Neptune in 2014–’15

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Observations of Neptune, obtained both visually and by imaging in 2014 and 2015, are presented. In both years, long-lived bright atmospheric features on the planet were detected. For 2015, the daily drift of a major bright storm over a period of four months was determined.

Introduction

Since the demotion of Pluto to a dwarf planet, Neptune is the outermost planet in the solar system. For amateurs, it is a difficult object to study because of its small diameter of only 2.4 arcseconds. A telescope with a large aperture is required to visually observe the disc of the planet, but detection of its large satellite Triton is relatively easy in medium-sized telescopes due to its brightness of magnitude +13.5. For astrophotographers, recording Neptune and Triton is a challenge. In general, no details on Neptune are visible, except that the southern hemisphere is sometimes slightly brighter than the northern (Figure 1).

The visit of *Voyager 2* to Neptune in 1989 brought a major breakthrough in our understanding of the planet. This spacecraft discovered dark and bright storms, which are sometimes very stable. It also became clear that there are very rapid atmospheric motions. In the Equatorial Zone atmospheric streams rage continuously at a speed of 1,200km/h or more, and the rotation period decreases towards the pole.

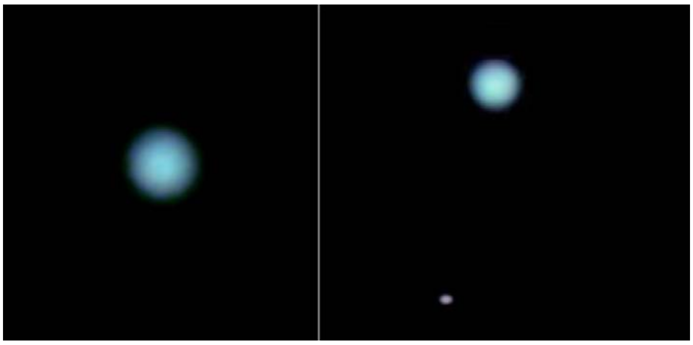

Figure 1. Neptune and Triton. RGB images; north up. ***Left:*** 2015 Jul 15. *S. Kidd.* ***Right:*** 2014 Sep 27. *J. Sussenbach*

Neptune in 2014

In 2014 Neptune was located in Aquarius and was at opposition on Aug 23. The number of Neptune observers in 2014 was very limited and the observations submitted were scarce. A list of the observers, their locations and their instruments is presented in Table 1.

Most observers show Neptune as a tiny bluish disc without details, with the major satellite Triton as a bright dot (Figures 1 & 2). However, on 2014 Oct 7, Anthony Wesley reported the presence of a bright spot using a 610nm longpass filter. Using the *WinJUPOS* program,[1] the coordinates of the spot were determined. It was located at longitude 138°, latitude 42°S and was shown to rotate with the Neptune globe (Figure 3). Measurements on a tiny disc are rather difficult and errors of ±5° and more occur easily. Since observations of the bright spot were very limited in number, no further analysis of its development could be performed.

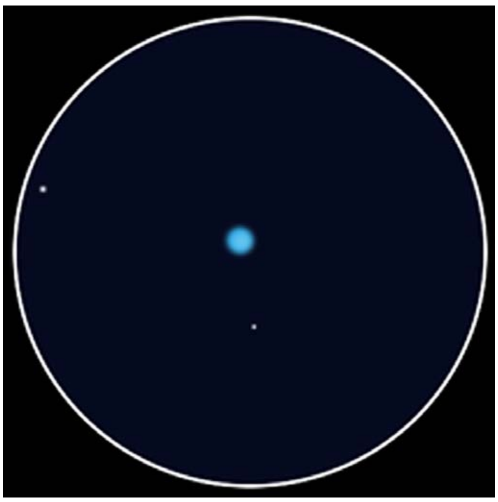

Figure 2. Drawing of Neptune and Triton (approximately at the six o’clock position) on 2015 Sep 22, 00:04–00:11 UT. The field of view is 0.19°. 203mm Newtonian reflector, ×312. Seeing: AII. *P. Abel*

Neptune in 2015

In 2015, Neptune was still located in Aquarius and was at opposition on Sep 1. An interim report of the 2015 apparition was published previously.[2] Fortunately, the number of observers submitting images of Neptune was much higher in 2015 (Table 2). This was mainly due to an initiative of the professional planetary astronomer Ricardo Hueso Alonso. On 2015 Jul 13, Hueso and his colleagues at Escuela Técnica Superior de Ingeniería in Bilbao, Spain discovered a bright spot at latitude 41°S with the 2.2-metre telescope of the Calar Alto Observatory.[3] The spot was named Spot A. Later, some minor bright spots were also detected.[3] Hueso invited amateur astronomers around the globe with larger amateur telescopes

Table 1. List of observers in 2014

Name	*Observing location*	*Visual (V) or imaging (I)*	*Instrument*	*Camera*
Michael Andrews	Laindon, Essex, UK	I	279mm SCT	ASI120MC
David Gray	Kirk Merrington, Durham, UK	V	415mm Dall–Kirkham	–
John Sussenbach	Houten, Netherlands	I	279mm SCT	QHY5LII
Graham Taylor (Tenerife, Canary Islands)	Bradford Remote Telescope	I	357mm SCT	Microline E2V
Anthony Wesley	Murrumbateman, Australia	I	406mm Newt.	Grasshopper 3

Instrument abbreviations: SCT = Schmidt–Cassegrain (Telescope); Newt. = Newtonian reflector.

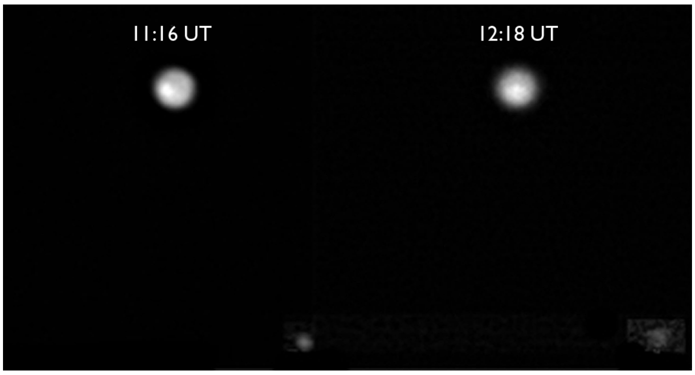

Figure 3. Neptune on 2014 Oct 7. North up. Triton is present at the bottom of the images. At 11:16 UT, CM = 110°; at 12:18 UT, CM = 133°. *A. Wesley*

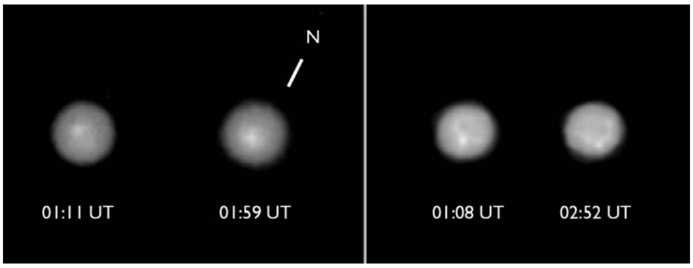

Figure 4. ***Left:*** Neptune on 2015 Jul 20. *J. Sussenbach.* CM = 265.1° at 01:11 UT and 283.0° at 01:59 UT. ***Right:*** Neptune on 2015 Aug 1. Combination of images by J. Sussenbach (CM = 220.4° at 1:08 UT) and W. Kivits (CM = 259.1° at 2:52 UT). North is up.

to investigate whether the bright spot could be detected with their instruments.

On 2015 Jul 20, Sussenbach detected a bright spot on Neptune in the vicinity of the predicted position at the central meridian.[4] Comparison of the images of 01:11 UT and 01:59 UT shows that the feature moved with the planet’s rotation (Figure 4). On 2015 Aug 1, Spot A and some minor spots were captured by Sussenbach and Kivits at different points in time. The rotation of Spot A is clearly detectable.

The presence of Spot A was confirmed by several other observers (Maxson, Milika & Nicholas, Miles, Peach and Wesley; see Figure 5). There is also a visual observation of the spot by Maksymowicz (Figure 6).

Spot A remained visible till 2015 December. A second, fainter feature at latitude 20°N, Spot B, was visible in 2015 September and October (Figures 7 & 8). Due to the small size of the planet, this fainter spot was not visible under poor seeing conditions.

Drift of Spot A

Due to the stability and brightness of Spot A, this feature was followed by amateurs and measurements of its changing position allowed the establishment of its drift. The coordinates of the spot on Neptune’s disc were measured in 26 images using *WinJUPOS*. Accurate measurements on a tiny disc are a challenge in itself. A complicating factor is that due to limb darkening and contrast enhancement, very often the apparent disc of the planet is smaller than the actual outline, which causes very inaccurate coordinate values (Figure 9). Figure 9 clearly indicates that the Neptune image is smaller than the outline, whereas the angular distance of Triton to the centre of Neptune is equal.

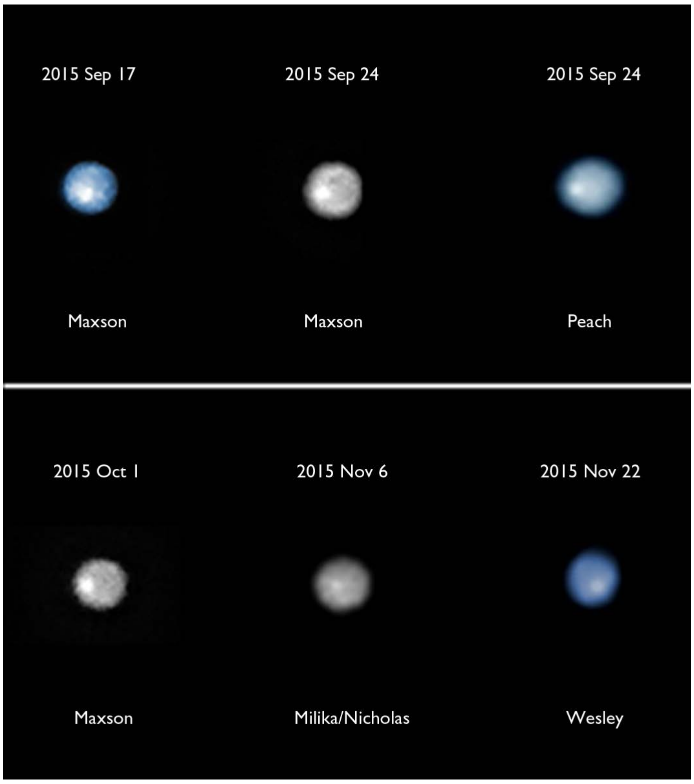

Figure 5. Compilation of images by several observers showing bright Spot A. For all, a 610 or 685nm IR pass filter was used. The blue colour of some images is the result of false-colouring. Maxson – 2015 Sep 17, CM = 329°; 2015 Sep 24, CM = 292°; 2015 Oct 1, CM = 253°. Peach – 2015 Sep 24, CM = 123°. Milika & Nicholas – 2015 Nov 6, CM = 275°. Wesley – 2015 Nov 22, CM = 178°.

By aligning the outline of Neptune and Triton with the image using *WinJUPOS*, the accuracy of coordinate measurements is improved considerably. Since the image scale of Neptune is rather small, the standard deviation of the measured coordinates

Table 2. List of observers in 2015

Name	*Observing location*	*Visual (V) or imaging (I)*	*Instrument*	*Camera*
Paul Abel	Leicester, UK	V	203mm Newt.	–
Abdul Ahad	California, USA (Home loc.: Luton, Beds., UK)	I	0.61m *f*/10 Cassegrain SSO	FLI CCD
Alan Clitherow	Fife, Scotland, UK	I	254mm Newt.	ASI224C
Peter Edwards	Horsham, West Sussex, UK	I	357mm SCT	ASI1244MC
Clyde Foster	Centurion, South Africa	I	357mm SCT	ASI224C
Manos Kardasis	Athens, Greece	I	357mm SCT	DMK 21
Simon Kidd	Cottered, Herts., UK	I	357mm SCT	ASI224
Willem Kivits	Siebengewald, Netherlands	I	357mm SCT	DMK618
Stanislas Maksymowicz	Ecquevilly, France	V	254mm SCT	–
Paul Maxson	Surprise, Arizona, USA	I	315mm Dall–Kirkham	ASI120MM-S
Phil Miles	Rubyvale, Australia	I	Fullum 508mm Tech Mirror	Grasshopper 3
Darryl Milika & Pat Nicholas	Adelaide, Australia	I	357mm SCT	ASI224C
Damian Peach	Selsey, UK	I	357mm SCT	ASI224C
John Sussenbach	Houten, Netherlands	I	279mm & 357mm SCT	QHY5LII, ASI224MC
Anthony Wesley	Rubyvale, Australia	I	406mm Newt.	Grasshopper 3

Instrument abbreviations: as given in Table 1.

is ±5° and sometimes more. The resulting longitude values of Spot A over time are present- ed in Figure 10. From this graph, the drift rate of the spots can be determined. Their combined data yielded a drift of 24.1°/d. This fits reasonably well with the drift of 24.0°/d reported by Sussenbach *et al.* (2017),[4] and a value of 24.27°/d reported by Hueso *et al.* (2017),[3] using a combination of 90 measurements obtained with amateur telescopes and nine obtained with pro- fessional telescopes. The data of Spot B were very sparse. For that reason, no drift rate was established for this spot.

The 24.1°/d drift of Spot A corresponds quite well with the zonal wind velocity on Neptune at latitude 40°S of –89m/s, as measured by *Voyager 2*.[3] Interestingly, the latitude of Spot A is the same as that of a bright spot discovered by Wesley in 2014.

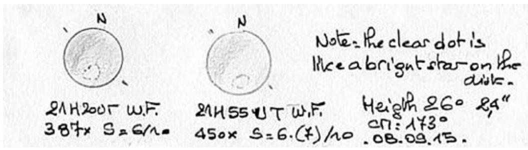

Figure 6. Drawing on 2015 Sep 8. *S. Maksymowicz*

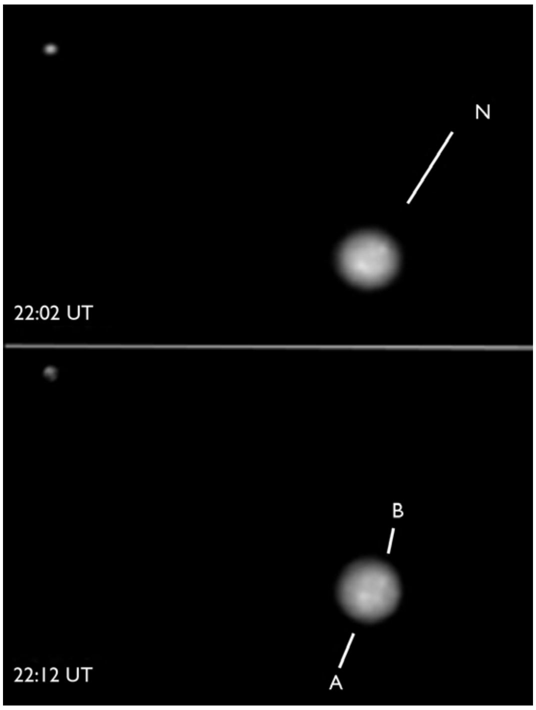

Figure 7. Neptune and Triton on 2015 Sep 10. Spot A as well as Spot B are visible. CM = 181.5° at 22:02 UT and 185.2° at 22:12 UT. A 685nm filter was used. *W. Kivits*

Concluding remarks

It is obvious that detection of albedo features on Neptune is quite a challenge and that it requires a telescope with an aperture of 10 inches or larger. Even then it is not an easy task and good seeing conditions are a requirement. The development of astronomical cameras with high sensitivity for the infrared part of the spectrum was essential for these observations.

In 2014 only a single observer detected a bright spot on Neptune (Wesley), but a year later several observers were able to follow the development of Spot A.

The detected bright spots represent major storms that sometimes develop in the Neptunian atmosphere. The outer atmosphere of the planet contains methane. When astronomical cameras in combination with a Baader red longpass filter (>610nm) are used, that part of the reflectance spectrum of Neptune is captured that covers the methane absorption bands at 619, 727, 862 and 889nm. The deeper the sunlight penetrates into the Neptunian atmosphere, the more light can be absorbed by methane and less is reflected. When high-altitude clouds are present in the atmosphere, they appear as bright spots, because the reflected sunlight does not pass a thick layer of methane-containing atmosphere but is reflected by the high-altitude clouds accompanying the storm.

The reported detection of bright spots by several amateurs demonstrates that these phenomena are also within reach of the amateur community. Even the measurement of the drift of individual spots is possible.

The observation of these features demonstrates that there is great interest from the professional world in amateur observations. The problem that professionals have is that they have limited access to large telescopes and therefore cannot easily carry out long, and frequent, observing runs with these instruments. Amateurs always have access to their own telescopes and if it is cloudy at one location, it is very likely that it is clear at another location, so there is continuity in the observations. The invitation extended by Ricardo Hueso Alonso to the amateur community eventually lead to a paper on the storms on Neptune in 2015, by a combination of professional and amateur observers.[3] We trust that in future the number of pro-am collaborations in planetary imaging will increase, which in turn will stimulate amateurs to improve the scientific quality of their observations.

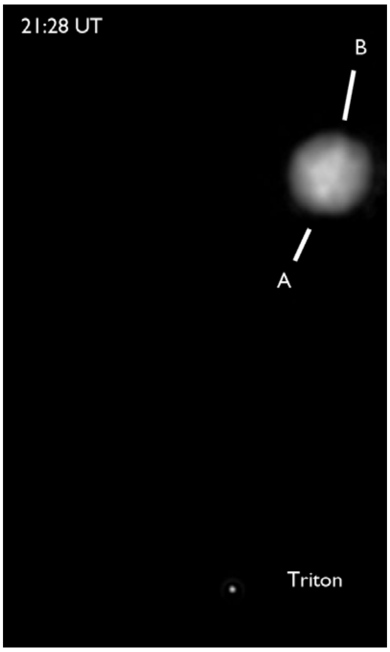

Figure 8. Neptune on 2015 Oct 11, with Spot A and Spot B. CM = 272°. North is up. *J. Sussenbach*

Figure 9. Neptune and Triton (bottom) analysis with *WinJUPOS*. ***Left:*** False-colour image by P. Miles (2015 Nov 10, 10:28 UT, CM = 237°); North is up. ***Right:*** Outline of Neptune and Triton as predicted by *WinJUPOS*.

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References

1 *WinJUPOS* website: **http://jupos.org/gh/download.htm**
2 Foulkes M., 'Interim report – Neptune in 2015', *J. Br. Astron. Assoc.*, **126**(1), 6–7 (2016)
3 Hueso R. *et al.*, 'Neptune long-lived atmospheric features in 2013–2015 from small (28-cm) to large (10-m) telescopes', *Icarus*, **295**, 89–109 (2017)
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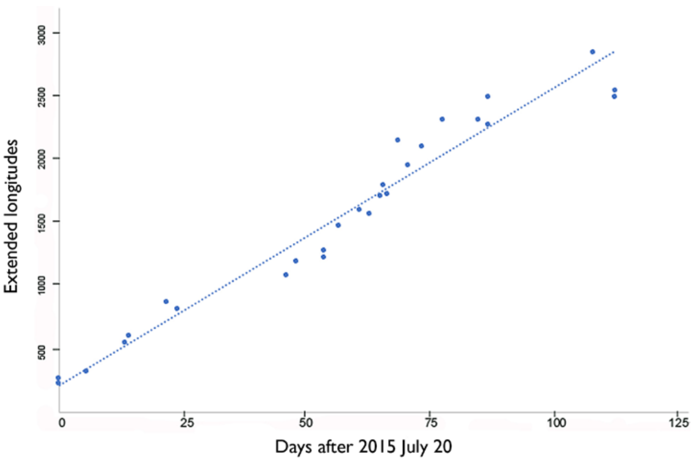
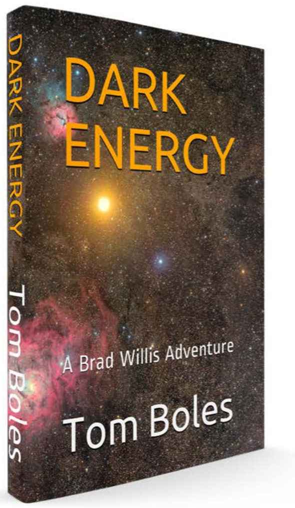


Figure 10. The drift of Spot A was measured by determining the longitude and latitude of the spot in images by Kivits, Maxson, Milika & Nicholas, Miles, Peach, Sussenbach and Wesley, using the *WinJUPOS* measurement tool.[1]

AN ASTRONOMER IS THE HERO



When two explosions occur killing three people, the scientific community is on full alert. The explosions appear to be unrelated. Their only connection is that they happened in scientific centres of excellence in Switzerland and the United States. Brad Willis knows that he must uncover the secret to save more lives from being lost.

MI6 calls on Willis to use his background as an astronomer to infiltrate the site of the Large Hadron Collider to discover the truth behind the claims. When Willis starts to uncover the facts, everyone is under suspicion… until they start dying. The situation gets worse when he uncovers the murders are related to a potential world-changing discovery of a new sub-atomic particle, that has the potential to manipulate commodity markets worldwide.

Written by well-known astronomer, Tom Boles
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