THE BAA OBSERVERS' WORKSHOPS

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At York, Jonathan Shanklin described techniques for visually observing comets.

Visual observation of comets

by Jonathan Shanklin

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2003 September 6

Despite the rapid increase in the use of CCDs in the last few years, visual observations are still valuable and with practice are easy to carry out. There are usually several comets visible in simple equipment every year and observing them is a rewarding pastime. This description of techniques for the visual observation of comets is abridged and updated from material presented at the BAA Workshop in York on 2003 September 6.

CCDs have taken over in many areas of amateur observation, where clearly they do a better job than the human eyeball. Planetary observation is one clear example and I know that I could not even *see* the detail presented in the majority of CCD and webcam images. Supernova searching is another area where, at least in the UK, the CCD patrollers are beating visual hunters hands down. CCDs are also without doubt best for the precise astrometry of stars, asteroids and comets.

This series of images by David Strange of comet 2001 C1 (Ikeya–Zhang) on 2002 March 7 shows what you might see with a telescope (top), binoculars (middle) and naked eye (bottom).

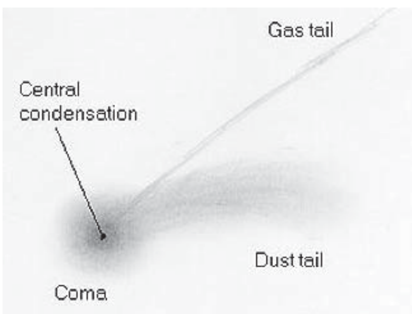
There are however some areas where the visual observer is more productive, does a better job, or provides continuity with the past. Variable star observation is one such area, where a visual observer can produce many more, though not necessarily as accurate, observations. For many variable stars the precise magnitude is not important, but what is important is the general shape and amplitude of the light curve and a visual observer can easily provide this. Meteor watching is another area where the visual watcher reigns supreme and also provides continuity with the past, as the style of observation has not changed for many years.

With comets there is a need for both CCD and visual observations. CCD work was covered in an earlier Workshop and here I will talk about visual observation. As Director of the Section I am concerned that there is a perception that visual observation is a thing of the past and has no value. This is apparent in the fewer visual observations that are coming in, particularly from UK observers. In part this may be due to increasing light pollution, and it will certainly make a big difference to your observations if you can get to a dark sky site; however observation is still possible from a suburban back garden and I have made observations of several comets from my home in Cambridge.

Whilst a good site is one key aspect for visual observation, another is to match the equipment to the comet. As an example take the recent apparition of comet 2P/Encke, which was very diffuse. I made an observation of the comet with the 0.3-m Northumberland refractor at the Cambridge University Observatory on 2002 October 27, estimating it at magnitude 12.4. The following morning I saw a report on the Internet saying that it was visible in binoculars. This seemed a bit unlikely given my observation, however the Cambridge site does suffer from light pollution, so the next evening I drove out to a dark sky site and was astounded to see the comet in 20×80 binoculars at an estimated magnitude of 9.9.

Features of a comet

Through a telescope or binoculars there are several features to see in a comet. The majority show a diffuse coma, some arcminutes in diameter, with perhaps a nearly stellar nuclear condensation. This is not the true solid nucleus as seen from spacecraft, as this is far too small to be seen from any earth-based telescope. The comet



may show a tail, either composed of dust that is reflecting sunlight, or of ionised gas that is fluorescing in its own right. This tail normally, but not always, points away from the Sun. Under high power, observers may see features such as jets or hoods in the inner coma, particularly if it is a bright comet relatively close to the Sun.

Visual observation is always subjective to a greater or lesser extent, because it is a synthesis of how the brain interprets what the eye sees. Everyone's eyes see differently, indeed no two eyes are the same. Their spectral sensitivity may be different and the optical defects of each eye will also be different, with some more defective than others. Once the image has formed on the retina it has to be interpreted and this will depend on our background and preconceptions. Despite all these handicaps, visual observers still produce the goods and make valuable observations.

There are many reasons for making an observation. For amateur observers, personal satisfaction plays a large part and so an observation need not satisfy any scientific goal. It can be simply to tick an object off on a list, or the satisfaction gained in making an artistic drawing. Amateur observers can however make significant contributions to science and the visual observation of comets is no exception. Visual magnitude estimates go towards making up a light curve, which allows the determination of the absolute magnitude of a comet. This gives a measure of the size of the nucleus and professional astronomers then draw up a statistical picture of the size distribution. This can tell us much about the evolutionary history of comets. With periodic comets that have been observed over many returns it is possible to investigate if the absolute magnitude is changing with time and it is therefore essential to use consistent methods over a long period of time. Whilst CCD observation might give a precise magnitude, there are many problems in the reduction of CCD images. For example when visual observers were reporting 2P/Encke as being easily visible in binoculars, some CCD reports on the Internet gave magnitudes fainter than 13.

Jonathan Shanklin in Antarctica.

The Comet Section

The Comet Section was formed in 1891, the year after the BAA was founded. Since 1945 observers have contributed some 30,000 visual observations of 400 comets, including returns of 80 periodic comets. Sadly the raw records prior to 1945 were lost during the Second World War, though there are some reports and analyses in the *Journal*. There are a number of Section publications, including *Journal* papers covering past comets, predictions on comets for the coming year, an observing guide, a Section newsletter and frequently updated web pages.

The first Director of the Section was W. F. Denning, who discovered five comets himself. The third Director, Dr A. C. D. Crommelin, didn't discover a comet, but did compute the true orbit of what is now known as 27P/Crommelin. I am the 12th Director and don't have any comets named after me, though I have discovered seven SOHO comets. Today visual discovery is unlikely, thanks to professional search programmes such as LINEAR (Lincoln Laboratory Near Earth Asteroid Research) and NEAT (Near Earth Asteroid Tracking), however Southern Hemisphere observers still stand a chance and Albert Jones discovered a comet visually in 2000. There is also a chance of discovery in what might be termed the 'twilight zone', which is too close to the Sun for LINEAR and too far from the Sun for the SOHO (Solar and Heliospheric Observatory) LASCO (Large Angle Spectroscopic Coronagraph) coronagraphs, although even this area is covered by its SWAN (Solar Wind Anisotropies) camera and some budding professional survey programmes.

Observing equipment

Observing comets is rarely a naked eye pastime, so some visual aid is desirable. Binoculars are a good starting point and I have half a dozen pairs ranging through 10×25, 3×40, 7×50, 10×50, 20×80 and 25×100. Of these the most frequently used are the 20×80B as the higher magnification and light grasp are good in light polluted conditions as well as in dark sky conditions. Telescopically I mostly use the old long-focus refractors of the Cambridge University Observatory – the Northumberland 0.30m f20 and the Thorrowgood 0.20m f14. One important reason for continuing to use these telescopes is to provide continuity with the past, but to provide comparison I also use a 0.15m f8 Newtonian, a 0.20m LX200 and a 0.33m f4.5 Dobsonian. The Dobsonian mounting is a great benefit when comets are overhead.

The location of the observing site is important and ideally there should be no light pollution, but these days this is rarely possible. It is however worth making the effort to get to the best site that is readily accessible, particularly if you have portable equipment. As a guide you should be able to see a 7th magnitude comet in 7×50 binoculars for a comet above 45° altitude.

You will also need some accessories such as an observing log book, a dim red torch and finder charts. Good preparation prior to observing is very important as you can waste a lot of time looking in the wrong place for a faint comet. Digital setting circles are a big help, but very often the comet is not immediately visible and then detailed charts are essential. Even then it is still not always obvious which star is which and I often use the traditional method of star hopping so that I am certain of the field. Using a planetarium style program such as *Megastar* or *Guide* I prepare a wide field finder chart showing the track of the comet with respect to stars down to around 9th magnitude. For fainter comets I then make a narrow field view showing stars down to around mag 14.

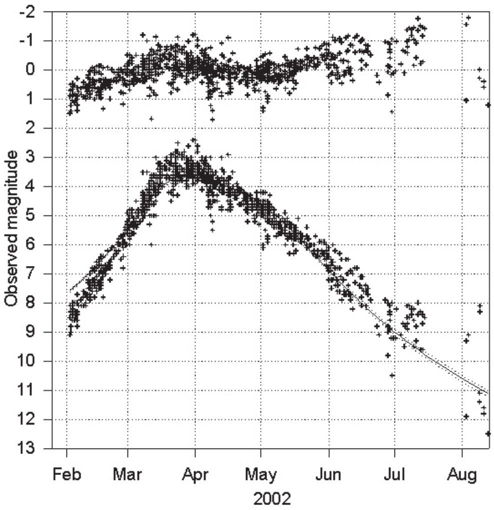
Simple observations

The first step in observing a comet is simply to find it and confirm that it is (or is not) visible. This by itself can be a useful observation as a large number of comets are known to outburst, and so may be much brighter than the ephemeris prediction would suggest. Alerting other observers to such an outburst can allow detailed scientific study of the processes taking place.

The next stage in observing is to try making a drawing. Drawings are a good way of training the eye to see more detail and also provide a lasting record of what you saw. They can also be true works of art and perhaps the first of these was the drawing of a comet (which might be Halley's) by Giotto. Guidance on drawing techniques is given in many books on observing and the styles most commonly used in comet drawings are the 'smudged finger', white on black or isophote methods.

Detailed observations

Visual observers should concentrate on the visual magnitude of the comet, with some



The light curve of comet 2002 C1 (Ikeya-Zhang).

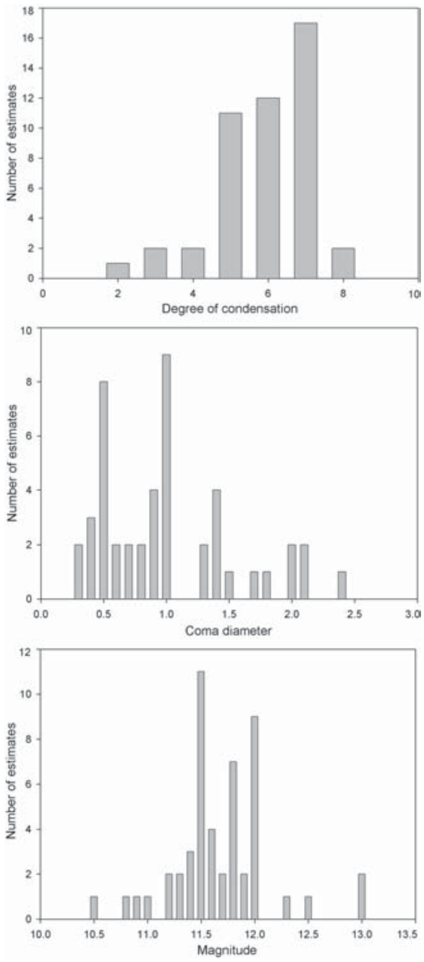
associated description of the coma. Tail observation is better left to CCD or photographic observation as this is best suited to measuring lengths, angles and features in the tail. One point to remember when measuring the position angle of the tail (or other features) is to do so with respect to the celestial coordinate system and not with respect to the terrestrial one.

The diameter of the coma can most easily be measured with respect to pairs of stars in the field. The separation of these can then be measured later using one of the many planetarium programs on the market. Another important aspect of the coma is its degree of condensation. An uncondensed coma is virtually the same brightness from centre to edge and is rated 0, a well condensed comet might be DC5 and a comet approaching close to the Sun often assumes a nearly starlike appearance of DC9. Comets that undergo outbursts, such as 29P/Schwassmann–Wachmann, often change from nearly stellar to very diffuse in the space of a week or two. There are illustrations of the scale in the Section observing guide.

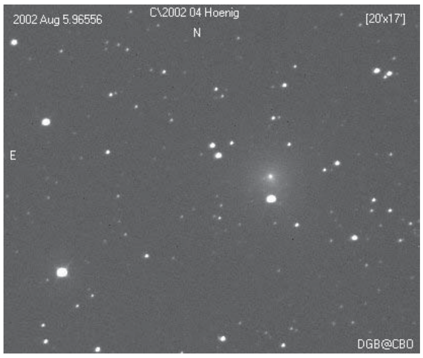
The standard method that the Comet Section uses for estimating the total magnitude of a comet is the in-out or Sidgwick method. This technique was first described by J. B. Sidgwick in *Observational Astronomy for Amateurs*, which was the pre-eminent manual for observers when I was at school. The method is broadly similar to that used by variable star observers, however the hard part is that the in-focus comet has to be compared with out-of-focus stars. The stars have to be sufficiently out of focus to match the apparent diameter of the coma. With practice the method becomes straightforward, however it does take a while getting used to. One important point is to choose the smallest aperture and magnification that clearly shows the comet as this gives the most consistent results. In general a larger aperture gives a fainter magnitude, however it is possible to correct for this in the analysis.

With comet observing we don't usually stick to a standard field, as the comet's position changes throughout the apparition as does its elevation, though some observers use the North Polar Sequence. The widespread availability of the Tycho catalogue for comparison star magnitudes has improved the consistency of estimates across widely separated fields for brighter comets, but there are still problems for fainter ones. No observer is perfect and we all tend to make small random errors in our estimates, superimposed on a bias from the mean, which give a significant scatter in the light curve. When all observations are taken together the mean curve is usually very consistent and this allows a good measurement of the magnitude parameters.

During the workshop I carried out a practical exercise in observing a comet, using images taken by Rolando Ligustri and Denis Buczynski. To demonstrate the observing technique I showed an image of C/1999 T2 (LINEAR) taken by Rolando and then alternated this with a specially defocused transform. This was followed by an image of



Results of the exercise conducted by the audience at the York meeting. *Top:* degree of condensation estimates; *Middle:* coma diameter estimates; *Bottom:* magnitude estimates.



Comet 2002 O4 (Honig) imaged by Denis Buczynski on 2002 August 5.97.

C/2002 O4 (Honig) taken by Denis and a corresponding finder chart. The audience were asked to estimate the coma diameter, degree of condensation and the magnitude.

The 47 DC estimates ranged from 2 to 8, with a median of 6, mode of 7 and an average of 5.9. Although there is no right answer, my preference would be for the modal value. The 46 coma diameter estimates were rather more scattered with a range from 0.3 to 2.4 minutes, a median of 0.9 and a mean of 1.0. The observations were bimodal with eight observers giving 0.5′ and nine giving 1.0′. This may suggest some quantisation, or, more likely, observers rounding to the nearest half minute. I think the observers estimating near the top of the range were closer to the truth and I estimated the diameter at around 2.0′. The 50 magnitude estimates range from 10.5 to 13.0, with the median at 11.6, mode at 11.5 and mean at 11.7. Again there is an element of bimodal or quantised behaviour with eleven estimates at 11.5 and nine at 12.0. My estimate would be towards the brighter end of the range at 11.3. On this date visual observers were actually estimating the comet's magnitude at 8.8, a coma diameter of 5′ and DC of 4, quite different to the experimental values, exemplifying the difference between CCD and visual observers.

In conclusion I asked the audience to go out and observe two comets that would become visible over the autumn and winter: 2P/Encke and C/2002 T7 (LINEAR). Comet Encke performed fairly close to my optimistic light curve, reaching about 4th magnitude at its brightest, though in the UK we lost it as a 6th magnitude object in early December. Observations of this comet by the BAA show no significant change to its absolute magnitude over the last 50 years. To date C/2002 T7 LINEAR is doing rather better than in the light curve that I presented at the meeting and indeed at the moment each time I rerun the analysis with more data I find a brighter comet. By the time you read this we will know whether or not this trend has continued, but I am hopeful that we will have seen two spectacular comets in 2004, and that these will have been well observed by BAA members.

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