Observing the Horsehead Nebula

Generally, popular objects are easy to observe, but one that clearly breaks that rule is the 'Horsehead' nebula (Barnard 33) in Orion. Few deep sky targets can have caused as much heartache over the years as this tiny dark nebula just south of Orion's belt, and yet it is on everyone's observing list. Even photographers found it difficult before the CCD revolution. In 1986 Martin Mobberley guided for 50 minutes on the Horsehead with a 14-inch f/5 Newtonian and managed only the merest hint of the nebula. Now, a few minutes exposure with a 25cm telescope and a CCD camera will give an image reminiscent of those from the 200-inch Hale telescope that graced popular science books of the 1950s. Recent images submitted to the Section have been by David Arditti, Peter Carson, Cliff Meredith, Martin Mobberley, Gordon Rogers and Bob Winter.

The exact details of the discovery of the Horsehead are unclear, but it appears to have first been noticed in 1888 by Williamina Fleming of Harvard College Observatory, examining a plate exposed by William Pickering. In Dreyer's *Index Catalogue* (1895) the discoverer of the IC434 region (which includes the Horsehead) is listed as Pickering, which is usually taken as meaning William's elder brother Edward, who was Director of the Harvard Observatory. Williamina was a Scottish lady, originally employed by Edward Pickering as a maid. Her ability however was such that despite her lack of scientific training she rose to become a prominent member of the observatory staff.

Photograph of the Horsehead by Geoffrey Johnson, 1988 January. 250mm f/5 Newtonian, 50 minutes, hypered Kodak Technical Pan 2415 film, red filter.

The great American observer Edward Emerson Barnard was intrigued by the Horsehead and first photographed it in 1894 from Lick Observatory. This was the start of much photography and visual observation of these dark objects, and resulted in the Horsehead becoming B33 in his list of dark nebulae (the Horsehead moniker came much later and it is unclear who first gave it its now common name). An account of the Horsehead's discovery and subsequent observation is available online at: **http://home.earthlink.net/~astro-app/horsehead/B33_1.htm.**

Lying at RA 5h 40.9m and Dec –2°

Image of IC 434 and the Horsehead nebula obtained by Gordon Rogers with a Takahashi FSQ 106 guided by a 16-inch RCOS. 80 minutes H-alpha plus 20 minutes each RGB; SBIG ST10 CCD.

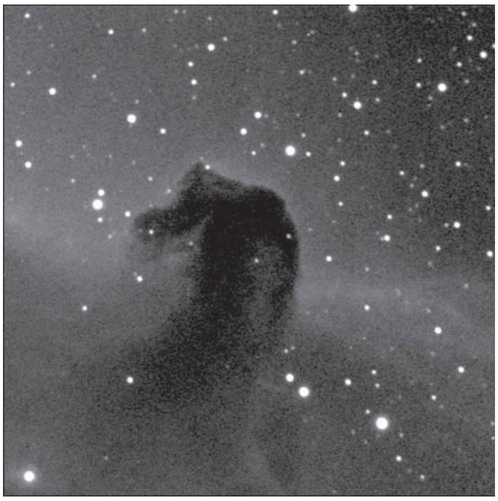


Image of the Horsehead by Martin Mobberley, 2005 January 4 (see text).

28min (2000.0) the Horsehead is a small (5×4 arcmin) dark intrusion in the thin strip of emission nebulosity known as IC434, which extends south from Alnitak (Zeta Orionis), the easternmost star in Orion's belt. The Horsehead lies only 40 arcminutes south of Zeta and it is the glare from this star that adds to the difficulty of observing it. Narrow band filters have revolutionised the observation of emission nebulae and the hydrogen-beta filter is so good on B33 that it is frequently marketed as the Horsehead filter. With its passband centred on the H-beta line at 486.6nm and a band width of only 9nm, it enhances the contrast between the low excitation hydrogen emission from IC434 and the dark nebula intrusion which is the Horsehead. Using this filter can make the difference between seeing it – or at least suspecting it – and not seeing it. As with any challenging visual object pristine skies are preferable along with averted vision and, in the case of the Horsehead, high power. Many people fail because, familiar with the dramatic images they've seen, they look for something much larger than it really is – do not expect it to appear as it does in photographs. Observing with a 635mm telescope and H-beta filter at an altitude of 2,200m on Tenerife in 2006, the Director and Owen Brazell found the Horsehead so easy it could almost have been classed as a showpiece object. Without the filter however it was much more difficult.

As already mentioned, in pre-CCD days photographing the Horsehead was challenging. The image here by Geoffrey Johnson is typical of the better quality photographs obtained at that time. It is a scan of a photograph taken by him in 1988 January. He used a 250mm f/5 Newtonian and guided for 50 minutes on home-hypered Kodak Technical Pan 2415 film through a red filter. The field of view is just over 1°. The bright patch of nebulosity below and slightly to the right of the Horsehead is NGC 2023, a combined emission and reflection nebula around an 8th magnitude star. It lies 25 arcseconds southeast of Alnitak and is a good starting point for visual observers in their quest.

Other images shown here are by Martin Mobberley and Gordon Rogers. Martin's high resolution image was obtained in 2005 January using a Celestron C14 at f/7.7 and a SBIG ST9XE CCD, all mounted on a Paramount ME. Imaging time was 2×180 seconds. All the traditional features are visible, with fine structure displayed in the 'nose' and 'mane'. Gordon's wide field image shows what can be achieved with modern small refractors and provides an interesting contrast with Geoffrey's photograph of a similar field size. The image was obtained through a Takahashi FSQ 106 guided by a 16-inch RCOS. Exposure times were 80 minutes of H-alpha plus 20 minutes each of RGB, all captured on a SBIG ST10 CCD. This image shows stunning detail in the nebulosity surrounding the Horsehead and demonstrates just what an interesting area this is to explore.

One can only wonder what E. E. Barnard, who manually guided on the Horsehead in freezing conditions for up to six hours, would make of such images – all obtained from a warm office rather than a cold observatory.

Stewart L. Moore, *Director, Deep Sky Section*

Forthcoming events on Saturn

One of the most interesting periods for Saturn observers is around the time when the rings appear edge-on. The last time this occurred was in 1995/1996. Since then, the south pole of the planet and the south face of the rings have been tilted towards the Earth. Over recent apparitions, the apparent tilt of the rings has been decreasing towards the next edge-on phase, which occurs during 2009. Once again, the time running up to this edge-on phase and for some time afterwards promises to be yet another fascinating opportunity for amateur observers.

The ring tilt as seen from the Sun (designated by the parameter B') is slowly decreasing and the rings will be edge-on to the Sun on 2009 August 10 (Figure 1).

If the Earth's orbit lay in exactly the same plane as that of Saturn, then the apparent ring tilt as seen from the Earth (designated by the parameter B) would be identical to that seen from the Sun. However the Earth's orbit is tilted by approximately 2.5° to Saturn's orbit. For about half of its orbit, the Earth will be positioned above the plane of Saturn's orbit and for the other half it will be positioned below. Consequently, the apparent ring tilt seen by an observer on the Earth will vary slightly from that seen by an imaginary observer located on the Sun, as shown in Figure 1. To an observer on the Earth, the rings will appear edge-on on 2009 Sept 4. Between Aug 10 and Sept 4, the south face of the rings will still be tilted towards the Earth but this will not be illuminated by the Sun.

Unfortunately conditions for observing both of these edge-on events are unfavourable as they occur very close to solar conjunction. Even on August 10, Saturn will only be 10° above the horizon at sunset and will set approximately one hour after the Sun (for a UK observer at 52°N, 0°E). For those observing from southern latitudes, the ecliptic makes a steeper angle to the horizon and so Saturn will be much higher in the sky at sunset. When Saturn re-appears in the morning skies after solar conjunction, the north face of the rings will be on view.

The best time to observe the rings at a very narrow angle will be over the Christmas period this year. At this time, the rings will be tilted towards the Earth at approximately 0.8°.

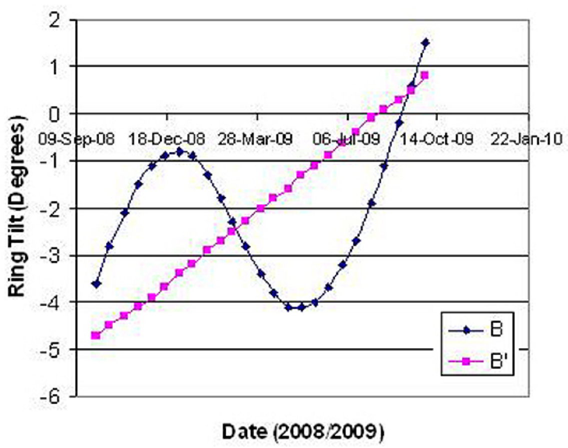
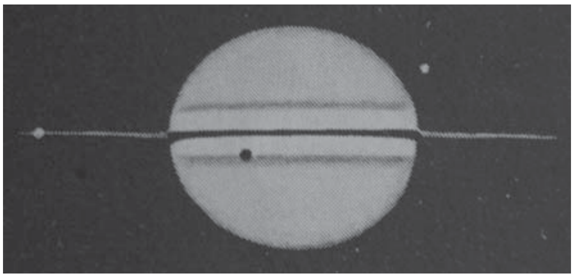


Figure 1. The apparent ring tilt as seen from both the Earth (parameter B) and from the Sun (parameter B') from 2008 October 1 until 2009 October 1. (Positive values indicate the north face of the rings is on view; negative values indicate the south face of the rings is visible).



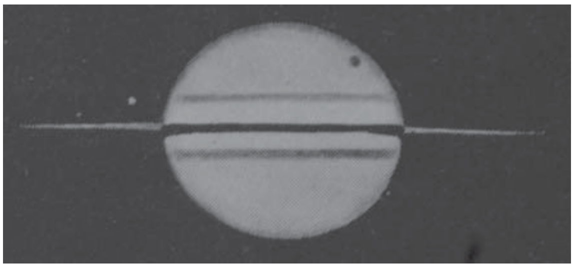


Figure 2 *(top)*. 1980 January 13, 01:15 UT, 320mm refractor. Drawing by Richard McKim showing Titan's shadow on the disk projected against the North Equatorial Belt. Titan itself is following the planet. (South is uppermost).

Figure 3 *(below)*. 1980 January 13, 03:30 UT, 320mm refractor. Drawing by Richard McKim made after Figure 2. Titan's shadow has moved off the disk and Titan itself is in transit on the South Polar Region.

The tilt will then increase to a maximum of approximately –4.1° in early May and then reduce again towards the edge-on phase (Figure 1). It will be interesting to record the appearance of the rings throughout this period, particularly when the tilt is small.

Throughout the remainder of 2008 and during early 2009, the south face of the rings will be tilted at a greater angle towards the Sun than towards the Earth (Figure 1). As a result, the ring shadow on the globe will appear as a dark band crossing Saturn and will lie north of where the rings cross the globe. This ring shadow will become narrow and difficult to see in late February/early March. It will then appear to the south of where the rings cross the globe.

Eclipses, occultations and transits of Jupiter's four major satellites are interesting events to watch and can be observed with relatively small telescopes. Moreover such events occur regularly during each apparition of Jupiter. However such phenomena for Saturn's major satellites are far less common. This is a very simplified explanation of why this is so.

All of Saturn's major satellites, from Titan inwards, orbit the planet with small inclinations relative to the plane of the planet's equator and hence the plane of the rings. As a result, the apparent tilt of these orbits as seen from the Earth is closely matched to the apparent tilt of the rings. The orbits of the satellites will appear to cross in front of or behind Saturn's disk only when the apparent tilt of their orbits is sufficiently small. Then occultations and transits can occur when the satellite is in conjunction with Saturn. Such conditions only exist for a few years either side of the time when the rings appear edge-on. At other times no occultations or transits can take place.

The exception amongst Saturn's major satellites to this very simplified explanation is Iapetus. The orbit of Iapetus is tilted by less than 15° to the planet's equator. Occultations and transits of this satellite take place approx. two years prior to the edge-on phase (such as in early 2007).

From the current month (2008 October), a series of eclipses, occultations and transits of Titan will commence and the series will last into 2010. The first event will be on Oct 19 but this is not visible from the UK.

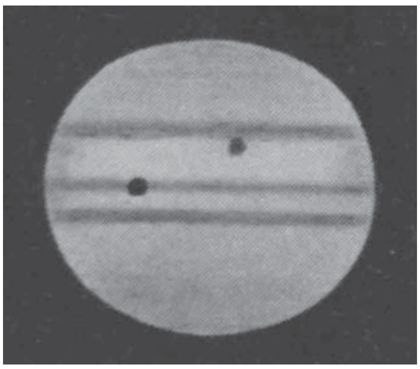


Figure 4. 1980 February 29, 22:45 UT, 300mm Newtonian. Drawing by Alan W. Heath showing Titan and its shadow in transit. The rings were nearly edge-on at the time of this observation and so were not visible.

The angular size of Titan and its shadow is sufficient to allow their transits to be observed even with relatively small telescopes. Titan's shadow will appear as a very dark spot during transit and Titan itself will also appear dark when it has moved onto Saturn's disk, as shown by previous observations of these events (Figures 2 to 4).

Details of all the Titan events are given in the BAA *Handbooks* for 2008 and 2009. Predictions for the larger satellites including Titan can also be derived using the *WinJupos* programme (a freeware download from **http://jupos.privat.t-online.de/index.htm)** or similar software.

Until the rings are edge-on, the occultations of Titan will occur behind Saturn's southern hemisphere, whereas during transit, Titan and its shadow will be projected against the planet's northern hemisphere.

As with the other satellites, Titan's shadow will enter transit before Titan itself when the transit occurs before opposition. After opposition, this order will be reversed. Titan's orbital distance is such that Titan and its shadow may not be simultaneously visible against Saturn, particularly if the transit occurs around the time of quadrature. Examples of this effect are shown in Figures 2 and 3.

As noted above, Earth's orbit is inclined to that of Saturn. If a transit occurs when Earth is not close to the plane containing Titan and the Sun, then the track of Titan's shadow across Saturn's disk will appear displaced relative to the track of Titan, such as shown in Figures 2 to 4.

If the transit or occultation of Titan is central across Saturn's disk, then this can take approximately six hours to complete.

UK observers will be able to see Titan reappear from occultation on Saturn's following limb on a number of occasions from 2008 November until 2009 January. In all of these cases, the associated disappearance behind Saturn will not be visible from the UK as Saturn will be below the horizon at the time. The reappearance events on the nights of Nov 12/13 and Jan 31 will occur shortly after Saturn has risen. Saturn will be much higher in the sky for the reappearances on the nights of Nov 28/29, Dec 14/15, Dec 30/31 and Jan 15/16. Dione and its shadow will be in transit when Titan reappears from occultation during the early hours of Nov 29. Similarly, Mimas and Enceladus will be in transit when Titan reappears from occultation on Jan 16.

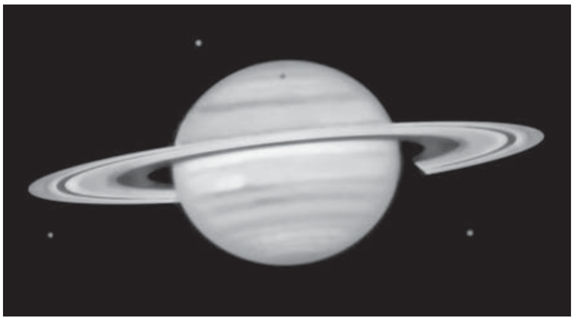


Figure 5. 1994 December 19, 17:00 UT, 415mm Dall–Kirkham Cassegrain. Drawing by David Gray showing the shadow of Rhea on the South Polar Region near the central meridian. Rhea itself is preceding the planet.

Unfortunately for UK observers, the circumstances for observing transits of Titan are poor. The end of a transit will be visible on the nights of Dec 6/7, Dec 22/23 and Jan 7/8. However all of these events occur very shortly after Saturn has risen and the planet's altitude will be less than 5° (based on an observer located at 52°N, 0°E). Otherwise no transits will be observable from the UK

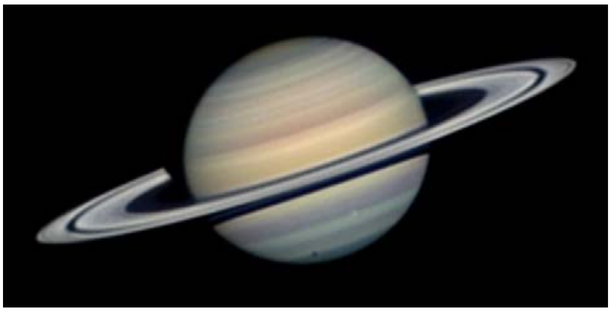


Figure 6. 2007 December 10, 07:38 UT, 355mm Schmidt–Cassegrain. Image by Damian Peach showing Tethys and its shadow in transit. Tethys appears on the north edge of the North Equatorial Belt following the central meridian. The shadow appears near the north preceding limb against the North Polar Region.

but observers in other parts of the world will be better placed to see these events.

Shadow transits commence on 2009 February 24, and on this date, the shadow will appear to the north of Titan and close to the north limb. The situation is reversed for the transit on March 12. In this case, Titan skirts along the northern limb with its shadow further to the south. Thereafter only shadow transits occur and transits of Titan temporarily cease until July 17. The track of the shadow moves southwards for successive transits over this time and during August appears south of the projection of the rings onto the globe. After Aug 19, no more transits occur until 2010 April, although shadow transits still occur over this time.

From 2009 March, Titan will undergo a number of eclipses in Saturn's shadow.

From the end of 2007, conditions have been sufficient for the satellites from Dione inwards to undergo occultations and transits, although the Dione events temporarily ceased from 2008 February until July. These events, plus occultations and transits of Rhea, will continue during the current apparition. Rhea is Saturn's second largest satellite but is less than a third the size of Titan. Consequently, visual observation of Rhea in transit has been challenging even when using a large amateur telescope (Figure 5). The other major satellites are even smaller, but recently, amateurs have been able to record transits of Tethys using digital imaging techniques (Figure 6). Over the coming months it will be interesting to see what telescope sizes are required to observe a given satellite in transit.

There will also be a number of close conjunctions between the various satellites. Predictions of the conjunctions between Saturn and Rhea are given in the BAA *Handbook*. However conjunctions between other satellites have still to be investigated and details will be published when known.

One benefit of the low ring tilt is that the glare of the rings around the planet will be considerably reduced. This will make the detection of the inner satellites, Enceladus and Mimas, much easier.

The low ring tilt over the coming months also means that the inner satellites will appear in approximate line with the major axis of the narrow rings. This will be particularly noticeable around Christmas this year when the apparent ring tilt will be small. The satellites will appear very close to the rings when they are at the relevant positions in their orbits.

Some interesting satellite groupings will also occur and probably the most significant takes place on 2009 Jan 31 at 07:00 UT. Here, Mimas, Enceladus, Tethys, Dione and Titan will be grouped in an 8 arcsecond area of the sky. This event will be visible to UK observers as Saturn will be over 20° above the horizon at the time.

Although the conditions for observing the edge-on phases of the rings are unfavourable, and little will be seen of the Titan transits from the UK, there will still be many interesting events to be observed, whether by visual means or by digital imaging techniques. At the time of the last ring plane crossings in 1995/1996, amateur digital imaging was very much in its infancy, so the coming months will give many amateurs their first opportunity to image these relatively rare events. Observational reports of these events will be welcomed by the Saturn Section.

I would like to thank Val White for providing the data on Saturn's satellites used in the BAA *Handbook* prior to publication, and Richard Miles for pointing out the close grouping of the satellites on 2009 Jan 31.

Mike Foulkes, *Director, Saturn Section*

A convenient and garden-friendly telescope cover

When I moved to my present house eleven years ago I built a summerhouse which became the 'observatory.' In it I kept the telescope, a 200mm LX200, and the computer on which to download the images acquired. To use the telescope it was necessary to carry it out and place it on a pier and clamp it in place, then connect the power and computer cables etc. Over the last couple of years I have found this increasingly difficult and tiresome and was looking for a way of making the whole operation more agreeable without the expense of a second building.

The appearance of the garden is as important to me, and my wife, as is the need for a decent telescope. So whatever I was to construct needed to blend in and after much thought I came up with a design for a dummy dovecote to cover the instrument. After consulting the Yellow Pages in the 'glass fibre' section I contacted a company called 'Artistic Solutions'. The name alone gave some cause for confidence. A telephone call was made, and a drawing posted off to them. The company agreed to construct the dovecote and produced an estimate that was half what I was prepared to pay.

When installed the telescope cover is very user friendly. The power and computer cable are permanently connected and all that is necessary is to remove the three sections, and for some operations only the two top sections need to be removed. The only thing I had to build was a step device to enable me to remove the top two sections.

I chose a dummy dovecote, but now wonder what other shapes would enhance the garden if only I had the imagination!

Geoffrey Johnstone