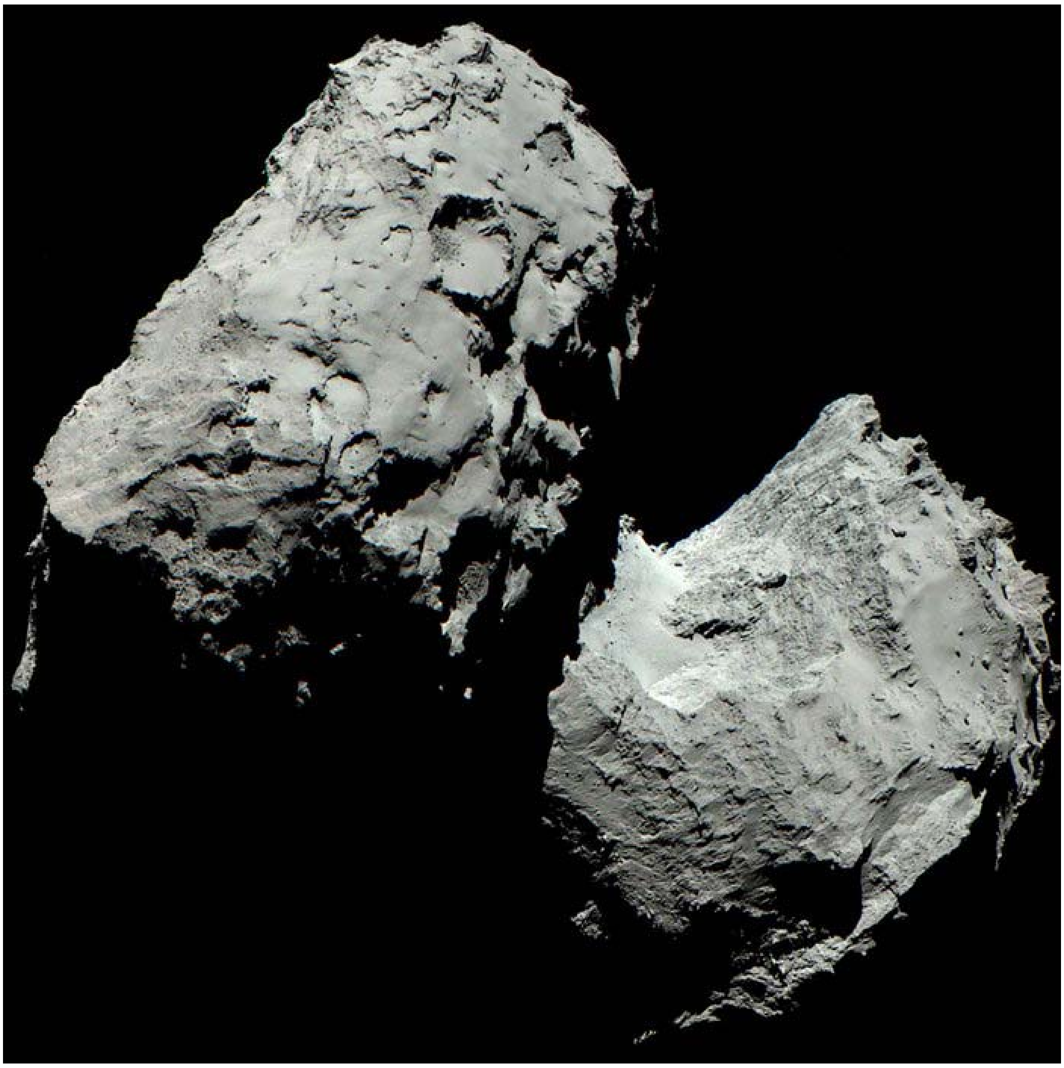
THE COMET'S TALE

Journal of the Comet Section of the British Astronomical Association

Number 34, 2015 January

Success for Rosetta



Colour image of 67P/Churyumov-Gerasimenko (ESA).

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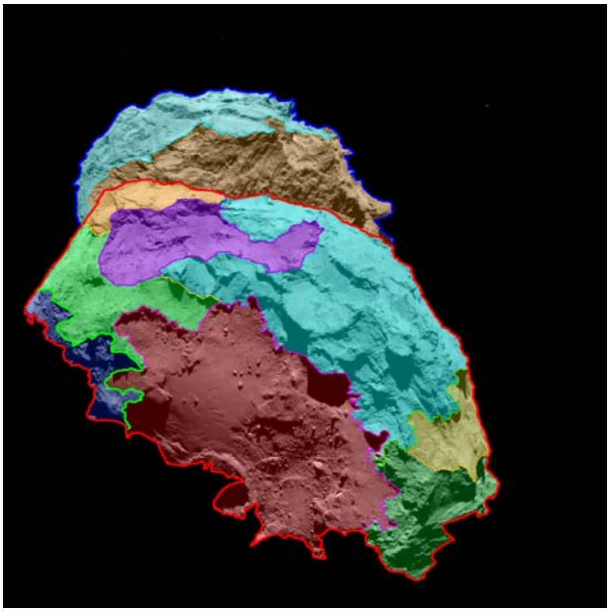
Comet Section contacts

Director:	Jonathan Shanklin, 11 City Road, CAMBRIDGE. CB1 1DP England. Phone: (+44) (0)1223 571250 (H) or (+44) (0)1223 221482 (W) Fax: (+44) (0)1223 221279 (W) E-Mail: JDS@AST.CAM.AC.UK or J.SHANKLIN@BAS.AC.UK WWW page : http://www.ast.cam.ac.uk/~jds/
Assistant Director (Observations): (and also Editor of *The Astronomer* magazine)	Guy Hurst, 16 Westminster Close, Kempshott Rise, BASINGSTOKE, Hampshire. RG22 4PP England. Phone & Fax: (+44) (0)1256 471074 E-Mail: GUY@TAHQ.DEMON.CO.UK *or* GMH@AST.STAR.RL.AC.UK
Assistant Director (CCD):	Nick James, 11 Tavistock Road, CHELMSFORD, Essex. CM1 6JL England. Phone: (+44) (0)1245 354366 E-mail: ndj@nickdjames.com
Section Secretary:	Denis Buczynski, Templecroft, Tarbatness Road, Portmahomack, Near Tain, Ross-Shire IV20 1RD Scotland Phone: (+44) (0)1862 871187 E-mail: buczynski8166@btinternet.com
Assistant to the Director: (Outreach and Mentoring)	Roger Dymock, 67 Haslar Crescent, Waterlooville, Hampshire PO7 6DD Phone: (+44) (0) 23-926-47986 E-mail: roger.dymock@ntworld.com

Section News from the Director

Dear Section member,

Rosetta is giving us stunning images of 67P/Churyumov-Gerasimenko, though those released so far are just a taster. Some preliminary scientific results are slowly being revealed at conferences, but much is being held over until publication in scientific journals. This is particularly true of the higher resolution images and this is a pity. Some organisations insist on immediate public release of all data – in my Antarctic work we make our ozone and weather data immediately available on the internet. SOHO and STEREO have found to their benefit that amateurs are pretty good at finding comets in the images and this has enormous benefits to the science. Who knows – amateurs might have been able to locate the Philae lander if they had access to the high resolution images. ESA is funded by the European tax payer, and so needs to insist that all its data is made freely available. It is doing so with its Gaia astrometry mission, but not with all the Rosetta data. The project scientists need not worry about precedence when it comes to publication – they should understand their instruments and data far better than anyone else, and will therefore have a better idea of what the data actually means. Even when all details are made publicly available they are often not read. For example, I had to correct one draft paper on ozone depletion where the author had used our data but had failed to read the quality control qualifiers that we had also put on our public web page.



Several morphologically different regions are indicated in this preliminary map, which is oriented with the comet's 'body' in the foreground and the 'head' in the background. ESA/Rosetta/MPS for OSIRIS Team

Amateurs will be able to help the Rosetta professionals in another way. Professional telescopes have strict limits on where they can point and they are not expecting to image 67P from the ground before June. Amateurs can do what they like and this will be particularly important when 67P begins to come out of solar conjunction in March. The solar elongation only slowly increases and the comet remains at low altitude for quite a while. I'd be very surprised if anyone actually manages to image it in late March, and it will be quite an achievement to image it in April. Visual observations are unlikely before late May. If you have access to a telescope located in the optimum zone of between about 10°S and 30°S do see if you can make a contribution to the new pastime of extreme imaging! See http://www.ast.cam.ac.uk/~jds/rosetta.htm for ephemeredes and visibility diagrams.

What is already clear is that a comet is now much more than just an icy snowball, indeed as the images show it is anything but an icy snowball. Exactly what this comet is will become clearer as the Rosetta mission proceeds and the results are published. We should however consider that all comets may be different and no one object is typical of the family. A follow-up mission will be needed! Indeed one is planned to the Main Belt Comet 133P/Elst-Pizarro as described in the Professional Tales section. It is also just possible that a mission is already on its way to such an object. The NASA Dawn mission is approaching (1) Ceres and water has been found outgassing from this asteroid. Perhaps the in-situ observations from the spacecraft will reveal that cometary processes are happening, in which case an additional name may be needed.

On my botanical travels in North Northumberland I came across an outcrop of rock with curious markings inscribed upon it. These immediately struck me as representing a tailed comet, however they are more usually known as cup and ring markings. Apart from knowing that they probably date back to the early Neolithic period 6000 – 7000 years ago, archaeologists have no idea of what they depict, though similar forms of marking are widespread in Europe. Perhaps some of them do indeed represent the earliest record of a comet.

An early Neolithic comet image ?

The Minor Planet Centre has continued to publish comet orbits which give a level of precision quite unwarranted by the observations. JPL give a similar level of precision, but qualifies this with estimates of the error bars. Very often preliminary orbits are given to a precision that is more than 10^6 times better than the observations indicate.

PanSTARRS now seems to be devoting more time to detecting moving objects and this has resulted in it catching 33 comets during the year. At this rate it will pass the 100 mark in 2015. Its discoveries also helped set a ground based record of 12 cometary discoveries during a half-month, with comets W1 to W12 being designated in the second half of November. Although there are statements that the second telescope became operational in 2014, all the observations to date are credited to the first telescope.

Lots of images are submitted to the Section. Some provide excellent illustrations to my cometary reports and the work of Damian Peach amongst others shows just what can be done. Others are taken for astrometric purposes and to get the best positional accuracy these generally need to be of short exposure. They are therefore rarely photogenic, but the positions are a valuable contribution to orbit determination. Other imagers, for example Martin Mobberley, specialise in recording tail detail, or features in the inner coma. I would like to encourage more imagers (ideally every imager!) to follow the example of Kevin Hills who follows the procedures developed by Roger Dymock to extract total equivalent visual magnitude values from their images and report them in ICQ format. This would make a truly valuable scientific contribution to the work of the Section.

Tail rays in 2014 Q2 (Lovejoy) imaged by Martin Mobberley on 2015 January 8 10:44 UT

Having made the decision to restrict Section reports for the BAA Journal to cover the brighter comets of each year, I have been making rapid progress in reducing the backlog. I have now submitted reports up to 2008. This means that there is likely to be a comet report in most issues of the Journal over the next year or two. Some of the fainter comets are still under electronic observation (eg 2006 S3, 2009 F4, 2010 S1), so their magnitude parameters may need revision at the proof stage. Rather more comets from 2011 are still under observation, so that will put a brake on further progress.

A publication that is still work in progress is the revision of the BAA Observing Guide to Comets. This has been promised for a while now, but there is some progress. In the meantime I've put a pdf of the draft in the Members section of the BAA web pages at http://britastro.org/downloads/5424 . Our intention is to try and get the new edition out by the autumn. This will include revision to the material on electronic observations and an update to the recommended ICQ keys. Alexander Baransky pointed out that many imagers now use UCAC sources, however the basic photometry in the UCAC is not recommended for visual or visual equivalent use as it lies between V and R. UCAC4 includes V magnitudes from the AAVSO Photometric All-Sky Survey and this source is the appropriate one to use.

There are several meetings of interest to Section members this year. First is the BAA Winchester Weekend, which will include a meeting of the Section. Unfortunately I was already committed to a botanical weekend meeting when the date was chosen, so won't be there. Denis Buczynski is giving the George Alcock Memorial Lecture to the BAA on Wednesday, May 27 on the subject of "Discovering Comets and Novae, Then and Now". On September 26th there is an observers workshop at Burlington House on London, devoted to practical techniques in the observation of comets and meteors. One session will specifically target reduction of images to produce equivalent visual magnitudes. Some provisional details are given later in The Tale.

William A (Bill) Bradfield, the noted discoverer of several bright comets died on June 9, aged 86. Although he discovered all his comets from near Adelaide, Australia, he was born in New Zealand. He discovered 18 comets in all and for all of them he was the sole discoverer; the first in 1972 and the last in 2004. One of the earliest comets that I observed was his second one, 1974 C1, which I remember observing from Arran during a geology field trip. A report on the brighter comets of 2004, due to appear in the Journal includes description of his last comet, 2004 F4, which was his brightest comet.

The old Northumberland dome at Cambridge, with 1995 O1 (Hale-Bopp) in the background.

This is my final message as I will be handing over the Directorship in October. Whilst I have nominated a successor, it is for the BAA Council to make the appointment and details should be announced at the October BAA meeting. My 25 years as Director seem to have passed astonishingly quickly and have seen some spectacular comets. Particularly memorable for me were 1995 O1 (Hale-Bopp) a naked eye object for many months, 1996 B2 (Hyakutake) seen from a roundabout off the A14 in Northamptonshire with a tail stretching across half the sky and 2006 P1 (McNaught) seen from a footpath near Cambridge. If we are lucky, my successor may well have another spectacular comet to start his period in office.

Best wishes, *Jonathan Shanklin*

Section News from the Secretary

The main event of 2014, from an organisational perspective for the Comet Section, has been the establishment of a new Comet Image Archive. This has been created by Nick James and incorporates the BAA Comet Gallery (which resided on the old BAA Website), the image archive which resided on Jon Shanklin's Comet Website and importantly, the Comet Archive which was part of The Astronomer Website. Many observers had submitted images to all three comet galleries and it was decided that one permanent Comet Archive would be more appropriate and useful. This Archive can be viewed at the following link: http://www.britastro.org/cometobs/

There has been a regular flow of images submitted over this year and mention must be made of the most prolific contributors. Those imagers who observe more or less exclusively in the UK are Peter Carson, Denis Buczynski, Nick James, David Storey, Glyn Marsh, James Fraser, Gordon Mackie and recently David Arditti. Richard Miles is in the process of rebuilding his observatory and should be contributing images again soon. The UK based observers who use robotic overseas telescopes to great effect are Martin Mobberley, Damian Peach, Ian Sharp, Alan Tough and occasionally Nick James.

2014 Q2 (Lovejoy) imaged by Alan Tough on December 30 using the iTelescope T12 wide-field system at Siding Spring. The bright star at mid-left is magnitude 4.70 HD34968 in Lepus.

Special mention must be made of Erik Bryssinck who observes both from his own observatory in Belgium and by a fruitful cooperative arrangement with Josh Hambsh whose robotic telescope is located in Chile. Tony Angel is very active using his own observatory in Spain and regularly submits many images. Alexander Baransky in Ukraine is also very active and has been a regular contributor to the BAA and TA for many years.

We are pleased that some of the world's most accomplished comet imagers have agreed to allow us to archive their images, the most prolific of these being Alfons Diepvens (who images many of the faint comets). Michael Jaeger, Gerald Rhemann and Rolando Ligustri produce wonderful comet images which enhance the value of our Archive. The work of many other comet imagers (Manos Kardasis, Nirmal Paul, Jose Chambo, John Drummond) are in our Archive and I thank them all (if I have missed any names then I apologise). All comet images are welcome and will be added to our collection. This includes drawings and sketches. Andrew Robertson regularly submits comet sketches. We encourage others to do so.

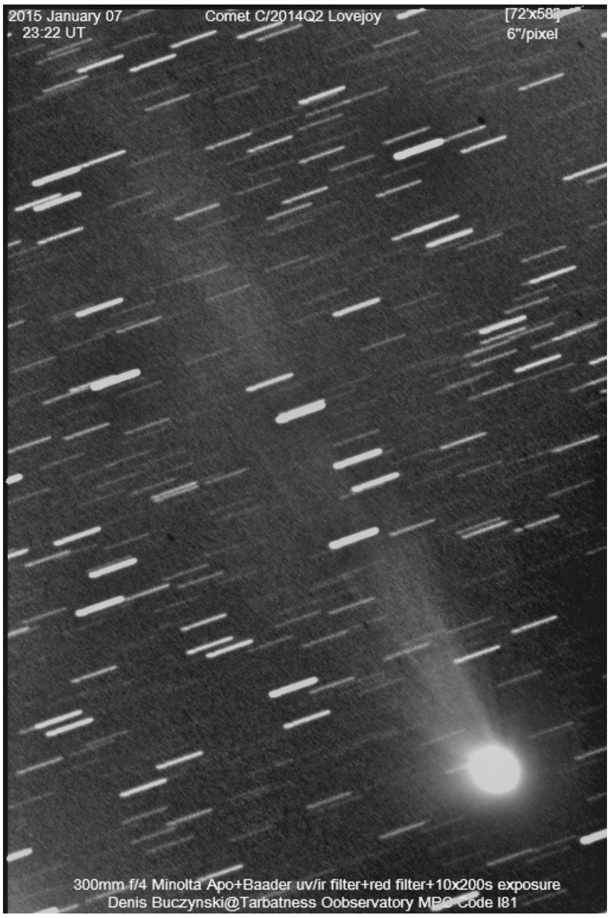
2014 E2 (Jacques) showing faint tail rays when imaged by Alfons Diepvens on 2014 August 7

I have also had fruitful communications with other Comet Groups around the world including those in Australia, America, South Africa, Spain, Czechoslovakia, Germany, Canada, Russia, Ukraine, Holland and others. All these groups are willing partners who share their expertise and experiences freely.

An important aspect of the BAA Comet Section work is to monitor and record the brightness and morphology of comets. The application of digital imaging in this field is becoming ever more dominant, with the number of visual observers declining. As Jon has mentioned on many occasions, the scientific value of digital images can be more fully exploited by observers if they would apply the methods outlined by Roger Dymock in his excellent project Alcock. http://www.britastro.org/projectalcock/CCD%20Astrometry%20and%20Photometry.htm

It is very noticeable that in Jon's review of comets observed during 2014 that Kevin Hills has been the main observer who has followed this method of observing and reporting with great success. As a Section we want to increase the number of CCD imagers who will also follow this methodology. We are very pleased that Kevin has agreed to speak about this approach at the Comet Section Meeting at Winchester. We will then follow this up with a practical workshop at Burlington House in September. Hopefully by the end of 2015 we will have many more observers adopting this important procedure and reporting Visual Equivalent Magnitudes.

I would like to take this opportunity on behalf of the BAA Comet Section to thank Jon Shanklin for the hard work he has put into running the Section for 25 years. That is a very long time to continue with the commitment that is required to run both the BAA Comet and SPA Comet Section's as well as conducting a highly successful professional career as a research scientist with the British Antarctic Survey. We were lucky to have such a highly respected and distinguished person as our Director. Hopefully we will be able to persuade him to continue to contribute to the Section both observationally and with his comet light curve analysis.



2014 Q2 (Lovejoy) imaged by Denis Buczysnki on January 7 from Tarbatness Observatory

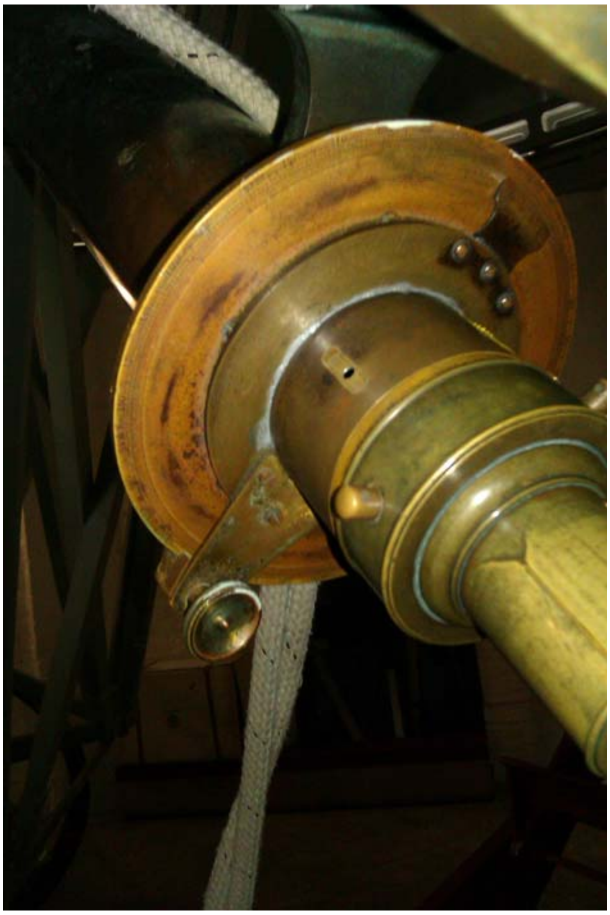
Lastly, as I write this in early January, I am looking forward to seeing and imaging 2014 Q2 (Lovejoy). This comet is greatly anticipated by all. We have seen some wonderful and beautiful images of this comet as it approaches perihelion and moves into the northern sky. The comet is now visible to the naked eye and may become brighter in late January. The view of a bright comet passing through our familiar northern constellations is to be savoured. Whilst there will be many magnificent pictures of this comet produced by the world's most accomplished comet imagers, I personally will be anticipating the view through binoculars on a dark, cold and clear winter night in Highland Scotland where I live. I always see bright comets best using these commonly available instruments. Enjoy the view and report what you see.

I look forward to meeting many of you at the meetings scheduled to take place in 2015.

Denis Buczynski

Tales from the Past

This section gives a few excerpts from early RAS Monthly Notices and BAA Journals. The BAA was formed in 1890.

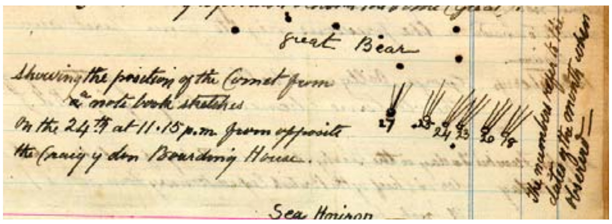


The position circle on the finder of the Northumberland refractor

150 Years Ago: The report to the 44th AGM of the Royal Astronomical Society mentions work done on the Northumberland refractor at Cambridge Observatory. A small position-circle has been applied to the finder, so as to give the means of measuring approximately angles of position, such as that of the tail of a comet which could not be observed in the large instrument. [*This is still present as shown above, though I have never used it to measure pa*.] The Presidential Address in November noted the publication in Philosophical Transactions of the Royal Society of Sir John Herschel's General Catalogue, which listed 5079 Nebulae and Star-clusters, several of which have been searched for in vain since their first discovery, and hence must be concluded to have been Comets or variable Nebulae. He also drew attention to Wm Huggins paper On the Spectra of some of the Nebulae. Dr Donati observed the spectrum of 1864 N1 (Tempel) and found that it was composed of three bright lines; a fact which tends to show that Comets also may consist of gases in a state of incandescence, and be self-luminous. A letter from Mr Tebbutt from New South Wales noted "On 15th September a strong west wind blowing into the shutters interfered much with the accuracy of the work that evening."

The iconic fresco painted by Giotto di Bondone showing the Star of Bethlehem as a comet

100 Years Ago: Dr Crommelin read a note on Delavan's Remarkable Comet (1913 Y1) and predicted that it would become a bright object. The President said they must wait and see what this comet was going to be in the matter of spectacular brilliancy. If it turned out a bright naked-eye comet, Dr Crommelin's fame in the cometary branch of astronomy would rise still higher. Observations of 28P/Neujmin (1913 R2) were reported that extended the arc to four months. Dr Crommelin said there should be no difficulty in recovering at the next return in 1931 [*it was recovered]*, and if so it would add another member to Saturn's comet family, following 8P/Tuttle. At the February meeting Mr G F Chambers read a paper on Halley's comet in 1301, citing European literature, including Dante, and concluded that there had been two comets in that year, the first of which was 1P/Halley. The European observations related to a different comet. [*It is still not entirely clear whether there was another comet in addition to 1P/Halley in 1301, appearing in December. 1P/Halley is probably the comet illustrated by Giotto di Bondone and it would have been a spectacular sight in late September 1301 with a tail stretching half way across the sky,*]. A letter later suggested that Dante was not referring to a comet, but to a meteor. Dante had quoted from Seneca, and the writer concluded with a quotation from the same book "Some man will arise who will teach us the pathway of every comet, and tell us their size and number. Let us be content with what has been already discovered; our descendents will add to the truths that we know.". Comet Notes include reference to a paper by Dr J Holetschek in Astr. Nach. On the brightness of 20D/Westphal which had faded two magnitudes in the autumn, before fading very rapidly and becoming very diffuse. [*This was the last time the comet was seen.*] Metcalf's comet had undergone similar changes, but to a lesser extent. In March Dr Crommelin noted that he had been unable to see Delavan's comet owing to the bad sky they so often had at Greenwich in the south and west, and the amount of London smoke. He also said that it was curious that in recent years practically all comets had been discovered in the autumn; there had been a complete lull in the early months of the year. Notes record that The 81st Donohoe Comet Medal was awarded to Mr P T Delavan of La Plata for the discovery of an unexpected comet on 1913 December 27. John Francis Skjellerup of Rosebank, Cape Province, South Africa, was elected a member at the April meeting.

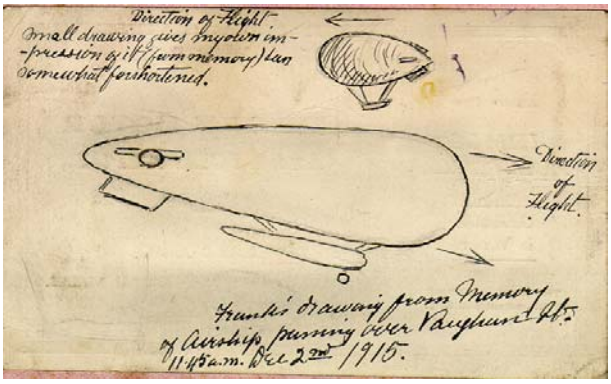


A sketch from the diaries of Harry Thomas who on 1914 September 24 noted: Comet observed below great bear. See the BAA Journal for 2003 October for the full article.

Mr W F Gale, who was a co-founder of the New South Wales Branch, spoke at the June meeting. He had discovered two Southern Hemisphere comets, but he said that this was something of an accident, as he had been searching a portion of the sky in connection with the variability of certain stars. The report for the year noted that Dr J Lunt, who was a member of the Association had discovered a comet at the Cape Observatory on September 18 (1914 S1). There were hopes of a good showing from Delavan's comet. There were reports on what the various loans from the Instrument Collection had been used for, and it was noted that No 27 (Equatorially-mounted achromatic telescope, by Newton, 5-in. aperture, with driving clock. Presented by Miss Penington.) on loan to Miss A Grace Cook was in excellent working order. An eye-piece having a large field suitable for comet-seeking had been added. Much useful work on the Moon, Comets and Planets was being done. The October comet notes say that Delavan's Comet (1913 Y1), in its conspicuous position under the Plough, attracted general attention during September. In October the tail was so bright that several people mistook it for the searchlight of an airship.

The equatorial mount of Instrument No 27 carrying the George Alcock refractor and mounted on a pier belonging to Denis Buczynski.

The circumstances of the 1848 apparition of 2P/Encke were very similar to those of 1914 and A C D Crommelin pondered on how much loss of brilliance the comet might have suffered in the 66 years. He noted that "Encke's Comet is famous for sudden fluctuations of brightness; a few years ago the late Mr W T Lynn predicted, after one of its faint apparitions, that astronomers had seen the last of it. I remarked at the time that I thought he was too pessimistic, and Mr Sola's observation (easily visible in an opera glass) justifies my view. The November comet notes record that Lunt's comet had been earlier discovered by Mr Westland of New Zealand (also a BAA member) and might fairly be called by their joint names. On the Continent and in America it was called Campbell's Comet having been independently found by Mr Leon Campbell at Arequipa. [*The Catalogue records it as comet Campbell. It was also discovered independently by Bernard Thomas from Tasmania. In his diary, Harry Thomas noted on 1914 November 2:"In a letter from Bernard to Nina and Daisy he mentioned having discovered a new comet. He has reported the same to Melbourne Observatory*."] They also note that 2P/Encke was 6th magnitude on November 16, and did not appear to have suffered very much in brightness in the last 66 years. Reginald Lawson Waterfield, The Principal's House, Cheltenham, was elected a member at the November meeting. Centralstelle telegrams had ceased (being taken over by Harvard) and the outbreak of war had lead to the non-receipt of the *Astronomiche Natchrichten*, leading to a loss of cometary news, however Dr Crommelin had managed to make up for it at the December meeting. He discussed further what name and discovery letter Lunt's Comet should bear. Delavan's Comet had set a record for discovery time in advance of perihelion and another comet, Neujmin had nearly set a record for the most distant perihelion [*3.75 au*]. Professor Buckland suggested an explanation for the variability in brightness of 2P/Encke: Particles of 2P/Encke might be in some way polarised, being thin flat discs always keeping their plane unchanged, so that they looked dim when seen edgeways, bright when seen squarely. A couple of photographs of 1914 S1, taken by Dr Lunt, were published in the December Journal. New Books notes the receipt of Vol XI of the Publications of the Lick Observatory. This consisted of photographs of the Milky Way and of Comets. Three awards of the Donohoe Comet Medal had been made: To Prof. H H Kritzinger of Bothkamp, Germany, to M V Zlatinsky of Mitau, Russia and to M G Neujmin of Simeis, Russia.



A sketch from the diaries of Harry Thomas, showing an airship

50 Years Ago: At the March meeting Harold Ridley reported on observations of the Leonid meteors and noted that the parent comet had been long since lost, though members of the Section were still searching for it whenever possible. The annual report of the Section noted that it had been a quiet year. Michael Hendrie now had Instrument 27 on loan. [*Denis Buczynski tells me that it now resides with him and although the long focus 5 inch refractor which was originally mounted on it is no longer used (it resides in a very long box in his workshop), the mounting carries the 4 inch f/12 George Alcock refractor which the BAA presented to him some years ago. George used this refractor for many years and started his comet searches with it before switching to more suitable binoculars for that work.*] A paper on the Current theories of the origin and formation of comets by Peter Lancaster-Brown was read at the Leeds Meeting and appeared in the Journal. In the paper he compares the Whipple (dirty snowball) and Lyttleton (flying sandbank) models of a cometary nucleus and the Lyttleton (Interstellar accretion) and Oort & Van Woerkom (planetary disruption) theories of cometary origin.

RAS Specialist Discussion Meeting 2014 April 11

Bridging the Gap: Comets after Stardust and Before Rosetta

These are my edited notes taken during the meeting, and may not fully reflect what the speakers said or intended to say. Rather more speakers used the IAU comet name convention compared to the previous professional meeting that I attended, perhaps as a result of a letter that I sent to A&G explaining why nomenclature matters. There were still a few die-hards. I haven't elaborated on much of the terminology, so you may need to do a bit of Google searching if you need further explanation. It was notable that work on comets is now becoming geologically based, and that as technology develops we can do things that were not expected when missions were originally designed. Support needs to be made available for developing these techniques and fully characterising what spacecraft actually measure.

Matt Taylor (ESA) set the scene by describing the Rosetta mission. Rosetta is an ESA follow-up to the Giotto mission to 1P/Halley in 1986. Its development started in the mid 1980s. The original idea was for a Comet Nucleus Sample Return mission, but this was too expensive. Five comets have had fly-bys, but Rosetta will be much closer. Its solar panels are 32m across to provide sufficient power when the spacecraft is over 4 au from the Sun. The minimum objectives of the mission are to rendezvous with the comet, to observe it and to land on it. There are a large suite of instruments to make measurements, both on the orbiter and lander. The mission will investigate how cometary activity actually works and how it evolves. The latest estimate is that it has a 12.7 hour rotation period, with three major active regions, and the southern hemisphere more active than the north. The mission carried out science during Earth and Mars flybys. It flew by asteroid (2867) Sterns in 2008 and (21) Lutetia in 2010. It was then put into hibernation from 2011 to 2014. ESO and ESA are in co-operation to characterise the comet from the ground, and there is also pro-am collaboration. The ICES web site http://ices.engin.umich.edu/ does an Inner Coma Environment Simulation. ESA has a special public relations campaign, very different to what has happened with other missions. Examples are using the 1971 hit “Rosetta” by Alan Price, Twitter, Facebook etc. It has been very successful in outreach, getting to perhaps 75 million people. Instruments are being commissioned during 2014 April. The comet was imaged on 2014 February 28 by the VLT, and has been imaged by the spacecraft cameras. By July we should start getting detailed images, and the nucleus will be full frame in August. The orbit round the nucleus will be complex, and the escort phase requires intricate navigation. The landing will be on November 11 The main science phase is all pre-programmed and lasts just three days. In answer to a question he said that the programmed measurements may not be suitable for radiometric dating of the surface as has been done with Curiosity on Mars. The ESA blog http://blogs.esa.int/rosetta/ has the best up-to-date information.

The Philae obelisk on the south lawn at Kingston Lacy in Dorset. Credit Pete Vines

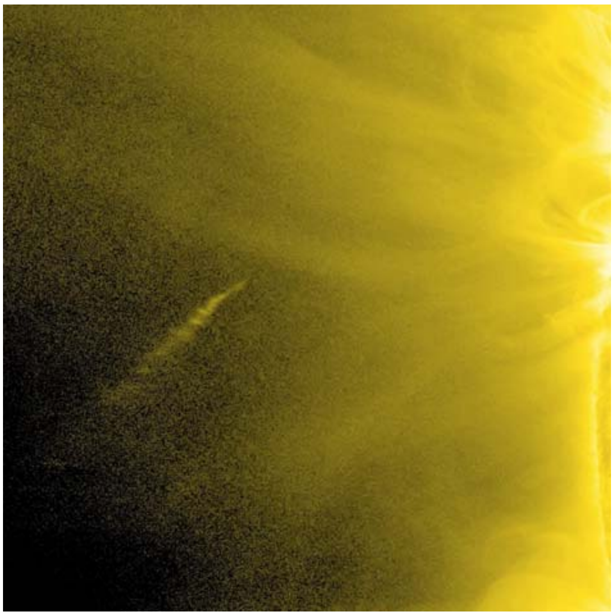
Colin Pillinger (Open University) followed with a talk on *Maximising the science outreach potential of the Philae lander for the Rosetta mission*. The aim is reach a non-science orientated audience. The name of the comet (67P/Churyumov-Gerasimenko) is a put-off, whilst Rosetta is familiar. Thomas Young (of Young’s Modulus) actually broke the Rosetta code, but Champollion gave the first full translation. Young was a noted public understanding of science lecturer of his day. William Bankes, who transcribed the Philae obelisk, brought it back to Kingston Lacy. ESA will be working with the National Trust, eg by putting up information boards about the mission. See http://www.open.ac.uk/science/pssri/research/missions/rosetta/rosetta.php and http://www.nationaltrust.org.uk/kingston-lacy/history/ [This was one of Colin’s last public appearances, as sadly he died on May 7, before Rosetta successfully began observing 67P from up close.]

Simon Green (Open University) spoke on *Dust grain fragmentation in comets*. Comets are the major source of interplanetary dust. We know fragmentation occurs at very large scales. About 5% of comets disrupt, but we don’t know the mechanism. We can’t image directly, but we do see striae in dust tails. These could be due to fragmentation or they could be due to jet activity. Many observations have alternative explanations. We really need direct in-situ detection. Hypotheses are that either fragmentation occurs mostly within about 10 radii of the nucleus or from about 10 R to the edge of the outer coma, after acceleration away from the nucleus. The closest approach to-date is a few hundred kilometres. Vega (to 1P/Halley) did see packets of dust at 10^4 – 10^5 km, so grains must have fragmented at a distance. Similarly Stardust (to 81P/Wild) saw evidence of distant fragmentation, with swarms of particles and also sorted particles. The missions must be seeing fragmentation of dust grains. The mass distribution index changes through the coma. With Rosetta it will be possible to measure the speed, size and trajectory. The flux will be lower, as the spacecraft is moving slowly with respect to the comet compared to Stardust, at perhaps 20 per hour at 1.5 au, but much higher in “clouds”. Dust may coat camera lenses, solar panels etc. It may be possible to discover the mechanism of fragmentation. At 103P/Hartley EPOXI (previously Deep Impact) saw 30cm sized boulders leaving the comet, but didn’t see fragmentation. Boulders were not seen at 9P/Tempel, so the two comets are different.

The next talk on the complex topic of *Oxygen isotope reservoirs in the comet forming region*, by **Ian Franchi** (Open University) was rather difficult to follow. Laboratory based analysis of extra-terrestrial materials, mostly meteorites show differential fractionation in oxygen atoms of ^{17}O and ^{18}O compared to ^{16}O. Meteorites sample the inner solar system and comets may show the outer solar system. Stardust samples have ratios indistinguishable from chondritic meteorites, so there must have been a lot of mixing in the early solar system. The analysis has all been on large terminal particles, not the fine grained material along the walls of the track. We know that fine grained material is present in interstellar dust particles (IDPs), captured for example by high flying research aircraft, but we don't know which comet they come from. Laboratory measurement needs about a milligram of material, which is equivalent to around 10^6 IDPs! The spectrum of compositions suggests mixing. He suggested that early forming comets would be ^{16}O rich, whilst late forming ones would be ^{16}O poor and will plot differently on the fractionation line. They have found a few rare grains or bits of grains that plot far to the right on the fractionation line and show signs of aqueous alternation. He expects Rosetta material to plot on the right.

Penny Wozniakiewicz manning the the meteorites stand at Lyme Regis Fossil Festival.

Penny Wozniakiewicz (Natural History Museum) gave a stimulating talk on *Searching for cometary micrometeorites in the mid-Pacific*. She is looking a new ways of collecting extra-terrestrial dust, which has very different characteristics to terrestrial dust, but is mostly swamped by the background (eg Sarahan dust). Dust can be collected in the stratosphere by using high flying aircraft with collecting panels coated in silicone oil. They are also found in Antarctic ice (eg in sludge from drinking water manufacture using hot water to melt ice). Some are ultra-carbonaceous with a high Deuterium/Hydrogen ratio, but are only found in young snow and are difficult to date to within more than a few decades and may still have undergone weathering. She wanted to collect in real-time, so that it would be possible to relate to meteor shower activity and also minimise weathering. To be far from possible sources of pollution she went to the mid Pacific at Kwajalein in the Marshall Islands, where she deployed a high volume air sampler on the airport roof. There was a problem with salt contamination and a large filter area, but it was possible to wash off the salt and concentrate the dust. She found lots of spherules, some similar to those found in IDPs, un-melted micro-meteorites and CP-IDP (chondritic porous) like particles which may come from comets, but don't yet know the source of any of the particles.



SDO's view of 2011 W3 (Lovejoy) plunging through the million degree hot solar atmosphere.

Geraint Jones (Mullard Space Sciences Laboratory) concluded the morning session with a talk on *Comet ISON: An Encounter with the Sun*. The Mars orbiters will image 2013 A1 (Siding Spring) and may be able to image the nucleus. EPOXI saw snowballs coming off 103P/Hartley. 1680 V1 was a sun-grazing comet [strictly sun-approaching as it is not a member of the Kreutz group] and was the first comet to have its orbit determined (by Newton). He showed examples of members of the Kreutz group, including those imaged by SOLWIND and SMM. Today there is a flotilla of spacecraft imaging the Sun: SOHO, STEREO A, STEREO B (the pair are due to pass each other in the near future, one having travelled ahead of the Earth in its orbit, the other lagging behind) and SDO. As a consequence of their orbits, Kreutz comets are always seen best in the Southern Hemisphere. 2011 W3 (Lovejoy) showed spiralling ions in SDO in the strong solar magnetic field. It lost most of its coma and tail when very close to the Sun, but these soon re-grew. It broke up a few days after perihelion and became a head-less tailed comet. 2012 S1 (ISON) was discovered a long way from perihelion (allowing professionals time to plan observations) and was an Oort Cloud comet. It was initially bright for its distance. NASA set up its Comet ISON Observing Campaign (CIOC) and many amateurs contributed. There was a good cadence of images from SECCHI (on STEREO) and a very variable solar wind. After perihelion only dust emitted pre-perihelion was seen. The post perihelion brightening was thought to be due to bunching of a string of fragments as they receded from the Sun. The Hubble Space Telescope saw no fragments. A paper on the SOHO results by Matthew Knight and Karl Battams has been published http://iopscience.iop.org/2041-8205/782/2/L37/ . SOHO is now 20 years old.

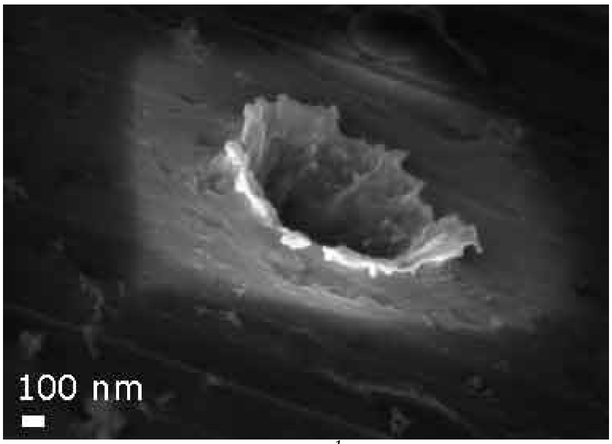
The afternoon session began with a talk by **John Bridges** (University of Leicester) on *The mineralogy of Jupiter family comet Wild 2*. 81P/Wild was the target of the Stardust mission. It is a "new" periodic comet, having been captured into its present orbit by Jupiter in 1974. Micron grains were well preserved by the aerogel capture, but the finer fraction melted into the aerogel. So far 180 tracks have been harvested. There is a low proportion of interstellar grains, mostly FeMg silicates (olivine and pyroxene). There are two types of track: "carrots" and "bulbous". Terminal grains are at the end of the carrot. The bulbous segment is an explosive chamber. The terminal particle is a Mg rich pyroxene and is also Al rich, typical of a carbonaceous chondrite. The mineralogy implies a high temperature formation above 1200°C. It has not been re-heated like chondrites. Calcium Aluminium inclusions are similar to CV3, CH and CO chondrites. There were no phylosilicates, so these are probably absent in the comet, though the evidence suggests that they were present in 9P/Tempel. To see low temperature phases they have made use of the Diamond synchrotron at Harwell and have found magnetite, which implies water activity. The 81P/ material is larger than in IDPs. The conclusion is that there must have been high temperature formation of some comets in the outer solar system. Jupiter family comets must be variable in composition.

Mark Burchell (University of Kent) spoke about *Raman spectroscopy of olivines captured in aerogel*. He had used Raman spectroscopy to investigate grains in "Bulbous" tracks. This is possible with lasers without needing to cut up the aerogel. Olivine ranges from Forsterite (Mg) to Fayalite (Fe) and spectroscopy can distinguish which is present. They first needed to check that there is no alteration during capture and found that there was, and also that lasers affect Forsterite. Real grains turned out to be iron oxides. Measurements on one grain suggested that it was magnesium rich.

Kathryn McDermott (University of Kent) followed up with *Raman spectroscopy of fine-grained olivine aggregates in small impact craters in aluminium*. Impact residue is found round craters in aluminium foils from Stardust. As an experiment they fired samples at test aluminium foil using the high velocity gas gun at Kent. The melt residues shift down in apparent composition. Next they investigated if fine grained material showed the same effect, and found that it shifted in the opposite direction. She concluded that further work was needed.

Completing a trio of University of Kent talks, **Mark Price** spoke on *Raman analyses of thirty-six Stardust cometary grains from tracks 170, 176, 177 and 178: comparison of organic signatures with a CR3 chondrite*. The Raman laser can heat grains, changing the material. The system can see sub-grains as well as terminal grains. They see the D and G carbon lines from sub-grains (possibly contamination) and enstatite. Others showed olivine >Fo_{70}. Sub-grains have a different composition to terminal particles. Carbonaceous material was concentrated round bulbs. He wanted to investigate the carbon, and started by firing gold into aerogel using the gas gun. This created bulbous tracks, but no carbon as yet. CR3 chondrite spectra are broadly similar to Stardust tracks.

Next **Ian Lyon** (University of Manchester) gave a talk on *Micron-scale organic analysis of cometary samples*. Bulbous tracks are caused by highly volatile material and residue should be on the walls. He uses C_{60} ion gun to focus down to one micron. He finds a lot of organics, but not particularly associated with a carrot track. There is some enrichment in bulbous tracks, but this seems to be associated with the manufacture of the aerogel. There is therefore no chance of detecting cometary material. He next looked at residue surrounding foil craters, and first tested the system with known substances fired at foil using the gas gun. The temperature at impact must be much less than 1000°C, but above 500°C. The next step is to look at Stardust material.



Impact crater formed at 6 kms^{-1} on aluminium foil strips of the Stardust collector tray. This image was taken with a scanning electron microscope OU/UL.

The final talk was given by **Anton Kearsley** (Natural History Museum) on *Do impacts on metal and tracks in aerogel tell us the same story about comet Wild 2 dust?* We shouldn't expect to see the same evidence from very different materials, and foil and aerogel will be different. Although the basic investigative techniques have been studied for a decade, they are still not fully determined, constrained or calibrated. He suggests that the bulbous tracks are not caused by the loss of volatiles, but are from low density, friable particles. They have only found one silicon carbide grain in aerogel and five in foil, and this might imply that there is not much fine grained material in 81P/Wild. However experiments suggest that there is a dramatic reduction to around 10% in such particles after impact, so it is probably there. Few craters indicative of organics or volatiles have been found. There is lots more to do to fully characterise both observations and experiments. Once properly interpreted aerogel and foil will tell the same story.

I left after the specialist discussion meeting, but Kenelm England stayed for the monthly meeting of the RAS and provided notes on **Mark Burchell**'s talk on *Cometary delivery of volatiles to the Moon: what can we learn in the laboratory?*

Professor Burchell began with a summary of the exploration of the Moon since the 1970s with the latest spacecraft testing new technologies and providing more detailed information of the lunar surface. He referred to old missions from 1959 to 1976.

Since 1990 14 missions have reached the Moon either in orbit, landing or impacting. LADEE mission's neutron detector noted a spike during the Geminid display, which indicated the presence of water. Future missions may include Chang'e 4 (2015), Luna-Glob A orbiter and penetrometer (2016), Chandrayaan 2 orbiter/rover (2017), Chang'e 5 sample return (2017) and Luna-Glob G rover (2018). Manned missions from America, India and China are planned for the 2020s.

The question of volatiles on the Moon. Its formation by giant impactor would create a dry, devolatilised object. Apollo samples and lunar meteorites would indicate relatively recent chondritic impactors. In 2012 30 fragments of an ancient lunar breccia meteorite contained 350 – 1000 ppm of water. Sources would include meteorite impacts (light flashes on the surface), comets, asteroids and solar wind ions, which would migrate to cold traps. Evidence from Chandrayaan 1 measuring OH/H_2O in surface areas, EPOXI measuring possible 0.3 – 0.5% ice at the north pole, Lunar Prospector measuring hydrogen by neutron flux at the south pole. When LCROSS hit the south pole, 5.6±2.9% water ice ain the debris. He estimated that 3 – 6% of asteroids' and comets' volatiles would remain on the surface. The contribution from the solar wind would be rather small.

The question of volatiles surviving impact. Professor Burchell had been using the gas gun at the University of Kent (mentioned in several presentations during the afternoon session). In the laboratory he fired frozen materials at water ice and sand to simulate the lunar surface. He used dimethyl sulphoxide embedded in ice to simulate organics from a cometary impactor. The molecules survived the impact intact and were spread around the sand, which was then analysed.

He completed the talk by looking to increase the impact velocity, use more complex molecules, quantify the surviving molecules, calculate the temperatures and pressures, combine comet composition material (from Rosetta) and create computer models of the impact events.

Jonathan Shanklin & Kenelm England

Comet Meetings in 2015

A Comet Section Meeting takes place in the afternoon of Saturday, April 11, at Sparsholt College, Winchester http://www.sparsholt.ac.uk/information/how-to-find-us/ This forms part of the BAA Winchester Weekend http://britastro.org/meeting_render/5479 but it is open to everyone. You don't need to be a resident at Winchester to come along. The speakers are:
Nick James - The Comet Section in the digital age;
Damian Peach - Comet imaging;
Kevin Hills - Obtaining Visual Equivalent Magnitudes from CCD images;
Richard Miles - Outbursting comets

The main talk at Winchester, the Alfred Curtis Lecture, is comet-themed as well since Matt Taylor will be talking about "Rosetta – Europe's comet catcher".

At the **BAA Evening Meeting** on Wednesday, May 27 at Burlington House, London, http://britastro.org/meeting_render/5589, Denis Buczynski will be giving this year's George Alcock Lecture. His topic will be "Discovering Comets and Novae, Then and Now".

The courtyard at Burlington House often has interesting art exhibits [Wikipedia]

There is an all day **BAA Observers' Workshop on Comets and Meteors** on Saturday, September 26 at Burlington House, London. http://britastro.org/meeting_render/6141 The objective of this meeting is to give hands-on tuition in various observing techniques. We hope to cover comet image processing and extraction of visual equivalent magnitudes amongst other things.

Professional Tales

Many of the scientific magazines and journals have articles about comets in them and this regular feature is intended to provide a few that you may have missed. Other papers have been mentioned on the BAA Comets discussion forum, so they are not duplicated here.

Pan-STARRS 1 Observations of the Unusual Active Centaur P/2011 S1 (Gibbs) H.W. Lin et al.

2011 S1 (P/Gibbs) is an outer solar system comet or active Centaur with a similar orbit to that of the famous 29P/Schwassmann-Wachmann. 2011 S1 (P/Gibbs) has been observed by the Pan-STARRS 1 (PS1) sky survey from 2010 to 2012. The resulting data allow us to perform multi-colour studies of the nucleus and coma of the comet. Analysis of PS1 images reveals that 2011 S1 (P/Gibbs) has a small nucleus < 4 km radius, with colours g-r (p1) = 0.50±0.02, r-i (p1) = 0.12±0.02 and i-z (p1) = 0.46±0.03,. The comet remained active from 2010 to 2012, with a model-dependent mass-loss rate of ~100 kg s^{-1}. The mass-loss rate per unit surface area of 2011 S1 (P/Gibbs) is as high as that of 29P/Schwassmann-Wachmann, making it one of the most active Centaurs. The mass-loss rate also varies with time from ~40 kg s^{-1} to 150 kg s^{-1}. Due to its rather circular orbit, we propose that 2011 S1 (P/Gibbs) has 29P/Schwassmann-Wachmann -like outbursts that control the out-gassing rate. The results indicate that it may have a similar surface composition to that of 29P/Schwassmann-Wachmann 1.

Our numerical simulations show that the future orbital evolution of 2011 S1 (P/Gibbs) is more similar to that of the main population of Centaurs than to that of 29P/Schwassmann-Wachmann. The results also demonstrate that 2011 S1 (P/Gibbs) is dynamically unstable and can only remain near its current orbit for roughly a thousand years.

Hubble witnesses an asteroid mysteriously disintegrating. Astrophysical Journal Letters http://www.spacetelescope.org/news/heic1405/

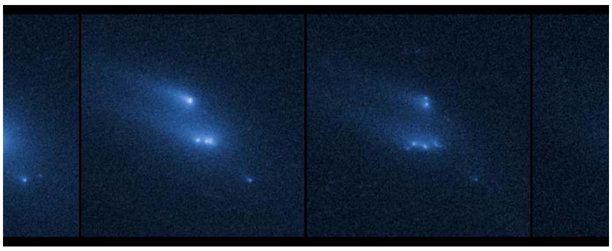


Image: NASA, ESA, and D. Jewitt (UCLA)
http://www.spacetelescope.org/static/archives/images/screen/heic1405a.jpg

The NASA/ESA Hubble Space Telescope has photographed the never-before-seen break-up of an asteroid, which has fragmented into as many as ten smaller pieces. Although fragile comet nuclei have been seen to fall apart as they approach the Sun, nothing like the break-up of this asteroid, P/2013 R3, has ever been observed before in the asteroid belt.

"This is a rock. Seeing it fall apart before our eyes is pretty amazing," said David Jewitt of UCLA, USA, who led the astronomical forensics investigation.

The crumbling asteroid, designated P/2013 R3, was first noticed as an unusual, fuzzy-looking object on 15 September 2013 by the Catalina and Pan-STARRS sky surveys. Follow-up observations on 1 October with the Keck Telescope on Mauna Kea, Hawaii, revealed three co-moving bodies embedded in a dusty envelope that is nearly the diameter of Earth.

"Keck showed us that this thing was worth looking at with Hubble," Jewitt said. With its superior resolution, the space-based Hubble observations soon showed that there were really ten distinct objects, each with comet-like dust tails. The four largest rocky fragments are up to 200 metres in radius, about twice the length of a football pitch.

The Hubble data showed that the fragments are drifting away from each other at a leisurely 1.5 kilometres per hour — slower than the speed of a strolling human. The asteroid began coming apart early last year, but the latest images show that pieces continue to emerge.
"This is a really bizarre thing to observe — we've never seen anything like it before," says co-author Jessica Agarwal of the Max Planck Institute for Solar System Research, Germany. *"The break-up could have many different causes, but the Hubble observations are detailed enough that we can actually pinpoint the process responsible."*

The ongoing discovery of more fragments makes it unlikely that the asteroid is disintegrating due to a collision with another asteroid, which would be instantaneous and violent in comparison to what has been observed. Some of the debris from such a high-velocity smash-up would also be expected to travel much faster than has been observed.

It is also unlikely that the asteroid is breaking apart due to the pressure of interior ices warming and vaporising. The object is too cold for ices to significantly sublimate, and it has presumably maintained its nearly 480-million-kilometre distance from the Sun for much of the age of the Solar System.

This leaves a scenario in which the asteroid is disintegrating due to a subtle effect of sunlight that causes the rotation rate to slowly increase over time. Eventually, its component pieces gently pull apart due to centrifugal force. The possibility of disruption by this phenomenon — known as the YORP effect [*the Yarkovsky–O'Keefe–Radzievskii–Paddack effect. This effect occurs when light from the Sun is absorbed by a body and then re-emitted as heat. When the shape of the emitting body is not perfectly regular, more heat is emitted from some regions than others. This creates a small imbalance that causes a small but constant torque on the body, which changes its spin rate.*] — has been discussed by scientists for several years but, so far, never reliably observed.

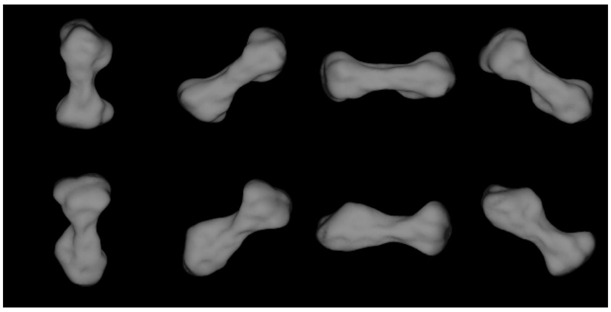
For break-up to occur, P/2013 R3 must have a weak, fractured interior, probably the result of numerous ancient and non-destructive collisions with other asteroids. Most small asteroids are thought to have been severely damaged in this way, giving them a "rubble pile" internal structure. P/2013 R3 itself is probably the product of collisional shattering of a bigger body some time in the last billion years.

"This is the latest in a line of weird asteroid discoveries, including the active asteroid P/2013 P5, which we found to be spouting six tails," says Agarwal. *"This indicates that the Sun may play a large role in disintegrating these small Solar System bodies, by putting pressure on them via sunlight."*

P/2013 R3's remnant debris, weighing in at 200 000 tonnes, will provide a rich source of meteoroids in the future. Most will eventually plunge into the Sun, but a small fraction of the debris may one day blaze across our sky as meteors.

Formation of Pebble-Pile Planetesimals *Karl Wahlberg Jansson and Anders Johansen* Astronomy & Astrophysics Preprint at http://arxiv.org/abs/1408.2535

Asteroids and Kuiper belt objects are remnant planetesimals from the epoch of planet formation. The first stage of planet formation is the accumulation of dust and ice grains into mm-cm-sized pebbles. These pebbles can clump together through the streaming instability and form gravitationally bound pebble `clouds'. Pebbles inside such a cloud will undergo mutual collisions, dissipating energy into heat. As the cloud loses energy, it gradually contracts towards solid density. We model this process and investigate two important properties of the collapse: (i) the timescale of the collapse and (ii) the temporal evolution of the pebble size distribution. Our numerical model of the pebble cloud is zero-dimensional and treats collisions with a statistical method. We find that planetesimals with radii larger than ~100 km collapse on the free-fall timescale of about 25 years. Lower-mass clouds have longer pebble collision timescales and collapse much more slowly, with collapse times of a few hundred years for 10-km-scale planetesimals and a few thousand years for 1-km-scale planetesimals. The mass of the pebble cloud also determines the interior structure of the resulting planetesimal. The pebble collision speeds in low-mass clouds are below the threshold for fragmentation, forming pebble-pile planetesimals consisting of the primordial pebbles from the protoplanetary disk. Planetesimals above 100 km in radius, on the other hand, consist of mixtures of dust (pebble fragments) and pebbles which have undergone substantial collisions with dust and other pebbles. The Rosetta mission to the comet 67P/Churyumov-Gerasimenko and the New Horizons mission to Pluto will both provide valuable information about the structure of planetesimals in the Solar System. Our model predicts that 67P is a pebble-pile planetesimal consisting of primordial pebbles from the Solar Nebula, while the pebbles in the cloud which contracted to form Pluto must have been ground down substantially during the collapse.



The previous model of Kleopatra: Stephen Ostro et al. (JPL), Arecibo Radio Telescope, NSF, NASA

Dumb-Bell-Shaped Equilibrium Figures for Fiducial Contact-Binary Asteroids and EKBOs *Pascal Descamps* Icarus Preprint at http://arxiv.org/abs/1410.7962

In this work, we investigate the equilibrium figures of a dumb-bell-shaped sequence with which we are still not well acquainted. Studies have shown that these elongated and nonconvex figures may realistically replace the classic ``Roche binary approximation" for modelling putative peanut-shaped or contact binary asteroids. The best-fit dumb-bell shapes, combined with the known rotational period of the objects, provide estimates of the bulk density of these objects. This new class of mathematical figures has been successfully tested on the observed light curves of three noteworthy small bodies: main-belt Asteroid (216) Kleopatra, Trojan Asteroid (624) Hektor and Edgeworth-Kuiper-belt object 2001 QG_{298}. Using the direct observations of Kleopatra and Hektor obtained with high spatial resolution techniques and fitting the size of the dumb-bell-shaped solutions, we derived new physical characteristics in terms of equivalent radius, 62.5±5km and 92±5km, respectively, and bulk density, 4.4±0.4 g cm^{-3} and 2.43±0.35 g cm^{-3}, respectively. In particular, the growing inadequacy of the radar shape model for interpreting any type of observations of Kleopatra (light curves, AO images, stellar occultations) in a satisfactory manner suggests that Kleopatra is more likely to be a dumb-bell-shaped object than a "dog-bone."

Large Retrograde Centaurs: Visitors from the Oort Cloud? *C. de la Fuente Marcos and R. de la Fuente Marcos* Astrophysics and Space Science Preprint http://arxiv.org/abs/1406.1450

Among all the asteroid dynamical groups, Centaurs have the highest fraction of objects moving in retrograde orbits. The distribution in absolute magnitude, H, of known retrograde Centaurs with semi-major axes in the range 6-34 au exhibits a remarkable trend: 10% have H < 10 magnitude, the rest have H > 12 magnitude. The largest objects, namely (342842) 2008 YB_3, 2011 MM_4 and 2013 LU_{28}, move in almost polar, very eccentric paths; their nodal points are currently located near perihelion and aphelion. In the group of retrograde Centaurs, they are obvious outliers both in terms of dynamics and size. Here, we show that these objects are also trapped in retrograde resonances that make them unstable. Asteroid 2013 LU_{28}, the largest, is a candidate transient co-orbital to Uranus and it may be a recent visitor from the trans-Neptunian region. Asteroids 342842 and 2011 MM_4 are temporarily submitted to various high-order retrograde resonances with the Jovian planets but (342842) may be ejected towards the trans-Neptunian region within the next few hundred kyr. Asteroid 2011 MM_4 is far more stable. Our analysis shows that the large retrograde Centaurs form a heterogeneous group that may include objects from various sources. Asteroid 2011 MM_4 could be a visitor from the Oort cloud but an origin in a relatively stable closer reservoir cannot be ruled out. Minor bodies like 2011 MM_4 may represent the remnants of the primordial planetesimals and signal the size threshold for catastrophic collisions in the early Solar System.

New catalogue of one-apparition comets discovered in the years 1901–1950 I. Comets from the Oort spike ? *Malgorzata Królikowska, Grzegorz Sitarski, Eduard M. Pittich, Slawomira Szutowicz, Krzysztof Ziolkowski, Hans Rickman, Ryszard Gabryszewski and Bozenna Rickman* Astronomy & Astrophysics www.aanda.org/articles/aa/pdf/2014/**11**/aa24329-14.pdf

Context. The orbits of one-apparition comets discovered in the early part of the last century have formerly been determined with very different numerical methods and assumptions on the model of the solar system, including the number of planets taken into account. Moreover, observations of the comet-minus-star-type sometimes led to determination of the comet position that are less precise than what we can derive today by using a more modern star catalogue.

Aims. We aim to provide a new catalogue of cometary orbits that are derived using a completely homogeneous data treatment, accurate numerical integration, and a modern model of the solar system.

Methods. We collected the complete sets of observations for investigated comets from the original publications. Then we recalculated the cometary positions for the comet-minus-star-type of observations using the Positions and Proper Motions Star Catalogue, and applied a uniform method for the data selection and weighting. As a final result, new osculating orbits were determined. Secondly, dynamical calculations were performed to the distance of 250 au from the Sun to derive original and future barycentric orbits for evolution backward and forward in time. These numerical calculations for a given object start from a swarm of virtual comets constructed using our osculating (nominal) orbit. In this way, we obtained the orbital element uncertainties of original and future barycentric orbits.

Results. We present homogeneous sets of orbital elements for osculating, original, and future orbits for 38 one-apparition comets. Non-gravitational orbits are derived for thirteen of them.

Reassessing the Formation of the Inner Oort Cloud in an Embedded Star Cluster II: Probing the Inner Edge, *R. Brasser and M.E. Schwamb,* Monthly Notices of the Royal Astronomical Society, Preprint at http://arxiv.org/abs/1411.1844

The detached object Sedna is likely at the inner edge of the Oort cloud, more precisely the inner Oort cloud (IOC). Until recently it was the sole member of this population. The recent discovery of the detached object 2012 VP_{113} has confirmed that there should be more objects in this region. Three additional IOC candidates with orbits much closer to Neptune have been proposed in the past decade since Sedna's discovery: 2000 CR_{105}, 2004 VN_{112} and 2010 GB_{174}. Sedna and 2012 VP_{113} have perihelia near 80 au and semi-major axes over 250 au. The latter three have perihelia between 44 au and 50 au and semi-major axes between 200 au and 400 au. Here we determine whether the latter three objects belong to the IOC or are from the Kuiper Belt's Extended Scattered Disc (ESD) using numerical simulations. We assume that the IOC was formed when the Sun was in its birth cluster. We analyse the evolution of the IOC and the Scattered Disc (SD) during an episode of late giant planet migration. We examine the impact of giant planet migration in the context of four and five planets. We report that the detached objects 2004 VN_{112} and 2010 GB_{174} are likely members of the IOC that were placed there while the Sun was in its birth cluster or during an episode of Solar migration in the Galaxy. The origin of 2000 CR_{105} is ambiguous but it is likely it belongs to the ESD. Based on our simulations we find that the maximum perihelion distance of SD objects is 41 au when the semi-major axis is higher than 250 au. Objects closer in are subject to mean motion resonances with Neptune that may raise their perihelia. The five planet model yields the same outcome. We impose a conservative limit and state that all objects with perihelion distance q>45 au and semi-major axis a>250 au belong to the inner Oort cloud.

STEREO A image of 96P/Machholz on 2007 April 3

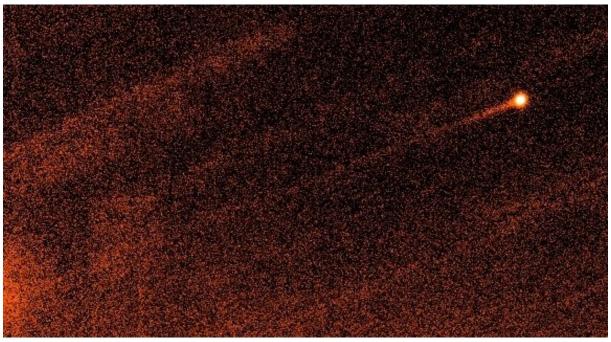
Flipping Minor Bodies: What 96P/Machholz can Tell Us about the Orbital Evolution of Extreme Trans-Neptunian Objects and the Production of Near-Earth Objects On Retrograde Orbits, *Carlos de la Fuente Marcos, Raúl de la Fuente Marcos and Sverre J. Aarseth*, Monthly Notices of the Royal Astronomical Society, Preprint at http://arxiv.org/abs/1410.6307

Nearly all known extreme trans-Neptunian objects (ETNOs) have argument of perihelion close to 0°. An existing observational bias strongly favours the detection of ETNOs with arguments of perihelion close to 0° and 180° yet no objects have been found at 180°. No plausible explanation has been offered so far to account for this unusual pattern. Here, we study the dynamical evolution of 96P/Machholz, a bizarre near-Earth object (NEO) that may provide the key to explain the puzzling clustering of orbits around argument of perihelion close to 0° recently found for the population of ETNOs. 96P/Machholz is currently locked in a Kozai resonance with Jupiter such that the value of its argument of perihelion is always close to 0° at its shortest possible perihelion (highest eccentricity and lowest inclination) and about 180° near its shortest aphelion (longest perihelion distance, lowest eccentricity and highest inclination). If this object is a dynamical analogue (albeit limited) of the known ETNOs, this implies that massive perturbers must keep them confined in orbital parameter space. Besides, its future dynamical evolution displays orbital flips when its eccentricity is excited to a high value and its orbit turns over by nearly 180°, rolling over its major axis. This unusual behaviour, that is preserved when post-Newtonian terms are included in the numerical integrations, may also help understand the production of NEOs on retrograde orbits.

The Mass Disruption of Jupiter Family Comets, *A. Michael J.S. Belton*, Icarus, 2015 January 1

I show that the size-distribution of small scattered-disk trans-Neptunian objects when derived from the observed size-distribution of Jupiter Family comets (JFCs) and other observational constraints implies that a large percentage (94-97%) of newly arrived active comets within a range of 0.2 to 15.4 km effective radius must physically disrupt, i.e., macroscopically disintegrate, within their median dynamical lifetime. Additional observational constraints include the numbers of dormant and active nuclei in the near-Earth object (NEO) population and the slope of their size distributions. I show that the cumulative power-law slope (-2.86 to -3.15) of the scattered-disk TNO hot population between 0.2-15.4 km effective radius is only weakly dependent on the size-dependence of the otherwise unknown disruption mechanism. Evidently, as JFC nuclei from the scattered disk evolve into the inner solar system only a fraction achieve dormancy while the vast majority of small nuclei (e.g., primarily those with effective radius <2 km) break-up. The percentage disruption rate appears to be comparable with that of the dynamically distinct Oort cloud and Halley type comets (Levison et al. 2002, Science, 296, 2212-2215) suggesting that all types of comet nuclei may have similar structural characteristics even though they may have different source regions and thermal histories. The typical disruption rate for a 1 km radius active nucleus is ~$5x10^{-5}$ disruptions/year and the dormancy rate is typically 3 times less. We also estimate that average fragmentation rates range from 0.01 to 0.04 events/year/comet, somewhat above the lower limit of 0.01 events/year/comet observed by Chen and Jewitt (1994, Icarus, 108, 265-271).

The Castalia Space Mission http://bit.ly/mbcmission



133P/Elst-Pizarro: NTT, ESO La Silla, 2013 Sept. 3

The Castalia Space Mission will be launched in the mid-2020s, to go and explore Comet 133P/Elst-Pizarro, a Main Belt Comet. Main Belt Comets (MBCs) are a newly identified population in the Asteroid Main Belt. Their orbits are undistinguishable from those of the asteroids, but they display cometary activity —a dust coma or a dust tail. 133P/Elst-Pizarro behaves like a normal comet: its cometary activity happens regularly while it passes through perihelion, i.e. when it is closest to the Sun. The most likely explanation is that some water ice is buried in its nucleus, and starts sublimating when it is heated by the Sun.

Castalia will study the nature of this comet, and illuminate the role of the MBCs in the overall planetary formation and during the early ages of the solar system. Furthermore, Castallia will explore the connection of MBCs with the origin of water on Earth. The mission will be launched around middle of the 2020s. The spacecraft will travel 5 years before reaching the comet several months before the cometary activity starts. It will study the nucleus and observe the onset of the activity, and then will probe the dust and gas released by the comet.

The technology for the spacecraft and for the instrument is either available today, or is at a suitable level of readiness for successful implementation. The spacecraft envelope and financial budget of the Castalia mission is at the level of a typical ESA M-class mission. The design of the mission and the spacecraft are developed by the science team and by the Institute of Space Systems / System Analysis Space Segment (DLR) and OHB System.

Rosetta

Nick James

After over ten years in space and more than four orbits around the Sun the European Space Agency Rosetta spacecraft finally arrived at its target, comet 67P/Churyumov–Gerasimenko, in 2014.

The year started with Rosetta waking up from its 30 month hibernation on January 20. Following the wakeup all of the spacecraft's systems were functioning correctly and the next few months were spent making large thrusters burns which aligned the velocity of the spacecraft with that of the comet. The final rendezvous burn was made on August 6. This changed the spacecraft velocity by 1 m/s and put it on the first arc of a triangular trajectory around the comet. This initial "orbit" was not dynamically stable since it required a thruster burn at each vertex in order to maintain station with the comet but it was the first time in history that a spacecraft had gone into orbit around an active cometary nucleus. The initial range to the comet was around 100 km.

Rosetta carries a large number of scientific instruments but the imaging cameras generate the biggest headlines. There are two scientific cameras on board the main spacecraft. OSIRIS-WAC which is a wide angle camera with a field of view of 12°, and OSIRIS-NAC which has a much higher angular resolution and a FoV of 2.2°. Both cameras use E2V 2K×2K CCDs. There is also a navigation camera, NAVCAM, which is operated by ESA and which has an intermediate resolution. The release of images from OSIRIS has been limited due to an agreed scientific proprietary period but NAVCAM data has been released on an almost daily basis.

Early images from OSIRIS-NAC released unofficially in mid-July showed that the nucleus appeared to consist of two lobes and there was speculation that 67P was a contact binary. Later images taken after rendezvous show that it is more likely to be a single object and that the "neck" region has been repeatedly eroded by sublimation at each return. The comet's nucleus is around 5×3 km in size and these images show an extraordinary amount of surface variation for such a small object.

67P was already active on September 10
ESA/Rosetta/MPS for OSIRIS Team

Careful tracking of the spacecraft's radio signal allows us to measure its trajectory very accurately and this leads to a very precise measurement of acceleration due to the nucleus' gravitational field. The comet's mass is around 10^{13} kg and this corresponds to an escape velocity at the surface of 0.6 – 0.8 m/s depending on where you stand.

67P has an orbital period of 6.5 years and was around 520 million km from the Sun at rendezvous. At this distance the nucleus is relatively quiet but OSIRIS-WAC was able to image faint jets of material emanating from the neck region. This dust WAS detected in situ by Rosetta's Grain Impact Analyser and Dust Accumulator, GIADA. The first detection was made as early as August 1, when Rosetta was 814 km from the comet. Further impacts from three more dust grains were detected on August 2, 4, and 5. From the measured momentum of the impacts, it was possible to estimate the sizes of the collected grains and the largest was about 0.35 mm across.

In early September the spacecraft entered the Global Mapping phase. In this phase the spacecraft moved much closer to the nucleus in order to improve the physical resolution of the OSIRIS NAC camera. At its closest Rosetta was in a circular orbit with a radius of 9.8 km and period of 66 hours. At this distance the OSIRIS-NAC camera had a resolution of around 0.15m/pixel. From late October Rosetta was moved further from the nucleus and it is unlikely to get as close again this side of perihelion.

A key objective of the mission was to deploy the Philae lander to make in-situ measurements on the surface. The selection of landing site was compromise between engineering constraints (lander operation, battery charging, data return and navigation) and scientific goals. A key constraint was that uncertainties in the navigation of the orbiter and the comet’s gravitational field meant that it is only possible to specify any given landing zone in terms of an error ellipse with an area of around 1 km^2. By September ESA had selected five potential landing sites which were reduced to two (a primary and a backup) following detailed analysis of the OSIRIS imagery. The primary landing site was named Agilkia after a small island in the Nile where a number of the Philae artefacts were moved during the building of the Aswan dams.

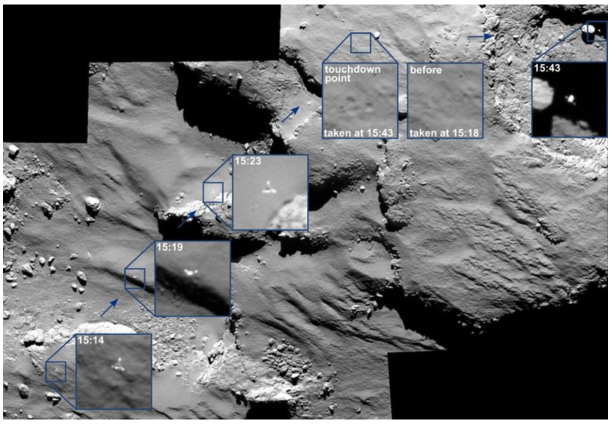
In preparation for the landing Rosetta left the Global Mapping orbit on October 28 and transferred into a pre-delivery orbit which took it out to 30km from the nucleus. The landing of Philae was scheduled for November 12. At the time of the landing 67P was about 500 million km from Earth and radio signals from the spacecraft took over 28 minutes to make the journey from the spacecraft to the ground.

One of the key challenges of the mission was always going to be the successful landing of Philae on the comet’s nucleus. Landing on a comet that has an escape velocity of less than 1 m/s is a real problem since there is very little gravity to hold the lander on the surface. Philae had a downward pointing thruster (called ADS) along with harpoons which would hold the lander on the surface for long enough that screws in the feet could be driven in to anchor the spacecraft.

The lander has no way of controlling its trajectory. It is ejected from Rosetta by a mechanical arrangement that imparts a velocity of around 0.2 m/s and then falls in whatever direction Rosetta aims it. This meant that the trajectory of Rosetta before separation was critical. In the days before the landing detailed measurements were done to determine the orbit and two hours before planned separation a critical manoeuvre was performed to put Rosetta on the delivery trajectory. Telemetry from the spacecraft confirmed that this had gone as planned and a final “Go” was given for separation.

During the night before release engineers had not been able to prime the ADS thruster but it was decided to go ahead anyway given that there was very little probability of resolving the problem and the landing would get harder as the comet became more active.

Separation of the lander was confirmed in Rosetta downlink telemetry at 09:03 UTC on November 12. Up to that point telemetry from Philae had been routed through an electrical umbilical but this was now disconnected. From now on Philae would relay its data via a radio link with Rosetta. Rosetta would then transmit the data to the ground. Philae’s was now falling at around 0.9 m/s from a release altitude of 22.5 km. It would take around 7 hours to fall to the surface. Just after separation both Philae and Rosetta took images of each other but these images would not be sent back to the ground until later.



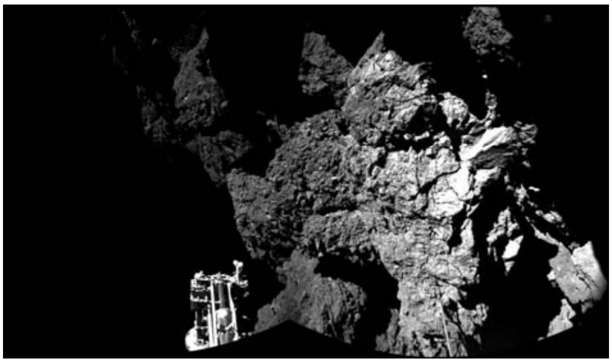
OSIRIS spots Philae drifting across the comet: ESA/Rosetta/MPS for OSIRIS Team

Good telemetry was received throughout the descent but things got very tense as the expected landing time approached. Confirmation of the landing would come via the Philae telemetry that was being relayed back via Rosetta. After a nail-biting wait the landing was confirmed at 16:03 UTC. Philae continued to send back data but there some confusion about how stable the spacecraft was and interpretation of the telemetry was very difficult. The deflection of the landing gear indicated a gentle touchdown but the harpoons, which had been intended to operate on landing, did not work. Subsequent analysis showed that Philae touched down within 20m of the aim point but it then bounced several times and came to rest around 1km from its nominal position in a rather inhospitable spot.

The telemetry showed that the lander systems were working well and the CIVA panoramic camera system sent back images showing the surface, horizon, sky and one of the lander footpads. Unfortunately the solar panels were only in sunlight for only around 1.5 hours of every 12.4 hour cometary day. This meant that the lander battery was not charging so the mission would have to rely on its primary battery and this would run flat late on day 3.

Since the lander was not anchored to the surface mission controllers scheduled the low risk science operations first but, as the available battery power dropped into the third day, controllers started to command the more risky elements of the experiments including the MAPUS penetrator/hammer and the SD2 drill. Early results from MAPUS indicate that the surface was much harder than expected since the penetrator didn't make much impression despite the hammer being on maximum power. The drill was commanded to extract and deliver a sample to the COSAC composition instrument but at the time of writing it is not known whether this was successful and what scientific data was returned.

As the battery ran down, one of the last actions taken by the lander was to raise itself up on its landing gear and perform a 35 degree rotation. This was to align the largest solar wall with the little sunlight that was available. There is a possibility that, as the comet approaches perihelion later this year and the Sun gets stronger, the panel will generate enough power to allow Philae to wake up from hibernation. The probability is small since the battery will be very cold but Rosetta will be listening just in case.



Philae's final landing site (ESA)

Finally, at around 00:10 UTC on November 15 Philae went into a low power mode with the science payload switched off. It continued to transmit low-rate engineering telemetry until loss of signal at 0045.

Rosetta itself continues its mission and the OSIRIS-NAC camera has been used to search for Philae, although with no success so far. Some early scientific results from operations at the comet were been presented at the American Geophysical Union meeting in December and the press conference is worth a watch. You can find it on Youtube here:

https://www.youtube.com/watch?v=ISfa_l-Ji90

Project Alcock Update

The following sections have been added during 2014:

Astrometry and photometry of CCD images using Iris
How to obtain an MPC observatory code
A beginner's guide to using iTelescope
Using the SSON robotic telescope
Submitting images to the BAA and other organisations
Spectroscopy Part I - using the SSON Transmission Grating Spectrograph
Spectroscopy Part II - Generating a profile using Visual Spec
Spectroscopy Part III - Analysing spectra using Visual Spec
Spectroscopy Part IV - Resources

Spectroscopy Parts III and IV are very much works in progress. To date I have imaged stars but hopefully 2014 Q2 (Lovejoy) and possibly a few others will be bright enough to make good targets for spectroscopy.

Comets A to Z continues to be updated

Roger Dymock

Review of comet observations for 2014 January - 2014 December

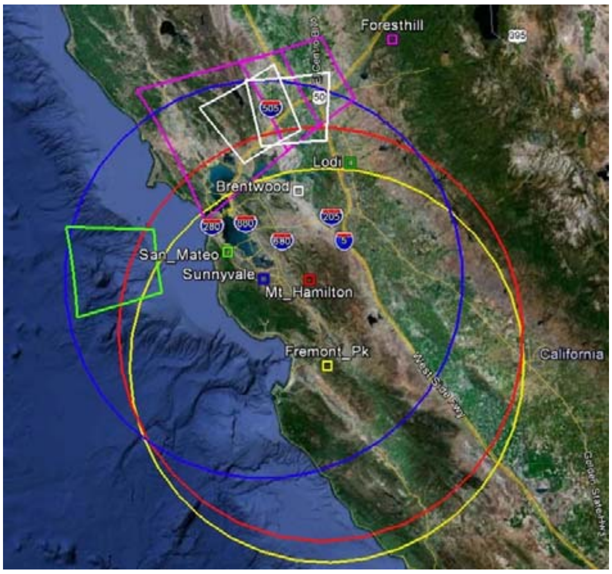
The information in this report is a synopsis of material gleaned from CBETs, MPECs, The Astronomer (2013 December – 2014 November) and the Internet. It covers comets designated during 2014, and those with electronic or visual observations made during the year. Note that the figures quoted here are rounded off from their original published accuracy. Light-curves for the brighter comets are from observations submitted to the Director and TA. A report of the brighter comets seen during the year, including observations published in The Astronomer will be produced for the Journal in due course. I use the convention of designating interesting asteroids by A/Designation [Discoverer] to clearly differentiate them from comets, though this is not the IAU convention.

Further information can be found on the Section web pages, in previous editions of *The Comet's Tale* and in the BAA Guide to Observing Comets. Images of comets can be found in the Section Comet Gallery, and only a photogenic selection is shown here as those taken for astrometric purposes do not reproduce very well. Magnitude estimates are in the year files which are on the Section web page; these include some electronic observations of comets which are not mentioned here.

Observers contributing magnitude estimates used in the analyses include: James Abbott, Salvador Aguirre, Alexandre Amorim, Alexandr R. Baransky, Sandro Baroni, Nicolas Biver, Denis Buczynski, Paul Camilleri, Matyas Csukas, Yurij Dubrovski, Roger Dymock, Fraser Farrell, James Fraser, Stephen Getliffe, Antonio Giambersio, Massimo Giuntoli, J J Gonzalez, Marco Goiato, Bjoern Granslo, Ernesto Guido, Werner Hasubick, Kevin Hills, Guy Hurst, Andreas Kammerer, Heinz Kerner, Carlos Labordena, Martin Lehky, Luis Mansilla, Jose Carvajal Martinez, Michael Mattiazzo, Peter Morris, Artyom Novichonok, Mieczyslaw L. Paradowski, Nirmal Paul, Stuart Rae, Walter Robledo, John Sabia, Jonathan D. Shanklin, Giovanni Sostero, Willian C de Souza, David Spooner, Enrico Stomeo, David Storey, Melvyn Taylor, Graham W. Wolf, and Seiichi Yoshida. Apologies if anyone has been left out.

4P/Faye was poorly placed when it was at its brightest, but Seiichi Yoshida and Kevin Hills picked it up as it was fading through 14^{th} magnitude from September to December.

An outburst of meteors from **8P/Tuttle** was observed around midnight on December 22/23 by the Canadian Meteor Orbit Radar. The timing of this peak is a reasonable match to the prediction by J. Vaubaillon of December 23d00h40m UT for an encounter with material released by 8P/Tuttle in 1392 AD. Material released from the comet at its 1405 AD return was detected by Peter Jenniskens, during routine low-light-level video triangulations with NASA's Cameras for Allsky Meteor Surveillance (CAMS) project in California.



Location of the CAMS stations in California

15P/Finlay was reported to outburst in December, however its brightness in outburst was close to that expected from the previous return. At that return it brightened quite rapidly and it may have done the same thing this time round.

The 8 visual observations received so far suggest a preliminary uncorrected light curve of

$$m = 8.8 + 5 \log d + [20] \log r$$

16P/Brooks was observed twice by Kevin Hills in September and October when it was around 17^{th} magnitude.

17P/Holmes, which had a major outburst at its last return, was a particular target for Roger Dymock, with a visual observation by Seiichi Yoshida and an electronic one by Denis Buczynski. Observations span the period from August to November, when the comet was around 14^{th} magnitude. It was several months past perihelion and retreating from the Sun, but was approaching the Earth, which gave almost constant brightness. The error bars on the fit are roughly one magnitude. Denis Buczynski also took other images, but these have not yet been reduced to ICQ format. Richard Miles analysed them to derive near nuclear magnitudes and reports a possible outburst of 0.7 magnitude between November 3 and 10.

29P/Schwassmann-Wachmann was well observed by Kevin Hills and Roger Dymock between January and October, with some additional observations by more southerly based visual observers. For most of this period it was around 12^{th} to 14^{th} magnitude, with the fainter estimates in August and September. There are no clearly defined outbursts, though the visual observations may indicate ones in early March and early May.

Observations of **32P/Comas Sola** during the last three months of the year suggest that it was around 14^{th} magnitude.

The 11 electronic and visual observations received so far suggest a preliminary uncorrected light curve of

$$m = 6.2 + 5 \log d + [20] \log r$$

Although not at perihelion until 2015, Kevin Hills observed **44P/Reinmuth** from July to September as it brightened from 17^{th} to 16^{th} magnitude.

52P/Harrington-Abell was imaged by Roger Dymock and Kevin Hills during the first half of the year as it faded from 14^{th} to 18^{th} magnitude.

84P/Giclas faded from 16^{th} to 18^{th} magnitude during the first couple of months of the year according to observations by Kevin Hills.

108P/Ciffreo was around 14^{th} magnitude in the last quarter of the year from observations by Kevin Hills.

110P/Hartley was also observed by Kevin Hills who found it brightening from 15^{th} to 14^{th} magnitude in the last two months of the year.

The 7 electronic observations received so far suggest a preliminary uncorrected light curve of

$$m = 5.5 + 5 \log d + [20] \log r$$

116P/Wild is not due at perihelion until 2016, but is already under observation by Kevin Hills in December, who reports the comet at around 16^{th} magnitude. It could reach 12^{th} magnitude late in the year.

117P/Helin-Roman-Alu has a relatively low eccentricity orbit with perihelion at 3.1 au and slowly brightened to reach 13th magnitude in September. There was a mix of visual and electronic observations.

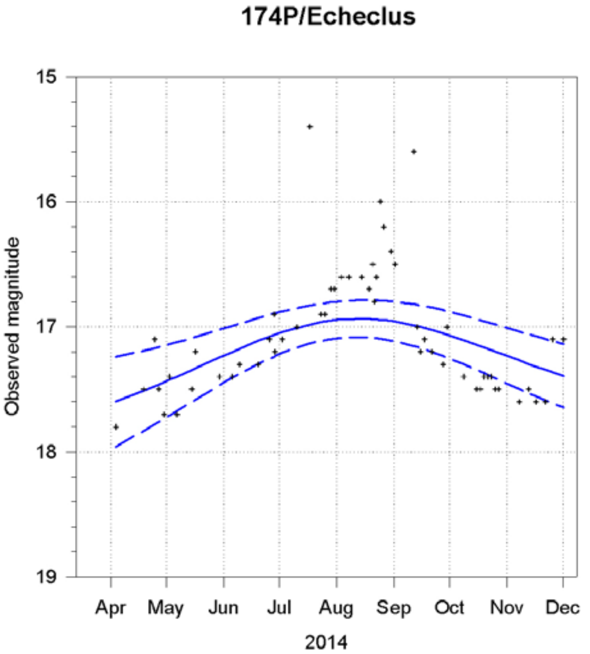
119P/Parker-Hartley was observed by Kevin Hills in January and November with the comet fading from 17th to 18th magnitude.

134P/Kowal-Vavrova was under observation from March to September when the comet was 13th to 14th magnitude.

154P/Brewington was observed by Carlos Labordena in January and February as it faded from 11th to 12th magnitude.

158P/Kowal-LINEAR was at perihelion in 2012. Two observations by Kevin Hills put it at 19th magnitude in 2014.

170P/Christensen was around 17th magnitude when observed by Kevin Hills in September and October.

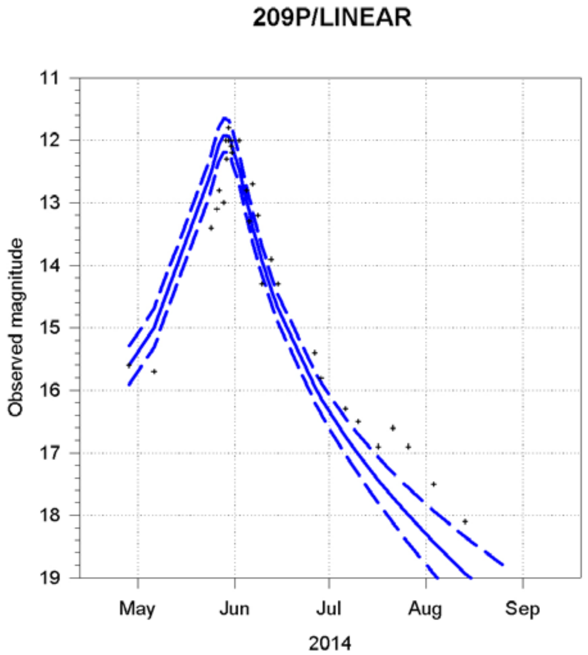


174P/Echeclus reaches perihelion in 2015 and has been a major target for Roger Dymock and Kevin Hills. In addition to its cometary designation it also classed as Centaur asteroid (60558) Echeclus. The centaur Echeclus was killed by Ampyx in the battle with the Lapiths [JPL Horizons]. Its rotation period is given as 26.8 hours±30%. Although JPL give an absolute magnitude of 9.6, this is probably based on an assumption of purely reflective behaviour. The BAA observations from 2006 to 2014 give an absolute magnitude of 8.6 with this assumption, but a much brighter value of 4.5 if cometary behaviour is assumed. Taking just the 2014 observations gives an absolute H_{10} magnitude of 5.7 or H_5 of 9.5, close to the JPL value, and they are best fitted by generally asteroidal behaviour. The observations in August are rather brighter than the mean curve, whilst those at the end of the year are fainter. The rather sparser observations from 2006 and 2011 are much brighter than would be expected from the 2014 observations and clearly the object has very variable behaviour. It is worth keeping under observation as it approaches perihelion.

Observations of **178P/Hug-Bell** in January by Kevin Hills put the comet at around 17th magnitude.

201P/LONEOS was around 15th magnitude when observed by Kevin Hills in the last quarter of the year.

209P/LINEAR was observed visually and electronically from March to August. It passed 0.055 au from the Earth on May 29 at 07:51. It brightened very rapidly from 16th magnitude at the end of April to 12th magnitude around the time of closest approach, then faded equally rapidly. It is an intrinsically very faint comet with an H_{10} absolute magnitude of 18.0, and also has low activity so that an asteroidal light curve fits the observations quite well. Meteors were seen as expected from the Camelopardalid shower, however peak rates were only 20 per hour at best.



242P/Spahr was at perihelion in 2012. Three observations by Kevin Hills put it at 19th magnitude in early 2014.

244P/Scotti was at perihelion in 2012. An observation by Kevin Hills put it at 19th magnitude in early 2014.

246P/NEAT returned to more normal behaviour following its 2012 March outburst and was around 15th to 16th magnitude in observations by Kevin Hills.

257P/Catalina was observed once by Kevin Hills in January when it was 18th magnitude.

Four observations of **266P/Christensen** by Kevin Hills in early 2014 put the comet at around 18th magnitude.

270P/Gehrels was 19th magnitude in an observation by Kevin Hills in January.

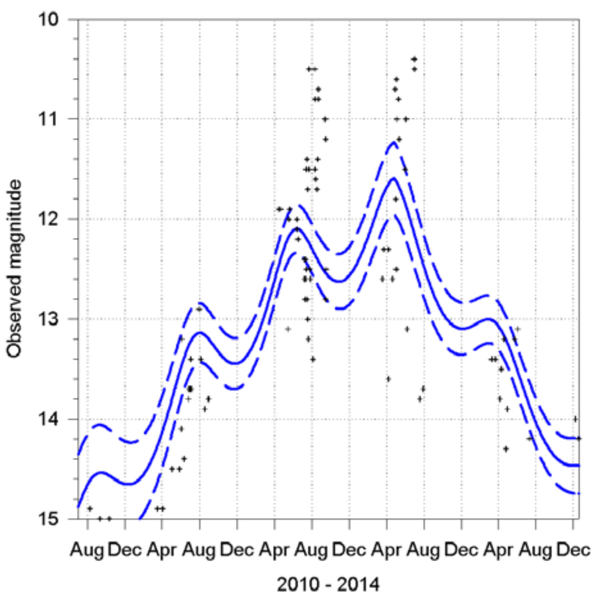
284P/McNaught was observed electronically by Kevin Hills and visually by Seiichi Yoshida. It brightened from 17th magnitude in May to an autumn peak of around 14th magnitude.

290P/Jager continued under visual observation during the first four months of the year as it slowly faded from 12th to 13th magnitude.

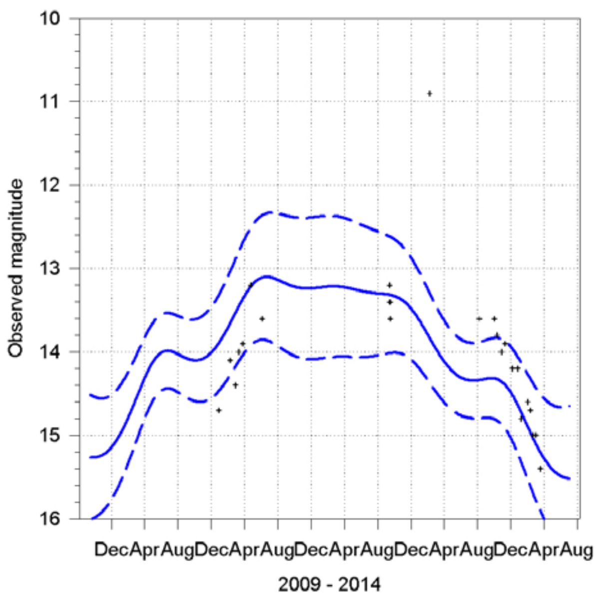
292P/Li was 16th magnitude in early in the year in observations by Kevin Hills.

One observation of **294P/LINEAR** in May put the comet at 18th magnitude.

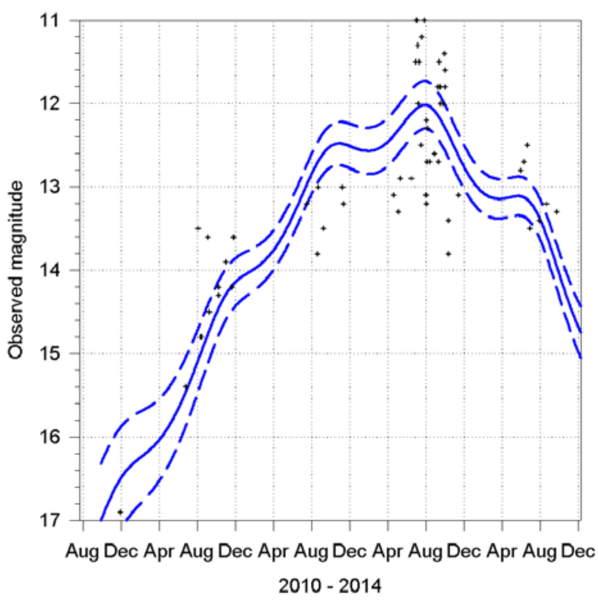
Observations of **2006 S3 (LONEOS)** continued through 2014, though all bar one were imaging results. This comet now has one of the longest spans of observation in the Section records. The first electronic observation was in 2006, though the next observations were not until 2010. At its brightest in 2012 and 2013 the comet reached around 11th magnitude. Taken together the observations suggest a linear form of lightcurve, with the comet reaching its peak activity some 12 months after perihelion.



Kevin Hills continued imaging **2009 F4 (McNaught)** as it faded from 15th to 17th magnitude.



2010 S1 (LINEAR) was slowly fading and was around 13th magnitude for much of the year according to a mix of visual and electronic observations. It was a distant comet, and probably quite a large one judging by its bright absolute magnitude (H_{10}=1.2).



2011 F1 (LINEAR) was imaged by Kevin Hills, though it had faded to 18th – 19th magnitude.

2011 J2 (LINEAR) was observed by several imagers and one visual observer at around 14th magnitude. Although a faint object, it provided interest when a secondary component 'B' was discovered, with many amateurs contributing follow-up astrometry. Zdenek Sekanina, Jet Propulsion Laboratory, reported in CBET 3986 [2014 September 24] that a modelling of the companion's motion relative to the primary nucleus, based on positional offsets, suggests that the companion, a strongly decelerating fragment (about 0.0008 the sun's gravitational acceleration) of a fairly short lifetime (estimated at 20-40 days at 1 au from the sun); separated with a sub-metre velocity from the parent some 2 weeks after perihelion, in early January 2014. The solution is somewhat uncertain because the observations span a period of time nearly centred on the earth's transit across the comet's orbit plane, which occurred on 2014 September 6.8. A second fragment 'C' was subsequently detected by Ernesto Guido, Nick Howes & Martino Nicolini at Remanzacco Observatory on October 9.

Kevin Hills imaged **2011 KP$_{36}$ (Spacewatch)** at 17th magnitude in August.

Roger Dymock made a final observation of **2011 L4 (PanSTARRS)** in April when it was 15th magnitude.

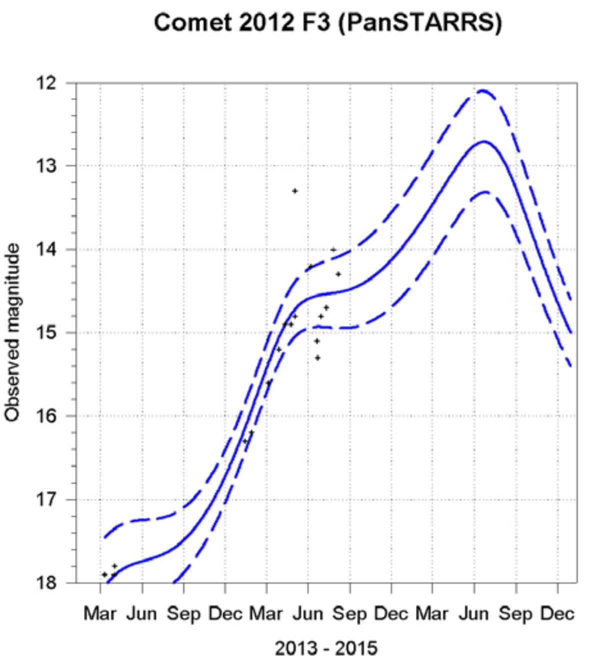
Kevin Hills continued observing **2011 O1 (LINEAR)**, which was around 17th magnitude in January and February.

2012 B1 (P/PanSTARRS) continued to be imaged by Kevin Hills. Somewhat contrary to expectations it was brighter at its post perihelion opposition than it was pre-perihelion in 2013. This suggests a linear type light curve with a delay of peak brightness of several months. It is in quite a distant orbit with a period of around 17 years, so it will be some time before this hypothesis can be tested.

2012 F3 (PanSTARRS) brightened on its way to perihelion in 2015 April. It could reach 13th magnitude, though it is best seen from the Southern Hemisphere.

The 21 electronic and visual observations received so far suggest a preliminary uncorrected light curve of

$$m = 4.5 + 5 \log d + 11.1 \log r$$



2012 J1 (Catalina) was another of the many comets observed by Kevin Hills. This one was around 16th magnitude in early 2014.

The Catalina Sky Survey Schmidt (LPL)

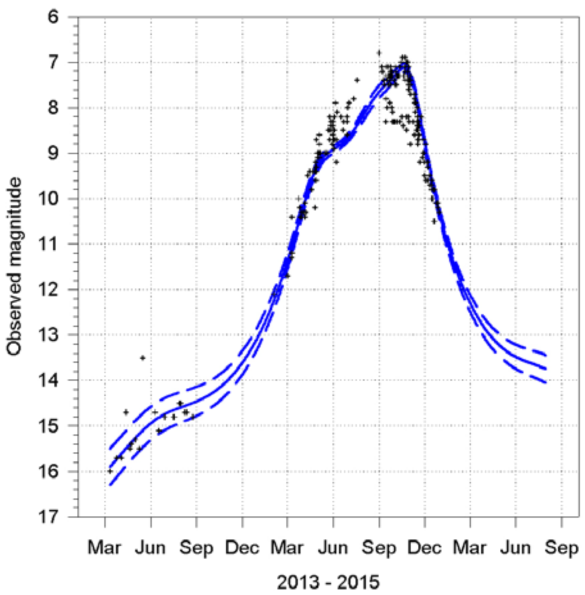
2012 K1 (PanSTARRS) was one of the brighter comets under observation during the year. Visual observers picked it up in February, when it was 12th magnitude. By April it was within range of large binoculars, and Jonathan Shanklin observed it from central Cambridge in 20x80B on April 26.89 when it was 9.2. It brightened, though in June and July was clearly brighter than the mean curve. James Abbott estimated it at 7.9 in 15x70B on June 4.99. It passed through conjunction in August, being recovered by Marco Goiato at 6.8: on the last day of the month. Unfortunately it was a morning object when at its brightest in the early autumn. It then headed south and will remain an essentially Southern Hemisphere object as it continues to fade.

Electronic observations seemed to under-estimate the magnitude when the comet was at its brightest. They also reported significantly smaller coma diameters and were perhaps not integrating out to the true visual coma diameter. It will be worth establishing the limits of the technique, but in the first instance it is perhaps worth restricting reduction to comets with visual coma diameters less than about 6' or electronically measured diameters of approximately less than 4'.

The 357 visual observations received so far suggest a preliminary uncorrected light curve of

$$m = 6.1 + 5 \log d + 7.2 \log r$$

2012 K1 (PanSTARRS) imaged by Damian Peach on 2014 September 16. 20" CDK with FLI camera. L filter. 10 mins exposure.

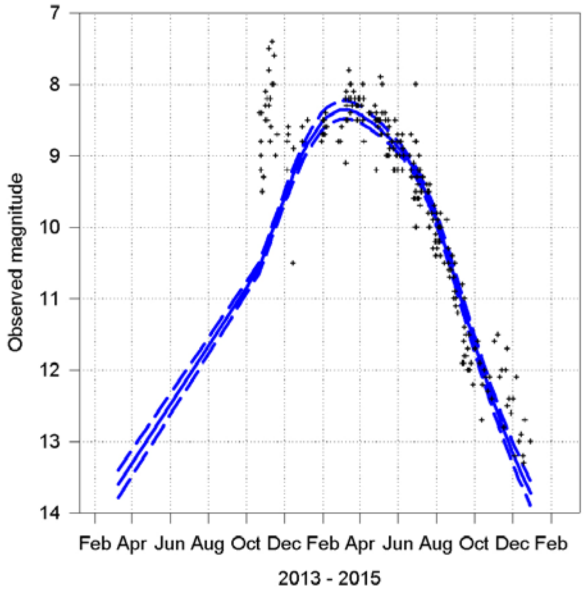


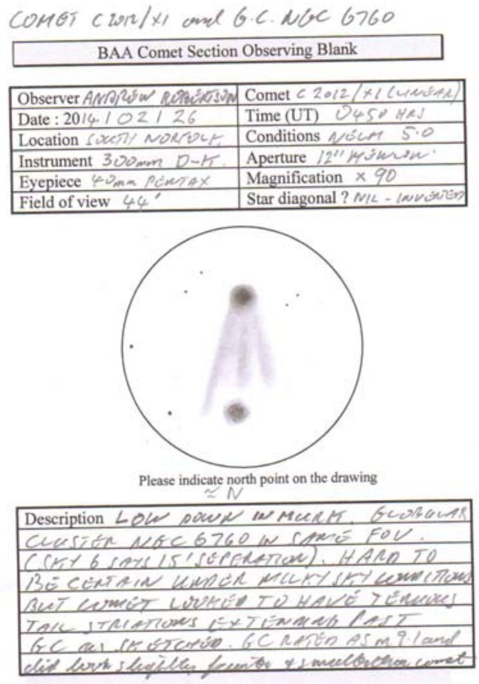
2012 K6 (McNaught) was observed by Kevin Hills at 15th magnitude in the first quarter of the year.

2012 S3 (PanSTARRS) was also observed by Kevin Hills, this one being 18th magnitude in the first quarter.

Kevin Hills extended the light curve of **2012 V2 (LINEAR)** as it faded during the first half of the year.

2012 X1 (LINEAR) provided another example of comets behaving like cats and doing what they want. After its outburst in 2013 October, normal outburst behaviour would have suggested an expanding coma becoming ever more diffuse and then fading from view. The observations suggest that this happened during the last quarter of 2013, with an underlying light curve that is a perfectly normal cometary one. The outburst created a spike of around two and a half magnitudes. The comet was brightest around the time of perihelion, and orbital geometry has meant that it slowly faded during the rest of the year.





COMET C 2012/X1 and G.C. NGC 6760

BAA Comet Section Observing Blank

Observer ANDREW ROBERTSON	Comet C 2012/X1 (LINEAR)
Date : 2014 / 02 / 26	Time (UT) 0450 HRS
Location SOUTH NORFOLK	Conditions NELM 5.0
Instrument 300mm D-K.	Aperture 12" [illegible]
Eyepiece 40mm PENTAX	Magnification × 90
Field of view 44'	Star diagonal ? NIL - INVERTED

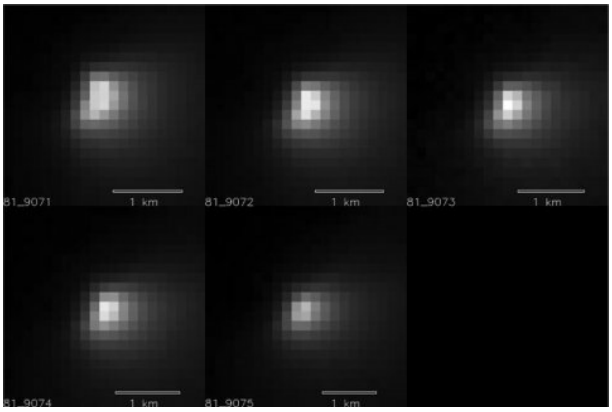
Please indicate north point on the drawing
≈ N

Description LOW DOWN IN MURK. GLOBULAR CLUSTER NGC 6760 IN SAME FOV. (SKY 6 SAYS 15' SEPERATION). HARD TO BE CERTAIN UNDER MILKY SKY CONDITIONS BUT COMET LOOKED TO HAVE TENUOUS TAIL STRIATIONS EXTENDING PAST GC AS SKETCHED. GC RATED AS m 9.1 and did look slightly fainter & smaller than comet

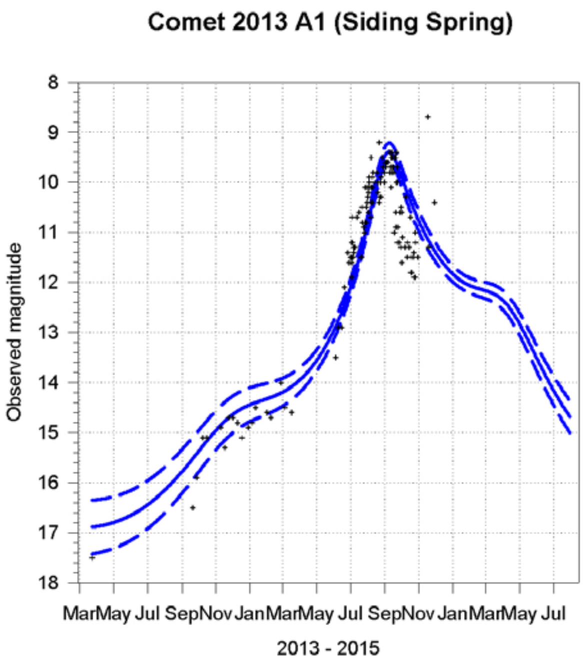
2012 X1 (LINEAR) drawn by Andrew Robertson on 2014 February 26

2012 X2 (PanSTARRS) was another observed by Kevin Hills, with his observations giving around 17th magnitude in the first four months of the year.

There was hope that **2013 A1 (Siding Spring)** might be a great comet for Martians. It was discovered when still 7.2 au from the Sun, and did not reach its 1.4 au perihelion until 2014 October. The comet passed very close to Mars on 2014 October 19 at 18:29, missing by a nominal 0.00094 au. It was not a very active comet, but despite this it would have been -5 in Martian skies according to the light curve. The delta effect would however have probably made it fainter than this in reality. Although NASA spacecraft and ESA's Mars Express imaged the comet during its close approach the images released so far show nothing more than a fuzzy object, despite some suggestions that they would be able to image the nucleus.



Images from Mars Orbiter on October 19



Science results suggest that the comet deposited substantial amounts (perhaps a few tons) of dust in Mars' atmosphere and significantly affected its ionosphere. MAVEN was able to directly sample and determine the composition of some of the dust. Analysis of these samples by the spacecraft's Neutral Gas and Ion Mass Spectrometer detected eight different types of metal ions, including sodium, magnesium and iron. MAVEN also detected uv emissions from ionised magnesium and iron, than was more intense than had ever been detected in Earth's atmosphere. The nucleus was smaller than 1.2 km and has a rotation period of about 8 hours.

So far it has been a southern hemisphere object and was at its brightest of around 9th magnitude in early September. The light curve suggests that there was a significant drop in activity just after perihelion, though there is a lot of scatter. It will be a morning object of 12th to 13th magnitude for Northern Hemisphere observers when it emerges from solar conjunction.

The 132 visual observations received so far suggest a preliminary uncorrected light curve of

$$m = 8.7 + 5 \log d + 4.8 \log r$$

2013 C2 (Tenagra) is a very distant comet, but was 18th magnitude when observed by Kevin Hills during the first half of the year.

2013 E1 (McNaught) was observed by Kevin Hills in January at 19th magnitude.

2013 A1 imaged by Rolando Ligustri on October 9 when it was close to M6

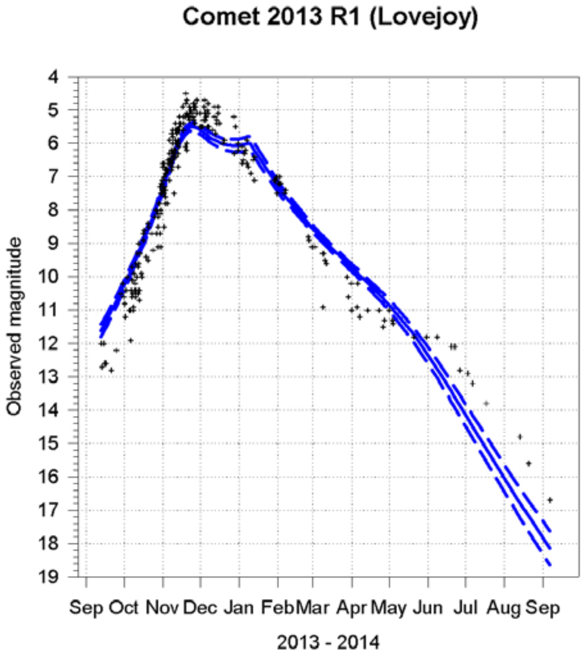
2013 E2 (Iwamoto) was observed by Kevin Hills in January at 17th magnitude.

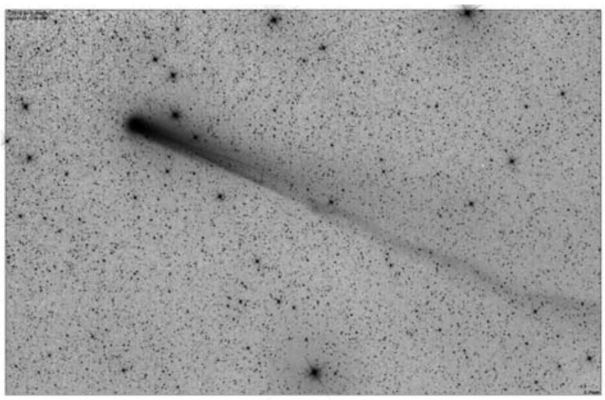
2013 G6 (Lemmon) was observed by Kevin Hills fading 17th to 19th magnitude in the first two months of the year.

2013 G7 (McNaught) was observed by Kevin Hills in July at 17th magnitude.

2013 R1 (Lovejoy) had perihelion at 0.8 au near the 2013 December Solstice. Observations dropped when it was lost to view from the evening sky in early January. It was conveniently placed from my bedroom window in late winter, so I made a few early morning observations which showed it fading quite rapidly. It had a short tail, which imagers showed to be in constant evolution. It faded from 6th to 17th magnitude over nine months. Standard and linear light curves both have small deviations from the observations. The linear curve with the comet peaking in brightness 18 days after perihelion is shown here.

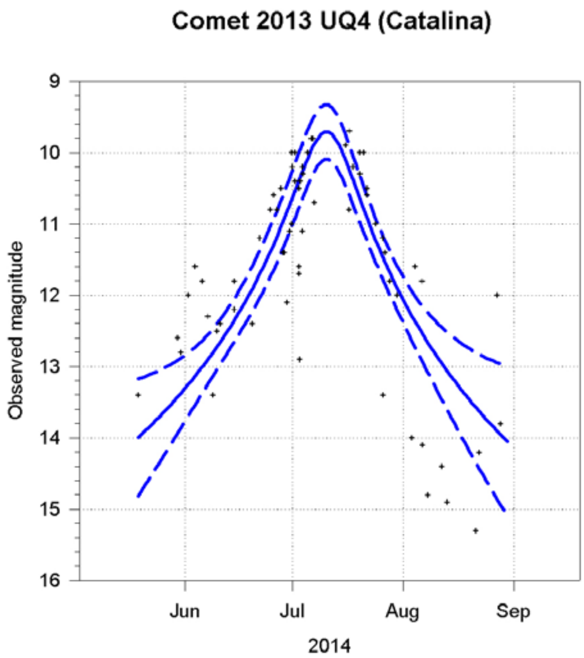
2013 R1 (Lovejoy) imaged by Erik Bryssinck on 2014 January 4





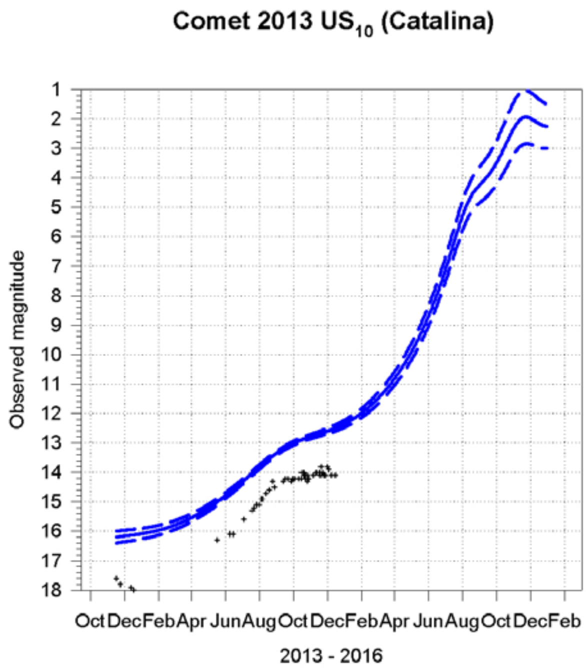
2013 R1 imaged by Damian Peach on January 3. A long exposure B filter image to help enhance the ion tail contrast. 106mm F5. STL-11k. Blue filter. 7x 3mins

2013 UQ$_4$ (Catalina) was at perihelion in the middle of the year and reached 10th magnitude. Unusually the electronic observations in late July and August are substantially fainter than the visual ones. It seems likely that the outer parts of the coma were missed in the electronic reductions as they report a coma diameter only 10% of the visual one.



2013 US$_{10}$ (Catalina) was 8.3 au away from the Sun at discovery and still 3.9 au away in mid December 2014. There are some indications from electronic magnitude estimates made by Kevin Hills and Nirmal Paul that it may be worth getting up early in the morning in the second half of November 2015.

52 visual and electronic observations received so far suggest a preliminary aperture corrected light curve of $m = 1.7 \pm 0.5 + 5 \log d + 11.0 \pm 0.7 \log r$



This light curve applies the standard aperture correction, but takes no account of the possibility that the comet may develop a faint outer coma. Hopefully well-placed visual observers should be able to pick it up before it enters solar conjunction later this month.

2013 V1 (Boattini) was observed by Kevin Hills in January at 14th magnitude.

2013 V3 (Nevski) was observed by Carlos Labordena fading from 11th to 12th magnitude in January and February.

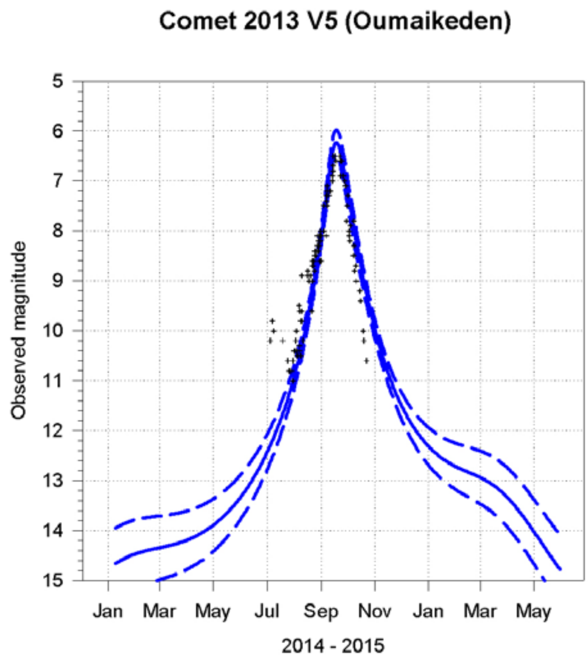
2013 V4 (Catalina) was another target for Kevin Hills during the year. It brightened from around 17th magnitude in January to around 15th magnitude in December. It has a distant perihelion of 5.2 au in 2015 October.

2013 V5 (Oumaikeden) imaged by Michael Jaeger on 2014 August 28 02:25 UT. LRGB from Austria 8"/2.8 ASA FLI8300 L4x180 filter clear and 2x 330 green 2x2 bin RGB140/140/140 4x4bin

2013 V5 (Oukaimeden) reached perihelion at 0.6 au in 2014 September when it was best seen from the Southern Hemisphere. It appears to have peaked at around magnitude 6.5 near perihelion and then faded quite quickly. It has very low activity. It is currently a morning object for Northern Hemisphere observers, but could remain around 12th magnitude for several months.

The 114 electronic and visual observations received so far suggest a preliminary uncorrected light curve of

$$m = 8.8 + 5 \log d + 5.8 \log r$$



2013 W1 (P/PanSTARRS) was observed by Kevin Hills in January at 19th magnitude. It was near its brightest.

2013 Y2 (PanSTARRS) brightened from 16th magnitude at the beginning of the year to around 14th magnitude near the time of perihelion in June.

2014 SOHO comets A SOHO C2 comet discovered by Zhijian Xu on May 17 may be linked with 2008 Y12, with previous (unobserved) returns on 1998 February 16 and 2003 July 23.

2014 A1 (296P/Garradd) 2007 H3 (P/Garradd) was recovered by an observing team at the Pierre Auger Observatory, Malargue using the 0.3m f/10 reflector on January 6.31. Following recovery prediscovery NEAT images from 2001 June were identified. The comet was close to the predicted time of return.

It was observed at 18th magnitude by Kevin Hills from June to August.

2014 A2 (P/Hill) Rik Hill, a BAA Member, discovered a 19th magnitude comet during the Catalina Sky Survey with the 0.68m Schmidt on January 9.43. Prediscovery images from 2013 November were found in Mt Lemmon Survey data. [MPEC 2014-B01, 2014 January

16] The comet was at perihelion at 2.1 au in 2013 October and has a period of around 14 years. This was Rik's 25th comet discovery and puts him at 5th on the all-time list of personal comet discoverers.

2014 A3 (P/PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on January 9.51. [MPEC 2014-B02, 2014 January 16] The comet was at perihelion at 3.6 au in 2013 April and has a period of around 10 years.

2014 A4 (SONEAR) An 18th magnitude object was discovered by Cristovao Jacques, Eduardo Pimentel and Joao Ribeiro de Barros with the 0.46m telescope (the MPEC says 0.3m) at the Southern Observatory for Near Earth Research at Oliveira, Brazil on January 12.03. It was noted as cometary by other astrometrists. [MPEC 2014-B03, 2014 January 16] The comet has perihelion at 4.2 au in 2015 September.

Cristovao Jacques provides the following discovery information:

The Southern Observatory for Near Earth Asteroids Research (SONEAR) is located in Oliveira, a city 120 km from Belo Horizonte, which is the third largest in Brazil. The sky is pretty good, although we have a 1200mm annual rainfall. We began our operations in 2013 July with a 12" Schmidt Cassegrain, got the Y00 code and in late October our main instrument was ready to begin operation and adjustments. Now we use a 18" f/2.9 telescope reflector completely made in Brazil. The mount is a Paramount MEII with a FLI microline 16803 CCD. This system yields a 1.64 x 1.64 degree field, plate scale of 1.44 "/pixel, with 8 seconds downloads.

Our observatory is a roll-off 6 x 4 meters. http://www.youtube.com/watch?v=LVJPlM8TG5E and http://www.youtube.com/watch?v=V0RSOJNfVN8 You can see a picture of our telescope at: http://www.observatorio-phoenix.org/t_proj/Sonear/sonear.htm. I am still not satisfied with the telescope performance because we are struggling with collimation and other small issues.

For detection, we use Paulo Holvorcem´s software called Skysift. We are now tuning the parameters, so we can better detect objects. If anyone is interested in this software you can contact him at holvorcem@mpc.com.br For planning the night we use Holvorcem´s software called TAO: http://sites.mpc.com.br/holvorcem/tao/readme.htm. For telescope and CCD control we use ACP and Maxim.

December and January are the rainy season months in Brazil, but this year has been atypical, so we had 12 clear nights in a row. 2014 A4 was discovered on the night of January 12th, as we were surveying the region between R.A 5 and 6 hours, and declination -40 and -50. As the beginning of the survey was centralized in dec -40, half of the field was above this declination, so we spotted the object in declination -39.6 in a matter of luck. Since December 18th, we have been sending a Sky Coverage report to MPC. http://www.minorplanetcenter.net/iau/SkyCoverage.html

I analysed the images 12 hours after the end of the night. The object was apparently asteroidal. On the next day, Ernesto Guido emailed me saying that he imaged the object in Australia and it was a little bit elongated. One day more, he confirmed the comet nature using Faulkes South.

2014 A5 (PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on January 4.41. It was not confirmed until observations were made with the 3.6m Canada-France-Hawaii telescope on January 26. [MPEC 2014-B54, 2014 January 27] The comet is at perihelion at 4.8 au in 2014 August.

2014 AA$_{52}$ (Catalina) A 20th magnitude asteroid was discovered by the Catalina Sky Survey on January 11.39. [MPEC 2014-A87, 2014 January 15] The object had a retrograde orbit with a period of around 50 years and perihelion at 1.8 au in 2015 March. It was classed as a Centaur.

On February 26 it was reclassified as a comet following the detection of cometary activity. The latest orbit is hyperbolic with perihelion at 2.0 au in 2015 February.

2014 B1 (Schwartz) Michael Schwartz discovered a 20th magnitude comet in images taken with the Tenagra II 0.41-m f3.75 astrograph on January 28.10. [MPEC 2014-C03, 2014 February 1] The comet is at perihelion at 9.6 in 2017 September.

2014 C1 (P/TOTAS) The Teide Observatory Tenerife Asteroid Survey discovered a 19th magnitude comet with the 1.0m f4.4 reflector on February 1.24. [MPEC 2014-C10, 2014 February 4] The comet was at perihelion at 1.7 au in 2013 December and has a period of around 5.4 years.

2014 C2 (STEREO) Alan Watson reported a fast moving object in MPEC 2014-C25 reported an orbit for the object on February 8. The comet was at perihelion at 0.5 au on February 18. Man-To Hui notes that the comet was at nearly 180Ã‚Â° phase angle from the perspective of the spacecraft at discovery and would have shown strong forward scattering. Hidetaka Sato was able to image the comet from the ground with the iTelescope at New Mexico on February 19, when he estimated it at 15.6, not far from the ephemeris position.

2014 C3 (NEOWISE) An 18th magnitude comet was discovered by the WISE spacecraft on February 14.71 in its new guise of NEOWISE. [MPEC 2014-D11, 2014 February 20] Hirohisa Sato computed an improved a retrograde orbit. The latest orbit is retrograde, with perihelion at 1.9 au in 2014 January and has a period of over 1000 years.

2014 C4 (298P/Christensen) Jim Scotti recovered 2007 C1 (P/Christensen) in images taken with the 1.8m Spacewatch II reflector on February 9.54. The comet returned to perihelion 0.52 days earlier than predicted.

A/2014 CW_{14} (Mt Lemmon) A 21st magnitude asteroid was discovered by the Mt Lemmon Survey on February 10.29. [MPEC 2014-D08, 2014 February 19] The object has a retrograde orbit with a period of around 90 years and will reach perihelion at 4.2 au in 2014 December. It is classed as a Centaur. Aphelion is at around 35 au. The Tisserand parameter of the orbit with respect to Jupiter is -2.12 and it approaches to within 0.5 au of the planet.

2014 D1 (297P/Beshore) The comet was recovered at the Cordell-Lorenz Observatory with their 0.3m Schmidt-Cassegrain on February 27.40, with pre-recovery images then found in Mt Lemmon data from January 2. The comet returns to perihelion 0.3 days earlier than predicted.

2014 D2 (299P/Catalina-PanSTARRS) An 18th magnitude comet was discovered by the Catalina Sky Survey in images taken on February 27.31 and by PanSTARRS in images taken on February 27.43. The comet appeared about a magnitude fainter in the PanSTARRS images. Pre-discovery images were found in PanSTARRS data from 2013 January, December, 2014 January and February. [MPEC 2014-E50, 2014 March 9]. The comet has a period of 9.1 years with perihelion at 3.1 au in 2015 February.

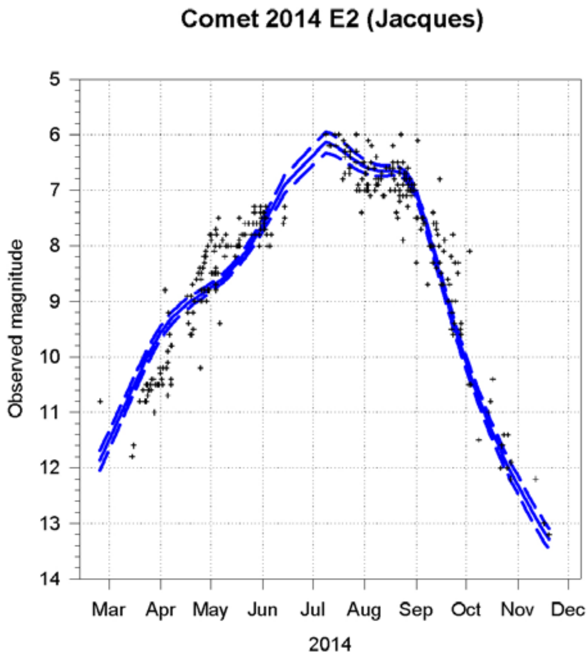
When the orbit improved the comet was linked to asteroid 2005 EL284 observed by LONEOS and LINEAR in 2005 March and by the Siding Spring Survey in 2005 July.

Kevin Hills observed it in May, when it was 18th magnitude.

A/2014 DD_{10} (Mt Lemmon) A 21st magnitude asteroid was discovered by the Mt Lemmon Survey on February 20.47. [MPEC 2014-D32, 2014 February 24] The object has an orbit with a period of around 8 years and was at perihelion at 0.5 au in 2013 November. It is classed as an Apollo. The Tisserand parameter of the orbit with respect to Jupiter is 2.12 and it approaches to within 0.2 au of the planet. It approached Venus to about 0.1 au in 2013 October.

A/2014 DB_{11} (La Sagra) A 19th magnitude asteroid was discovered by the La Sagra team on February 22.99. [MPEC 2014-D40, 2014 February 24] The object has an orbit with a period of around 5 years and will be at perihelion at 1.2 au in 2014 March. It is classed as an Amor. The Tisserand parameter of the orbit with respect to Jupiter is 2.93 and it approaches to within 0.4 au of the planet.

2014 E1 (P/Larson) Steve Larson discovered a 17th magnitude comet during the Catalina Sky Survey with the 0.68m Schmidt on March 10.45. Prediscovery images from 2014 January were found in CSS data. [MPEC 2014-E78, 2014 March 12] The comet is at perihelion at 2.1 au in 2014 May and has a period of around 7.1 years.

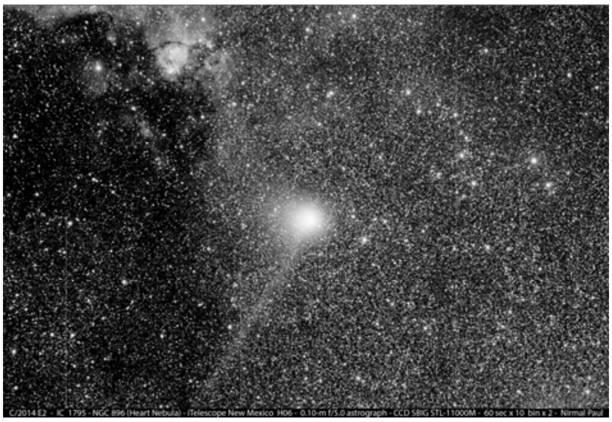


2014 E2 (Jacques) imaged by Gerald Rheman on 2014 August 4 03:25 UT. Location: Farm Tivoli, Namibia SW-Africa Telescope: ASA 12" f 3.6 Camera: FLI ML 8300 Mount: ASA DDM85 Exposure time: LRGB 18/9/9/9 min.

2014 E2 (Jacques) Cristovao Jacques discovered a 15th magnitude comet on March 13.06 using the 0.45m telescope at the Southern Observatory for Near Earth Research at Oliveira, Brazil. [MPEC 2014-E84, 2014 March 14] The comet reached perihelion at 0.7 au in July. Some observations suggested that it was already 11th magnitude just after discovery, and it continued to brighten fairly quickly. It was brightest at around 6th magnitude in July and then faded slowly until September. It is now fading quite rapidly.

The 304 visual observations received so far suggest a preliminary uncorrected light curve of

$$m = 7.0 + 5 \log d + 10.3 \log r$$



2014 E2 near IC 1795 - NGC 896 (Heart Nebula) on August 21 09:36 UTC imaged by Nirmal Paul using the iTelescope New Mexico H06 - 0.10-m f/5.0 astrograph - CCD SBIG STL-11000M - 60 sec x 10 bin x 2

2014 F1 (Hill) Rik Hill, a BAA Member, discovered a 19th magnitude comet during the Catalina Sky Survey with the 0.68m Schmidt on March 29.47. [MPEC 2014-G02, 2014 April 1] The comet was at perihelion at 3.5 au in 2013 October.

2014 F2 (Tenagra) An asteroidal object discovered at the Tenagra II Observatory by Michael Schwartz and Paulo Holvorcem with the 0.41m astrograph on March 31.35 was found to show cometary features after posting on the NEOCP. [MPEC 2014-G12, 2014 April 3]. The comet has an orbit with perihelion at 4.3 au in 2015 January and a period of around 2000 years.

2014 F3 (Sheppard-Trujillo) Follow up observations by S S Sheppard on May 22/23 of a 23rd magnitude object discovered by Sheppard and C Trujillo on March 26.33 with the 4.0-m CTIO reflector at Cerro Tololo showed cometary features. [MPEC 2014-K30, 2014 May 23]. The comet has an orbit with a period of around 60 years and perihelion at 5.6 au in 2021.

2014 G1 (PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on April 5.57. [MPEC 2014-G42, 2014 April 7] The comet was at perihelion at 5.5 au in 2013 December. This was PanSTARRS 50th comet.

2014 G2 (300P/Catalina) 2005 JQ_5 (P/Catalina) was recovered by M. Masek, J. Cerny, J. Ebr, M. Prouza, P. Kubanek, M. Jelinek, K. Honkova and J. Jurysek at the Pierre Auger Observatory, Malarque with the 0.3m reflector on April 9.39. [MPEC 2014-G70, 2014 April 10]. The comet returns to perihelion 0.1 days earlier than predicted.

The comet can make close approaches to Venus, Earth and Mars. Its last close approach to Earth was at the discovery apparition in 2005, when it came to 0.10 au and in 2036 it will approach to 0.06 au. It will approach within 0.08 au of Mars in 2132 and approached Venus to 0.09 au in 1957.

It was observed by Kevin Hills in May and June when it was around 14th magnitude.

2014 G3 (PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on April 10.54. [MPEC 2014-H04, 2014 April 17] The comet is at perihelion at 4.7 au in 2015 February.

2014 H1 (Christensen) Eric Christensen discovered an 18th magnitude comet on April 24.42 on images taken during the Mt Lemmon Survey with the 1.5m reflector. [MPEC 2014-H33, 2014 April 25]. The comet was near perihelion at 2.1 au. An improved orbit by Hirohisa Sato suggests that the orbit is a long period ellipse.

2014 J1 (Catalina) An 18th magnitude object was discovered by the Catalina Sky Survey on May 9.36. [MPEC 2014-K03, 2014 May 16] The object was found to show cometary features by other observers. It has a retrograde orbit and perihelion at 1.7 au in 2014 June. It is intrinsically faint.

2014 K1 (301P/LINEAR-NEAT) 2001 BB_{50} (P/LINEAR-NEAT) was recovered in images from PanSTARRS taken on May 17.28, with earlier images taken at the SATINO remote observatory, Haute Province on March 1.93. The comet will return to perihelion 1.76 days earlier than predicted and has a period of 13.7 years.

2014 K2 (302P/Lemmon-PanSTARRS) A 21st magnitude comet discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on April 29.36, was linked to asteroid 2007 RJ236 discovered during the Mt Lemmon survey on 2007 September 13.30. It was also linked to observations made by the Purple Mountain Observatory in 2007 August. [MPEC 2014-K28, 2014 May 23] The comet is at perihelion at 3.3 au in 2016 April and has a period of 8.86 years.

2014 K3 (P/SOHO) A non-group SOHO comet discovered in C2 images by Zhijian Xu on May 17 was quickly linked to 2008 Y12 by Michal Kusiak and the orbit confirmed by Reiner Kracht. A linked orbit by Gareth Williams was published on MPEC 2014-K37 on May 24. The comet has a period of 5.4 years and perihelion 0.07 au.

A/2014 KG_2 [NEOWISE] A 19th magnitude asteroid was discovered by the NEOWISE spacecraft on May 18.54 [MPEC 2014-K22, 2014 May 21] It is classed as a Centaur, with a period of around 16 years and near perihelion at 1.4 au. The error bars on the orbital parameters are very large. The Tisserand parameter of the orbit with respect to Jupiter is 2.08.

A/2014 KL_4 [PanSTARRS] A 21st magnitude asteroid was discovered by PanSTARRS on May 17.26 [MPEC 2014-K33, 2014 May 23] It is classed as a Centaur, with a period of around 50 years and not far past perihelion at 1.9 au. The error bars on the orbital parameters are very large. The Tisserand parameter of the orbit with respect to Jupiter is 1.98.

2014 L1 (303P/NEAT) 2003 U3 (P/NEAT) was recovered in images taken at the ESA Optical Ground Station in Tenerife with the 1.0m reflector by P Ruiz. The comet will return to perihelion 1.80 days earlier than predicted and has a period of 11.4 years. [MPEC 2014-L12, 2014 June 2]

It was observed by Kevin Hills in September as it brightened from 18th to 17th magnitude.

2014 L2 (P/NEOWISE) Rachel Stevenson reported a probable comet in NEOWISE spacecraft images from June 7.41. Follow-up ground-based observations confirmed the comet at 16th magnitude. [MPEC 2014-L61 CBET 3901, 2014 June 15] The comet was at perihelion at 2.2 au in 2014 July and has a period of around 16 years. It approached to within 0.01 au of Saturn in 2009 July.

15 observations received so far suggest a preliminary uncorrected light curve of

$$m = 9.1 + 5 \log d + [10] \log r$$

2014 L3 (P/Hill) Rik Hill discovered an 18th magnitude comet during the Catalina Sky Survey with the 0.68m Schmidt on June 10.36. Prediscovery images from June 2 were also found in Catalina data. [MPEC 2014-L62, 2014 June 15] The comet was near perihelion at 1.9 au and has a period of around 25 years.

2014 L4 (304P/Ory) 2008 Q2 (P/Ory) was recovered by Hidetaka Sato in images taken with the iTelescope 0.51m astrograph at Siding Spring on June 2.79. The comet is very close to the prediction by B. G. Marsden on MPC 65935. It has a period of 5.8 years. [MPEC 2014-M10, CBET 3906, 2014 June 18]

2014 L5 (Lemmon) A 20th magnitude comet was discovered during the Mt Lemmon survey with the 1.5m reflector on June 9.44 and confirmed after a period of time on the NEOCP and PCCP. [MPEC 2014-M57, 2014 June 28] It has perihelion at 6.2 au in November.

2014 M1 (PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on June 24.49. [CBET 3915, MPEC 2014-N01, 2014 July 1] The comet will reach perihelion at 5.6 au in 2015 August.

2014 M2 (Christensen) Eric Christensen discovered a 20th magnitude comet on June 25.31 on images taken during the Mt Lemmon Survey with the 1.5m reflector. [CBET 3916, MPEC 2014-N02, 2014 July 1]. The comet was at perihelion at 6.9 au in 2014 July.

The Mt Lemmon 1.5m reflector (LPL)

2014 M3 (Catalina) A 19th magnitude object was discovered by the Catalina Sky Survey on June 26.40. [CBET 3917, MPEC 2014-N03, 2014 July 1] The object was found to show cometary features by other observers. It has a retrograde orbit and perihelion at 2.4 au in 2014 June. It is intrinsically faint.

2014 M4 (P/PanSTARRS) R Wainscoat discovered a 21st magnitude comet in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on June 30.57. [CBET 3920, MPEC 2014-N45, 2014 July 7] The comet will reach perihelion at 2.4 au in 2014 December and has a period of around 14 years.

2014 M5 (306P/LINEAR) 2003 O3 (P/LINEAR) was recovered by Hidetaka Sato in images taken with the iTelescope 0.51m astrograph at Siding Spring on June 21.77. The comet was missed at its 2009 return and is close to the prediction in the 2014 ICQ Handbook. It has a period of 5.5 years with perihelion at 1.3 au. [MPEC 2014-N76, CBET 3922, 2014 July 14]

2014 MG_4 (P/Spacewatch-PanSTARRS) Spacewatch discovered an asteroidal object with the 0.9m reflector at Kitt Peak on June 20.42. PanSTARRS observers then discovered a 19th magnitude comet in images taken with the 1.8m Ritchey-Chretien on July 25.46 that was found to be the same object. [CBET 3924, MPEC 2014-O48, 2014 July 28] The comet was at perihelion at 3.7 au in 2013 June and has a period of around 11 years.

A/2014 MH_{55} [PanSTARRS] A 20th magnitude asteroid was discovered by PanSTARRS on June 29.32 [MPEC 2014-N26, 2014 July 5] It is classed as a Centaur, with a highly inclined orbit, a period of around 150 years and near perihelion at 1.8 au. The Tisserand parameter of the orbit with respect to Jupiter is 0.12.

2014 N1 (305P/Skiff) Gareth Williams found images of 2004 V1 (P/Skiff) in images taken taken with the PanSTARRS 1 1.8m Ritchey-Chretien on July 3.51. The comet will return to perihelion 0.32 days earlier than predicted and has a period of 9.9 years. [CBET 3918, MPEC 2014-N43, 2014 July 7]

2014 N2 (PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on July 2.55. [CBET 3919, MPEC 2014-N44, 2014 July 7] The comet will reach perihelion at 2.2 au in 2014 October.

2014 N3 (NEOWISE) An 18th magnitude comet was discovered by the NEOWISE (formerly WISE) spacecraft on July 4.52. [CBET 3921, MPEC 2014-N71, 2014 July 13]. The comet has perihelion at 3.9 au in 2015 March. Electronic observations suggest that it is around 14th magnitude.

2014 O1 (307P/LINEAR) A team of observers at the European Space Agency's Optical Ground Station recovered 2000 QJ46 (P/LINEAR) with the 1.0m reflector on July 25.15. The indicated correction to the prediction by B. G. Marsden on MPC 75735 is Delta(T) = -0.24 day.Ã‚Â [CBET 3923, MPEC 2014-O44, 2014 July 27] The comet has a period of 14 years and reaches perihelion at 1.9 au in December.

2014 O2 (308P/Lagerqvist-Carsenty) A team of observers at the European Space Agency's Optical Ground Station recovered 1997 T3 (P/Lagerqvist-Carsenty) with the 1.0m reflector on July 29.08. The indicated correction to the prediction by B. G. Marsden on MPC 79348 is Delta(T) = -1.28 days.Ã‚Â [CBET 3925, MPEC 2014-O65, 2014 July 30] The comet has a period of 17 years and reaches perihelion at 4.2 au in 2015 May.

2014 O3 (P/PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on July 30.43, with pre-discovery images found from July 8. [CBET 3930, MPEC 2014-P26, 2014 August 5] The comet was at perihelion at 4.6 au in 2014 April and has a period of around 20 years.

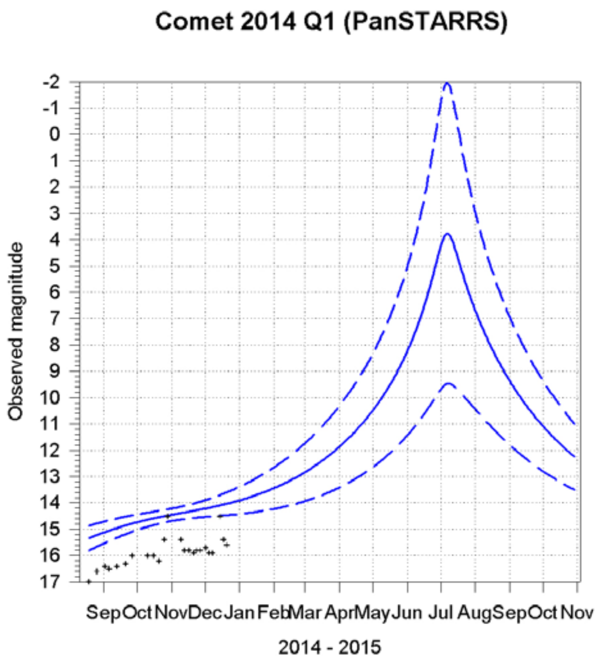
2014 OE_4 (PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on July 26.82, though by the time its cometary nature had been reported it had already been given a minor planet designation. [CBET 3928, MPEC 2014-P08, 2014 August 2] The comet will reach perihelion at 6.2 au in 2016 December.

A/2014 OR_2 [NEOWISE] A 20th magnitude asteroid was discovered by the NEOWISE spacecraft on July 22.67 [MPEC 2014-O41, 2014 July 26] It is classed as an Outer Main-belt Asteroid, with a period of around 9 years and was near perihelion at 1.9 au. The Tisserand parameter of the orbit with respect to Jupiter is 2.67.

A/2014 ON_{27} [PanSTARRS] A 21st magnitude asteroid was discovered by PanSTARRS on July 25 [MPEC 2014-P20, 2014 August 4] It is classed as a Centaur, has a period of around 60 years and reaches perihelion at 4.2 au in 2015 September. The Tisserand parameter of the orbit with respect to Jupiter is 2.80.

A/2014 OH_{338} [PanSTARRS] A 20th magnitude asteroid was discovered by PanSTARRS on July 29.59 [MPEC 2014-P14, 2014 August 3] It is classed as a Centaur, has a period of around 25 years and reaches perihelion at 1.6 au in November. The error bars on the orbital parameters are quite large. The Tisserand parameter of the orbit with respect to Jupiter is 2.12.

A/2014 PP_{69} [NEOWISE] A 22nd magnitude asteroid was discovered by the NEOWISE spacecraft on August 5.63 [MPEC 2014-Q52, 2014 August 26] It is classed as an Amor, with a period of around 45 years and was just past perihelion at 1.2 au. The Tisserand parameter of the orbit with respect to Jupiter is 0.32. It is near the closest it gets to the Earth at 0.44 au.



2014 Q1 (PanSTARRS) An 18th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on August 17.72. [CBET 3933, MPEC 2014-Q09, 2014 August 19] The comet will reach perihelion at 0.3 au in 2015 July. The apparition is a poor one for northern hemisphere observers, but it may be visible in the southern hemisphere after perihelion, possibly initially at naked eye brightness.

24 electronic observations received so far suggest a preliminary aperture corrected light curve of

$$m = 7.1 \pm 1.0 + 5 \log d + 7.6 \pm 1.8 \log r$$

This suggests a possible peak magnitude of around 4, with error bars of 6 magnitudes, however the rate of brightening may change as the comet approaches the Sun.

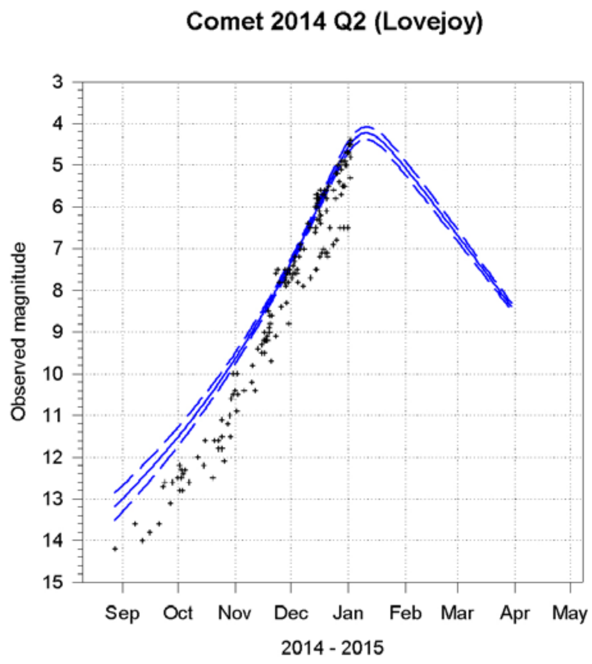
2014 Q2 (Lovejoy) Terry Lovejoy discovered a 15th magnitude comet in CCD images taken with his 0.2m Schmidt-Cassegrain on August 16.55. [CBET 3934, MPEC 2014-Q10, 2014 August 19] The comet has perihelion at 1.3 au at the end of 2015 January. The comet was within visual range by 2014 September, with Paul Camilleri reporting it at 13th magnitude. Jonathan Shanklin saw the comet from Dodleston near Chester on Christmas Eve, after bell-ringing for the midnight service. The comet was low down and difficult to see, but in 20x80B it was well-condensed at magnitude 5.8. Thereafter it steadily climbed higher in northern skies, but at first the Moon became brighter and rather drowned it out. It was an easy object of 4th magnitude once the moon cleared the area. Global imaging by amateurs demonstrated the evolution of a major tail disconnection event on 2015 January 8.

2014 Q2 close to M79. Imaged by Rik Hill with the Catalina Sky Survey Schmidt on December 29 and processed by Chris Schur.

Tail rays in 2014 Q2 imaged by Peter Carson on 2015 January 10 21:15 UT with 0.3m Dall-Kirkham reflector

The 134 visual observations received so far suggest a preliminary aperture corrected light curve of

$$m = 3.6 \pm 0.1 + 5 \log d + 18.5 \pm 0.6 \log r$$



2014 Q3 (Borisov) Gennady Borisov discovered a 17th magnitude comet with the 0.3m astrograph at the Crimea-Nauchnij observatory on August 22.01. [CBET 3936, MPEC 2014-Q38, 2014 August 24] The comet has a period of around 150 years and reached perihelion at 1.6 au in 2014 November. It reached 12th magnitude in late September. It is at high northern declination.

12 electronic and visual observations received so far suggest a preliminary light curve of

$$m = 7.1 + 5 \log d + [20] \log r$$

2014 Q4 (309P/LINEAR) Krisztian Sarneczky recovered 2005 Q4 (P/LINEAR) with a 0.6m Schmidt at the Piszkesteto Station of Konkoly Observatory on August 23.00, with PanSTARRS images from the same night later found by Gareth Williams. The indicated correction to the prediction by Gareth Williams on MPC 75706 is Delta(T) = -0.26 day. [CBET 3937, MPEC 2014-Q39, 2014 August 24] The comet has a period of 9.4 years and reaches perihelion at 1.7 au in 2015 February.

2014 Q5 (310P/Hill) Krisztian Sarneczky recovered 2006 S6 (P/Hill) with a 0.6m Schmidt at the Piszkesteto Station of Konkoly Observatory on August 24.98. The indicated correction to the prediction by Gareth Williams on MPC 79348 is Delta(T) = -0.32 day. [CBET 3938, MPEC 2014-Q53, 2014 August 26] The comet has a period of 8.5 years and reaches perihelion at 2.4 au in 2015 April.

2014 Q6 (PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on August 31.35. [CBET 3961, MPEC 2014-R44, 2014 September 4] The comet will reach perihelion at 4.2 au in 2015 January.

2014 QU_2 (PanSTARRS) A 20th magnitude asteroid was discovered by PanSTARRS on August 16.59

[MPEC 2014-Q13, 2014 August 20] It was classed as a Centaur, with a retrograde orbit, a period of around 55 years and a month or two past perihelion at 2.2 au. The error bars on the orbital parameters were large.

Subsequent imaging in mid September showed a distinct coma and tail, so the object was reclassified as a comet. It is in a long period orbit, with perihelion at 2.2 au in 2014 July. The Tisserand parameter of the orbit with respect to Jupiter is -1.03. [CBET 3974, MPEC 2014-S10, 2014 September 17]

2014 R1 (Borisov) Gennady Borisov discovered a 16th magnitude comet with the 0.3m astrograph at the Crimea-Nauchnij observatory on September 5.05. [CBET 3968, MPEC 2014-R64, 2014 September 7] The comet reached perihelion at 1.3 au in 2014 November.

8 observations received so far suggest a preliminary uncorrected light curve of

$$m = 8.4 + 5 \log d + [10] \log r$$

2014 R2 (312P/NEAT) 2001 Q11 (P/NEAT) was recovered in images taken by Eric Christensen at Mt Lemmon with the 1.5m reflector on September 6.45. After the object was posted on the PCCP, Hidetaka Sato was able to find the comet in images taken on July 28.82. The comet will return to perihelion 0.68 days earlier than predicted and has a period of 6.4 years. It was discovered by Maik Meyer in 2010 in images taken in 2001, though no images could be found from the 2007 return. [CBET 3971, MPEC 2014-R91, 2014 September 12]

2014 R3 (PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on September 6.33. [CBET 3972, MPEC 2014-S05, 2014 September 16] The comet is at perihelion at 7.3 au in 2016 August.

2014 R4 (Gibbs) Alex Gibbs discovered a 17th magnitude comet on September 14.48 on images taken during the Catalina Sky Survey with the 0.68m Schmidt. [CBET 3973, MPEC 2014-S09, 2014 September 17]. The comet was nearing perihelion at 1.8 au in October.

2014 R5 (P/Lemmon-PanSTARRS) A 19th magnitude comet was suspected in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on September 19.47. Tim Spahr linked the suspect with an apparently asteroidal object found during the Mt Lemmon Survey on September 14.39. Other CCD astrometrists then commented on the suspects cometary characteristics. [CBET 3987, MPEC 2014-S81, 2014 September 24] The comet was at perihelion at 2.4 au in 2014 June and has a period of around 8 years.

2014 S1 (PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on September 19.56. [CBET 3988, MPEC 2014-S82, 2014 September 24] The comet was at perihelion at 8.1 au in 2013 October.

2014 S2 (PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on September 22.47. [CBET 3989, MPEC 2014-S83, 2014 September 24] The comet is at perihelion at 2.1 au in 2015 December.

2014 S3 (PanSTARRS) A 22nd magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on September 22.52. [CBET 3990, MPEC 2014-S114, 2014 September 27] The comet was at perihelion at 2.0 au in 2014 August.

2014 S4 (313P/Gibbs) Alex Gibbs discovered a 19th magnitude comet on September 24.31 on images taken during the Catalina Sky Survey with the 0.68m Schmidt. Subsequently pre-discovery images were found in Sky Survey data. [CBET 3991, MPEC 2014-S115, 2014 September 27].

With an improved orbit, S Nakano found the comet in LONEOS images from September and November 2003 and it was designated 2003 S10 for that return. No observations have been found for the 2009 return. [CBET 4003, 2014 October 19, MPEC 2014-U24, 2014 October 20]

The comet was at perihelion at 2.4 au in 2014 August and has a period of 5.6 years.

A/2014 SQ_{339} [PanSTARRS] A 22nd magnitude asteroid was discovered by PanSTARRS on September 29.52 [MPEC 2014-T36, 2014 October 4] It is classed as a Centaur, has a period of around 140 years and reached perihelion at 2.8 au in 2014 June. The Tisserand parameter of the orbit with respect to Jupiter is -1.05. The orbit is akin to that of many long period comets.

2014 TG_{64} (Catalina) A 19th magnitude asteroid was discovered by the Catalina Sky Survey on October 14.30. [MPEC 2014-U18, 2014 October 18; CBET 4025, MPEC 2014-W93, 2014 November 24] The object was found to show cometary features in PanSTARRS observations on November 22.4, which were confirmed by CFH images the next day. It was at perihelion at 3.2 au in 2014 May and has a period of around 60 years. Although I had noted it as of potential interest, it had made no close planetary approaches, so I did not list it on the web page.

2014 U1 (314P/Montani) 1997 G1 (P/Montani) was recovered on October 13.31 at the Steward Observatory, Kitt Peak by Terry Bressi and A F Tubbiolo with the 0.9m reflector. [CBET 4005, MPEC 2014-U63, 2014 October 25] The perihelion date was by chance in good agreement with that given in the Section predictions for 2016, which used the predicted value of T for the equinox of date in 2014 May, and around 1.2 days earlier than those published for the equinox of perihelion.

2014 U2 (P/Kowalski) Richard Kowalski discovered an 18th magnitude comet on October 25.38 in images taken during the Catalina Sky Survey with the 0.68m Schmidt. Pre-discovery CSS images from October 18.35 were quickly found and other imagers confirmed the discovery. [CBET 4006, MPEC 2014-U97, 2014 October 27] The comet has a period of around 5 years with perihelion at 1.2 au and was just past perihelion. It is intrinsically very faint, but was discovered during a relatively good return when it was only 0.4 au from Earth; the MOID is 0.2 au. An approach to within 0.5 au of Jupiter in 2017 will reduce the perihelion distance to 1.1 au in 2019.

2014 U3 (Kowalski) Richard Kowalski discovered a 19th magnitude comet on October 26.41 in images taken during the Catalina Sky Survey with the 0.68m Schmidt. [CBET 4007, MPEC 2014-U98, 2014 October 27] Based on an arc of less than a day, the comet had perihelion at 0.2 au in 2014 July according to the published MPEC. The time of perihelion was given to a precision of 5dp, when according to JPL the 1-sigma uncertainty was 104 days. This is not good physics. As I suggested, further observations changed the orbit significantly. MPEC 2014-W120 [2014 November 27] gives perihelion at 2.6 au on 2014 August 31.1, still to 5dp, whilst JPL gives it on 2014 September 3.6, and with a 1-sigma uncertainty of 0.3 days. This was noticed and the next days another MPEC was issued bringing the elements into alignment. Gareth Williams noted " Due to a production issue, the orbit on MPEC 2014-W120 was not the updated orbit that was meant to be included."

2014 U4 (P/PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on October 28.53, with pre-discovery images found from September 2 (found by Gareth Williams), and also in Catalina Sky Survey images from September 30 and Spacewatch images from October (found by Tim Spahr). [CBET 4014, MPEC 2014-V41, 2014 November 10] The comet was at perihelion at 1.8 au in 2014 August and has a period of 6.5 years. It made a relatively close approach to within 0.3 au of Jupiter in 2004 August.

2014 U5 (P/LONEOS-Christensen) 2005 RV25 (P/LONEOS-Christensen) was recovered on October 22.98 at the ESA Optical Ground Station, Tenerife by D Abreau with the 1.0m reflector. The recovery was confirmed by J D Armstrong with the Faulkes-North [CBET 4017, MPEC 2014-W19, 2014 November 19] The comet has perihelion at 3.6 au in 2015 October and a period of 8.9 years. The correction to the prediction by B. G. Marsden on MPC 79351 is Delta(T) = +0.50 day.

2014 V1 (P/PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 9.21. [CBET 4015, MPEC 2014-V52, 2014 November 14] The comet is at perihelion at 2.6 au in 2014 December and has a period of around 9 years. There is an uncertainty of 2.5 years in the period

2014 W1 (P/PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 17.35. [CBET 4018, MPEC 2014-W54, 2014 November 21] The comet was at perihelion at 2.7 au in 2014 August and has a period of around 9 years. There is an uncertainty of 0.8 years in the period. Calculations by Hirohisa Sato suggest a period of 8.6 years with perihelion at 2.8 au in September.

2014 W2 (PanSTARRS) A 19th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 17.35. Tim Spahr identified pre-discovery images of the comet in Catalina Sky Survey data from October 26 and November 16. [CBET 4019, MPEC 2014-W55, 2014 November 21] The comet will reach perihelion at 2.7 au in 2016 March. Calculations by Hirohisa Sato suggest that it moves in a long period ellipse.

2014 W3 (PanSTARRS) A 19th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 18.47. [CBET 4020, MPEC 2014-W56, 2014 November 21] The comet was at perihelion at 6.1 au in 2014 February. It is classed as a hyperbolic comet.

2014 W4 (P/PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 18.50. Tim Spahr identified pre-discovery PanSTARRS images from October 25. [CBET 4021, MPEC 2014-W57, 2014 November 21] The comet will be at perihelion at 4.3 au in 2015 December and has a period of around 17 years.

2014 W5 (Lemmon-PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 20.48. It was also discovered as a 20th magnitude asteroid by the Mt Lemmon Survey on November 16.29, but did not make the NEOCP. [CBET 4023, MPEC 2014-W68, 2014 November 22] The comet will reach perihelion at 2.6 au in 2016 February. The orbital parameters are not yet well-defined. So far it has only been observed over a six day arc.

2014 W6 (Catalina) An 18th magnitude object was discovered by the Catalina Sky Survey on November 20.51. The object was found to show cometary features by other observers. [CBET 4024, MPEC 2014-W69, 2014 November 22] It has perihelion at 3.1 au in 2015 March.

2014 W7 (Christensen) Eric Christensen discovered a 19th magnitude comet during the Mt Lemmon Survey with the 1.5m reflector on November 22.52. [CBET

4027, MPEC 2014-W116, 2014 November 26] It has perihelion at 1.5 au in 2014 December. It has a period of around 40 years. The comet is intrinsically faint.

2014 W8 (PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 22.42. [CBET 4028, MPEC 2014-W117, 2014 November 26] The comet will reach perihelion at 5.0 au in 2015 September. The orbital parameters are not yet well-defined.

2014 W9 (PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 22.64. Pre-discovery observations were made at Mt Lemmon on October 25. [CBET 4029, MPEC 2014-W118, 2014 November 26] The comet will reach perihelion at 1.6 au in 2015 February. It has a period of around 40 years.

2014 W10 (PanSTARRS) A 21st magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 25.25. [CBET 4030, MPEC 2014-X31, 2014 December 5] The comet will reach perihelion at 7.4 au in 2015 February and has a period of around 80 years.

2014 W11 (PanSTARRS) A 19th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on November 26.55. Tim Spahr identified pre-discovery observations in images taken by Mt Lemmon, ISON and Catalina. [CBET 4031, MPEC 2014-X32, 2014 December 5] The comet will reach perihelion at 3.4 au in 2015 June and has a period of around 30 years. An encounter with Saturn will increase the perihelion distance to 3.7 au and slightly reduce the period at the next return.

2014 W12 (P/Gibbs) Alex Gibbs discovered an 18th magnitude comet during the Mt Lemmon Survey with the 1.5m reflector on November 30.07. [CBET 4032, MPEC 2014-X33, 2014 December 5] It has perihelion at 1.7 au in 2014 November and a period of around 7 years. It can approach quite closely to Jupiter. The orbit is not yet completely defined, with the JPL and MPEC orbits having different periods. Values here are from JPL as they do at least give error bars.

2014 X1 (P/Elenin) Leonid Elenin discovered an 18th magnitude comet in images taken with the 0.4m astrograph at the ISON Observatory near Mayhill, New Mexico on December 12.16. Gareth Williams found pre-discovery PanSTARRS images from September, and Mt Lemmon images from October. [CBET 4034, MPEC 2014-X66, 2014 December 13] The comet is at perihelion at 1.8 au in 2015 January and has a period of around 16 years.

2014 XB_8 (PanSTARRS) A 20th magnitude asteroid discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on December 15.37 was found to have cometary features when imaged by the University of Hawaii 2.2m telescope the next day. [CBET 4040, MPEC 2014-Y87, 2014 December 30] The comet will reach perihelion at 3.0 au in 2015 April.

A/2014 XS_3 [PanSTARRS] A 20th magnitude asteroid was discovered by PanSTARRS on December 8.21 [MPEC 2014-X68, 2014 December 14] It is classed as a Trans-Neptunian Object, has a slightly retrograde orbit, a period of around 200±200 years and was near perihelion at 3.2 au. The Tisserand parameter of the orbit with respect to Jupiter is -0.28.

2014 Y1 (PanSTARRS) A 20th magnitude comet was discovered in PanSTARRS 1 images taken with the 1.8m Ritchey-Chretien on December 16.46. Tim Spahr found pre-discovery images in PanSTARRS data from a month earlier. [CBET 4037, MPEC 2014-Y20, 2014 December 19] The comet will reach perihelion at 2.2 au in 2016 January. It might reach 14th magnitude around the time of perihelion.

Provisional magnitude parameters for the brighter comets under observation are on the Section web page. Final parameters for all the comets will be published in the comet reports in the BAA Journal in due course.

Comet Prospects for 2015

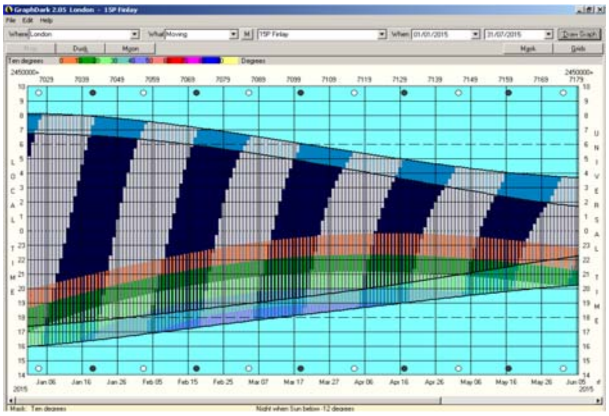
Comet 2013 US_{10} (Catalina) could be a bright object towards the end of the year. Comets 2014 Q1 (PanSTARRS) and 2014 Q2 (Lovejoy) could also reach naked eye brightness. There are no bright periodic comets predicted to return in 2015. What excitement there is comes from 67P/Churyumov-Gerasimenko, which reaches perihelion in August. It creeps into the morning sky shortly after perihelion and visual observations will be important to put the Rosetta observations into the context of previous apparitions.

These predictions focus on comets that are likely to be within range of visual observers. 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. Drawings are also useful, as the human eye can sometimes discern features that initially elude electronic devices. Images of these comets are in the BAA/TA comet image archive at http://www.britastro.org/cometobs/, which is regularly updated with the latest images and drawings.

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 observers using electronic imaging, especially those with time on instruments such as the Faulkes telescopes. Such observers are encouraged to report total magnitude estimates, using the ICQ format given in the BAA Guide and the reduction techniques described by Roger Dymock. When possible use a waveband approximating to Visual or V magnitudes. Such estimates can be used to extend the visual light curves, and hence derive more accurate absolute magnitudes.

In addition to those in the BAA Handbook, ephemerides for new and currently observable comets are published in the *Circulars*, and on the Section, CBAT and Seiichi Yoshida's web pages. Complete ephemerides and magnitude parameters for all comets predicted to be brighter than about 21^m are given in the International Comet Quarterly Handbook; details of subscription to the ICQ are available on the Internet, though the organisation seems rather moribund at present. A draft version of the BAA Observing Guide to Comets, which is being updated, is available in the BAA members' web pages.

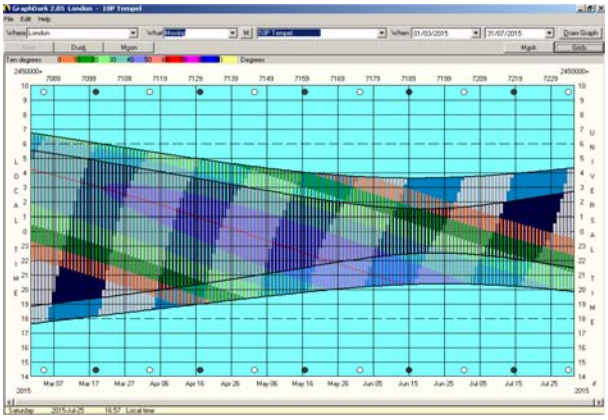
15P/Finlay was at perihelion in 2014 December, and may begin the year as a binocular object in the early evening sky. It quickly fades in January and February, but remains conveniently placed. Mars provides a good locator as the comet stays close to the red planet.



15P/Finlay from January 1 to June 5

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.

10P/Tempel makes its 23rd observed return since its discovery by William Tempel (Milan, Italy) as a 9th magnitude object in 1873. Several unfavourable returns were missed in the earlier years. The orbit is very stable, which is one reason why it is a favoured target for possible spacecraft missions. In 1983 the IRAS satellite detected an extensive dust trail behind the comet. Normally the light curve is highly asymmetric with a late turn on. There is a rapid rise in brightness as perihelion approaches, which continues more slowly for a couple more weeks after perihelion, followed by a slow decline until activity switches off. The activity may originate from a single high latitude source. It is one of the few comets with a measured rotation period (8.95 hours) and there is evidence that the period has increased over the last few apparitions. With a 5.5 year period alternate returns are favourable. The comet can be followed from the UK until early July, when it has brightened to 12th magnitude. The comet is better seen from the southern hemisphere, and at its best in October is 11th magnitude.

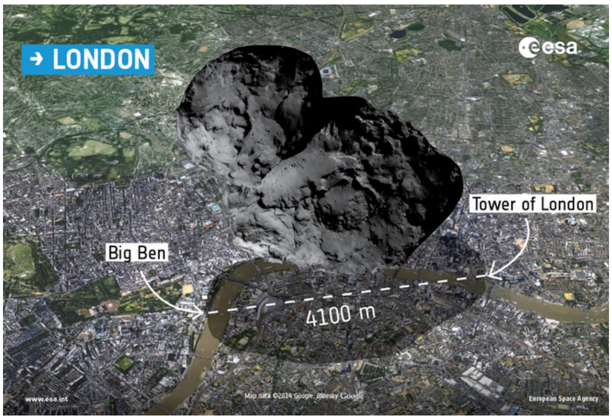


Comet 10P/Tempel from March 1 – July 31

Konigstuhl Observatory with the Bruce astrograph

22P/Kopff was discovered photographically by A Kopff at Konigstuhl Observatory in 1906, when it was around 11^m. The next return was unfavourable, but it has been seen at every return since then. Following an encounter with Jupiter in 1942/43 its period was reduced and the perihelion distance decreased to 1.5 AU. The following return was one of its best and it reached 8^m. The next return was unusual, in that it was 3^m fainter than predicted until perihelion, when it brightened by 2^m. It suffered another encounter with Jupiter in 1954, but this made significant changes only to the angular elements. 1964 was another good return and the comet reached 9^m. This is not a good return, and for UK observers it will barely be into visual range before it is lost in the summer twilight. Southern hemisphere observers do a little better, being able to follow it until just after perihelion, but it will only reach 11th magnitude.

67P/Churymov-Gerasimenko was discovered in 1969 September, by Klim Churyumov and Svetlana Gerasimenko on a plate taken for 32P/Comas Sola at Alma Ata observatory. It reached its present orbit after a very close encounter (0.05 AU) with Jupiter in 1959, which reduced the perihelion distance from 2.74 to 1.28 AU. During 2015 the Rosetta spacecraft and lander will be accompanying the comet on its way to perihelion, with the mission due to be completed at the end of the year. At the good apparition of 1982, when it approached the Earth to 0.4 AU and was well observed by the comet section, it reached 9th magnitude. Section observations show that the comet is usually brightest some 40 days after perihelion, which suggests that this year it should peak at around 9th magnitude in late September. Unfortunately the observing circumstances are not particularly good, with the comet a morning object. Because of the importance of providing ground truth for the spacecraft and putting the apparition into a historical context observations are particularly encouraged. There are observing diagrams for a variety of latitudes on the Section web page.



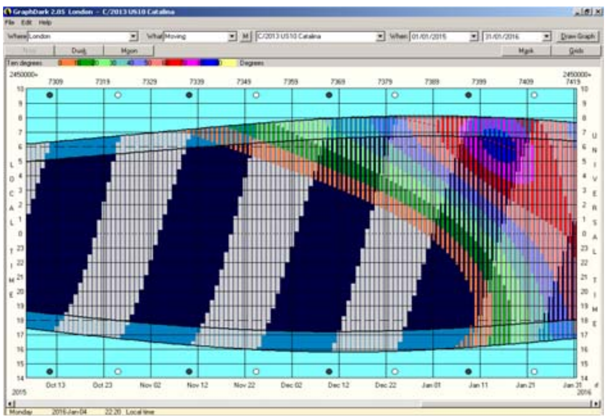
Comet 67P over London:
ESA/Rosetta/Navcam; Map data ©2014 Google, Bluesky

Ellen Howell discovered **88P/Howell** in 1981 with the 0.46-m Palomar Schmidt. It passed 0.6 AU from Jupiter in 1978, which reduced the perihelion distance, but the biggest change to its orbit occurred in 1585 when an encounter reduced q from 4.7 to 2.4 AU. The comet was well observed in 2009, though the light curve can be fitted by both a linear or standard curve. Assuming a standard light curve, this return may see the comet reach 9th magnitude at its brightest in April, however it is a southern hemisphere object that is best seen in the morning sky.

Donald Machholz discovered **141P/Machholz** with his 0.25-m reflector at 10m in August 1994. It proved to have multiple components, first reported by Michael Jager (Vienna, Austria). The four secondary components could all be described by the same orbit, but with perihelion delayed by up to half a day from the primary. At times there seemed to be a faint trail of material linking the components. The comet has a short period of 5.2 years with a perihelion distance of 0.75 AU and aphelion just inside the orbit of Jupiter. The orbit has been slowly evolving, with progressive changes occurring about every 50 years, thanks to approaches to Jupiter. The most recent close approach was in 1982. With a relatively stable perihelion distance, which is slowly increasing, it is perhaps surprising that the comet was not discovered earlier. There was a favourable return in winter of 1978/79 when it might have reached 8th magnitude and very favourable returns in the autumns of 1920, 1936 and 1957 when it might have reached 6th magnitude. The fact that it was not discovered at any of these returns suggests that the absolute magnitude at the 1994 return was not typical, and was the result of the fragmentation. The last return, in 2010, was a very poor one and visual observations were not received. At present the earth passes about 0.25 AU outside the descending node and the orbital evolution will slowly decrease this distance, raising the possibility of meteor shower from the comet in a few hundred years time. Whilst this return is better than that of 2010, there is a relatively short observing window in the northern summer morning sky when at best it will just reach 11th magnitude, and it may well be fainter than this.

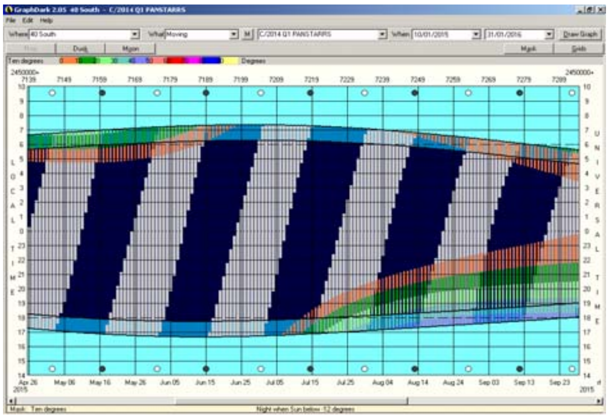
2012 K1 (PanSTARRS) was at perihelion in 2014, but remains visible for southern hemisphere observers. It fades from around 10th magnitude, but its solar elongation is decreasing and it will be lost in February. It emerges from conjunction in May, and could still be bright enough to be observed visually in the Southern Hemisphere.

2013 US$_{10}$ (Catalina) is a Southern Hemisphere object for much of the year. There the comet emerges from solar conjunction in late March and brightens until the comet is lost in the dusk in mid October. It is a morning object at the end of the year for UK observers, entering our skies from mid November, when the electronic observations received up to early December strongly suggest that it may be a prominent naked eye comet. Mars, Venus and the crescent moon will be close by around December 7.



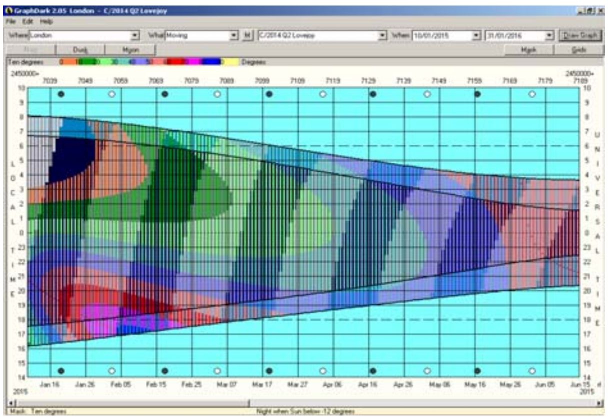
2013 US$_{10}$ from October 7 to 2016 January 31

2013 V5 (Oukaimeden) reached 6th magnitude at perihelion last year, but then faded rapidly and entered solar conjunction. The last observation was in October, but the comet should remain at around 11th magnitude for the first few months of 2015.



2014 Q1 for 40°S from April 26 to September 28

2014 Q1 (PanSTARRS) is a Southern Hemisphere object throughout its apparition and is poorly placed prior to perihelion in July, though it might be visible in the dawn sky in May and early June. Electronic observations by Kevin Hills, with the comet still over nine months from perihelion suggest that it could become a bright object, though the error bars on the peak magnitude are 8 magnitudes! If it does continue brightening as at present the comet will become a prominent object with a significant tail in late July. It will also be well-observed as it is an evening object in southern winter skies. There might be a good imaging opportunity around July 21, when Venus and Jupiter are close by. There is a slim chance that UK observers might be able to see the comet in twilight if it gets as bright as some of the extreme error bars permit.



2014 Q2 from January 10 to June 15

2014 Q2 (Lovejoy) begins the year as an easy binocular object in Lepus below Orion, and may be visible to the naked eye. It is likely to be at its brightest in the first half of January. It moves northwards, reaching Andromeda in early February and Cassiopeia in March, when it may still be a binocular object. Some wide-field imaging opportunities include mid January when it is relatively close to the Pleiades and February 2 when it transects the line between M34 and NGC752. It could remain within visual range until July.

The other periodic and parabolic comets that are at perihelion during 2015 are unlikely to become brighter than 12th magnitude or are poorly placed. Ephemerides for these can be found on the CBAT WWW pages. 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. Three SOHO comets are predicted to return, however these will only be visible from the SOHO or STEREO satellites.

Tail disconnection event in 2014 Q2 (Lovejoy) imaged by Rolando Ligustri on January 8

Looking ahead to 2016, 45P/Honda-Mrkos-Pajdusakova may be visible at the end of the year. Comet 252P/LINEAR passes within 0.0357 au of earth, but is only 10th magnitude at high southern declination when at its best. 2013 US$_{10}$ may still be a bright binocular object in the morning sky at the start of the year.

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Jonathan Shanklin

Comets reaching perihelion in 2015

Comet	T	q	P	N	H_1	K_1	Peak mag
Tenagra (2014 F2)	Jan 2.3	4.31			9.0	10.0	18
PanSTARRS (2013 W2)	Jan 4.4	4.45	34	1	13.5	5.0	18
P/Elenin (2014 X1)	Jan 7.7	1.81	15.7	1	15.0	10.0	17
201P/LONEOS	Jan 14.6	1.34	6.43	2	12.7	10.0	14
Tenagra (2013 G9)	Jan 14.7	5.34			7.0	10.0	17
D/Brooks (1886 K1)	Jan 21.6	1.36	5.71	1	8.0	15.0	11 ?
P/PanSTARRS (2014 V1)	Jan 25.1	2.54	10.6	1	14.0	10.0	21
Lovejoy (2014 Q2)	Jan 30.1	1.29			3.9	17.3	5
7P/Pons-Winnecke	Jan 30.5	1.24	6.32	23	10.0	15.0	13
PanSTARRS (2014 G3)	Feb 2.6	4.70			9.0	10.0	19
PanSTARRS (2014 W10)	Feb 9.2	7.42			8.0	10.0	21
PanSTARRS (2014 W9)	Feb 15.8	1.59	36.9	1	16.0	10.0	18
309P/LINEAR	Feb 16.8	1.74	9.36	2	15.0	10.0	19
Catalina (2014 W6)	Feb 19.5	3.18			10.5	10.0	17
299P/Catalina-PanSTARRS	Feb 23.3	3.14	9.15	2	11.5	10.0	18
Catalina (2014 AA52)	Feb 27.7	2.00			10.0	10.0	15
92P/Sanguin	Mar 1.2	1.83	12.4	3	12.0	15.0	18
6P/d'Arrest	Mar 2.5	1.36	6.56	19	12.4	15.0	16
PanSTARRS (2014 Q6)	Mar 3.9	3.79			11.0	10.0	20
NEOWISE (2014 N3)	Mar 13.1	3.88			7.0	10.0	16
D/Barnard (1884 O1)	Mar 13.6	1.32	5.41	1	11.5	15.0	15 ?
44P/Reinmuth	Mar 24.1	2.12	7.10	10	8.5	15.0	16
P/LINEAR (2008 WZ96)	Mar 25.9	1.65	6.16	1	13.5	10.0	18
C/PANSTARRS (2012 F3)	Apr 1.8	3.50			4.6	11.1	13
86P/Wild	Apr 3.4	2.26	6.84	5	8.5	15.0	15
PanSTARRS (2014 XB8)	Apr 5.2	3.01			13.5	10.0	20
88P/Howell	Apr 6.2	1.36	5.48	7	1.8	42.6	9
42P/Neujmin	Apr 8.3	2.03	10.8	5	13.0	15.0	19
310P/Hill	Apr 18.5	2.38	8.47	2	13.5	10.0	19
174P/Echeclus (60558)	Apr 22.5	5.82	34.9	1	9.5	5.0	17
218P/LINEAR	Apr 23.2	1.17	5.45	2	16.0	10.0	15
113P/Spitaler	Apr 23.7	2.12	7.06	4	12.5	5.0	16
268P/Bernardi	Apr 27.4	2.42	9.76	1	13.5	10.0	19
308P/Lagerkvist-Carsenty	May 7.2	4.23	17.1	2	13.0	5.0	19
P/Zhao (2007 S1)	May 9.9	2.49	7.41	1	13.0	10.0	19
205P/Giacobini	May 14.1	1.54	6.69	2	13.0	10.0	16
LINEAR-Hill (2008 QP2)	May 17.3	1.72	6.52	1	15.5	10.0	20
PanSTARRS (2014 S1)	May 17.7	8.17			7.0	10.0	20
57P/du Toit-Neujmin-Delporte	May 22.3	1.73	6.42	7	12.5	15.0	17
19P/Borrelly	May 28.9	1.35	6.83	14	6.6	14.0	10
P/Boattini (2009 Q4)	Jun 13.4	1.32	5.55	1	15.5	10.0	19
P/WISE (2010 B2)	Jun 13.4	1.61	5.48	1	17.0	10.0	21
P/Gibbs (2012 F5)	Jun 13.5	2.88	5.21	1	12.0	10.0	18
148P/Anderson-LINEAR	Jun 13.8	1.69	7.04	3	17.0	5.0	20
220P/McNaught	Jun 13.8	1.55	5.50	2	15.0	10.0	18
196P/Tichy	Jun 14.8	2.14	7.33	2	13.5	10.0	19
PanSTARRS (2014 W11)	Jun 17.3	3.43	30.6	1	10.0	10.0	17

P/Catalina (2009 WX51)	Jun 25.3	0.80	5.39	1	19.0	5.0	19
233P/La Sagra	Jun 25.4	1.79	5.28	2	15.0	10.0	20
P/Catalina-McNaught (2008 S1)	Jul 1.9	1.20	6.76	1	15.0	10.0	15
PanSTARRS (2014 Q1)	Jul 5.2	0.32			3.4	13.2	-3 ?
221P/LINEAR	Jul 11.6	1.76	6.44	2	14.0	10.0	16
162P/Siding Spring	Jul 12.0	1.24	5.34	4	15.0	10.0	17
P/LINEAR (2004 FY140)	Jul 24.8	4.06	10.8	1	12.5	5.0	18
140P/Bowell-Skiff	Aug 8.6	1.99	16.4	2	11.5	15.0	18
P/McNaught (2004 R1)	Aug 12.3	0.98	5.46	1	18.5	10.0	16
51P/Harrington	Aug 12.4	1.70	7.16	7	10.0	10.0	12
67P/Churyumov-Gerasimenko	Aug 13.1	1.24	6.44	7	9.5	10.0	9
P/WISE (2010 K2)	Aug 13.6	1.27	5.10	1	19.0	10.0	21
P/Yang-Gao (2009 L2)	Aug 15.0	1.43	6.61	1	15.0	10.0	17
141P/Machholz	Aug 24.9	0.76	5.25	4	13.0	10.5	11
PanSTARRS (2014 M1)	Aug 27.7	5.57			9.0	10.0	20
Tenagra (2013 C2)	Aug 31.7	9.13	64	1	10.0	10.0	24
P/SOHO (1999 R1)	Sep 4.1	0.05	3.99	4	22.1	12.8	
SONEAR (2014 A4)	Sep 6.0	4.18			6.0	10.0	15
34D/Gale	Sep 8.3	1.20	11.2	2	11.0	20.0	13 ?
PanSTARRS (2014 W8)	Sep 10.3	5.02			11.0	10.0	21
P/SOHO (1999 J6)	Sep 26.4	0.05	5.43	3	19.0	10.0	
61P/Shajn-Schaldach	Oct 2.2	2.11	7.06	7	10.0	10.0	13
Catalina (2013 V4)	Oct 7.6	5.19			-1.4	17.7	14
151P/Helin	Oct 8.1	2.47	13.9	2	12.0	10.0	17
P/NEAT (2001 H5)	Oct 21.8	2.44	15.0	1	12.0	10.0	18
P/Hill (2007 V2)	Oct 23.1	2.78	8.22	1	13.0	10.0	19
P/McNaught-Hartley (1994 N2)	Oct 24.5	2.45	20.6	1	10.0	10.0	15
22P/Kopff	Oct 25.1	1.56	6.40	16	7.0	15.0	11
P/LONEOS-Christensen (2005 RV25)	Oct 28.5	3.58	8.94	1	9.5	10.0	17
D/Helfenzrieder (1766 G1)	Nov 4.7	0.40	4.50	1	3.2	10.0	
P/Gibbs (2008 Y2)	Nov 6.0	1.63	6.78	1	16.0	10.0	19
214P/LINEAR	Nov 12.7	1.85	6.87	2	13.0	10.0	18
10P/Tempel	Nov 14.3	1.42	5.36	22	8.6	7.7	11
Catalina (2013 US10)	Nov 15.7	0.82			0.8	12.1	1 ?
230P/LINEAR	Nov 18.1	1.49	6.27	3	13.0	10.0	13
249P/LINEAR	Nov 26.7	0.50	4.59	2	18.5	10.0	16
P/La Sagra (2010 R2)	Nov 30.1	2.62	5.45	1	13.0	10.0	18
P/SOHO (1999 U2)	Dec 3.7	0.05	5.38	3			
P/LINEAR-Catalina (2003 WC7)	Dec 4.9	1.66	11.8	1	13.5	10.0	15
PanSTARRS (2014 S2)	Dec 8.0	2.10			10.0	10.0	15
P/Van Ness (2002 Q1)	Dec 10.9	1.56	6.73	1	13.0	10.0	16
204P/LINEAR-NEAT	Dec 11.6	1.93	6.99	2	9.9	10.0	13
180P/NEAT	Dec 13.0	2.49	7.59	3	11.0	10.0	17
P/LONEOS-Tucker (1998 QP54)	Dec 26.0	1.89	8.62	1	9.7	15.0	15
P/PanSTARRS (2014 W4)	Dec 30.2	4.26	16.9	1	11.0	10.0	20

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. 34D was last seen in 1938, when it may have been recovering from an outburst at the previous (discovery) return. The peak magnitude for 67P is based on its linear lightcurve, rather than the parameters given here. Magnitude information is not given for the SOHO comets; these have not been numbered by the IAU despite having been observed over several returns.

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

Comets reaching within 3 degrees of zero phase angle or 180° opposition

Ory	P/2008 Q2	2015	1	10	to	2015	1	16	19.7
Palomar	C/2012 LP_{26}	2015	1	11	to	2015	1	19	19.2
Jedicke	269P/	2015	1	14	to	2015	2	1	16.6
NEAT	P/2001 H5	2015	1	15	to	2015	1	29	18.9
Brooks	16P/	2015	1	16	to	2015	1	26	16.4
Parker-Hartley	119P/	2015	1	18	to	2015	2	1	15.2
PANSTARRS	C/2013 W2	2015	1	19	to	2015	2	10	19.4
Helin-Roman-Alu	132P/	2015	1	23	to	2015	1	31	16.0
Wilson-Harrington	107P/	2015	2	10	to	2015	2	26	19.7
NEAT	291P/	2015	2	10	to	2015	2	24	19.5
Palomar	C/2013 P3	2015	2	16	to	2015	2	26	19.8
Spacewatch	C/2013 TW_5	2015	2	27	to	2015	3	13	18.9
LINEAR	295P/	2015	3	9	to	2015	3	17	19.1
Shoemaker-Levy	129P/	2015	3	19	to	2015	4	8	19.5
Van Biesbroeck	53P/	2015	3	25	to	2015	4	10	18.8
LINEAR	P/2004 FY_{140}	2015	3	25	to	2015	4	16	18.0
PANSTARRS	C/2013 P4	2015	3	28	to	2015	3	30	19.6
Palomar	C/2013 P3	2015	4	7	to	2015	4	17	19.8
Blanpain	289P/	2015	4	11	to	2015	4	21	16.2
Boattini	P/2008 T1	2015	5	4	to	2015	5	24	19.4
ISON	C/2012 S1	2015	6	18	to	2015	6	28	17.5
Mueller	136P/	2015	7	16	to	2015	8	1	18.1
Palomar	C/2012 LP_{26}	2015	7	16	to	2015	8	1	18.4
Neujmin	25D/	2015	7	24	to	2015	8	13	?
Kowal-Vavrova	134P/	2015	7	28	to	2015	8	17	15.9
Spacewatch	C/2011 KP_{36}	2015	8	5	to	2015	8	25	14.9
LINEAR	218P/	2015	8	7	to	2015	8	13	17.9
Echeclus (60558)	174P/	2015	8	27	to	2015	9	28	16.8
Encke	2P/	2015	8	28	to	2015	9	15	17.5
Palomar	C/2013 P3	2015	8	29	to	2015	10	10	19.5
Arend	50P/	2015	9	5	to	2015	9	9	15.6
Helin	151P/	2015	9	10	to	2015	9	22	16.8
Neujmin	42P/	2015	9	17	to	2015	9	25	20.0
du Toit-Neujmin-Delporte	57P/	2015	9	23	to	2015	10	3	17.6
Shoemaker-Levy	118P/	2015	9	29	to	2015	10	3	14.7
Hill	P/2007 V2	2015	10	3	to	2015	10	15	18.7
Helin-Roman-Alu	117P/	2015	10	5	to	2015	10	21	16.8
SONEAR	C/2014 A4	2015	10	17	to	2015	10	19	14.1
PANSTARRS	C/2013 P4	2015	10	22	to	2015	11	27	19.3
Howell	88P/	2015	10	23	to	2015	11	4	19.4
LONEOS	P/2004 VR_8	2015	11	4	to	2015	11	14	17.9
Reinmuth	44P/	2015	11	21	to	2015	11	29	16.5
Gibbs	P/2012 F5	2015	11	27	to	2015	12	5	18.1
Russell	94P/	2015	11	29	to	2015	12	15	17.7
LONEOS-Christensen	P/2005 RV_{25}	2015	12	10	to	2015	12	28	17.1
Wild	81P/	2015	12	11	to	2015	12	23	12.3
Zhao	P/2007 S1	2015	12	16	to	2015	12	22	18.9
Christensen	170P/	2015	12	24	to	2016	1	1	20.0
Palomar	C/2012 LP_{26}	2016	1	12	to	2016	1	16	19.1
Hill	211P/	2016	1	15	to	2016	1	25	16.9
Schwartz	C/2014 B1	2016	1	19	to	2016	2	18	18.9
LINEAR-NEAT	204P/	2016	1	21	to	2016	1	29	14.9
Clark	71P/	2016	1	27	to	2016	1	29	16.6
LINEAR-Hill	P/2008 QP_{20}	2016	1	28	to	2016	2	11	19.1

The Comet's Tale is produced by Jonathan Shanklin, with thanks to the British Antarctic Survey and the Institute of Astronomy, Cambridge for the use of computing facilities. E&OE.