Uranus 2014 Apparition: An Interim Report of the BAA Saturn Section

Due to its small angular size, Uranus is a very challenging object to observe for both visual observers and imagers alike; even when using large amateur telescopes.

Although the disk can be observed with relatively small instruments, the detection of any disk features, if present, is much more difficult.

Any markings tend to be faint and close to the limit of resolution, which sometimes makes the interpretation more difficult. In addition, the appearance of features does seem to vary according to the filter used and such features tend be more visible when longer wavelength filters are used.

When observing visually, care must be taken that features are not illusory. Care must also be taken not to over process images as this may introduce artefacts.

Despite these challenges, amateur observations during the latter half of 2014 have not only detected belts and zones but have also detected storms in the planet's atmosphere.

This interim report presents the Uranus observations made during the period from mid-July until mid November of the 2014 apparition as reported. A detailed assessment will be made in the related apparition report.

Opposition occurred on October 7 when the planet's disk had an angular size of 3.6" and the planet's northern pole was inclined towards the Earth by 26.5° as shown in Figure 1.

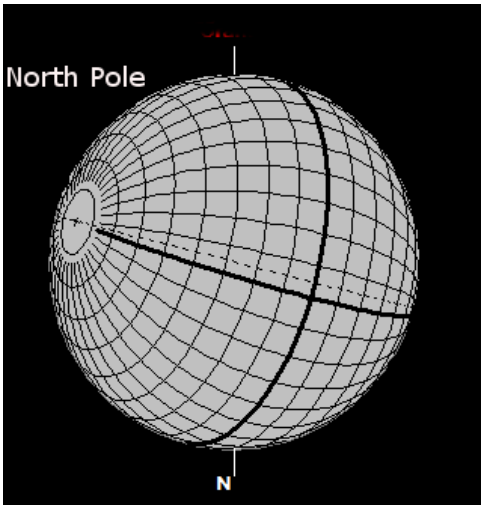

Figure 1. Polar Axis Orientation. This shows the orientation of the North Pole of Uranus relative to the north point on the sky at opposition on October 7 at 22:00. This also shows the location of the planet's equator. This figure was generated using the WinJUPOS software.

All figures in this report have been orientated to approximately match the orientation shown in Figure 1 except where noted.

At the time of writing this report, the following observers provided observations: Paul G. Abel (UK), Michael Andrews (UK), Kevin Bailey (UK), Marc Delcroix & F. Colas (France at the Pic Du Midi Observatory), William Diffin (UK), Mike Foulkes (UK), Bernd Gährken (Germany), David Gray (UK), Rik Hill (USA), Manos Kardasis (Greece), Stanislas Maksymowicz (France), Paul Maxson (USA), Darryl Milika & Pat Nicholas (Australia), Andrew Robinson and Alan Marriott (UK), John Sussenbach (The Netherlands), Graham Taylor (UK using the Bradford Remote Telescope) and Anthony Wesley (Australia). The observations were a mixture of visual and digital images.

Marc Delcroix kindly provided details of his images taken with F. Colas at the Pic Du Midi observatory. He also provided by e-mail details of the infrared images taken by the following French amateur observers: Régis De-Bénedictis, Pascal Bayle, and Yann Le Gall.

Many observations showed some form of belt and zone structure although a few observers recorded a blank disk.

Some typical amateur images taken over this period using differing infrared filters is shown in Figure 2.

Professional infrared observations have shown that the appearance of the planet varies according to the wavelength of the filter used. So some differences in the amateur infrared observations is to be expected and a direct comparison between the observations made at differing wavelengths may not be possible. However they generally show a darker broad belt extending from near to the planet's equator into mid northern latitudes. Its northern and southern edges are marked by brighter zones with the northern zone appearing brighter. Images by Milika & Nicholas often show a darker belt at high northern latitudes and a dark belt at mid southern latitudes.

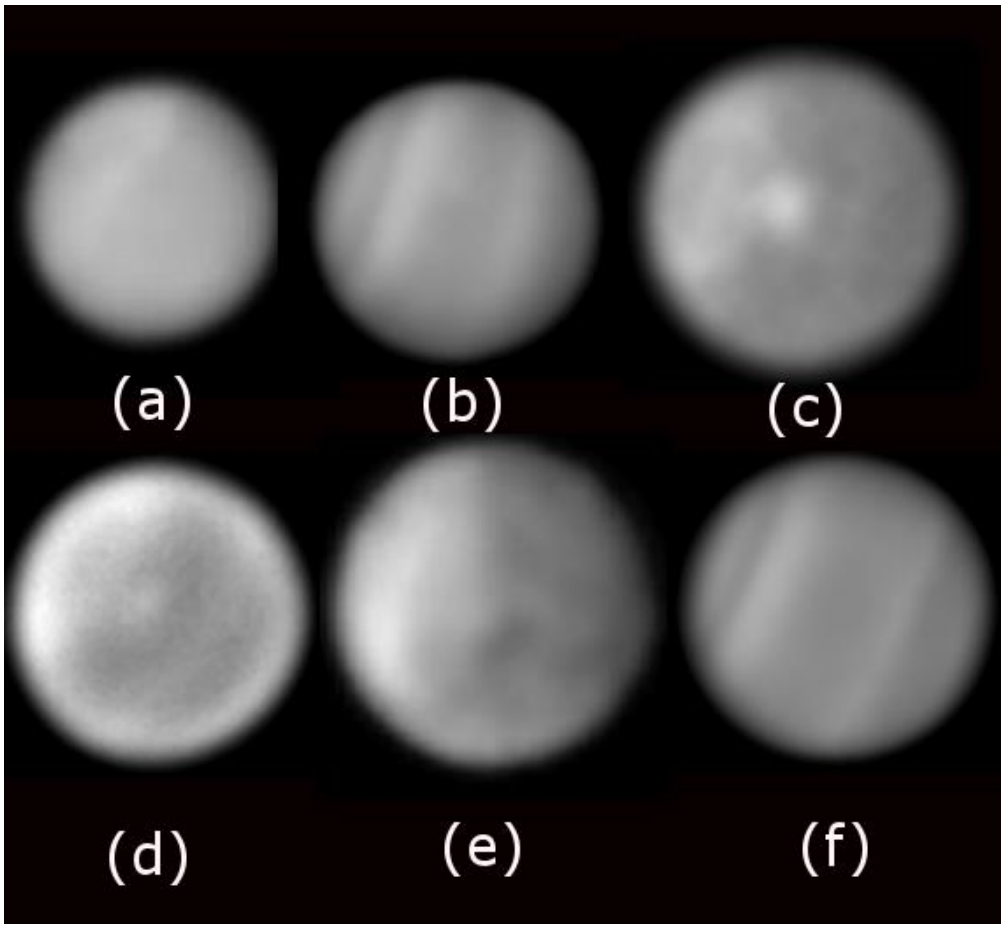

Figure 2. Infrared imaging observations.

Figure 2(a). 2014 Sep 08d, 00h 18m UT. CM= 158.7. 279mm Schmidt-Cassegrain. Bader IR long pass filter. (Sussenbach). This shows the bright region in the northern hemisphere with some shading within this region closer to the north pole.

Figure 2(b). 2014 Oct 02d, 14h 08m UT. CM= 214.5. 356mm Schmidt-Cassegrain 610nm filter. (Milika & Nicholas). This shows a faint spot near the Central Meridian which is identical to that shown in Figure 3(c)

Figure 2(c). 2014 Oct 02,15h18.8m UT. CM= 239.4. (Wesley). IR filter in the range 650 to 850nm. This shows a bright storm in the northern hemisphere plus a lighter region in the northern hemisphere and two darker broad belts. (This observation was also reported by David Arditti in the News Section of the BAA web site).

Figure 2(d). 2014 Oct 04d,00h 52.7m UT. CM= 220.2. 1060mm Cassegrain. IR filter > 685nm. (Delcroix and Colas) This shows a brighter storm feature in the northern hemisphere plus two broad darker belts.

Figure 2(e). 2014 Oct 10d, 22h 30m UT. CM= 78.7. 800mm Schiefspieler. IR ,Pass filter (Gährken). This shows the bright region in the northern hemisphere.

Figure 2(f). 2014 Oct 28 13h 50m UT. CM= 278.4. 356mm Schmidt-Cassegrain 610nm filter.(Milika & Nicholas).

Some typical visual observations are shown in Figure 3. There some differences but a darker band running from the equator to mid-northern latitudes flanked on its northern and southern edges is often shown.

Robinson recorded a dark northern hemisphere belt on September 29 when using a large 600mm Newtonian (Figure 3 (d)). This was independently confirmed by Marriott using the same telescope.

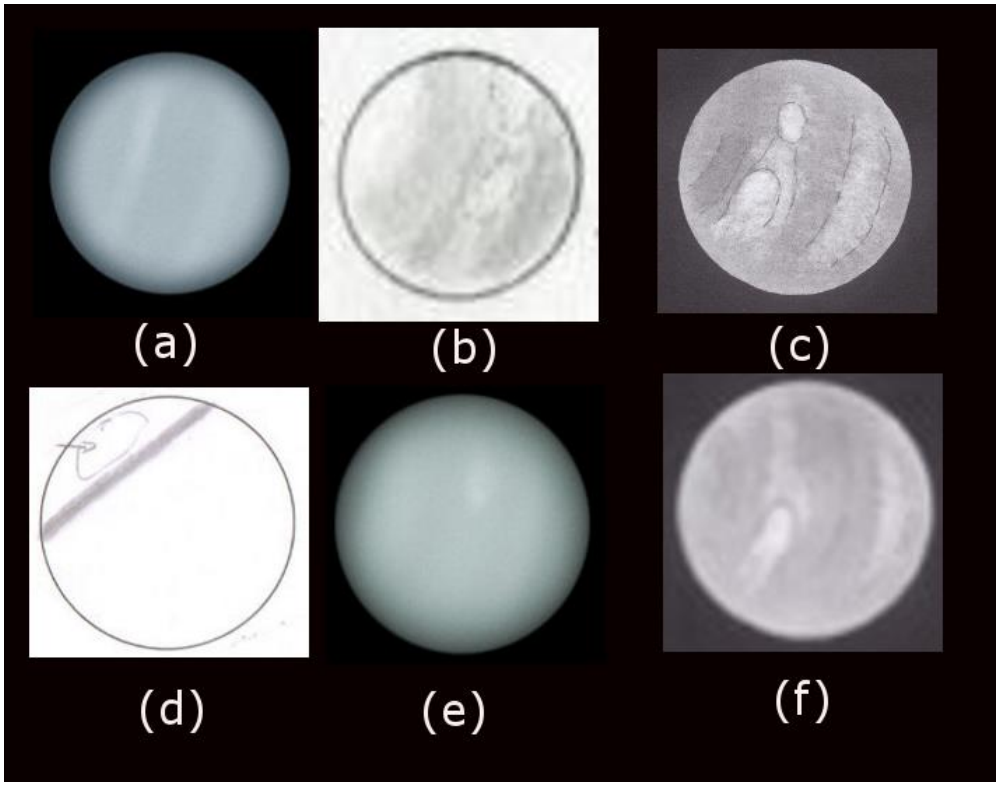

Figure3. Visual observations.

Figure 3(a). 2014 July 22d, 02h 50m UT. CM= 253.6. 415mm Dall-Kirkham (Gray).

Figure 3(b). 2014 Aug 14d, 02h 25m UT. CM= 252.3. 254mm Cassegrain (Maksymowicz). Brighter region near the Central Meridian.

Figure 3(c). 2014 Sep 08, 01h 00m UT. CM= 152.4. 254mm Newtonian (Bailey). Brighter patches with intensities exaggerated for clarity. Compare to Figure 2(a) which was made 42minutes earlier.

Figure 3(d). 2014 Sep 29d,01h 30m UT. CM= 247.4. 500mm Newtonian (Robinson). Dark belt in the northern hemisphere.

Figure 3(e). 2014 Oct 01d, 22h 25m UT. CM= 246.5. 415mm Dall-Kirkham (Gray). Light spot near the Central Meridian..

Figure 3(f). 2014 Oct 04 22h 05m UT. CM= 303.0. 254mm Newtonian (Bailey). Brighter patch near the Central Meridian with intensities exaggerated for clarity.

The significant event of this period was the detection of a number of bright storms in the atmosphere of Uranus by professional observers.

On August 5 and 6, observers at the Keck II observatory in Hawaii recorded a number of bright storms in the atmosphere of Uranus as shown in Figure 4.

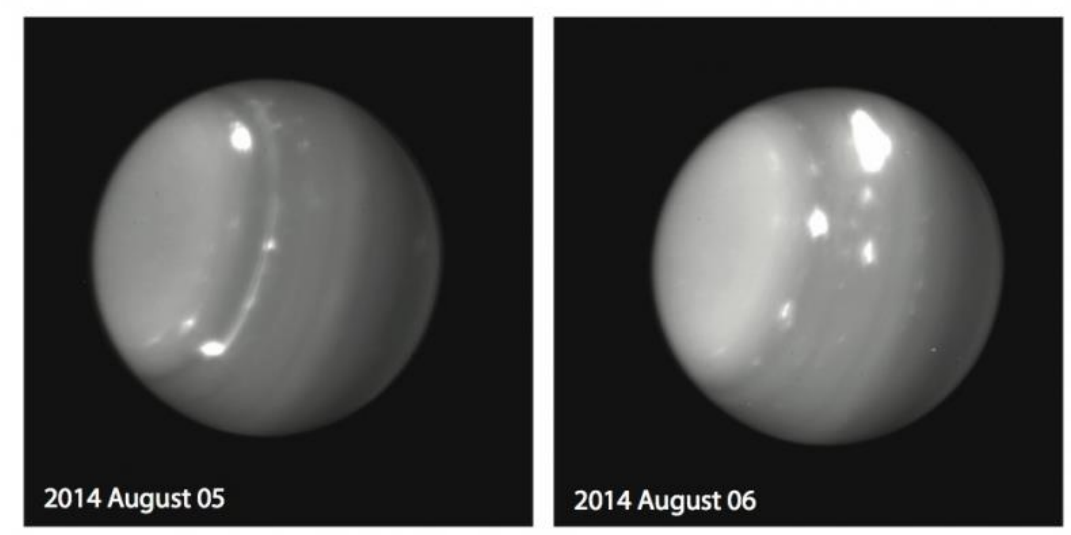

Figure 4. Images of Uranus taken by Imke de Pater (UC Berkeley), Larry Sromovosky and Pat Fry (U. Wisconsin), and Heidi Hammel (AURA). 10 m Keck II telescope with adaptive optics. Near infra-red camera NIRC2 operating at a wavelength of 1600nm. © Keck Telescope. The August 05 image was taken at ~ 12:30UT but the time of the August image is not yet available.

These storms appeared at several latitudes in the planet's northern hemisphere, although the August 6 image shows some smaller fainter spots close to or just south of the planet's equator. The largest and brightest storm appeared in the image taken on August 6 and had a latitude of approximately 17°N.

Observations taken over the following few weeks also showed storm activity but unfortunately the times when these all of these images were taken are currently not available. Consequently the Central Meridian longitude and hence the longitudinal positions of these storms cannot yet be derived and hence cannot yet be compared with the amateur observations described below.

Apart from the new storms, the Keck images also showed part of the northern hemisphere to be much lighter than the rest of the planet. This lighter region extended from the north pole to an approximate latitude of 45°N. Within this there was lighter region (which included some small storms) which extended from an approximate latitude of 55°N to 45°N. Further south, there were a series of darker belts and lighter zones extended to just north of the equator (approximate latitude of 5°N. A prominent darker belt lay south of the equator from approximately 2°S to close to the southern limb.

Elements of this storm have also been detected by amateurs in infrared images taken at shorter wavelengths than the Keck observations.

A distinct white spot has been recorded in the planet's northern hemisphere in amateur infrared images taken at shorter wavelengths than the Keck image, i.e.: on September 11 by De-Bénedictis, on September 27 by Bayle & Le Gall, on October 2 by Wesley (Figure 2(c)) and on October 4 by Delcroix & Colas (Figure 2(d)).

All of these observers produced a series of individual images on the nights they observed. These images showed that the bright spots moved with the rotation of the planet, therefore confirming the reality of these objects rather than being due to processing artefacts.

Wesley also produced an animation lasting from 14:40.6 UT to 16:13.0 UT on Oct 2. This animation is shown on both the main BAA and the Saturn section's web sites. Just over an hour before the Wesley observation, Milika and Pat Nicholas took a single image of the planet using a shorter wavelength

filter than used by Wesley (Figure 2(b)). This show a faint spot which we believe is identical to that observed by Wesley.

The WinJUPOS software was used to derive the spot latitude and longitudes from the above observations. These are shown in the following table.

DATE	OBSERVERS	LATITUDE	LONGITUDE
September 11	De-Bénedictis	35°N	272°
September 27	Bayle & Le Gall	33°N	340°
October 2	Milika & Nicholas	30°N	232°
October 2	Wesley	28°N	239°
October 4	Delcroix & Colas	34°N	223°

The positions for the French observations were kindly provided by Delcroix and other observations were measured by us (provisional values).

The observations made in early October are likely to be the same feature but the measurements differ in both latitude and longitude. This illustrates that the measurements are likely to have large uncertainties resulting from the following factors:

- The small angular size of the planet resulting in small image scales and which also makes the positioning of features on drawings more difficult.
- Uncertainty in the orientation of the image or drawing on the sky. This can lead to uncertainty in positioning the WinJUPOS measurement frame relative to the planet's poles.
- Uncertainty in the detection of the true limb of the planet for images.

Indeed Delcroix gives an uncertainty of ±5° in his measurements. This uncertainty makes the interpretation of the above observations more difficult, i.e. are these observations of a single storm or several storms.

Interestingly Gray also observed the planet visually on Oct 1 under good seeing. His first drawing (Figure 3(e)) shows a lighter object at approximately the same latitude as October infrared images described above. A subsequent observation using a red filter at 23:05 UT with a red filter shows this object had moved with the rotation of the planet. Gray is a very experienced visual observer and used a large (415mm) aperture telescope. However the drawings indicate a longitude ~15° - 20° f. the spot observed on Oct 2..

Earlier on August 14 (Figure 2(b)) and on August 16, Maksimowicz recorded a light patch at a similar latitude and longitude ~ 250°.

Infrared images taken by Kardasis, Maxson and Gährken (Figure 2(e)) also show brighter areas in the northern hemisphere, although, as single images, they do not show the movement of the spots with the planet's rotation.

Some other brighter regions in the northern hemisphere have been reported by other visual observers.

On July 17, Gray reported a brighter patch at an approximate longitude of 255° and a similar brightening (intensity 2-3) was recorded at approximately the same longitude on July 22 by both Gray and Bailey and again on August 24 (Bailey). Diffin reported a brighter region on Aug 20 but his subsequent observations show nothing similar.

From the end of August until early October, observations made by Bailey, Gray and Maksymowicz recorded brighter areas at approximately the same longitude as the Bayle & Le Gall observation described above.

Clearly more analysis is required of these and any subsequent observations and this will be addressed in related apparition report. .

In addition to the planet itself, images taken by Andrews, Bailey, Milika & Nicholas, Sussenbach and Taylor were able to record one or more of the satellites Ariel, Oberon, Titania and Umbriel. In addition,

Milika and Nicholas were able to record Miranda on November 9,. A typical observation is shown in Figure 5.

Figure 5. 2014 Oct 26. 03h 24m UT 356mm Schmidt Cassegrain (Bradford remote Telescope (Image by Taylor). Prime focus image showing four of the satellites of Uranus. North is upwards.

The Moon and Uranus were in close conjunction on September 11 and this event was observed by Sussenbach (Figure 6).

Figure 6. 2014 Sep 11. 127mm Schmidt-Cassegrain.(Image by Sussenbach) This shows the conjunction of Uranus with the Moon. North is upwards. The motion of Uranus relative to the Moon is shown. (Left at 01h 27m UT. Middle at 01h 27m UT. Left at 01h 37m UT).

Kevin Bailey (Section Uranus co-ordinator) and Mike Foulkes (Section Director)