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Spectroscopic and photometric albedo of Uranus and Neptune in 2019-2020

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Amateurs contribute to the study of Uranus and Neptune by taking images of a resolution high enough to image their brightest storms. This is done by imaging these planets in red and near infrared wavelengths (600 to 1000 nanometers). Over the past years, collaborations studies between professionals and amateurs have been fruitful and many articles can be found.

While high resolution imaging remains the main tool to follow these planets, they would benefit from a wider use of the technics of spectroscopy and photometry among the amateur community. In the mid 1990s, an extensive work of calculating full-disk albedo spectra of the four gas giants along with spectro-photometric data has been carried out by Erich Karkoschka (LPL, University of Arizona) [1][2]. In the amateur community, Richard Schmude from the Association of lunar and planetary observer has carried out some systematic surveys of Uranus and Neptune through UBVRI photometry [3]

During the summer and winter of 2019-2020, the author has conducted a similar work with his own equipment and the results will be presented in the poster to be submitted.

The author is using a 305 mm (12") altaz F/5 Newtonian along with a Star Analyzer 100 slitless grating, an IR-pass filter to record the infrared part of the spectra and a ZWO ASI290MM b&w CMOS camera. A detailed information of how the data is gathered and reduced as been made by the author with a poster at the EPSC 2019 see [4].

The geometric albedo of Uranus and Neptune has been calculated thanks to the formulae provided by Karkoschka in [1]:

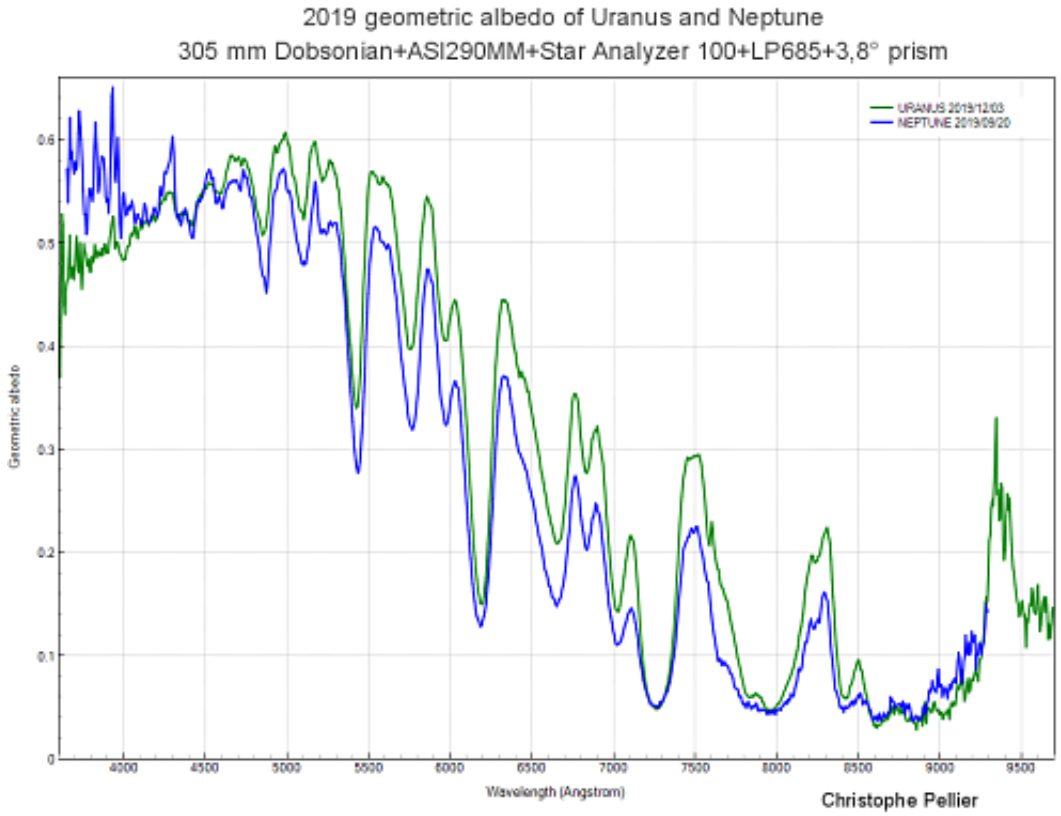
Albedo = $(\Delta r/\square)^2$ x (Neptune ADU spectrum/ Sun ADU spectrum)

(Where Δ and r are respectively the geocentric and heliocentric distances of Neptune.)

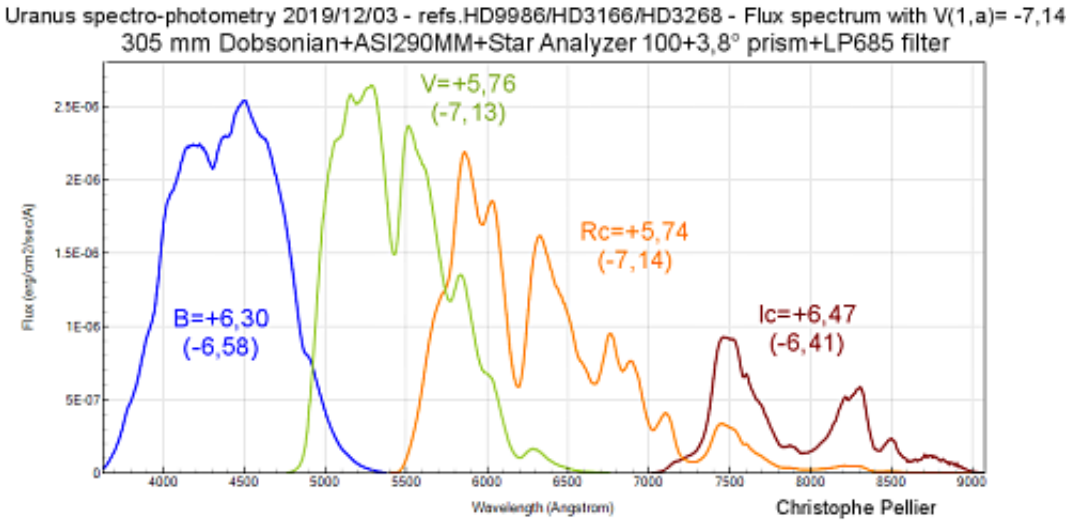
The photometric BVRI albedos of Uranus and Neptune have been derived using the method described by Schmude in [5], from magnitudes calculated through the differential photometry method of the American Association of Variable Stars Observers (AAVSO).

The obtained spectra extend from around 390 to 900/950 nm at a resolution of around 10 nm. This low resolution is still allowing a direct comparison with Karkoschka's results. The 2019 spectroscopic albedo are largely similar to those obtained in 1994 and 1995, with mild differences that can be linked either to the lower spectral resolution, to real differences or to inaccuracies. Here is a graph

showing the two spectroscopic albedos:



The photometric albedos are derived from spectro-photometry, and match quite well the results obtained by both Karkoschka and Schmude in B and V, but diverge significantly in R and I, where noticeably brighter magnitudes and albedos have been reduced. No reliable explanations have been found so far by the author to explain such differences. The full method have been tested in parallel on bright stars followed by the AAVSO and produced good results in all of the four BVRI bands. Here is a graph showing results obtained on Uranus (photometry only):



[1] Karkoschka E., "Spectrophotometry of the Jovian Planets and Titan at 300 to 100 nm Wavelength: The Methane Spectrum", ICARUS 111 (1994)
[2] Karkoschka E., "Methane, Ammonia, and Temperature Measurements of the Jovian Planets and

Titan from CCD-Spectrophotometry", ICARUS 133 (1998)
[3] See as an example Schmude R., "ALPO Observations of the Remote Planets in 2016-2017" The Strolling Astronomer, Vol.60, n°3, 2018.
[4] Full EPSC 2019 poster: The interest of spectroscopy to study Uranus and Neptune, available at http://www.astrosurf.com/pellier/EPSC2019_ODA2_Pellier.pdf
[5] Schmude R., "Uranus, Neptune, Pluto, and how to observe them", Springer 2008.