

## Bright features on Neptune in 2015

*John Sussenbach<sup>#</sup>, Willem Kivits\* and Marc Delcroix<sup>+</sup>*

*<sup>#</sup> Houten (The Netherlands)*

*\* Siebengewald, The Netherlands (Deceased 23 February 2016)*

*+ Toulouse (France)*

### 1. Introduction

Since the demotion of Pluto to a dwarf planet, Neptune is the outermost planet in the Solar System. The discovery history of this planet is, and remains, a very special story. It starts with the mathematical analysis of the deviations from predictions of the celestial course of Uranus by Urbain Le Verrier at the Paris Observatory in the first half of the 19<sup>th</sup> century (Fig.1). He carried out calculations in order to identify an unknown planet, which caused these disturbances. On 23 September 1846 these calculations led to the discovery of the planet Neptune by Galle and d'Arrest at the Berlin Observatory about one degree from the position predicted by Le Verrier. Later it turned out that at the same time in the United Kingdom John Adams had also calculated the position of the unknown planet close to its actual position.



*Fig. 1 Statue of Urbain Le Verrier in front of the Observatoire de Paris*

For amateurs Neptune is a difficult object to study because of its small diameter of about 2.4 arcseconds. Even at the highest magnifications Neptune remains a tiny blueish disc without any detail. You need a telescope with a large aperture 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. Also for astrophotographers recording Neptune and Triton is a challenge (Fig.2). In general, no details on Neptune are visible, except that the southern hemisphere is sometimes slightly brighter than the northern hemisphere, as several amateurs have shown.



*Fig. 2 Neptune and Triton 23 September 2009. North is up. (J.Sussenbach). C11 f/20, DMK21AU04 camera and RGB filters*

The visit of Voyager 2 to Neptune in 1989 brought a major breakthrough in our understanding of Neptune. This spacecraft discovered dark and bright storms on the planet, 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 1200 km/h or more and the rotation period decreases towards the pole

On 13 July 2015 Ricardo Hueso Alonso and colleagues (Escuela Técnica Superior de Ingeniería in Bilbao, Spain) discovered a bright spot on Neptune at latitude  $-41^\circ$  with the 2.2 meter telescope of the Calar Alto Observatory (1,2). Later, some other bright spots were also detected (3). He asked amateur astronomers around the globe whether they could detect these features with their telescopes. There have been some amateur observations of features on Neptune in 2013-2014, but the number of observations was scarce (1,2). Although the atmosphere in The Netherlands is often very turbulent two of us (Kivits and Sussenbach) accepted the challenge to detect the feature at latitude  $-41^\circ$ .

## **2. Equipment and Image Processing**

Willem Kivits lives in the Southern part of the Netherlands and uses a 35 cm C14 Schmidt-Cassegrain telescope as well as a 50 cm Newtonian telescope. John Sussenbach lives in the center of The Netherlands and observes with a C14 telescope. By combining our data we were able to compare and refine our observations. In general, these telescopes were used at f/22. Since the initial discovery images of bright spots on Neptune were obtained using infrared (IR) filters we also used filters in the near-infrared (NIR) range (Baader 685nm long pass filters). As for the recording instruments we started with monochromic DMK21AU04 and QHY5LII cameras, but later we used the relatively new ZWO ASI224MC camera. This color camera has a remarkably good NIR sensitivity (Fig.3).

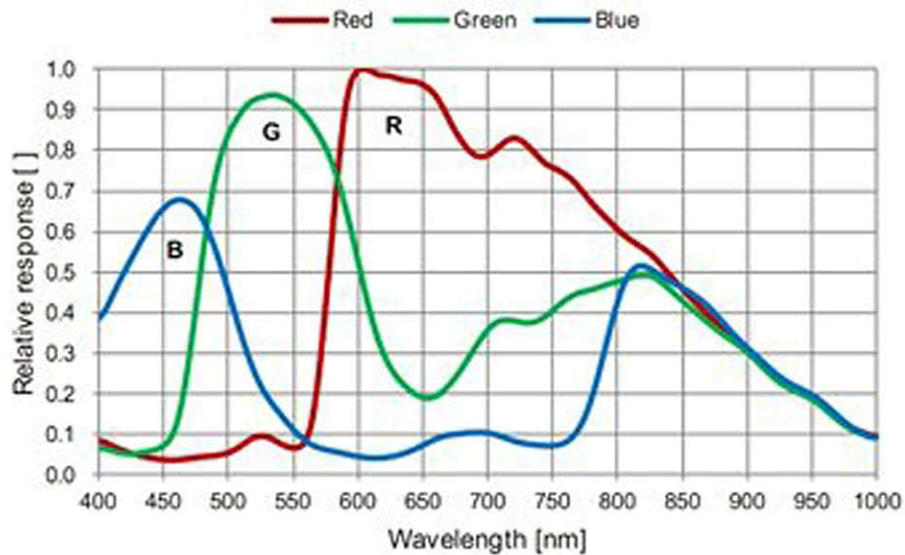


Fig. 3 Spectral sensitivity of an ASI224MC camera (ZWO) according to the manufacturer (4)

Above 800 nm the camera has the same sensitivity in the red, green and blue channels and behaves as a monochrome camera. Most of our images were obtained using 610 and 685 nm long pass filters. AVI's were recorded at a frame rate of 20 frames per second.

The AVI's were processed using centering of the images by Planetary Imaging PreProcessor software (PIPP) (5). For quality selection and stacking of frames, Autostakkert2! (6) and Registax 6.1 (7) were used, and the final processing was performed with Adobe Photoshop CS2.

### 3. Results

#### 3.1 Detection of bright spots

The first opportunity to detect the brightest feature discovered by Hueso and colleagues was 20 July 2015. Processing of the AVI's captured during that night yielded images which show a spot in the vicinity of the predicted position at the central meridian. Comparison of the images of 1:11 UT and 1:59 UT shows that the feature moves with the planet's rotation (Fig.4).

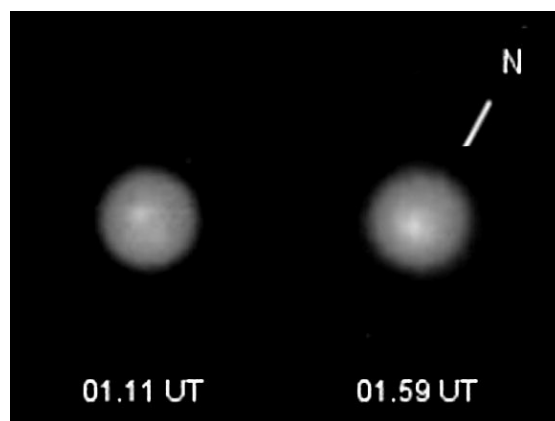
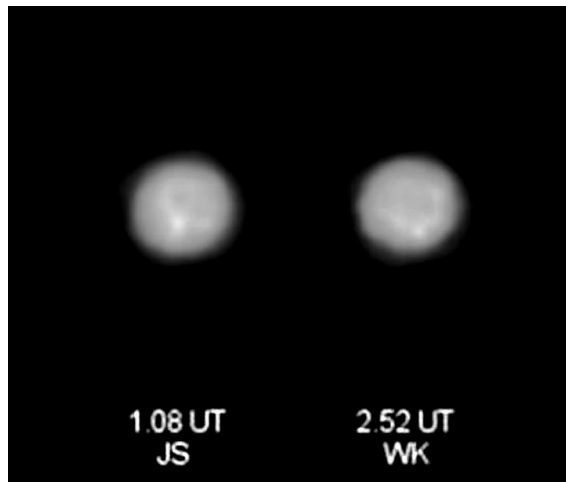


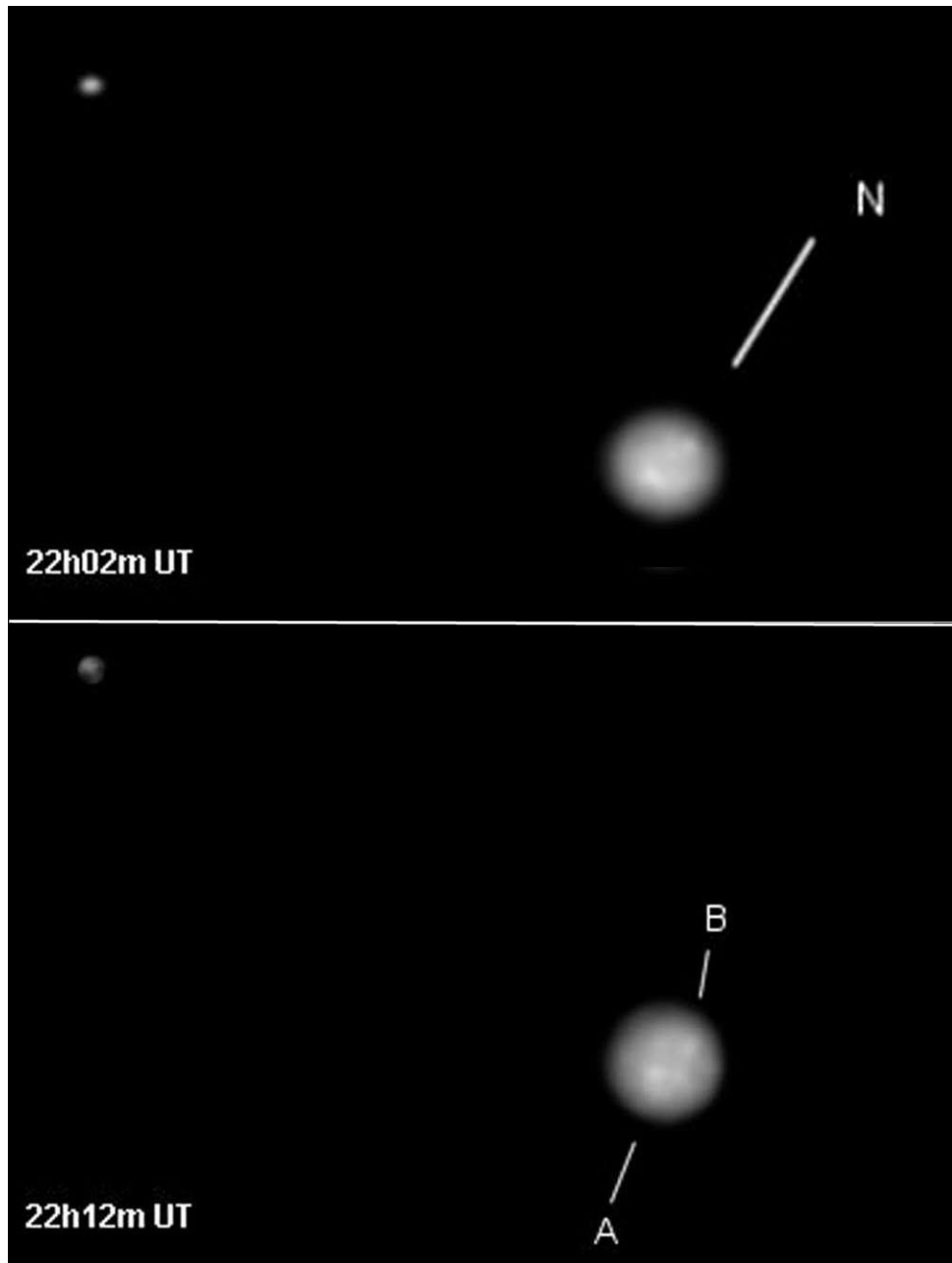
Fig. 4 Neptune on 20 July 2015. (J.Sussenbach). CM  $265.1^\circ$  at 01.11 UT and  $283.0^\circ$  at 01.59 UT. C14 f/22, QHY5LII camera and a 610 nm red long pass filter. North is up.



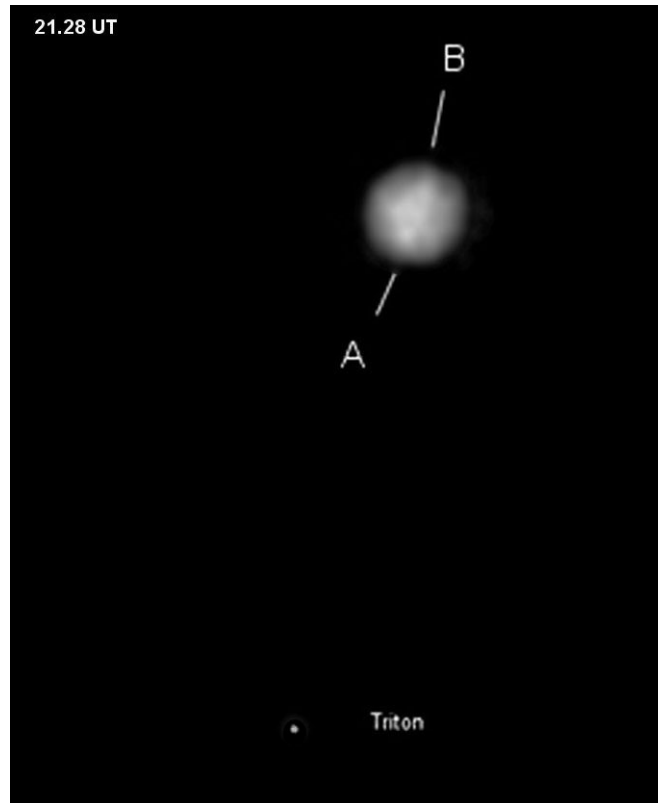
*Fig. 5 Neptune on 1 August 2015 North is up. Combination of images of J.Sussenbach and W.Kivits. CM 220.4° at 1.08 UT and 259.1° at 2.52 UT. C14 f/22, QH5LII camera and Red 610 nm long pass filter*

In the weeks and months that followed the bright spot proved to be very stable. This spot was now renamed Spot A (3). On 1 August 2015 Spot A was captured by both of us, albeit at different time points. Sussenbach captured the spot around 1:08 UT to and Kivits at 2:52 UT (Fig.5). The rotation of the bright spot is clearly visible.

The drift rate of Spot A located at latitude  $-41^{\circ}$  (3) was fairly constant and it remained visible through September and into October. A second feature, Spot B, at latitude  $+20^{\circ}$  also became visible in September (3) and is also visible in the two images of Neptune on 10 September 2015 depicted in Fig. 6.



*Fig. 6 Neptune on 10 September 2015. Spot A as well as Spot B are visible (W.Kivits). CM  $181.5^\circ$  at 22.02UT and  $185.2^\circ$  at 22.12 UT. 50 cm Newtonian telescope, ASI224MC camera and 685 nm NIR long pass filter.*



*Fig.7 Neptune 11 October 2015 Spot A and Spot B. (J.Sussenbach). North is up. CM 234.6° . C14 f/22, ASI224MC camera and Red 610nm long pass filter.*

Sussenbach also managed to detect both Spot A and Spot B on 11 October 2015 (Fig. 7). As Neptune was migrating to the West the observing conditions at Sussenbach's location were getting worse, so it became increasingly difficult to detect the spots from his location.

### **3.2 Drift of bright Spot A**

The coordinates of the bright features on Neptune's disk were measured by Delcroix using the program WinJUPOS (8). Two sets of eight images by Kivits and Sussenbach, respectively, were used to establish the drift of spot A. To determine the orientation of the planet we also visualized the position of Triton. In version 10.2.2 of WinJUPOS Grisca Hahn and coworkers have included the prediction of the positions of this moon. Applying this position and the position of the center of the Neptunian disk, each image with spots could be matched with the WinJUPOS simulation. Subsequently, the position of the spots could be determined. Since the image scale of Neptune is rather small, the standard deviation of the measured coordinates is  $\pm 5^\circ$ . The resulting coordinates of Spot A over time are presented in Fig.8. From this graph the drift rate of the spots could be determined. The data of Kivits yielded a drift of  $23.7^\circ/\text{day}$  and the data of Sussenbach a value of  $24.1^\circ/\text{day}$ . Our combined data yielded a drift of  $24.0^\circ/\text{day}$ . This fits reasonably well with the drift of  $24.27^\circ/\text{day}$  reported by Hueso et al. (1) using a combination of 90 measurements obtained with amateur telescopes and 9 obtained with professional telescopes. From these data they could also derive a longitudinal oscillation of Spot A reported by Hueso et al (1,2). However, our data are insufficient to detect such an oscillation.

The data of Spot B were very sparse. For that reason no drift rate was established for this spot.

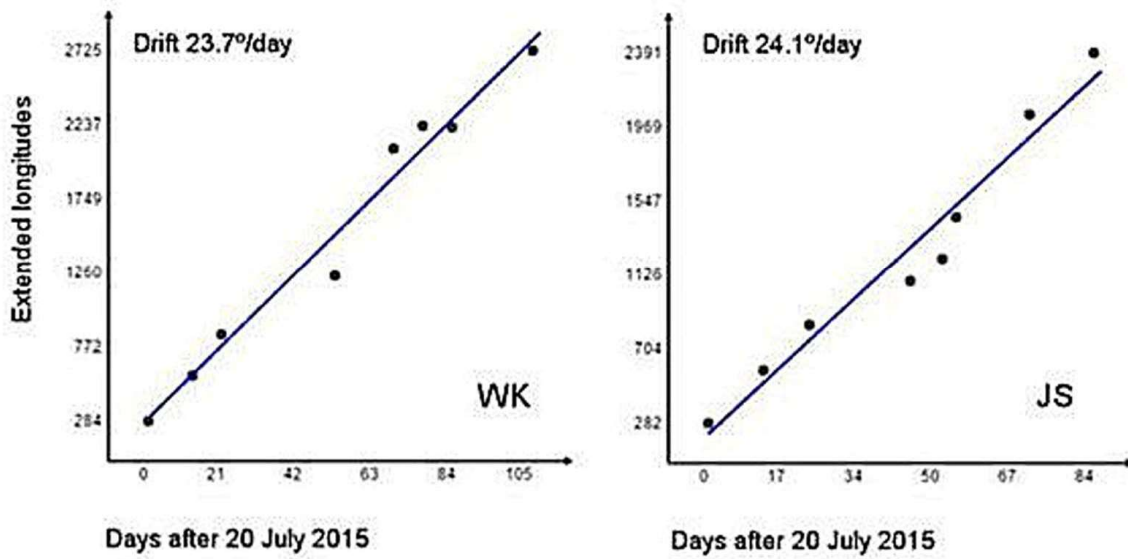


Fig. 8 Drift of Spot A measured in images of W.Kivits (WK) and J.Sussenbach (JS), respectively.

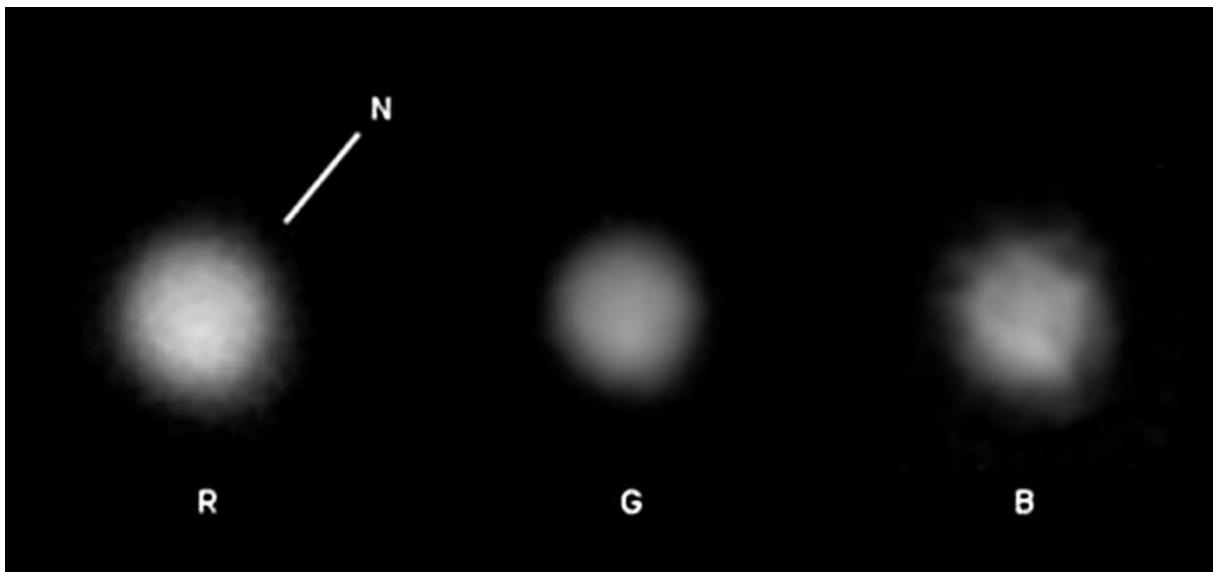


Fig. 9 Red, Green and Blue channels of Neptune on 10 August 2015 at 23.35 UT with spot A. North is up. CM 149.4°. C14 f/28, ASI224MC camera and a Baader 610 nm red long pass filter. (J.Sussenbach). Channels were separated in Adobe Photoshop CS2.

### 3.3 Spectral properties of the features

The outer atmosphere of Neptune contains different components including methane. When we use an ASI224MC camera in combination with a Baader red long pass filter (>610 nm) we capture that part of the reflectance spectrum of Neptune that covers the methane absorption bands at 619, 727, 862 and 889 nm (see Fig.3). The deeper the sunlight penetrates into the Neptunian atmosphere the more light can be absorbed by methane. When high altitude clouds are present in the atmosphere, they will appear as bright spots, because the reflected sunlight does not pass a thick layer of methane containing atmosphere.

To study the spectral properties of the bright features we captured an image of Neptune with an ASI224MC camera plus red long pass filter. Subsequently the image was split into its red,

green and blue channels (Fig. 9). The brightest channel is the red channel and the blue channel is the faintest. This is in agreement with the relative spectral sensitivity of the camera in the three channels as indicated in Fig. 3. Interestingly, spot A is visible in all three channels, but the best in the blue channel.

Obviously, the red channel contains a lot of background signal outside the methane absorption bands which hampers the detection of spot A. Although in the blue channel the image is rather grainy due to less signal being transmitted, spot A can be detected the best in this channel.

This is due to the fact that the 610 nm red long pass filter in combination with the blue channel, acts rather like a 780 nm long pass filter, letting the deepest methane absorption band (889 nm) signal pass. Along with less background signal, this leads to better contrast for spot A, although overall a smaller signal is obtained.

#### **4. Concluding Remarks**

The above observations show that with the current amateur telescopes and digital cameras, bright features on Neptune can be detected even from The Netherlands. The good sensitivity in the infrared of the ASI224MC camera makes it a valuable tool to capture these phenomena. It is likely that these spots indicate the presence of heavy storms on this planet.

A particular aspect of the observation of these features is 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 days at one location, it is very likely that it is clear at another location, so there is continuity in the observations.

We trust that in the 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.

Finally, unfortunately, W. Kivits passed away on 23 February 2016. This paper is a tribute to him and his never-ending perseverance to seek for the limits of amateur astronomy.

#### **5. Acknowledgement**

We gratefully acknowledge the support of Dr. Ricardo Hueso Alonso (Escuela Técnica Superior de Ingeniería Bilbao (Spain)), who after discovering spot A on Neptune on 13 July 2016 immediately informed the amateur astronomers about this finding and stimulated them to detect and to continue observing the development of this bright spot. We thank him for his assistance and instructions.

#### **6. References**

1. Hueso, R., Delcroix, M., et al. Bright features on Neptune in 2013-2015 from ground-based observations with small (40 cm) and large telescopes (10 m). Amer. Astron.Soc., DPS meeting # 47, 400.02 (2015). See also [https://files.aas.org/dps47/DPS\\_47\\_Abstracts.pdf](https://files.aas.org/dps47/DPS_47_Abstracts.pdf)
2. [http://www.astrosurf.com/delcroix/doc/2015-Hueso%20R.%20Delcroix%20M.%20et%20al.-Bright%20features%20in%20Neptune%20on%202013-2015%20from%20ground%20based%20observations%20with%20small%20\(40cm\)%20and%20large%20telescopes%20\(10m\)-%20DPS2015%20Washington%20November%202015.pdf](http://www.astrosurf.com/delcroix/doc/2015-Hueso%20R.%20Delcroix%20M.%20et%20al.-Bright%20features%20in%20Neptune%20on%202013-2015%20from%20ground%20based%20observations%20with%20small%20(40cm)%20and%20large%20telescopes%20(10m)-%20DPS2015%20Washington%20November%202015.pdf)
3. [http://www.pvol.ehu.es/pvol/neptune\\_2015.html](http://www.pvol.ehu.es/pvol/neptune_2015.html)
4. <http://astronomy-imaging-camera.com/products/usb-3-0/asi224mc/>
5. <https://sites.google.com/site/astropipp/>
6. <http://www.autostakkert.com/>
7. <http://www.astronomie.be/registax/>
8. <http://jupos.org/gh/download.htm>



## **Corresponding author**

Address: Dr.J.S.Sussenbach  
Meekrap-oord 3  
3991 VE Houten  
The Netherlands

Tel. +31-30-2203383

Email: [john@jsussenbach.nl](mailto:john@jsussenbach.nl)

Web [www.jsussenbach.nl](http://www.jsussenbach.nl)