britastro.org/cometobs/

This is maintained by Denis Buczynski and it is updated almost daily. It now contains thousands of images of hundreds of different comets and is one of the most extensive comet image archives in the world. We are keen to receive your images but if you have not submitted any before please contact Denis first for information on how to submit your observations.

Finally, I would like to welcome and to thank Ms Janice McClean for volunteering to take on the role of Editor, and for her work in preparing this first edition. Let's hope for good weather through the northern summer and for plenty of comet observing possibilities. The Comet Section officers look forward to receiving your observations.

Nick James – Section Director

2 Comet Predictions for 2016 May to December – Jonathan Shanklin

In the Southern Hemisphere 2013 X1 (PanSTARRS) could be visible in binoculars during their winter. 45P/Honda-Mrkos-Pajdusakova is the brightest of the periodic comets, and may be visible in binoculars at the end of the year, though it is relatively close to the Sun.

These predictions focus on comets that are likely to be within range of visual observers, though comets often do not behave as expected and can spring surprises. They have been revised from the version that appeared in the Journal for the Comet's Tale. A complete update is also available on the visual co-ordinator's web page.

Members are encouraged to make visual magnitude estimates, particularly of periodic comets, as long term monitoring over many returns helps understand their evolution. Guidance on visual observation and how to submit estimates is given in the BAA Observing Guide to Comets. Please e-mail your estimates using the ICQ format or submit them to COBS, and do refer to the data files on the visual co-ordinator's web page for correctly formatted examples. Drawings are also useful, as the human eye can sometimes discern features that initially elude electronic devices.

Theories on the structure of comets suggest that any comet could fragment at any time, so it is worth keeping an eye on some of the fainter comets, which are often ignored. They would make useful targets for those making electronic observations, especially those with time on instruments such as the Faulkes telescopes. Such observers are encouraged to report electronic visual equivalent magnitude estimates via COBS. When possible use a waveband approximating to Visual or V magnitudes. These estimates can be used to extend the visual light curves, and hence derive more accurate absolute magnitudes.

In addition to the information in the BAA Handbook and on the Section web pages, ephemerides for the brighter observable comets are published in the *Circulars*, and ephemerides for new and currently observable comets are on the JPL, CBAT and Seiichi Yoshida's web pages. The BAA Observing Guide to Comets is available from the BAA Office.

9P/Tempel was first observed in 1867, but was lost between 1879 and 1967 following an encounter with Jupiter in 1881, which increased the perihelion distance from 1.8 to 2.1 au. Further encounters in 1941 and 1953 put q back to 1.5 au and calculations by Brian Marsden allowed Elizabeth Roemer to recover it in 1967. Alternate returns are favourable, but an encounter with Jupiter in 2024 will once again increase the perihelion distance to 1.8 au. It was the target for the Deep Impact mission, with the Stardust spacecraft subsequently passing by the comet. The comet came into visual range in March, and remains visible for UK observers until June. It could be at its brightest around 11th magnitude in early July, when it passes south of the celestial equator, and Southern Hemisphere observers will be able to follow it as it fades.

29P/Schwassmann-Wachmann is an annual comet that has outbursts, which over the last decade seem to have become more frequent. The comet had one of its strongest outbursts yet recorded in early 2010. Richard Miles has developed a theory that suggests that these outbursts are in fact periodic, and arise from at least four independent active areas on the slowly rotating nucleus. The activity of the active areas evolves with time. The comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity. The comet is at a southern declination, reaching opposition in Scorpius in June and passing through solar conjunction at the end of December.

45P/Honda-Mrkos-Pajdusakova has had several close encounters with Jupiter, the most recent in 1983 which made dramatic changes to ω and Ω. The perihelion distance has steadily decreased and is close to the smallest it has been for the last 200 years, though is now increasing again. It can approach quite closely to the Earth and did so at the last return in 2011 (0.06 au) and is on its way to another close approach post perihelion, in 2017 (0.08 au). At present the MPC only lists eight approaches closer than 0.06 au out of 20 passes closer than 0.1 au, and nine of these are by five periodic comets. It can also pass close to Venus and passed at 0.085 au in 2006, getting even closer in 2092. The comet brightens rapidly in November, but it is well south of the celestial equator. For northern observers there may be a short period when it might be visible at the close of the year, when it is at perihelion and perhaps 7th magnitude.

226P/Pigott-LINEAR-Kowalski has a rather complicated history. It was discovered by Edward Pigott from York and was observed by Herschel, Mechain and Messier amongst others. A parabolic orbit was computed, but there were suspicions that it might be of short period. It was then lost until a comet was found by LINEAR in 2003 January, which was thought to probably be the long lost comet. The comet then passed 0.056 au from Jupiter on 2006 September 10 in an encounter that considerably changed the orbit. Finally Rich Kowalski discovered a very diffuse comet during the Catalina Sky Survey on 2009 September 10, which was then linked to the Pigott and LINEAR comets. This is a favourable return for northern observers, with the comet passing the celestial equator heading north in early August. It will be brightest at perhaps 10th magnitude in the autumn when it nears opposition.

2013 X1 (PanSTARRS) was 9th magnitude at the beginning of the year and well placed in the evening sky for northern hemisphere observers. It is rapidly moving south however, and after mid February will be lost to view. After solar conjunction Southern Hemisphere observers will be able to observe it from around April until September, with the comet brightest at around 6th magnitude in June.

The other periodic and parabolic comets that are at perihelion during 2016 are unlikely to become brighter than 12th magnitude or are poorly placed. Ephemerides for these can be found on the CBAT website. Several D/ comets have predictions for a return, though searches at favourable returns in the intervening period have failed to reveal the comets and the orbits will have been perturbed by

Jupiter. There is however always a chance that they will be rediscovered accidentally by one of the Sky Survey patrols. Six SOHO comets are predicted to return, however these will only be visible from the SOHO or STEREO satellites.

Looking ahead to 2017, there are some good prospects for once. **45P/Honda-Mrkos-Pajdusakova** emerges from solar conjunction on its way to passing 0.08 au from the Earth on February 11. It could be a binocular object as it moves rapidly across the sky during February. **2P/Encke** should also be seen during February, when it is visible in the early evening, perhaps reaching binocular brightness before it is lost in the twilight. February is likely to be a busy period for the new Director, as **41P/Tuttle-Giacobini-Kresak** is also likely to be a binocular object on its way to a 0.14 au approach to the Earth on March 30. It could be a binocular object from February until June and perhaps a naked eye object when brightest.

Jonathan Shanklin – Visual Observations and analysis coordinator

3 Comets reaching perihelion in 2016

Comet	T	q	P	N	H_1	K_1	Peak mag
302P/Lemmon-PanSTARRS	May 1.4	3.30	8.85	2	12.5	10.0	**20**
PanSTARRS (2015 B2)	May 6.4	3.37			9.5	10.0	**17**
77P/Longmore	May 13.6	2.34	6.88	6	7.0	20.0	**15**
LINEAR (2015 Y1)	May 15.9	2.50			12.0	10.0	**17**
Gibbs (2015 W1)	May 17.2	2.23			12.5	10.0	**18**
224P/LINEAR-NEAT	May 24.4	1.99	6.31	2	15.5	10.0	**21**
Spacewatch (2011 KP36)	May 26.9	4.88	238		4.5	10.0	**14**
Gibbs (2007 R3)	May 27.4	2.52	8.92	1	13.5	10.0	**19**
136P/Mueller	May 31.2	2.98	8.62	3	11.0	10.0	**17**
216P/LINEAR	May 31.2	2.15	7.63	2	12.4	10.0	**17**
157P/Tritton	Jun 10.4	1.36	6.29	3	14.0	10.0	**17**
202P/Scotti	Jun 10.6	2.52	7.33	3	13.5	10.0	**20**

P/Scotti (2011 A2)	Jun 14.0	1.55	5.47	1	16.5	10.0	**20**
118P/Shoemaker-Levy	Jun 17.0	1.98	6.44	4	9.3	9.6	**15**
PanSTARRS (2015 T4)	Jun 18.9	2.30	800	1	11.0	10.0	**16**
146P/Shoemaker-LINEAR	Jun 30.0	1.43	8.11	3	15.0	10.0	**18**
207P/NEAT	Jul 1.1	0.94	7.64	2	16.0	10.0	**17**
P/SOHO (1999 N5 = 2005 E4)	Jul 1.5	0.05	5.67	2			
P/SOHO (2000 O3)	Jul 1.9	0.05	5.31	3			
208P/McMillan	Jul 2.1	2.54	8.15	2	12.5	10.0	**18**
P/WISE (2010 N1)	Jul 8.0	1.63	5.95	1	17.0	10.0	**18**
279P/La Sagra	Jul 14.5	2.16	6.78	2	14.0	10.0	**18**
56P/Slaughter-Burnham	Jul 18.4	2.51	11.5	5	8.5	15.0	**16**
81P/Wild	Jul 20.3	1.59	6.41	6	8.7	6.9	**12**
P/Gibbs (2009 K1)	Jul 24.7	1.34	7.09	1	17.0	10.0	**20**
150P/LONEOS	Jul 25.0	1.76	7.66	4	13.5	10.0	**18**
9P/Tempel	Aug 2.6	1.54	5.58	11	6.6	19.7	**11**
ATLAS (2015 X7)	Aug 3.5	3.75			9.0	10.0	**18**
PanSTARRS (2014 R3)	Aug 7.9	7.28			6.5	10.0	**19**
P/Barnard (1884 O1)	Aug 10.8	1.31	5.41	1			
225P/LINEAR	Aug 16.8	1.32	6.98	2	18.0	10.0	**19**
43P/Wolf-Harrington	Aug 19.7	1.36	6.13	11	8.9	10.0	**12**
33P/Daniel	Aug 22.5	2.16	8.07	10	10.5	20.0	**19**
PanSTARRS (2015 V4)	Aug 25.8	5.47	80	1	8.5	10.0	**19**
LINEAR (TQ_{209})	Aug 27.5	1.41			10.5	10.0	**14**
330P/Catalina	Aug 30.0	2.96	16.9	2	10.0	10.0	**17**
LINEAR (2016 A8)	Aug 30.5	1.89	220		12.0	10.0	**15**
144P/Kushida	Aug 31.0	1.43	7.57	3	4.3	32.1	**11**

Sheppard-Tholen (2015 T5)	Sep 2.2	9.18	180	1	7.5	10.0	**22**
226P/Pigott-LINEAR-Kowalski	Sep 5.1	1.78	7.32	4	6.0	15.0	**10**
212P/NEAT	Sep 10.2	1.65	7.76	2	17.0	5.0	**20**
PanSTARRS (2015 H2)	Sep 13.3	4.97			7.5	10.0	**18**
314P/Montani	Oct 7.1	4.24	19.6	2	9.0	10.0	**18**
237P/LINEAR	Oct 11.7	1.98	6.57	2	14.5	5.0	**17**
P/SOHO (1999N5 = 2005 G2)	Oct 11.7	0.05	5.76	2			
238P/Read	Oct 22.8	2.36	5.63	2	14.5	10.0	**19**
94P/Russell	Oct 27.7	2.23	6.58	5	9.0	15.0	**16**
Read (2005 S3)	Nov 1.5	2.82	10.8	1	12.0	10.0	**18**
LINEAR (2010 A2)	Nov 8.5	2.01	3.47	1	15.5	10.0	**19**
288P/Spacewatch = (300163)	Nov 8.9	2.43	5.32	3	16.0	5.0	**19**
D/Haneda-Campos (1978 R1)	Nov 11.2	1.29	6.44	1			
P/Boattini (2008 T1)	Nov 18.2	3.06	8.76	1	11.0	10.0	**18**
P/McNaught (2008 J3)	Nov 23.0	2.30	7.71	1	12.0	10.0	**16**
323P/SOHO	Nov 23.8	0.04	4.15	3			
NEOWISE (2016 B1)	Dec 4.7	3.23			9.5	10.0	**18**
316P/LONEOS	Dec 6.8	2.42	11.2	1	10.0	10.0	**15**
PanSTARRS (2014 OE_4)	Dec 10.7	6.24			11.0	5.0	**19**
89P/Russell	Dec 15.2	2.24	7.32	5	11.5	15.0	**19**
45P/Honda-Mrkos-Pajdusakova	**Dec 31.2**	**0.53**	**5.26**	**11**	**12.6**	**19.1**	**7**

The date of perihelion (T), perihelion distance (q), period (P), the number of previously observed returns (N), the magnitude parameters H_1 and K_1 and the brightest magnitude (which must be regarded as uncertain) are given for each comet. The magnitudes, orbits, and in particular the time of perihelion of the single apparition D/ comets, are uncertain. Magnitude information is not given for the SOHO comets; these are now being numbered by the IAU once observed over sufficient returns.

Note: $m_1 = H_1 + 5.0 * \log(d) + K_1 * \log(r)$

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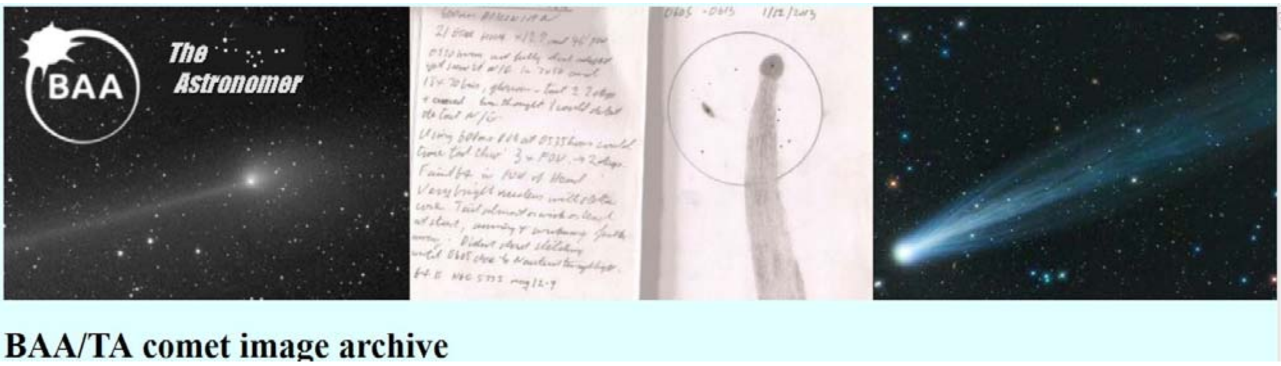
4 The BAA Comet Image Archive: An Appeal – Denis Buczynski



In the past two years the Section has established an extensive archive of thousands of images of comets that have appeared in our skies. The vast majority of these have been images in digital form that have been submitted to the Section from BAA members and subscribers to The Astronomer Magazine. This archive can be accessed at the following link: http://www.britastro.org/cometobs/

However there must be many members who still have images of comets, either printed as photographs or recorded on slides. There will be some who have sketches and drawings made at the telescope. We would like to include all of these in our archive and I invite members to submit these older observations. Many people will have access to a scanner so prints and sketches can easily be copied. Slides can be more difficult, but again many people may have slide scanners. If you have any older observations and want to submit them then send them to: cometobs@britastro.org

I hope to receive a flood of observations! We have very few images of comets such as 1P Halley or of great comets C/1995 O1 Hale-Bopp and C/1995 Y1 Hyakutake. I know there must be many observers who took pictures and made sketches of these and other comets. So please, consider searching through your own records and if you find any relevant images then submit them. No matter how old the observation may be.

Submission details for the BAA/TA comet image archive.

Our standard image-naming rules should be followed as we need to archive each image under a strict protocol. Please submit your images to cometobs@britastro.org.

The image archive pages are generated automatically based on the filename of the image so it would help us greatly if you could conform to the following format:

1. object_date_time_obscode.jpg
2. where the fields are separated by a single underscore character '_'. The fields are:
3. object = object name. For periodic comets this would be, for example, 303p. For long-period objects it is "2014q2".
4. date = UTC date in the format YYYYMMDD
5. time = UTC time in the format HHMM or HHMMSS.
6. obscode = Your observer code "xxxx" (Let me know if you would prefer a different code). You can have multiple different observer codes if you need them.

So, for example, an image of 2014q2 taken on 2014-12-29 at 23:45 UTC would be:

2014q2_20141229_2345_xxxx.jpg

You should include details in a caption on the image. If you would like to include other descriptive text in the archive you can do this by submitting a text file with the same name as the image but with .txt appended, i.e.

2014q2_20141229_2345_xxxx.jpg.txt

If you need any help in copying any observations then contact me at buczynski8166@btinternet.com

Denis Buczynski - Secretary Comet Section

5 Discovering comets using the SWAN instrument on SOHO – Michael Mattiazzo

I was born in Adelaide, South Australia, and I first became interested in astronomy at the age of 16 in 1986. That was at the time of comet Halley's reappearance. My first view of it was in early March through a pair of 7x50mm binoculars and it displayed a beautiful star-like nucleus, embedded within a coma, with a dust tail 5 degrees long looking directly over the city of Adelaide. It made a very strong impression on me and gave birth to a lifelong interest in observing and imaging comets.

Today the same feat would be impossible because of the Adelaide light pollution blocking most things from view. I know that I was very fortunate to observe the comet from a dark sky site that first time, and when it was at closest approach back in 1986 April 11. Not only could I see the comet and 5 degree tail easily with the naked eye, but the Milky Way also stood out in all its glory. The scene had me hooked and I was determined to find a comet of my own.

Becoming a comet hunter

I joined the Astronomical Society of South Australia in 1990 and had the privilege to know one of the greatest visual comet hunters of all time. Bill Bradfield, a noted discoverer of 18 comets, was my mentor and gave me much support. The only problem I had was dealing with Adelaide's increasing light pollution. I had the chance in 1997 when I took up a position as pathology laboratory manager in Wallaroo, a small town in South Australia. The dark skies were perfect and that is when I started observing and hunting for comets. Using an 8" telescope at the time, I narrowly missed out on finding comets Lee and Lynn.

In July 2000, I purchased a pair of 25x100mm binoculars. On the night of November 24, 2000, I swept up a bright 7th magnitude object in Ara which was not a known comet. I reported this to the Central Bureau Astronomical Telegrams, based in Harvard University in the USA, but subsequently discovered I had been piped at the post by Albert Jones in New Zealand, who had picked it up 24 hours earlier. The comet was announced as C/2000 W1 Utsunomiya-Jones.

I was disappointed. Then in 2002, the first SWAN comet was announced. SWAN stands for Solar Wind Anisotropies (i.e. winds directionally dependent), an experiment on board the SOHO (Solar and Heliospheric Observatory) spacecraft, developed in collaboration with the Finnish Meteorological Institute. The SWAN comet discovered was C/2002 O6 and was discovered by M. Suzuki, Utsunomiya, Tochigi, Japan. The SWAN camera can pick up comets quite easily via the ultraviolet emission of Hydrogen in the coma. At the same time the SWAN project team started to offer their data in "comet tracker map" form to the public.

As a result of this, I gave up visual comet hunting in favour of confirming SWAN comets. SWAN was capable of detecting comets as faint as 12th magnitude. The first object I picked up was in April 2003, but no one was able to confirm it on the ground until a month later when Eric Christensen of the Catalina Sky survey discovered it. This short period object is now called 210P Christensen but, in my opinion, it should have been labelled as SWAN-Christensen.

Eventually, my first success came in May 2004 with the detection of C/2004 H6 SWAN. It was a great sensation to be the first person in the world to visually observe this comet, just a few degrees above the evening horizon, using 25x100mm binoculars. Unfortunately the comet was approaching solar conjunction and I had to wait a further week, before reconfirming it in the morning sky. Then the next issue was to try and convince CBAT that the comet was real, since they are constantly receiving numerous reports of SWAN comets. I had to send them an image of the comet with its tail, as proof.

Currently I have been credited with the discovery of seven further SWAN comets, namely C/2004 V13, C/2005 P3, P/2005 T4, C/2006 M4 (the brightest one reaching 4th magnitude), C/2015 C2 and C/2015 P3. There are currently 15 comets carrying the SWAN name, with fierce competition amongst SWAN comet hunters. I have to say that it becomes addictive and I enjoy the competitive element too! My competitors are other successful SWAN hunters such as Robert Matson and Vladimir Bezugly.

My most recent discovery - C/2015 P3 SWAN

On 2015 Aug 9 at 03UT, I downloaded the latest SWAN comet tracker maps at http://swan.projet.latmos.ipsl.fr/ and noted a suspicious object located on the Leo/Coma Berenices border on images dated Aug 3 and 4. I measured very approximate positions on these dates, as well as a possible earlier detection on July 28. Position accuracy is generally in the order of 1 to 2 degrees of sky. Also since the comet tracker maps are posted with a time delay of nearly a week, I had to predict where the comet may have moved to, in the sky.

I searched a 10 degree square patch of sky in Virgo, situated around Rho Virginis that evening, at 09:11UT, and confirmed the comet photographically after the third sweep using a Canon 60Da + Sigma 200mm F/2.8 lens, tracking on a Vixen polarie star tracker. The comet appeared slightly condensed, of photometric magnitude 11.8, with a coma diameter of 2 arcminutes. The blue green colour of the comet stood out from the white appearance of the Virgo supercluster of galaxies.

Rapid motion was evident as I imaged the comet for the hour following discovery. I then measured its various positions using Astrometrica and sent it through to CBAT for posting on the Possible Comet Confirmation page. The discovery was announced on CBET 4136 and the comet designated C/2015 P3 SWAN. The preliminary orbit indicated that perihelion had already occurred on 2015 July 27 at 0.71AU. The comet was not expected to become much brighter than magnitude 11. It was very faint intrinsically (mag 14) and I'm surprised it even survived perihelion. A clue lies in its revised orbit - it is a dynamically evolved object, orbiting the Sun every 3,000 years.

Southern Comets Website

http://members.westnet.com.au/mmatti/sc.htm

The idea of setting up this webpage came about in 2002, after I had observed the spectacular outburst of C/2000 WM1 LINEAR, erupting from magnitude 6 to 2. Through 25x100mm binoculars, the starlike nucleus had 2 jets "horns" emanating at opposite poles of the nucleus. The view was very reminiscent of classical drawings of the past.

Since then, I have been documenting every bright comet that I have had the fortune to observe from my perspective in the Southern Hemisphere including the great comets C/2006 P1 McNaught and C/2011 W3 Lovejoy. I also simulate Kreutz sungrazing comets in my software as I search along the Kreutz line (as recommended by Bill Bradfield).

I had a simulated sungrazer already programmed in, with a perihelion date of December 15, and discovered that Terry Lovejoy's positions exactly matched, to within a few degrees of the simulation, showing the same speed and direction as the Kreutz comet. It was a eureka moment for me, knowing that his find was a member of the Kreutz group after just two sets of observations.

Michael Mattiazzo

My Telescope Setup

- Telescope: Celestron Nexstar 11GPS
- Camera: Starlight Express MX7c CCD, one shot colour 752x582 pixels, resolution of 1.9" per pixel at f/3.3 with C11 setup.
- Digital Camera: Canon 60Da + Sigma 70-200mm f/2.8 lens.
- Telescope control: Guide 9 software
- Image Processing: Maxim DL6
- Observatory codes used: E00 Castlemaine, D87 Brooklyn Park, D82 Wallaroo, 427 Stockport.

I currently observe from Swan Hill, Victoria, Australia. If you have a spare hour and would like to listen to me (and others) talk about comets for April, http://afm-originals.s3.amazonaws.com/AFM_CometWatch/AFM_CometWatch_160402-013_JupiterFamilyOfComets_DevID_6930.mp3

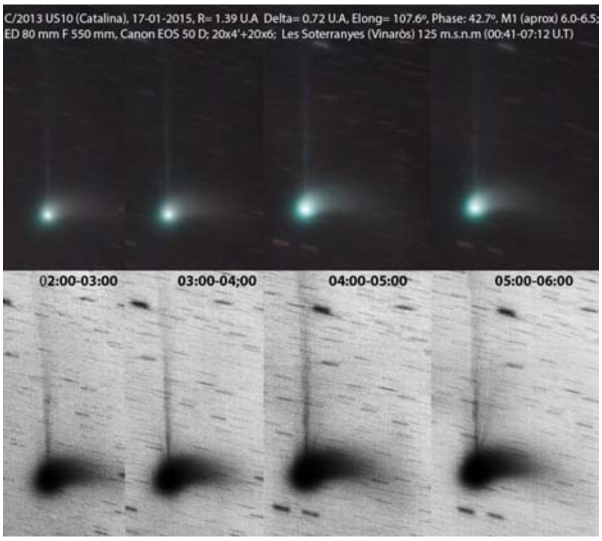
6 The Birth of Comet Watch – Neil Norman

C/2014 Q2 Lovejoy   Simon White

In the 80's Monthly magazines and TV shows such as the Sky at Night were the sources I used to access the latest news on my passion – Comets. But of course the Web has completely changed that now. Information is at my fingertips and I can communicate with fellow enthusiasts in seconds not days. The advent of Social Media such as Facebook and Twitter were seen as an intrusion for some but to me they seemed like a great opportunity to bring information together in one place.

In August 2013 I created a Facebook Group ahead of the arrival of Comet C/2012 S1 (ISON) It was due at perihelion that November. Touted as the 'Comet of the Century', I knew there would be much interest in following it and in sharing information and observations. I called the Facebook group 'Comet Watch' and from an initial 15 people it grew to over 1,500 members by the end of 2013. The aim of Comet Watch is to share information on all Comets visible in the sky, not just the bright ones.

Comet Watch, continued to grow strongly and by mid 2014 3,000 members were in the group. Whilst about 50% were only viewing, the remainder were regular contributors of observations and images. The site now has an archive of over 5,000 images from contributors all over the world. Although the quality may vary depending on the experience of the observer, even the newest observer's images may be a useful contribution to scientific knowledge. Images may help to identify or characterise disconnection events in tails as people submit images minutes or hours apart. In early November 2013 Tony Angel posted an image of C/2012 S1 (ISON) showing a totally different shape of the comet to other observers taken only the previous day. This proved to be the first images of ISON's outburst at pre-perihelion. A real catch for the new Facebook site.



Comet Watch attracts contributors of all skills and nationalities. We are proud to count names such as Rodney Austin, Thomas Bopp, Donna Burton, Leonid Elenin, Svetlana Gerasimenko, Alex Gibbs, Alan Hale, Cristovao Jacques, Richard Kowalski, David H Levy, Terry Lovejoy, Artyom Novichonok, Jim Scotti, Justin Tilbrook, and Tomas Vorobjov amongst our contributors. All great names, well known in the field of Comet observing.

One of the first memorable days for Comet Watch was when Cristavao Jacques submitted a message in the early morning of August 20th 2014. He stated that Terry Lovejoy had possibly found another Comet (after his previous year's C/2013 R1). The entire day was a flurry of constant updates on the progress of this new object on the JPL page (PCCP). Andres Chapman of Argentina confirmed it as a Comet on images he had taken, but it was a long wait until finally the announcement was made at around 21:30 UT August 20th that the new Comet was designated C/2014 Q2 (Lovejoy). Orbits were submitted to the site during the day and magnitude predictions gave it M1=10 at best, but how they were wrong! The Comet was a fantastic spectacle, briefly reaching naked eye visibility and I myself took over 150 observations of it over 6 months from Dec 2014 - June 2015.

Of course sandwiched between all this we had a close approach of C/2013 A1 (Siding Spring) to Mars and the hugely successful encounter of ESA's Rosetta with 67P. Comet Watch has also had submissions on bright Comets such as C/2014 E2, C/2012 K1, C/2015 M1, C/ 2014 Q1, C/2015 V5, 2p/, C/ 2014 us10, 254 Brewington and others.

The Internet may have its detractors but I strongly feel that, used in the right way, an enthusiastic and talented group of observers and imagers, brought together by the internet, can help to document and share the passing of known Comets and share the announcement of new discoveries. These contributions contribute to our understanding of these icy ghosts, objects which have engrossed humanity for centuries.

In addition to Comet Watch I shall continue with the monthly radio show, Astronomy FM. This is co-hosted with Nick Evetts and Mary Spicer that we record monthly for Astronomy FM. Each month we give a run-down on the latest news and have guests to chat with us. Regular contributors are Rodney Austin, David Eicher, Alan Hale, Terry Lovejoy, Michael Mattiazzo, Jim Scotti, and Justin Tilbrook. So even though comet activity may be low there is still lots to discuss until the next bright comet arrives. I do hope you will tune in, the website is - http://astronomy.fm/. Just search for 'astronomy FM' and it can be found. If you have the smartphone app for Tune-in radio you can find it there too - **http://tunein.com/radio/Astronomy-FM-s122373/**. As an historian of Comets, when quieter observing periods come, I like to concentrate on the greats of years past. An example of this is the article I have just completed on Comet D/1770 L1 (Lexell). There is something very special about these objects, not just the fact that they were bright or passed close to Earth or that they were visible in daylight or possessed 100 degree long tails. For me, it's about finding old images, old sketches and researching the circumstances surrounding the comet's discovery. I find the story of the men and women who discovered them, whether they were well known established professional observers, or they were just hobbying astronomers who happened to be looking in the right place at the right time, fascinating too.

I hope that you take a look at Comet Watch. If you have a Facebook account you can join the group and contribute.

Neil Norman

Director's comment – Neil's Facebook group is very active and, if you are a Facebook user, it is a great way to keep in touch with many comet observers around the world. It is complementary to the work that the BAA Comet Section does in more detailed analysis of comet data so please remember that if you submit images to a Facebook site you should also submit them to the BAA archive and make sure that any measurements (astrometry, photometry etc.) is submitted to the appropriate database (COBS or MPC) so that we (and others) can access it for analysis.

7 Detecting Comet Outbursts - Roger Dymock

In this project I play the part of the monkey to Richard Miles's organ grinder. Rather than collecting donations, others and myself, collect observations of these unusual comets. Observation of outbursting comets is interesting and useful science not least because of the different ways in which the outbursts occur: the measurement of the periods of activity, the varying expansion coma speeds, observations of the spectral emissions of the gas, light scattering and spectral reflectance, variations in shape and form of the coma and more. The reason why comets may periodically behave in this way has been described by Dr. Richard Miles and others at various conferences, meetings and in journals, as listed in the footnote.[1] In simple terms comets included in this project are subject to periodic outbursts which are not due to fragmentation. All have slow rotations and the cometary ices beneath the crust can be observed to start to melt and subsequently to outgas.

A comet which Richard Miles has investigated in some depth is Comet 29P/Schwassmann-Wachmann and its regular outbursts are well shown in Figure 1 taken from the Spanish Comet Group's

website at
http://www.astrosurf.com/cometas-obs/

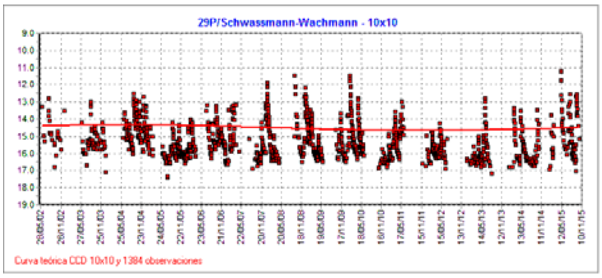


Figure 1. Variation of nuclear magnitude (m2) of comet 29P Figure 2 below shows how the total magnitude (m1) similarly varies. This lightcurve was taken from the Comet Observation Database (COBS) at http://www.cobs.si/.

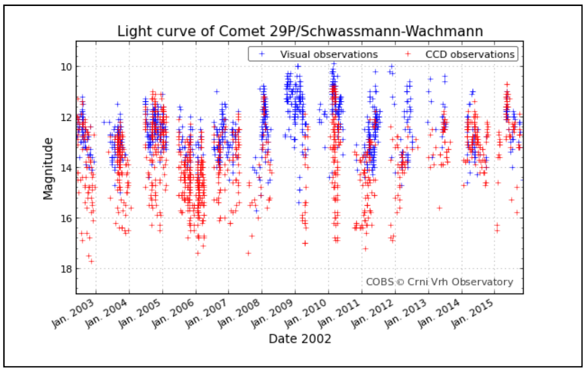
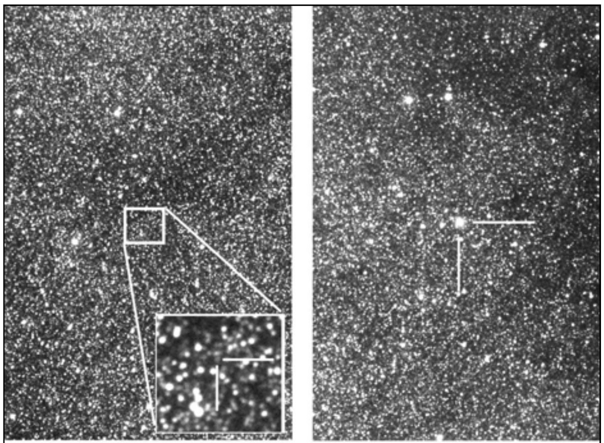


Figure 2. Variation of total magnitude (m1) of comet 29P

Comet section members are strongly recommended to submit their observations to COBS as it has become *the* world-wide repository for comet observations. How to generate total or Visual Equivalent Magnitudes from CCD images is described at
http://www.britastro.org/projectalcock/CCD%20Astrometry%20and%20Photometry.htm

Although it could be imaged using the Warrumbungle Robotic Telescope, Comet 29P was hiding in the Milky Way through most of 2015 and was thus difficult to measure. Figure 3 shows this and its variation in brightness. It was approx magnitude 12 (m1) on May 14th – obviously much brighter than on April 29th but the packed star field made it very difficult to measure its brightness on that date.



Comet 29P/Schwassmann-Wachmann, 2015 Apr 29, 1350UT (L), May 14, 1131UT (R) 28x18 arc mins, 90s exp, Warrumbungle Planewave 0.51m f/6.8CCD, unfiltered, R. Dymock, MPC Q65

Figure 3. Comet 29P lurking in the Milky Way

I have become a somewhat lazy astronomer and much prefer making observations using the SSON and Warrumbungle Robotic Telescopes - http://sierrastars.com/. The former is located in the USA and the latter in Australia and together give access to both northern and southern skies. Use of these telescopes is described in a tutorial at http://www.britastro.org/projectalcock/Using%20the%20SSON%20robotic%20telescope.htm

I am grateful to the BAA for helping to finance this particular exercise via the Robotic Telescope Project - http://www.britastro.org/robotscope/. Anyone wishing to submit projects should be aware that accepted projects receive 50% of the cost of using the SSON telescope from the BAA.

Using the SSON telescope is easy once an account has been set up and after logging in. Schedule a job by:

- Choosing the comet from a list
- Inputting title and observer name

- Selecting telescope, filter, duration, number of exposures (5), delay between each (15 mins)
- A confirmation email is subsequently received and then another one when the job has run.

I have found it extremely helpful to use planispheres for the USA and Australia to judge which comets are available for imaging together with Megastar, a planetarium programme, which incorporates the latest orbital elements downloaded from the Minor Planet Center.

The Moon can be a problem and a comet – Moon separation of at least 30 degrees is recommended when using the aforementioned robotic telescopes. Over exposure and trailing must be avoided and calculations to avoid such problems are described in the tutorial. Referenced above.

Recommended targets for 2016 are listed in Table 1. If you are interested in imaging these most interesting comets please contact Richard Miles (ARPS Section Director

Comet	Observational period, comments
17P/Holmes	**Approaching perihelion 2017 September – very faint**
29P/ Schwassmann-Wachmann	**All year**
41P/Tuttle-Giacobini-Kresak	**From 2016 November. Perihelion 2017 April**
174P/Echeclus	**2016 Jun – 2017 Feb**
186P/Garradd	**2016 Feb – 2016 Jun**
P/2010 V1 (Ikeya-Murakami)	**2016 Feb – 2016 Aug**
C/2013 C2 (Tenagra)	**2016 Feb – 2016 Aug**

Table 1. Observing opportunities for outburst comets

Roger Dymock - Outreach and Mentoring

The European Comet Conference on 2015 June 6. https://drive.google.com/file/d/0B8OVnW0WLB3EdVNDQmV4V3M3dHc

BAA Ordinary Meeting 2013 Dec 14 - https://britastro.org/video/99/3654

BAA Ordinary Meeting 2014 January 29 - https://britastro.org/video/5367

On Liquid phases in cometary nuclei, Richard Miles and George Faillace, Icarus Vol 219, pp 567-595 (2012).

Anatomy of outbursts and quiescent activity of Comet 29P/Schwassmann-Wachmann, Richard Miles, G A Faillace, S Mottola, H Raab, P Roche, J-F Soulier, and A Watkins. Icarus Vol 272, pp 327-355 (2016).

Discrete sources of cryovolcanism on the nucleus of Comet 29P/Schwassmann-Wachmann and their origin, Richard Miles. Icarus Vol. 272, pp 387-413 (2016).

Heat of solution: a new source of thermal energy in the subsurface of cometary nuclei and the gas-exsolution mechanism driving outbursts of Comet 29P/ Schwassmann-Wachmann and other comets, Richard Miles. Icarus Vol. 272, pp 356-386 (2016).

The chemistry of comets, Richard Miles, JBAA Vol. 126, No.2, 2016 April

8 Comet Imaging in a Light Polluted Site – Peter Carson

Background

Most observers and imagers operate from their home locations which generally tend to be in an urban area. These urban areas, whilst convenient for non-astronomical activities, are usually light polluted making them challenging for successful comet imaging. To alleviate these problems you could move house to a rural environment, move your observatory and operate it remotely or give up. All these options are usually not acceptable to either your partner, bank balance or your enjoyment.

Comets are transient objects of an unpredictable nature which is what makes them rewarding to observe. They demand attention at short notice and on a regular basis so ideally your equipment needs to be where you are…..in the light pollution. By adopting some specific techniques, a little advanced planning, and taking some basic precautions, good quality comet imaging can be done from a light polluted site. In fact, on the recent comet 67P Rosetta Pro Am collaboration social media site, at first glance it was quite difficult to tell apart images taken under a pristine sky at a mountain top site from images taken in the back gardens of amateurs living in towns with 4th magnitude visual limiting magnitude skies.

From my light polluted urban site with 18.5 to 19.5 magnitude per square arcsecond SQM zenith skies I can, with care, record comets fainter than magnitude 18. I'm using a 315mm reflector and exposures of 120 seconds with an Sbig ST8300 from the budget end of the CCD camera range.

So how should you go about imaging comets from a light polluted location? The considerations fall into four categories:

1) Site preparations
2) Image acquisition considerations
3) Post acquisition calibration techniques
4) Image clean up techniques

1) Site preparations

These are quite obvious and apply to all branches of astronomical observing and imaging.

Reduce your local sources of light pollution. Persuade your neighbours to adjust or reduce their lighting to avoid light spilling onto your observing site. Tackle major sources of local light pollution. I've found the majority of large commercial organisations, car park managers, pubs etc. can be encouraged to make improvements.

Reduce, as far as practical, the effects of street lighting. Local authorities usually co-operate with requests to shield offending lighting columns.

Screen your observing area from stray light or house your equipment in an observatory.

2) Image acquisition considerations

Where practical take your images when the comet has culminated reaching the highest point in the sky so you image through the least thickness of atmosphere.

Often artificial lighting levels reduce after midnight so light pollution levels tend to reduce in the early hours of the morning. My skies improve dramatically between 22.30hrs and 23.30hrs, i.e. they improve from diabolical to awful!!

Endeavour to image the comet in the least light polluted part of your local sky. A Sky quality meter is useful to determine the facts regarding what can otherwise be a subjective assessment.

Exposure lengths need to be short enough to freeze the motion of the comet against the background stars but long enough to achieve an acceptable signal to noise ratio. The resultant image must not be saturated. The full well depth capacity of the CCD, especially the pixels covering the comet, should not be exceeded. Ideally there should be a good spread of brightness levels across the camera's dynamic range, without brightness levels being bunched up at either the back or white ends of the histogram. Most DSLR cameras and software packages will enable you to view a histogram of the camera brightness levels. Choose an exposure length that creates the largest brightness count (which will be the background light pollution) no higher than 25% to 33% of the maximum level, providing this does not trail or saturate the comet nucleus or saturate too many background stars.

The exposure lengths need to be checked and re-adjusted depending on the altitude of the comet, the transparency of the sky on a particular night, the brightness of the comet and its speed of motion in the sky. It is very easy to over expose and risk saturating the camera when imaging a low altitude area of sky at a light polluted site.

Take lots of exposures, at least 7, preferably a few tens and stack them together. Light pollution will cause the image background to appear noisy. Stacking many image sub exposures will average out the noise making the image much smoother.

A Light pollution filter could be used if the image is intended to create an aesthetic record only. However because the image would be lacking various parts of the visual spectrum caused by the blocking nature of the filter it would not be a true record of the comets visual appearance. LPR filters spoil the scientific value of the raw data so filtered exposures are not suitable for subsequent photometry measurements.

3) Post acquisition calibration techniques

Probably the most important thing to do to any image taken under a light polluted sky is to properly calibrate it using a good master flat frame. Flat frames are images taken of a uniformly even light source and represent a measure of the inherent sensitivity variations of the camera pixels, the uneven light distribution of the optical system and shadows of dust particles in the light path. The flat frames, together with dark frames and bias frames, are used to correct the raw light images to remove uneven illumination and other electronic artefacts. This process, called calibration, can be carried out using most image acquisition software packages.

Because a comet, especially its tail, will be only just brighter than the light polluted sky background it is very important that a clean undiluted image is secured prior to contrast stretching or subsequent photometric measurement. This will enable only the weak tenuous signal from the comet to remain in the image which when contract stretched can be successfully displayed.

A good master flat frame should consist of an average of at least 50 sub exposures, preferably more.

Flat frames can be generated by imaging a clear twilight sky or more easily using a purpose made light box or illuminated flat panel. The uniformity of the light source should be checked by creating a stack of flat frames and calibrating them with an equal number of flat frames taken of the same light source rotated through 90 degrees. The resulting image, if heavily contrast stretched, will reveal any non-uniformity in the light source. Check the pixel information of the "flatted flat" in software such as MaxIm DL and aim to achieve all pixel brightnesses within 1% of each other.

4) Image clean up techniques

Some of the techniques used by the "deep sky picture" imagers can be employed here providing they do not introduce image artefacts or spoil the basic image data. I would suggest that unsharp masks or other filters, techniques involving working on parts of the image using a layers technique, or any similar image manipulation, are steps into the world of art and not science. However the use of simple gradient removal, the cloning out of obvious image defects and mild noise filtering is acceptable in producing an image that extracts the maximum true information from the image and faithfully represents what is present in the original data.

Gradient removal tools are useful for removing any remaining effects of light pollution present in the calibrated image. Light pollution is generally brighter nearer the horizon than at the zenith. This causes a brightness gradient across an image that is not removed by image flat field calibration. My favourite gradient removal tool is Gradient Xterminator a Photoshop plug-in written by Russel Crowman. MaximDL and other image processing packages contain similar tools. IRIS software is free and contains a simple to use gradient removal tool similar to Gradient Xterminator. Care must be taken when using these removal tools to avoid an unintentional change to the comet tail brightness by applying it too strongly.

Low level light pollution manifests itself as a background noise in your image, some of which is removed by calibration and gradient removal. The remaining noise can be tempered by using a software noise filter. These filters generally have a detrimental effect on the fine detail of an image but if used sparingly can be useful in creating a more pleasing visual appearance of a finished image. I prefer to use Noel Carboni's action for Photoshop, but many other software packages are available.

Conclusion

Certainly there is little reason to be put off from imaging comets from an urban light polluted site. Great images and good science can be carried out at these less than ideal locations. The convenience of having your telescope equipment set up and close at hand will enable you catch that exciting tail disconnection event, witness a nucleus fragmentation or be first to record the appearance of a newly discovered comet....and have the reassurance that your warm bed is only steps away!

My observatory is located in the back garden of my home under light polluted skies one mile from London Southend International airport in Essex. It's within the urban area of Southend on sea which part of the London Gateway business area, not an area most people associate with comet imaging and photometry. Whilst perhaps more difficult to achieve than from a dark site, my images do stand favourable comparison with imagers based at much better placed sites so don't let light pollution put you off from taking and submitting images to the Section.

Peter Carson
petercarson100@gmail.com

9 My Observatory - Tarbatness MPC Code I81 - Denis Buczynski

Tarbatness Domes

I first became interested in comets in 1974. Sir Patrick Moore appeared on TV telling the world that there was going to be a very bright comet visible in the western evening sky around Christmas and New Year. He said, “This is will probably be the Comet of the Century”. So I went out in the freezing cold, every clear evening, but I never did see that Comet. It was C/1973 E1 Kohoutek. But it sparked a fascination for observing comets that I have never lost.

Eventually I did see my first comet - Periodic Comet 6P/d’Arrest in 1976. I was determined to see this returning comet after reading a Comet Digest article in Sky and Telescope (July 1976) by John Bortle and Brian Marsden. The article outlined the prospects for its next upcoming apparition. A 6 inch f/8 Alt-Azimuth reflector was my only instrument at that time. I used a careful star-hopping method with that telescope until I reached the field containing my first comet. That simpler age is long gone and my routine now, during an observing run, is to image more than a dozen comets, many so faint that visual observation of them would be impossible.

6”f8 Newtonian and 30cm f4 Newtonian

My interest in comets and observing them was further enhanced with the prospect of the 1986 return of Periodic comet 1P/Halley. My friends and I had built a large 55cm F/5 reflector in my ‘Conder Brow Observatory’ in my home town of Lancaster. This telescope was equipped for comet photography and I was determined to observe comet Halley and make some scientific observations of it as it passed through our skies. I was focussed on methods of photographic cometary astrometry. This is the determination of precise positions for the purpose of comet orbit calculation.

I was very fortunate to be taught how to make measurements of the comet images on my photographs by an expert in the subject, Professor Vinicio Barocas at the University of Central Lancashire. Subsequently his successor, Professor Ian Robson, loaned to me UCLAN’s Hilger twin axis measuring machine. This allowed me to make the measurements at my home. The reductions of the measurements to celestial positions were made on a BBC Micro using software written for me by Keith Robinson at the Jeremiah Horrocks Observatory in Preston. Numbers from the sky, (i.e. positions and magnitudes), that was my aim.

55cm f5 Newtonian 1

As part of the BAA Comet Section/IAU Halley Watch Programme I was privileged to work alongside Dr Reggie Waterfield, Harold Ridley, Brian Manning and Peter Birtwhistle all ably directed by Mike Hendrie. Many positions of Halley and other comets were submitted to the MPC over the next 10 years and all were painstakingly obtained by means of photography and plate measurements.

However there was massive change on the horizon with the introduction and availability of the CCD to the amateur community. I remember walking into a BAA Exhibition Meeting in London in the early 1990's and Martin Mobberley stating, "photography is dead". Ron Arbour was demonstrating his new Terry Platt designed Starlight Xpress Framestore CCD camera. Objects that had needed tens of minutes of photographic exposure could now be captured in seconds on the sensitive CCD chips. We understood then that our newfound ability to record faint light sources, like comets, which had eluded us up until then showed that Martin was right and film photography's days were numbered. Comet Hale-Bopp in 1996 was probably the last comet to be widely observed using photographic means.

In 2010 I retired from work and moved to Highland Scotland. Now I had the opportunity to establish a modern and dedicated observatory from which to observe comets. My main interest is still cometary astrometry and now that I am freed from the constraints of earning a living I am able to pursue this with a renewed vigour and in a more relaxed way. A nights' observing now means stopping only when the observing conditions deteriorate or dawn arrives. All the comets above the horizon, bright or faint, are now available to me and my telescopes are set up and equipped for comet imaging without manual interference. The computers, CCDs and the GOTO systems go about their business, only prompted by me to move to the next target. I am now producing more cometary astrometry in a month than I did over 10 years of photographic astrometry.

I have installed two observatory domes at my home at Portmahomack on the stunning Tarbatness Peninsula. It lies between the Firths of Moray and Dornoch, jutting out into the North Sea about 40 miles north of Inverness. Both domes are 2.7 metres in diameter and have more or less unobstructed horizons. In one of the domes is a Celestron 0.35m, f/10 Schmidt Cass and a wide field 80mm Apo on a Paramount ME. The CCD cameras used at present on this instrument are an SBIG ST9XE and a Starlight Xpress SXVH9. The other dome contains a 30cm f/4 Newtonian with a Baader Multi-Purpose coma corrector (MPCC) and a BAA loan CCD, a SBIG ST10XE. In addition to these comet imaging telescopes I have two visual instruments - a 23cm f/4 Newtonian and a Victorian built 100mm Ross Apochromatic refractor (The George Alcock telescope). My observatory is also equipped with two automatic meteor detection cameras operating for the BAA NEMETODE Network.

I continue to produce cometary astrometry and will also participate in the programme to obtain visual equivalent cometary photometry from the CCD images I take. This will be new territory for me. However I am looking forward to taking part in this programme, possibly using the technique described by the Director elsewhere in this issue.

In a further step, I am joining the comet observing programme run by CARA (the Italian team) whose aim is to image comets in red light in order to measure and calculate comet dust production values defined through the parameter (Afρ). The prolific Belgian comet observer (and BAA Comet Section member) Erik Bryssinck is one of the mentors for this programme and I hope to enlist his assistance with my participation in this joint effort.

This is my cometary life to date. If you find yourself in my beloved Highlands, please let me know and arrange a visit. I will be very happy to see you and show you my observatories and telescopes. If it is dark and clear we may even see a comet or two.

Denis Buczynski – Secretary Comet Section

10 Method for the calculation of Visual Equivalent Magnitudes – and a plea for help – Nick James

For many years amateur comet imagers have been producing quality astrometry using highly automated programs such as Astrometrica. The astrometry is submitted to the Minor Planet Center and, despite the large amount of professional survey astrometry, it is still an important contributor to the computation of accurate comet orbits. Astrometrica also calculates a magnitude as a by-product of computing the astrometry but, for comets, this is often much fainter than the actual magnitude since the photometric aperture is small compared to the comet's apparent diameter.

Current Methods

From the inception of the BAA Comet Section visual observers have been contributing estimates of the total magnitudes of comets using several methods. The 'visual total magnitude' is defined as the total amount of light coming from the comet's coma. Brighter comets are generally estimated using smaller optical aid so that the full dimensions of the coma are seen. These magnitude estimates are submitted along with other information in the ICQ (International Comet Quarterly) format and can be used to generate lightcurves and to estimate the magnitude parameters of a particular comet. The COBS (Comets OBservation Database - http://www.cobs.si/) database is the current recommended repository for this information.

Given that there are now many more imagers than visual observers we in the Comet Section would like to find an easy way for imagers to extract Visual Equivalent Magnitudes (VEM) from their image data. In principle this is relatively straightforward. A determination of the VEM requires that a count all of the light arriving from the coma to obtain an instrumental magnitude. This can then be converted into a real magnitude by determining the magnitude zero point of the image using a catalogue containing photometric reference stars. Ideally, to correspond to a visual magnitude, the overall response of the imaging system should be approximate to that of the human eye.

Counting all of the light in the coma is complicated for two reasons:

1. We need to make a very accurate estimate of the sky background from the image so that the count contribution from the sky can be removed from the measurement. The sky background estimate is also important to get an accurate determination of the coma diameter.
2. We need to ignore the contribution from stars within the photometric aperture since this could otherwise significantly skew the estimate.

Visual observers somehow manage to do this very well by instinct and experience. Any software program designed to do this reduction must do the same by some kind of objective, repeatable algorithm.

One approach to producing a VEM is the method that is currently adopted by the Comet Section. This uses a combination of three programs: Astrometrica, Focas and kphot. In this method the magnitude of the coma is measured in six concentric photometric apertures of radii 5.6 – 33.6 arcsec. As the photometric aperture increases, the estimated magnitude will also increase since more of the coma is included. The measurements in consecutive apertures allows determination of a growth curve which defines the increase in counts as the aperture size increases. If the coma is smaller than the maximum radius aperture (and the sky has been estimated correctly) the growth curve should flatten out at large radius. If not, the growth trend will still be brightening even at the largest aperture. The six measurements from Focas are then used by kphot. This program assumes a particular physical model which predicts how brightness changes with radius, and it fits the measured growth curve to an example coma. Using the curve fit parameters it can extrapolate the total magnitude. This works well as long as the coma is reasonably small and the camera field of view is considerably larger than the coma diameter so that the sky estimate is accurate. The method fails if the coma is large compared to the FoV or the photometric apertures or if any bright stars are included in the concentric apertures since they will disturb the growth curve and lead to an incorrect extrapolation.

An alternative approach is to measure the light in the coma using a photometric aperture which is large enough so that it includes the entire coma. For this to be effective it is necessary to accurately estimate the sky background level and to remove the light contributed by the background stars in the photometric aperture. To obtain a good sky estimate the image field of view must be considerably larger than the actual apparent coma diameter so, for large bright comets a short focal length and a DSLR are ideal. The main problem with this method is that it involves the removal of the stars before the magnitude estimate is performed. There are some ways of doing this but they are often difficult to use.

Proposal – new approach

For some time I have been working on an alternative approach which I hope will simplify the extraction of VEMs to the point that the effort required is similar to that currently needed to extract astrometry using Astrometrica. My objective is to come up with a software approach which is robust over a wide range of circumstances: from faint comets in large telescopes to bright comets in wide-field systems and which requires minimal user interaction.

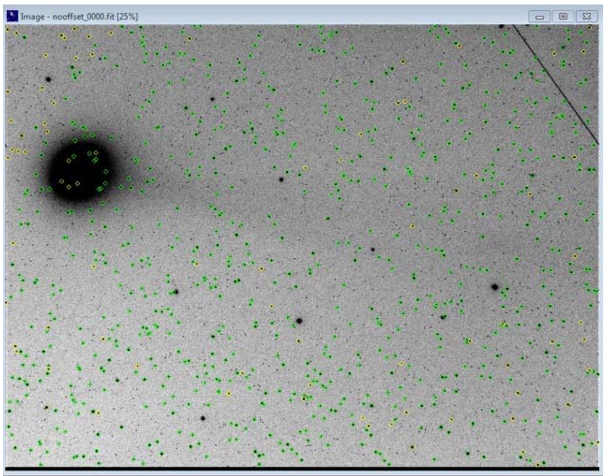
The approach is based on measuring the total counts in an aperture which matches the coma diameter. The software requires two stacks for each comet:

1. A stack which is aligned on the stars and which is used to determine the magnitude zero point using a defined catalogue.
2. A stack which is aligned on the comet's motion. This will have the same zero point as the first stack but the comet's motion will be frozen so that the photometric count in the coma aperture can be determined.

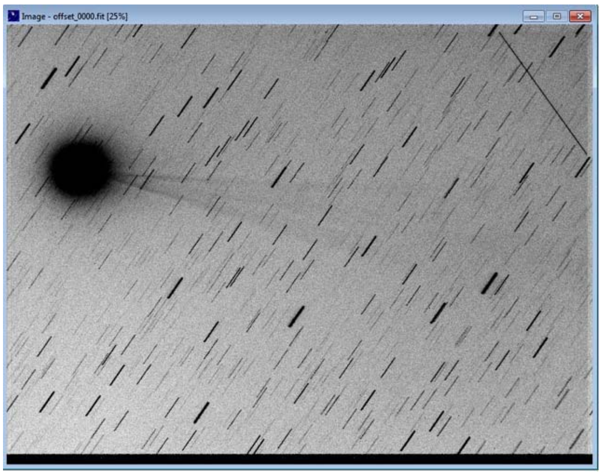
The program first makes an estimate of the sky background using a median estimator. This requires that the coma occupy only a relatively small part of the field of view. To automate this approach it is necessary to have a very robust method for estimating the sky background. As part of this it is important that the sky background in the measured image is flat so accurate flat fielding and gradient removal is necessary prior to performing the measurement. Once the sky background has been determined the program estimates the noise in the image as the first stage in setting a threshold for detection of the limits of the coma. The estimated diameter of the coma is then used to set the photometric aperture size.

Since the photometric aperture may contain stars in addition to the comet we need to remove them. A simple way of removing the stars is to use a statistical approach which assumes that the coma is essentially rotationally symmetric about the photocentre. I divide the photometric aperture into a set of concentric annuli centred on the photocentre. In each annulus I determine the median count. The median is a statistical average which corresponds to the middle value in a sorted list of values from the smallest to largest. It has the advantage that it is not biased by occasional outliers such as the stars which appear in the annulus. Effectively the stars are ignored in the median estimation. The total coma count is then the sum of all of the median counts in the different annuli. This appears to be an effective approach since the comae of most comets are symmetrical around the photocentre.

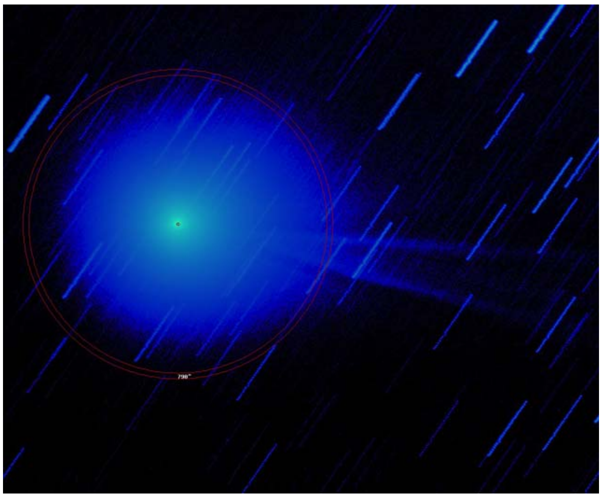
I currently have some Linux software that I have written to demonstrate this approach and I have been using it on a number of images taken by others and myself. I am pleased that in most cases the magnitude estimate is in line with visual observers but there are a number of cases where I have obtained results which are significantly different to other estimates on COBS. This is still work in progress and I am looking at ways to make the algorithm more robust. The images below give examples of the process for a bright comet (C/2014 Q2 Lovejoy) and a fainter one (C/2014 W2 PanSTARRS). In both cases the same software was used and all parameters were extracted automatically.



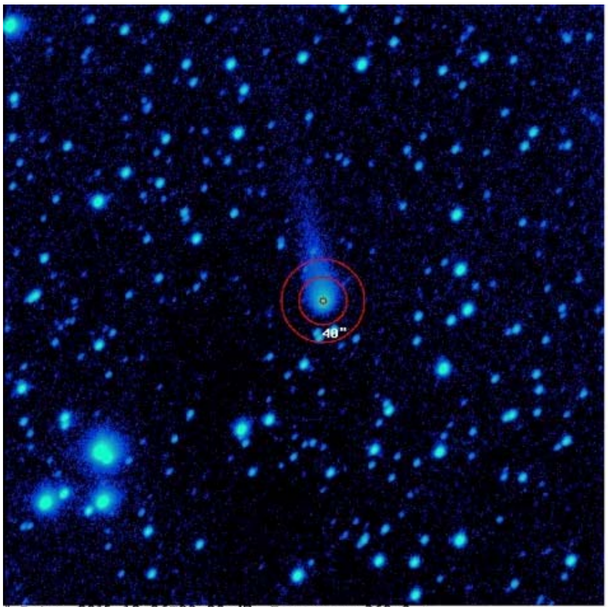
Example stack aligned on stars. C/2014 Q2. 2015 January 15, 20:53. 18x120s. FoV 143'x108'. Estimated zero point of this frame using UCAC-4, R mags = 23.01.



The same stack aligned on the comet. This is the full frame used for VEM measurement.



Detail of the stacked frame. The software has estimated and removed the sky background and has estimated the coma radius (and hence photometric aperture size) at 790 arcsec. This is a colour coded log stretch with pixels below the noise threshold set to zero. The photometric aperture size is shown as the inner red circle. Note that there are a large number of trailed stars in the aperture. The estimated magnitude in this aperture is 4.18. The mean of the 23 COBS visual estimates on this date is 4.20 with an RMS scatter of 0.41.




```
# Date: 2015-12-06T20:20:47, Exposure: 360.0 s
# Telescope: Unknown, Camera: SBIG ST-9 Dual CCD Camera
# Observer: Unknown
# Object: C_2014_W2__PANSTARRS_
# Scale: 1.98 "/pix, FoV 16.9x16.9 arcmin, PA: -1.6 deg, ZP: 26.42 ma
# Sky background before normalization: 2088.4
# Sky background from fixed stack: 2088.4
# Residual sky background in offset stack: -0.1, RMS sky 20.6
# Centroid at 272 252, Max pixel is 3600.0
# SKY: 10.0 (6 -> 21) 1200 0 50.1
# SKY: 40.0 (21 -> 36) 2628 0 8.6
# Sky estimation annulus inner radius 40.0 arcsec, skylevel 8.6
# Total pixels requested but outside frame: 0
 10x10   20x20   30x30   40x40   50x50   60x60
 14.43   13.63   13.33   13.17   13.08   13.02 # Counts
 14.43   13.70   13.39   13.25   13.20   13.17 # Median annuli
Total integrated magnitude: 13.15 (radius 45.1 arcsec)
```

Example result for a much fainter comet in a narrow field. This is an image of C/2014 W2 obtained by Denis Buczynski. This shows the output of the software which includes a Focas-like set of multi-box magnitude measurements. Note that the median approach leads to a 60x60 estimate which is around 0.15 mag fainter than the normal approach. This is because the median ignores faint stars in the aperture. The mean of the 7 visual observations in COBS around this date is 12.4 with an RMS scatter of 0.9.

Unfortunately, due to other commitments, I have not been able to progress with this project as fast as I would like. I have one volunteer who has offered to turn the algorithms into a user-friendly Windows program but this is being held up due to my own lack of progress in developing the basic approach. Most of the method is in place but more testing is required and some tweaks are necessary to make the process more robust. If anyone would like to take over this part of the development I would be more than happy to hear from you! Please contact me via email at the address on the front page

Nick James – Section Director

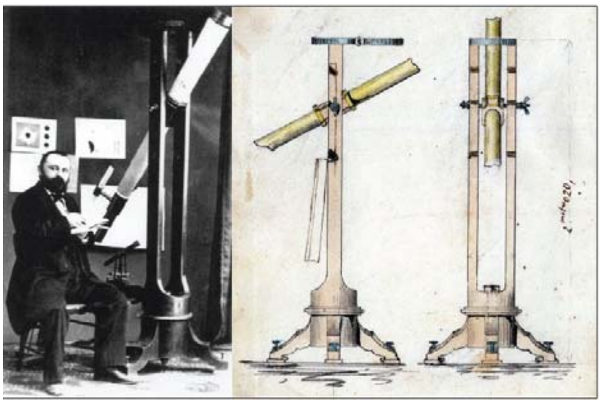
For a description of the various methods currently in use see:

http://www.britastro.org/projectalcock/CCD%20Astrometry%20and%20Photometry.htm

Comet Observers of the Past – Histories Contributions and Achievements

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

11 Wilhelm Tempel's Periodic Comets - Denis Buczynski



Tempel and his discovery telescope Journal of Astronomical History and Heritage, 13(1), 43-58 (2010). 43. WILHELM TEMPEL AND HIS 10.8-cm STEINHEIL TELESCOPE. Simone Bianchini et al

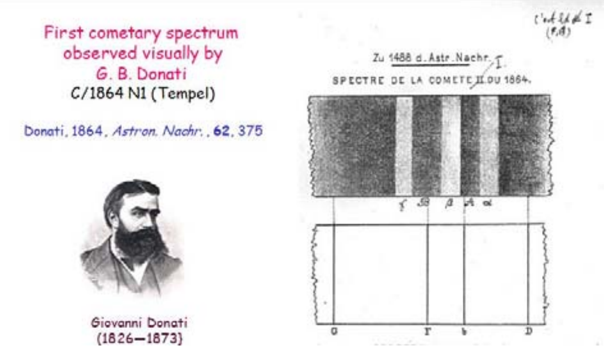
Observable in our skies during the past few months have been two of Wilhelm Tempel's periodic comets, 9P and 10P. So now is a good time to remember his life and work and to consider his important periodic comets.

Ernst Wilhelm Liebrecht Tempel (1821-1889) was born in Germany in the Kingdom of Saxony. His parents were farmers and Tempel's only formal education was at the village school. He was mentored by his teacher Johan Kiesewalter who introduced him to the night sky and also taught him the skills needed to become a lithographer. Both of these were to prove essential to Tempel throughout his life.

Tempel worked first as a lithographer in Copenhagen and then searched for and found work as an assistant astronomer at various European Observatories, mainly Marseilles, Bologna and Venice. It was during work at these observatories, but predominantly in his own personal time, that he discovered the comets, asteroids and nebulae that brought him fame but not fortune. He was a prolific observer and could have been described as somewhat obsessively single-minded in his devotion to astronomical observing.

It may seem surprising that the large telescopes situated at the formal observatories were not, in general, the telescopes that Tempel used to make his discoveries. For most of his life he employed a small 4 inch/10.8 cm Steinheil refractor of 5 feet/1.62 m focal length which he had purchased directly from the manufacturer in 1858. This small telescope was mounted in an unusual Alt-Azimuth form and remained unaltered during his long use of it until his death in

1889. He used very low power eyepieces (x24 with a 2 degree field) for observing comets and he attributed many of his discoveries to the excellent quality of the Steinheil telescope.



Tempel accomplished an impressive list of 28 discoveries of various classes of astronomical objects (19 comets, 6 asteroids, 1 reflection nebula, 1 galaxy and 1 planetary nebula). The reflection nebula discovered was the now famous Merope nebula in the Pleiades. These discoveries were made between 1859 and 1874. The observing sites were mainly in Venice, Marseilles and Milan. However the more precise locations were listed as "home garden" "home window", "home balcony". Only a few instances of discovery locations are listed as "Observatory". Some of the comets were independent discoveries and others were jointly discovered with other observers, but were unknown to Tempel at the time. He received many awards, medals and prizes during his life and was regarded by many of his contemporaries as an exceptional and keen-eyed observer. Today we mainly remember his name because of the periodic comets he discovered: 7P, 9P, 10P, 11P, 38P and 55P.

Table 1: Tempel's astronomical discoveries made with the 4-in Steinheil telescope (adapted from Tempel, 1868a and Flammarion, 1874).

No.	Name	Alternative Name	Type of Object	Discovery Date	Observing Location
1	C/1859 G1	1859	comet	2 April 1859	Venice, Escalier Lombard
2	NGC 1435	Pleiades Nebula	reflection nebula	19 October 1859	Venice, Escalier Lombard
3	C/1860 U1	1860 IV	comet	24 October 1860	Marseille Observatory terrace
4	(64) Angelina		asteroid	4 March 1861	Marseille Observatory terrace
5	(65) Cybele	Maximiliana	asteroid	8 March 1861	Marseille Observatory terrace
6	C/1862 N1	1862 II	comet	2 July 1861	Marseille, home garden
7	(74) Galatea		asteroid	29 August 1862	Marseille, home window
8	C/1863 G2	1863 III	comet	17 April 1863	Marseille, home garden
9	(79) Eurynome		asteroid	6 October 1863	Marseille, home window
10	C/1863 T1	1863 VI	comet	14 October 1863	Marseille, home balcony
11	C/1863 V1	1863 IV	comet	5 November 1863	Marseille, home garden
12	C/1864 N1	1864 II	comet	5 July 1864	Marseille, home garden
13	(81) Terpsichore		asteroid	30 September 1864	Marseille, home window
14	55P/1865 Y1	1866 I	comet	19 December 1865	Marseille, home balcony
15	38P/1867 B1	1867 I	comet	28 January 1867	Marseille, home balcony
16	9P/1867 G1	1867 II	comet	3 April 1867	Marseille, home window
17	(97) Klotho		asteroid	17 February 1868	Marseille, home window
18	7P/1869 G1 (?)	1869I, 1869a	comet	29 June & 12 August 1869	Marseille, home balcony
19	C/1869 T1	1869 II, 1869b	comet	12 October 1869	Marseille, home garden
20	11P/1869 W1	1869 III, 1869c	comet	27 November 1869	Marseille, home balcony
21	C/1870 K1	1870 I, 1870a	comet	30 May 1870	Marseille, home balcony
22	C/1871 L1	1871 II, 1871b	comet	14 June 1871	Milan, Brera Observatory
23	C/1871 V1	1871 IV, 1871e	comet	3 November 1871	Milan, Brera Observatory
24	10P/1873 N1	1873 II, 1873b	comet	4 July 1873	Milan, Brera Observatory
Other discoveries not included in the references above					
25	NGC 1398		galaxy	9 October 1861	Marseille
26	NGC 1360		planetary nebula	9 October 1861	Marseille
27	X/1871 Y1		comet	29 December 1871	Milan
28	C/1874 G1	1874 II, 1874b	comet	19 April 1874	Milan

Tempel's discoveries. Journal of Astronomical History and Heritage, 13(1), 43-58 (2010). 43. WILHELM TEMPEL AND HIS 10.8-cm STEINHEIL TELESCOPE. Simone Bianchini et al

These comets return to perihelion regularly and this allows us to observe them at multiple apparitions. Some of his periodic comets are important comets and are associated with major meteor showers and another was more recently associated with a spacecraft mission. The discovery details following are mostly derived from the excellent Cometography Series by Gary Kronk.

http://cometography.com/index.html

Also some details are taken from Jon Shanklin's Periodic Comet Section on his webpage - http://www.ast.cam.ac.uk/~jds/per0010.htm

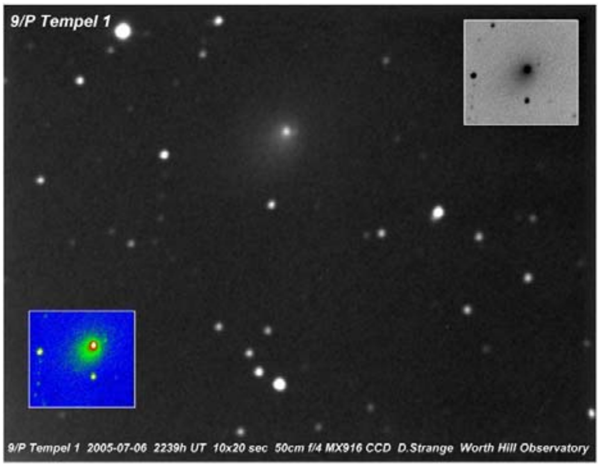
Lastly the most comprehensive paper on Tempel's life is to be found at this link - http://www.narit.or.th/en/files/2010JAHHvol13/2010JAHH...13...43B.pdf. I have relied heavily on this paper in writing this article.

Periodic comet 7P (period in 1996 was 6.37 years)

This comet was originally discovered by Jean Louis Pons at Marseilles on 1819 June 12. It was accidentally rediscovered by

Friedrich August Theodor Winnecke (Bonn, Germany) on 1858 March 8. Winnecke recovered it on 1869 April 10 and it was independently found by Tempel on 1869 June 29. This comet is associated with the June Bootids meteor shower.

Periodic comet 9P (period in 1972 was 5.5 years)

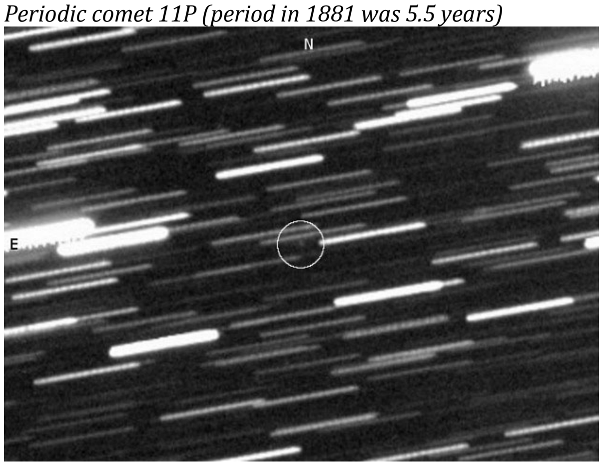


This was discovered by Tempel on 1867 April 3 at Marseilles. It was first recognised as being periodic early in May when K. C. Bruhns, Leipzig, Germany, determined the orbital period as 5.74 years. By the time of the final observations, the orbital period had been revised to 5.68 years. Tempel himself made the recovery observation at the 1879 return on April 25. Perturbations by Jupiter have resulted in observationally favourable and unfavourable apparitions but since 1972 all apparitions have been observed. This comet was chosen for the spacecraft Deep Impact Mission in 2005 and the spacecraft impactor crashed into the comet. It was re-visited by the Stardust spacecraft on 2011 February 15. The current apparition of 2016 is a favourable one.

Periodic comet 10P (period in 1873 was 5.1 years)

Tempel discovered this comet on 1873 July 4 at the Brera Observatory, Milan. He probably used his 4 inch Steinheil refractor which he considered to be a higher quality telescope than the mounted telescopes at the Observatory. The comet's orbit is stable. This is one of the reasons why it is a favoured target for possible spacecraft missions. In 1983 the IRAS satellite detected an extensive dust trail behind the comet. With a 5.5 year period alternate returns are favourable. The current apparition is ongoing.

Periodic comet 11P (period in 1881 was 5.5 years)



This image was obtained by J.-F. Soulier on 2014 September 1, using a 30-cm reflector and an SBIG ST8 XME CCD camera. The nuclear magnitude was determined as 20.5-20.7, while the comet was about 9" across. No tail was visible.

This comet was discovered by Tempel on 1869 November 27 in Marseilles but was only observed for 39 days thus making the determination of a period uncertain. The comet was independently discovered by Lewis Swift of the Warner Observatory, New York, as a diffuse, circular comet in Pegasus on 1880 October 11. By mid-November, astronomers realized Swift's comet was a return of Tempel's 1869 comet. After 1908 it was lost until observations on 2001 December 7 by the Lincoln Near Earth Asteroid Research (LINEAR) programme found an object using a 1.0-m reflector and a CCD camera. Carl Hergenrother of the Lunar and Planetary Laboratory and Kenji Muraoka in Kochi, Japan, independently suggested to Brian Marsden that the LINEAR comet might be a return of comet Tempel-Swift. The link was almost immediately confirmed by Marsden and Syuichi Nakano, in Sumoto, Japan. The current designation is 11P Tempel-Swift-LINEAR.

Periodic comet 38P (period in 1942 was 38.3 years)

Jérôme Eugène Coggia (Marseilles, France) found what he thought was an uncatalogued nebula on 1867 January 22.9. The sky clouded up almost immediately and remained completely cloudy until the night of January 24, when Édouard Jean-Marie Stephan in Marseilles, France, checked on the nebula through a brief break in the clouds and saw that it had moved. Stephan was able to confirm this was a comet on January 25.86 and said that it was rather brilliant, round, and with a very marked nucleus. The initial announcements did not mention Coggia's name and so the comet was named after Stephan. Tempel, then in Marseilles, independently discovered this comet on January 28.86. Although he knew of Stephan's discovery, he noted a distinct difference in the description from his and assumed wrongly that he had found a different comet. Tempel described the comet as very faint and about 3 arc minutes across. The comet was lost until it was accidentally found by Liisi Oterma in 1942. It now has the designation 38P Stephan-Oterma. In 2018 it should come within visual range in September as it brightens rapidly on its way to the November perihelion. It will be at its brightest in November, when it is in the late evening sky and remains well placed into 2019.

Periodic comet 55P (period in 1866 was 33 years)

Tempel discovered this comet from Marseilles on 1865 December 19. Horace Parnell Tuttle (Harvard College Observatory, Cambridge, Massachusetts) independently discovered this comet on 1866 January 6. Today it has the designation of 55P Tempel-Tuttle. A few years after the discovery, John Russell Hind made the suggestion that the comet might have previously been seen in 868 and 1366. No formal analysis was conducted until 1933, when Shigeru Kanda took up the challenge. He concluded that the comet of 1366 was most likely to have been Tempel-Tuttle, but the comet of 868 was not related. In 1965 Joachim Schubart took the comet's 1866 orbit and used a computer to examine the comet's motion through the solar system for 500 years into the past, applying the gravitational effects of the planets throughout that entire period. He confirmed Kanda's proof that the comet of 1366 was Tempel-Tuttle and also found that a single observation of a comet by Gottfried Kirch on 1699 October 26 was also Tempel-Tuttle. With three apparitions now available, the orbit was improved and Schubart provided a prediction for the 1965 return. The comet was recovered by Michael Bester in South Africa on 1965 June 30 and the position indicated that Schubart's prediction had been only 5 days too early. Giovanni Virginio Schiaparelli (Italy) wrote a letter to the Astronomische Nachrichten on 1867 February 2 which showed that this comet was probably related to the Leonid meteor storm that was observed during November of 1833 and 1866. A comparison of the comet's orbit with that of the November 1866 Leonid stream showed an almost perfect match. The last perihelion was on 1998 February 28 and the next is on 2031 May 20.

Another instance of scientific distinction is reserved for one of Tempel's comets, in that his comet C/1864 N1 was the first comet to have its spectrum observed. This was accomplished by Giovanni Battista Donati in 1864.

Tempel was a significant figure in the field of visual astronomical discovery. He was recognised by the major astronomical institutions and national bodies as an exceptional observer but this did not result in any personal wealth and at one point in 1865 he contemplated selling his Steinheil telescope to raise some money upon which to live. However he pulled back from this option, unable to part with his beloved telescope. During his life he and his wife Marianna Gambini shared a meagre and frugal life, and she found herself in a state of poverty upon the death of her husband, after which she did sell his telescope and papers to Arcetri Observatory where they remain today. His life was devoted to visual astronomical observing even when he was ill and close to death. His wife said, "Tempel worked to the last …the poor sufferer observed, ill as he was, from the top of his house with a small telescope."

By observing his comets today we are paying tribute to a great observer and discoverer.

Denis Buczynski - Secretary Comet Section

12 Editor's Whimsy – Janice McClean

"Mr. Babinet alerted by his housekeeper of the arrival of the comet..",

By M.Honoré Daumier, illustration for "Le Charivari", a French satirical magazine similar to Punch. This lithograph appeared on 22nd September 1858. With thanks to the Daumier Register Digital Work Catalogue

This lithograph is from a series called ACTUALITÉS (News of the Day).

A large section of Daumier's work carries a heavy socio-political message and must be interpreted as caricatures of protest against the French establishment. Almost a fourth of his lithographs deals with political topics and was published in the series ACTUALITÉS of the Charivari. The appearance of this series was directly linked to the free space left by censorship laws. Once a Government decided that the liberal press was getting too obnoxious, the laws immediately forced journalists as well as caricaturists to move towards less aggressive topics.

Most of the ACTUALITÉS series can be found in 1850 and 1851, before Napoléon III became emperor, reinstating the controlling system of the press. Between 1854 and 1856 during the Crimean war, the support of the press was again needed by the Government and ACTUALITÉS appeared uncensored for a short period. After 1856, once the war was over, publication of the series was stopped again and Daumier was forced to concentrate on the more harmless topics of everyday life. Occasionally, a print was published under the old series name, however it never covered any crucial themes questioning the' Emperor's [2] decisions.

Only in 1865, under pressure of the population who wanted to see and read more about France's involvement in her various military engagements under Napoléon III, the ACTUALITÉS started to appear again (DR3480) showing it's bite and bitter sarcasm towards military re-armament as a guarantee for peace. Later, between 1870 and 1871, Daumier's prints became rather biased when France declared war against Prussia. Still, one should not forget that in all of his work he vehemently opposed military force against France's neighbours.

[2] Louis Napoleon originally styled himself, "his Imperial and Royal Highness prince Louis Napoleon of France, Prince of Holland". Ultimately his full title was, "His Imperial Majesty Napoleon the Third, by the Grace of God and the will of the Nation, Emperor of the French".

The last print of this series (DR3936) appeared in December 1875, 25 years after the first print of ACTUALITÉS had been published.

"With thanks to the Daumier Register Digital Work Catalogue. For more examples on astronomy & caricature, go to:

http://www.daumier-register.org/werklist.php?themen=76&esok_themasrch=on

Janice McClean - Editor, Comet's Tale

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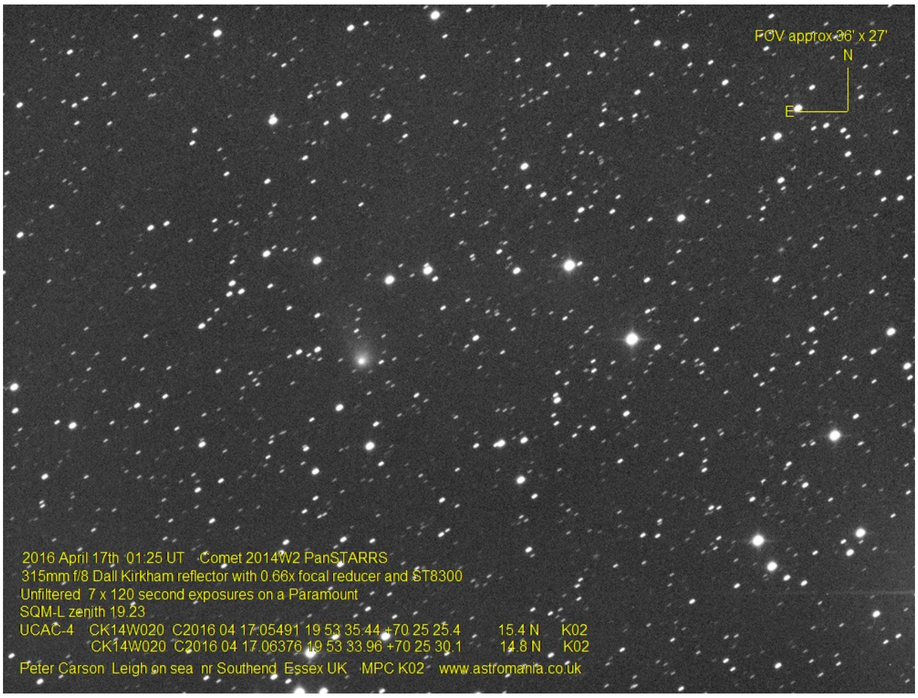
14 Picture Gallery

The Copyright for all images remains with the observer

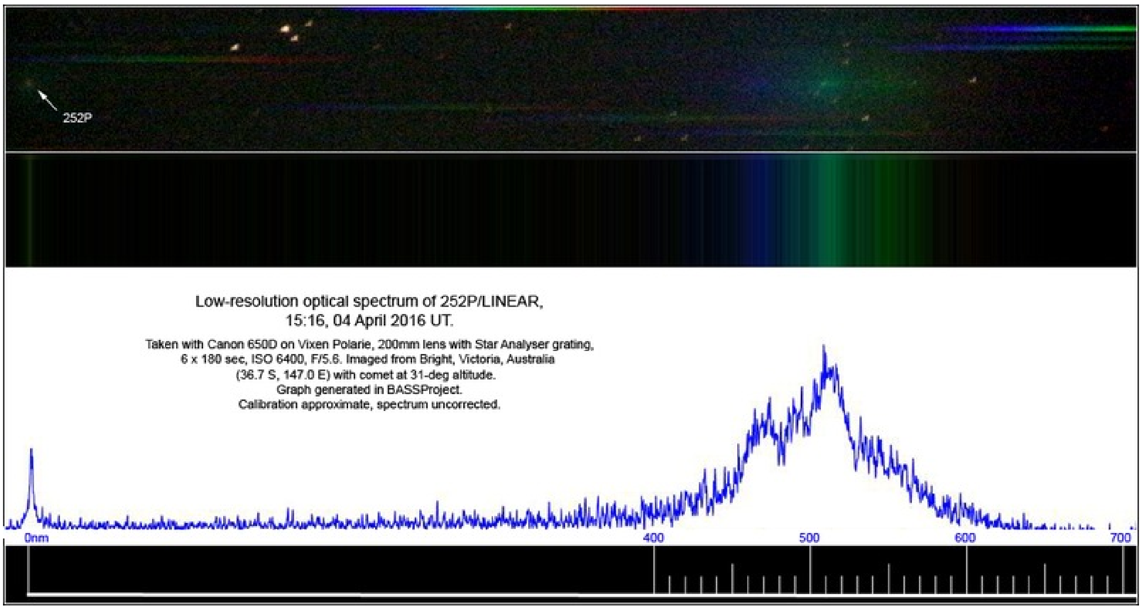
Comet 67P Churyumov-Gerasimenko :

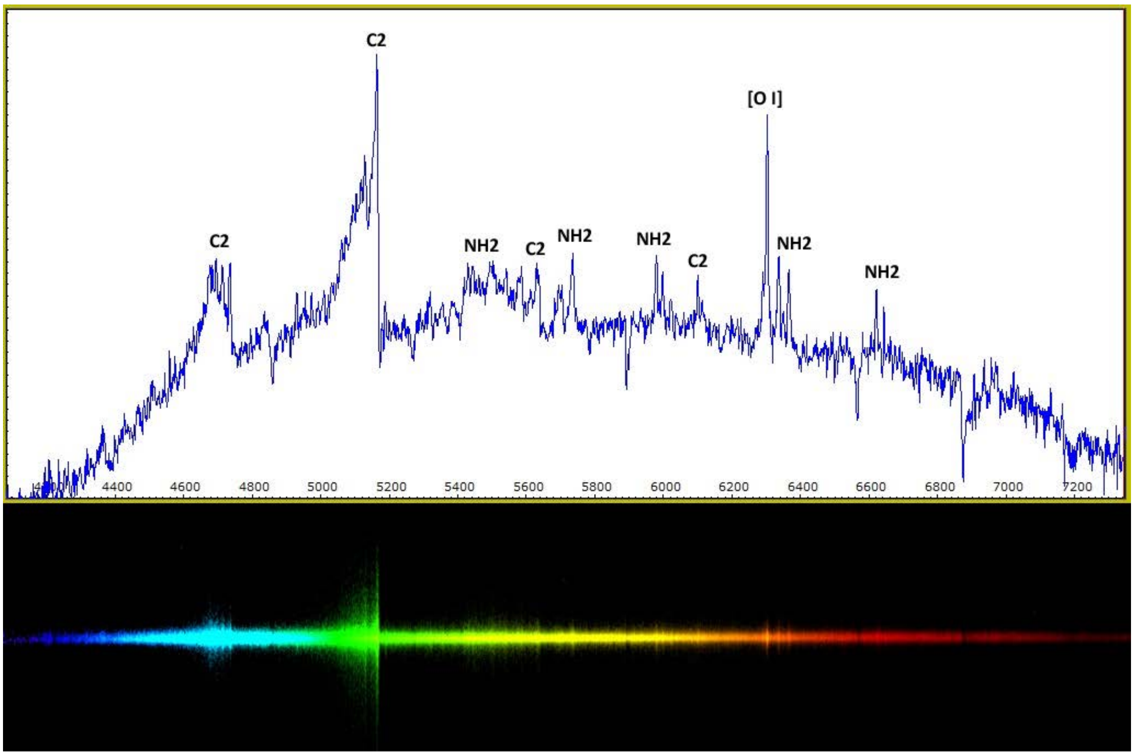
By Chris Schur, Arizona USA 2016April 14 Lens: 10" f/3.9 Orion Astrograph with Baader MPCC coma corrector Platform: Astrophysics AP1200 Camera: SBIG ST10XME Exposure: LRGB = 16:3:3:3m Location: Payson, Arizona Elevation: 5150 ft. Sky: Seeing 7/10, Transparency 8/10 Outside Temperature: 30F Processing Tools: Maxim DL6, Photoshop CS2

Comet 2014 W2 panSTARRS



Low and Higher resolution Cometary Spectra taken by amateurs.

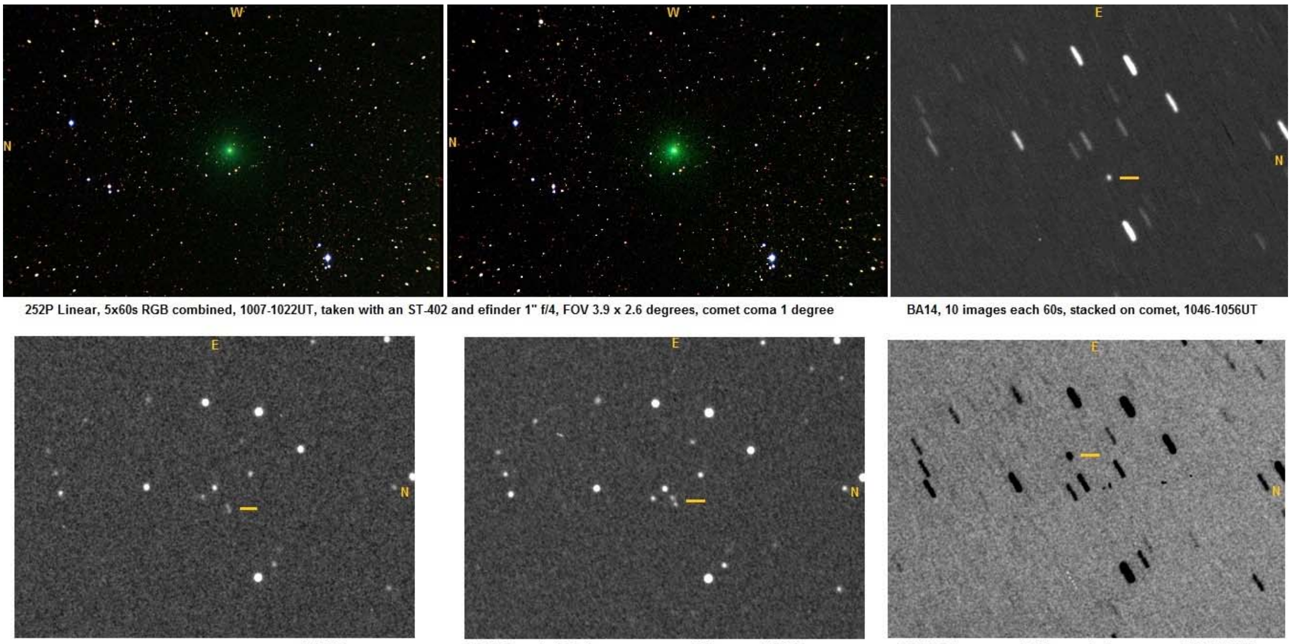




Spectrum of C/2013 US10 (Catalina) taken on 2016 January 19 with LISA spectrograph on C-11 D Boyd

Cometary activity observed by Juan Jose González in this unusual object. This comet may be associated with Comet 252P.

Cometary activity imaged by Mike Olason



252P Linear, 5x60s RGB combined, 1007-1022UT, taken with an ST-402 and efinder 1" f/4, FOV 3.9 x 2.6 degrees, comet coma 1 degree

BA14, 10 images each 60s, stacked on comet, 1046-1056UT

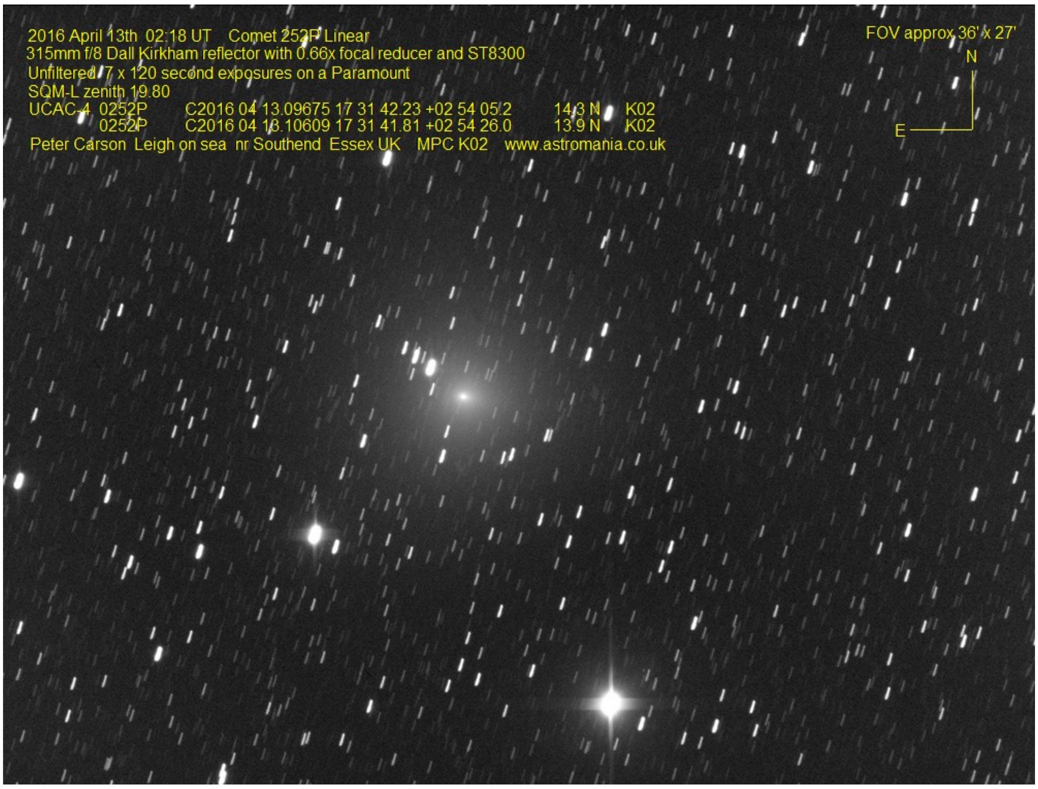
BA14, 2 stacked 30s images on stars, 90s apart, 1100UT

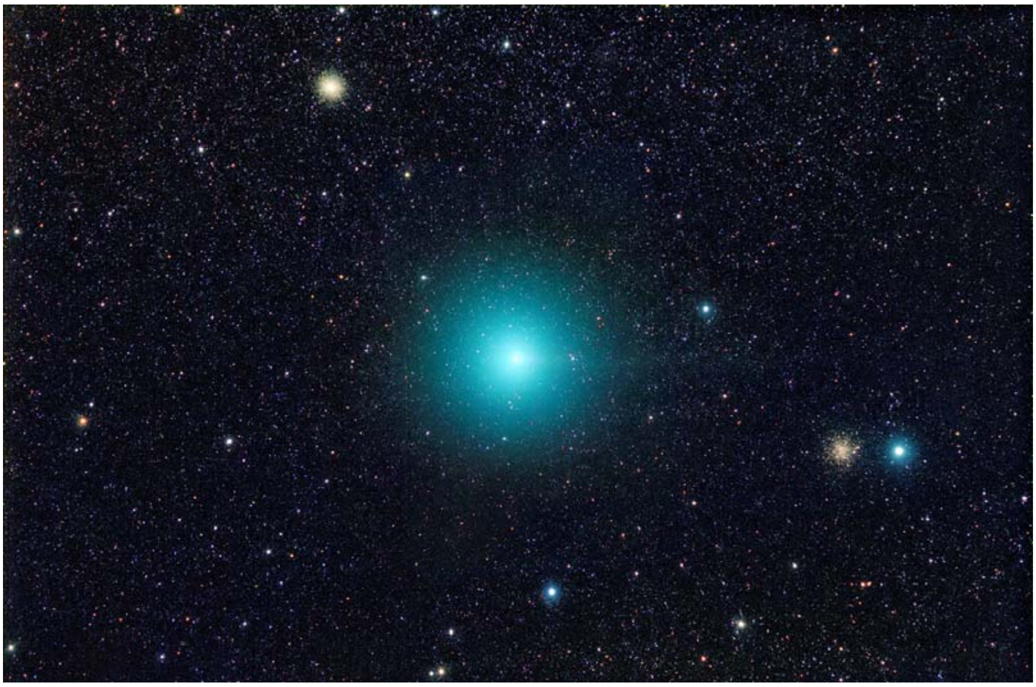
BA14, 2 stacked 60s images on stars, 180s apart, 1104UT

BA14, 5 images each 120s, stacked on comet, 1126-1136UT

Comets 252P Linear and P/2016 BA14 Panstarrs, BA14 may be a fragment of 252P. 252P is magnitude 6 and BA14 is magnitude 17.1, in Earth's sky they are 56 degrees apart when these images were taken on 2016/04/03. Moving away from Earth BA14 is 0.098AU from Earth and 252P is 0.086AU. Note that the images of 252P are 3.9 x 2.6 degrees and the images of BA14 are 9 x 7 arc minutes. The images of BA14 were taken with an 11" SCT f/6 and STF-8300M. The images of 252P were taken with an Efinder 1" f/4 scope and ST-402. 252P coma is about 1 degree. Mike Olason, Denver Colorado

Comet 252P images taken by Micheal Jäger and Peter Carson.





By Michael Jaeger:color image taken with Esprit 80/400 and Moravian G3-11002 April 5 UT 3.30 Green 3x540sec Blue, Green 1x540

Comet C/2013 US10

By Adriano Valvasori image 2016 March 11 :Image of C/2013 US10 :FSQ 105 f/5 SBIG STL-11000M l2x60s bin 1 RGB 1X120S bin2

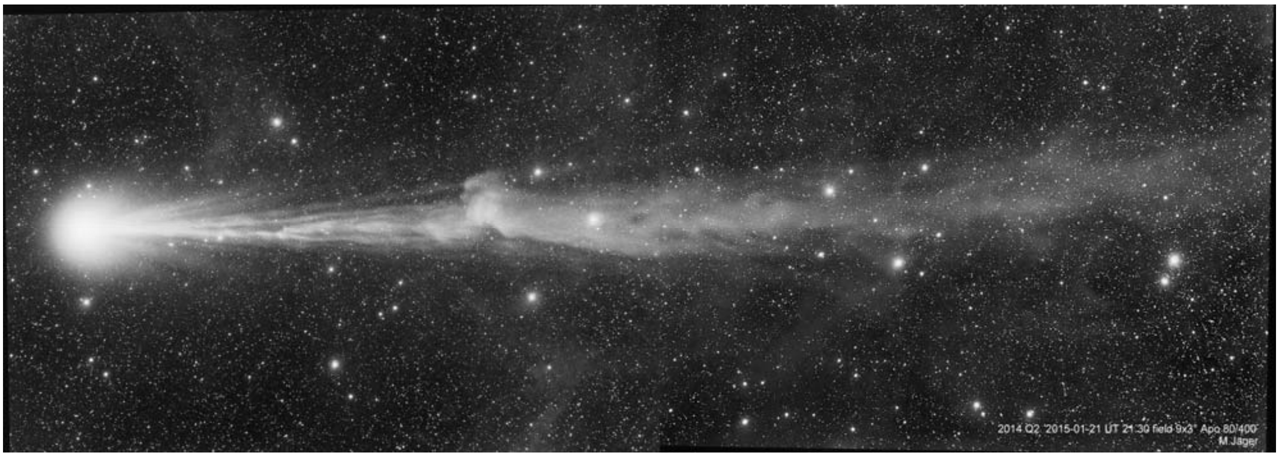
Comet C/2013 US10 continued

By Damian Peach

2016 January 18: Image of C/2013 US10. The ion tail shows some fine streamers. FSQ106 with STL11k. LRGB. 20/2/2/2min.

Comet C/2014Q2 Lovejoy

Ian Sharp



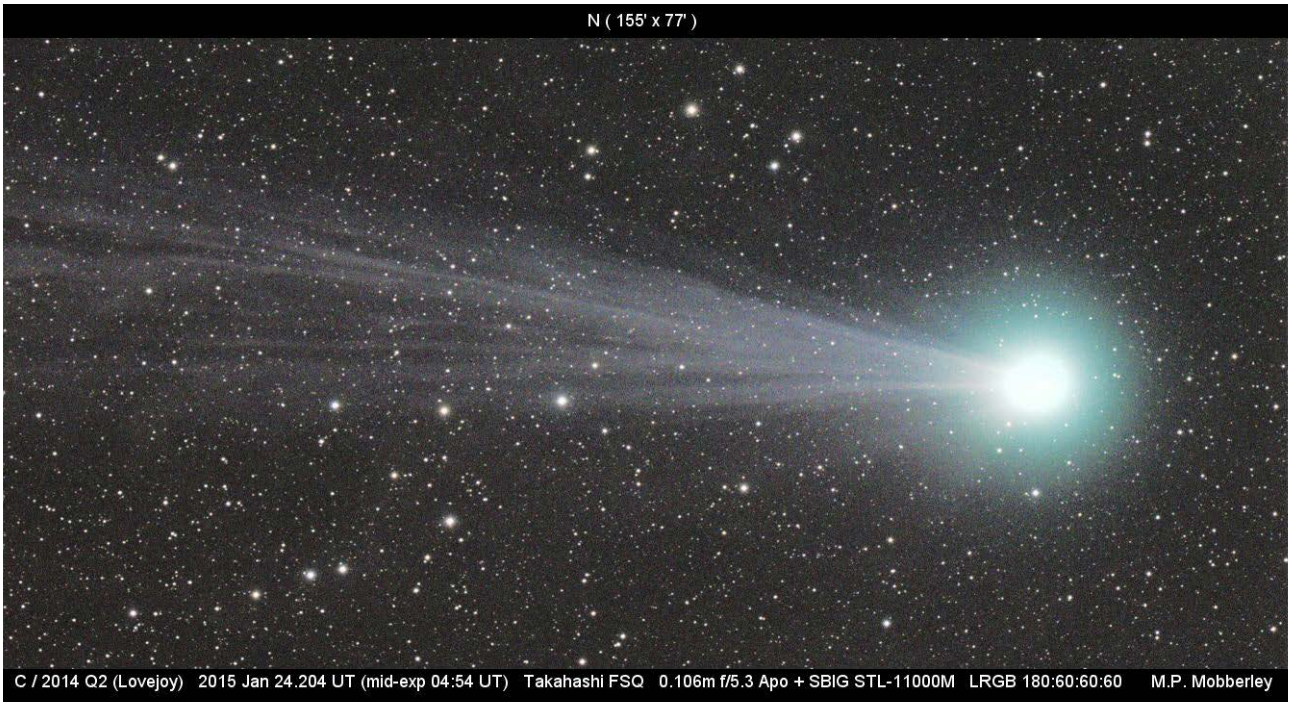
M. Jäger

Comet C/2014Q2 Lovejoy continued

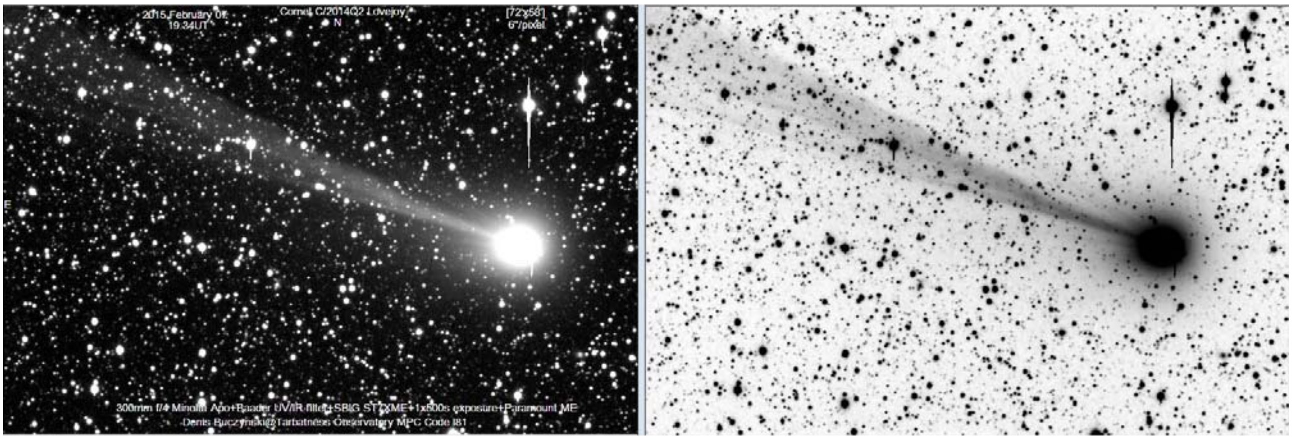
by Gerald Rhemann Comet C/2014 Q2 Lovejoy 2015 January 1 Mosaic of 3 panels Date: 21 01 2015 UT 18h17m Location: Turmkogel, Lower Austria Telescope: ASA H8 f 2.9 Camera: FLI PL 16803 Mount: ASA DDM60 Exposure time: LRGB 400/250/250/250 seconds each frame

by J. Tipping. 2015 January 24.

Comet C/2014Q2 Lovejoy continued



by Martin Mobberley. 2015 January 24.



by Denis Buczynski. 2015 February 1.

Comet C/2014Q2 Lovejoy continued

Chris Schur Arizona USA

Lens: 80mm f/4.6 Platform: Astrophysics AP1200 Exposure: L = 200m, RGB = 6m Camera: ST10xme Location: Payson, Arizona Elevation: 5150 ft. Sky: Seeing 4/10, Transparency 9/10 Outside Temperature: 25F Processing Tools: Maxim DL, Photoshop CS2