Saturn and the 'opposition effect'

Saturn came to opposition on 2008 February 24 at 09:48 UT. It is well known that at this time there is a very noticeable increase in brightness of the rings. They 'glow' brilliantly compared to the disk, to which at other times they are comparable in intensity. The phenomenon has been reported as being noticeable for a couple of days around opposition, but seems to be most striking in the few hours around actual minimum phase angle.

The night of Feb 23/24 was cloudy at my site, but these images (Figure 1) were captured very early on Feb 25, about 14 hours after minimum phase angle (0.196º on this occasion). Seeing was poor but transparency was good after rain. The telescope was a 356mm SCT working at about 7800mm focal length. Saturn was imaged at wavelengths from 320 to 804nm. The exposures were: IR, 133ms×240s; R, G, B, 33ms×60s, and UV, 4000ms×240s, with about 33% of all frames taken being stacked to generate the images. It is not possible to get a sharp image in UV because of the much longer exposures required for this wavelength. A false-colour (IR)G(UV) image was constructed, and also a 'natural colour' RGB image.

The interesting result is that the over-brightness of the rings compared to the globe is greatest in IR and UV. In R and G the intensities are similar, and in B the rings are brighter than the globe. These images can be compared with images taken in RGB on 2007 December 12 (Figure 2), more than two months before opposition (the image scales are not exactly the same). At this time, as normally, the rings and globe were of comparable intensity across the visual spectrum. Because the images are approximately normalised in overall brightness, the globe in the B opposition image looks dim, whereas it would in fact be absolutely brighter than away from opposition. Similarly, the RGB opposition globe appears relatively dull.

The excessive brightness of the rings is often known as the 'opposition effect' of Saturn. It is sometimes also called the 'Seeliger Effect', after Hugo von Seeliger (1849–1924), who noted the phenomenon, and used it as evidence to support Maxwell's particulate theory of Saturn's rings. However, Seeliger's explanation, that it is due to the disappearance of the shadows of the ring particles on one another from the point of view of Earth, is not now considered correct – this cannot explain the very sharp brightness increase close to zero phase angle. The opposition effect is now thought to be mainly due to 'coherent backscattering' from the icy particles making up the rings, a phenomenon familiar from the reflectivity of snow, as well as from its exploitation in devices such as road signs. I do not think the term 'Seeliger Effect' should be used, as it creates confusion with the Lommel–Seeliger model of planetary brightness, which does *not* predict the opposition effect.

It is of interest from the observations here that the backscattering effect from Saturn's rings does not seem to change in a simple manner with wavelength, but rather has a minimum in the visible. It is consequently emphasised in the false-colour image. Further quantitative work would be of interest to discover the precise wavelength-phase-reflectivity relationship involved in the opposition effect of Saturn.

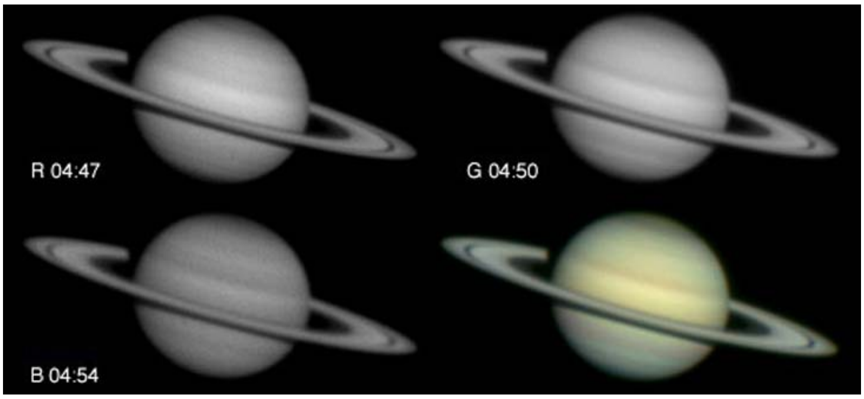

Figure 2. Images from 2007 Dec 12, for comparison with Figure 1. ***David Arditti.***

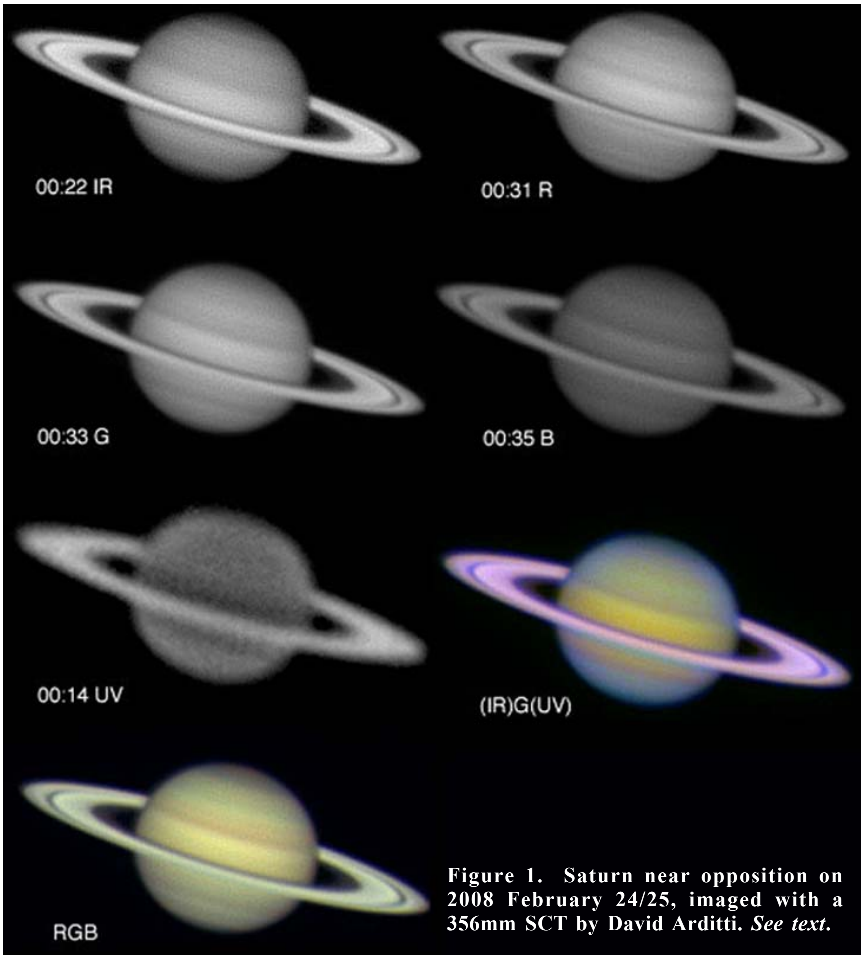

Figure 1. Saturn near opposition on 2008 February 24/25, imaged with a 356mm SCT by David Arditti. ***See text.***

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Variable stars

The VSS long term polar monitoring programme (LTPMP)

The BAA VSS (Variable Star Section) LTPMP has been set up to monitor, over a period of years, a selection of AM Her stars which are in need of further investigation. The objective is to observe on a nightly basis both visually and with CCDs, and to report any change in high/low state activity. The programme is supported by Dr Boris Gaensicke, Warwick University, whose article on Polars appeared in the 2006 September issue of the BAAVSS *Circular* (No. 129), and was the catalyst for this programme to be launched.

The AM Her type of X-ray variable is a binary star: a highly magnetic white dwarf orbiting a cool star (spectral type K or M). The cool star loses mass through Roche Lobe overflow, which falls to the white dwarf. The strong magnetic field prevents the formation of an accretion disc. Instead the mass stream follows the magnetic field lines, and is dumped onto the poles of the white dwarf. The light from polars varies in polarisation, which is why this type of object is known as a 'polar'.

The light variations can be complex. Polars are known to undergo periods of 'low states', when the star becomes much fainter than normal (or high state). This dimming can be up to four magnitudes. The reasons for this are not yet fully understood, but the two main theories are the presence of massive star spots on the cool star, or the disruption of the mass stream by magnetic fields.

BY Cam is a poorly observed polar with a blue magnitude range of 15.0–<17.0. The visual range over the past 13 years has been 14.0–15.7, as can be seen in Figure 1, from observations made by Gary Poyner. Low states are rare, and although BY Cam can reach magnitude 17.0, these 'dips' are usually very brief. The orbital variations in BY Cam are around 2.0 magnitudes, which again confuses matters as BY Cam fades and comes back during this cycle. A prolonged low state of BY Cam would tell us much about the system, and the detection of such a low state is one of the main reasons why this object is under constant observation.

More information about the BAAVSS LTPMP and other observing programmes can be found on the VSS web site at **http://www.britastro.org/vss/**.

Gary Poyner & Roger Pickard

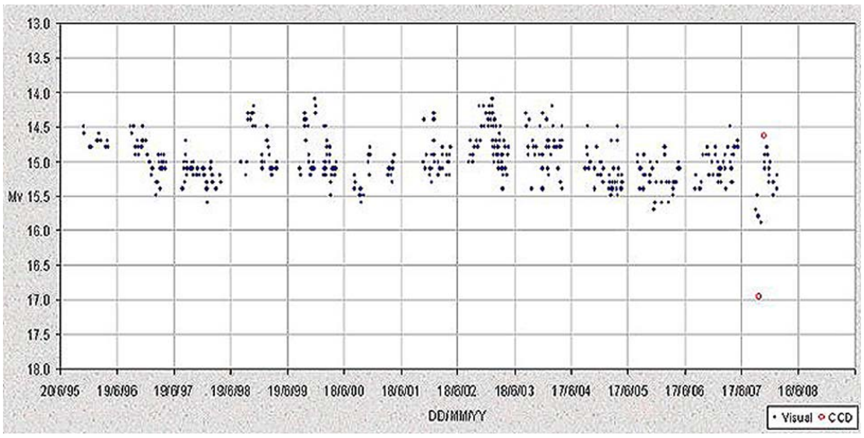

Figure 1. Lightcurve of BY Cam since 1995 by Gary Poyner.

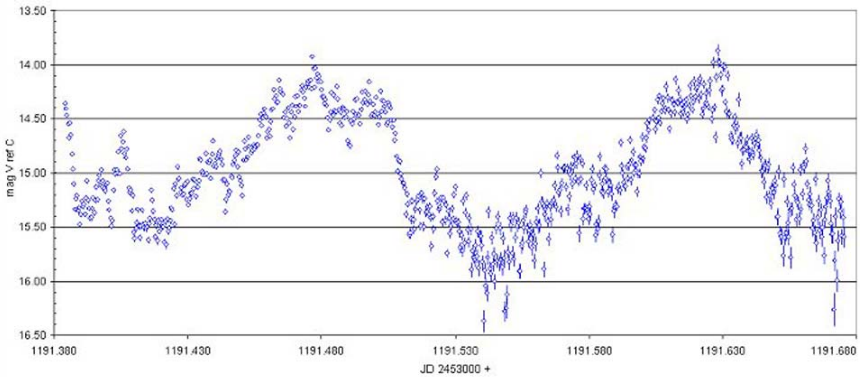

Figure 2. Observations by Ian Miller of orbital variations in BY Cam over a 7-hour period on 2007 March 31 using an unfiltered SXV-H9 CCD.

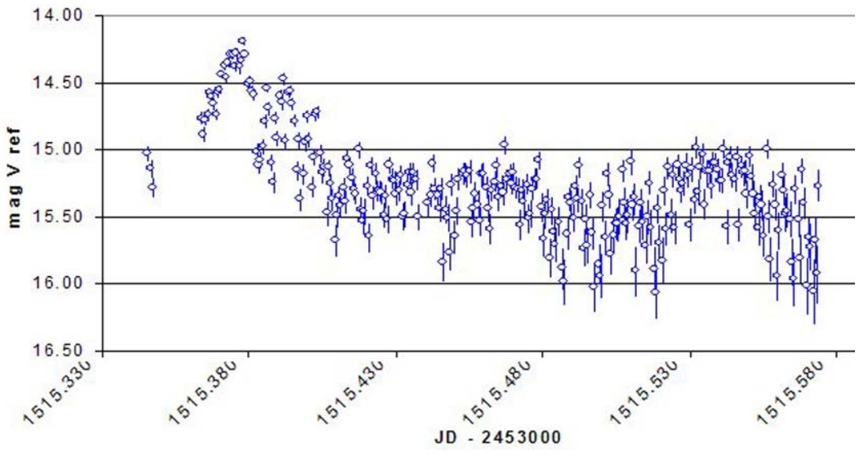

Figure 3. Observations over almost 6 hours by Roger Pickard on the night of 2008 February 18 using an SXV-H9 CCD plus V filter. The orbital variations seen by Miller have been swamped by other, unidentified, variations.

Deep Sky

Observing the 'Pacman' Nebula

Although circumpolar from northern latitudes, Cassiopeia is undoubtedly at its best when high overhead in the autumn and early winter skies, and seen against the backdrop of the winter Milky Way. If, however, you can't wait until next autumn, early morning April observations can give warmer observing conditions and often steadier seeing, provided of course that your observing site can tolerate the lower altitude of the constellation. Cassiopeia contains a wealth of bright nebulae and star clusters. Two (NGC 7635 and M52) were mentioned in the December 2007 *Journal* (Vol.117 No.6). Another nebula is discussed here.

Lying around 1.7° east of the mag 2.2 yellow giant star α Cassiopeiae (Schedar) – the star which marks the bottom right hand side of the familiar W shape – are an emission nebula and associated star cluster, NGC 281 and IC 1590. As with many deep sky objects there is much confusion around their catalogue designations. *Sky Atlas 2000.0*, *Uranometria 2000.0* and the *Millennium Star Atlas* all refer to NGC 281 as a cluster and nebula, whereas NGC 281 is actually the nebula and the associated cluster is IC 1590. This is fully explained by Brent Archinal and Steven Hynes in their book *Star Clusters* (Willmann–Bell, 2003). A further complication is that the *Deep Sky Field Guide to Uranometria* by Cragin, Lucyk & Rappaport (Willmann–Bell, 1993) lists both objects as open clusters, but at slightly different positions, while *Night Sky Observer's Guide* (Willmann–Bell, 1998) lists IC 1590 in its index but does not mention it on the indexed page, and at the same time again refers to NGC 281 as both a cluster and nebula.

Nevertheless, regardless of the uncertainty surrounding their cataloguing, these objects are rewarding targets for both the imager and the visual observer. The nebula was discovered by Edward Barnard in 1881 November while he was comet hunting with his 5-inch refractor, and the star cluster was discovered later by Guillaume Bigourdan using the 12-inch refractor at the Paris Observatory.

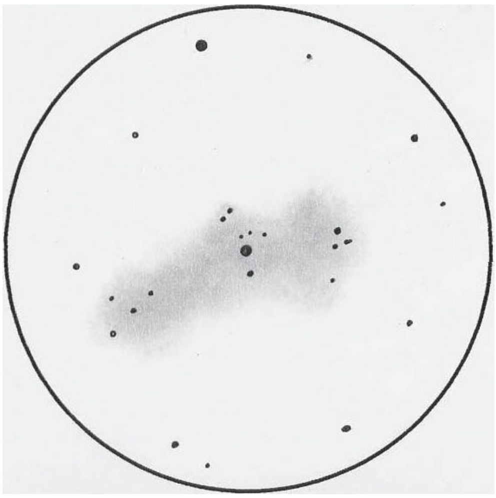

Figure 2. Sketch of the NGC 281 nebula complex by Stewart Moore.

Lying at a distance of around 10,000 light years and at position RA 00h 52.8m and Dec +56° 36' (2000.0), NGC281 is now commonly known as the Pacman Nebula because of its resemblance to the 1980s computer game character.

The nebulosity extends over half a degree – larger than the full Moon – and although it can be difficult to detect visually in small instruments under mediocre skies, it is obvious in instruments of 20cm aperture or more. Paul Brierley's image (Figure 1) clearly shows the Pacman shape. It was taken from his home in Macclesfield, Cheshire using a William Optics ZS66SD f/5.9 refractor and Atik ATK 16ic CCD camera, all mounted on a Losmandy G11 equatorial mount. Total image time was 1 hour (15×240s) through a 13nm H-alpha filter. South is up and west to the left.

Figure 1. Emission nebula NGC 281 with embedded star cluster IC 1590. Image by Paul Brierley.

Although the nebula is littered with stars of varying magnitudes, IC 1590 is the tight, and at first viewing rather poor, cluster of stars surrounding the bright star close to the centre of the nebulosity. It is the ultraviolet radiation from these hot stars that is ionising the nebula and making it visible. Many stars are visible in the cluster at high power, including the multiple star Burnham 1, and it is also possible that some of the other stars superimposed on the nebula are associated with the cluster.

Visually the Pacman shape is not at all clear, the southern extension of nebulosity on the eastern edge of the image being extremely tenuous and not easily detected. Even so this is still a lovely object for the visual observer, with a mottled texture over its surface. Filters do help, and a UHC filter makes the nebula much more obvious against the background sky and also hardens its edge. An OIII filter though, with its narrower pass band, gives a vastly inferior view, the nebulous area appearing smaller and much fainter. A sketch of the nebula and cluster by the Director, through a 35cm f/5 Dobsonian with a UHC filter, is shown here. The field diameter is 42' and the sketch was made under a mag 5.1 sky. The orientation is the same as for the CCD image.

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