EPSC Abstracts
Vol. 12, EPSC2018-172, 2018
European Planetary Science Congress 2018

Stellar Occultation of Triton on October 5th, 2017

Joana Oliveira (1), Bruno Sicardy (1), Erick Meza (1), Josselin Desmars (1), Jean Lecacheux (1), Marcelo Assafin (2,3), Julio Camargo (2), Jose-Luis Ortiz (4), Pablo Santos-Sanz (4), Wolfgang Beisker (5), Mike Kretlow (5), Rodrigo Leiva (6), Diane Bérard (1), the Rio and Granada occultation teams, the IOTA teams (Europe and USA), the Triton occultation teams
(1) LESIA/Observatoire de Paris, CNRS UMR 8109, Sorbonne Université, Université Paris-Diderot, 5 place Jules Janssen, F-92195 Meudon Cédex, France, (2) ON Rio de Janeiro, (3) OV/UFRJ Rio de Janeiro, (4) IAA Granada, (5) IOTA Europe, (6) SWRI Boulder (joana.oliveira@obspm.fr)

Abstract

On October 5th, 2017, a stellar occultation by Triton was observed from over 80 sites in Europe, North Africa, and USA, by both professional and amateur astronomers. These observations provide unique information on the thermal structure of Triton's atmosphere and its evolution since the Voyager 2 observations in 1989. A noteworthy feature observed in about 25 light curves is the so-called central flash, corresponding to an increase of brightness in the middle of the event. We will present preliminary results derived from this event, in particular a comparison of the pressure obtained at prescribed levels, with results from previous observations. Constraints on the atmosphere shape derived from the central flashes will be given.

1. Introduction

Triton is the largest of Neptune's satellites with a radius of 1353 km. It is the only satellite, other than Titan, to possess a significant atmosphere. Its atmosphere (mainly composed of molecular nitrogen N_2) is special as it is in vapor pressure equilibrium with the N_2 frost at the surface. The NASA/Voyager radio experiment provided a surface pressure of p_{surf} ~ 16 μbar in 1989 [1], consistent with vapor equilibrium with a surface at T_{surf} ~ 40 K. The sensitivity of p_{surf} to T_{surf} is very high, as each increment $\Delta T = 1$ K corresponds to an increase by a factor of two in pressure. In that context, seasonal effects are of paramount importance: in fact, due to the large variations of the sub-solar latitude, very different terrains are illuminated as time changes (Fig. 1). The decades 1990-2000 were exceptional due to an "extreme solstice", where southern latitudes of up to 50º S were directly illuminated by the Sun. This happens every 650 years, due to a combination of Neptune's heliocentric motion and Triton orbital precession. Since 1989, the Voyager data, combined with a few ground-based stellar occultations suggest that Triton's atmospheric pressure increased by a factor of about two. This increase could stem from the sublimation of N_2 ice deposited on Triton's southern polar cap [2].

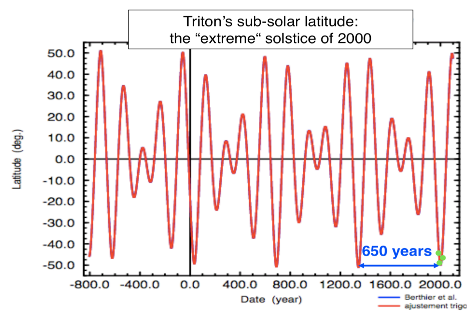

Figure 1 - Triton's subsolar latitude vs. time. Note the exceptional character of the 2000 solstice.

2. The event

This stellar occultation was unique, as it was the first one favourable since 1997. Thanks to a pre-release of the Gaia DR2 star positions around Triton, the final prediction was about 3 milli-arcsecond from the actual shadow path. It involved a bright star (V = 12) and densely populated areas in terms of observing sites, including amateurs. It was visible from a large part of Europe and Northern Africa, as well as from eastern USA (Fig. 2), resulting in a dense coverage of Triton's atmosphere (Fig. 3).

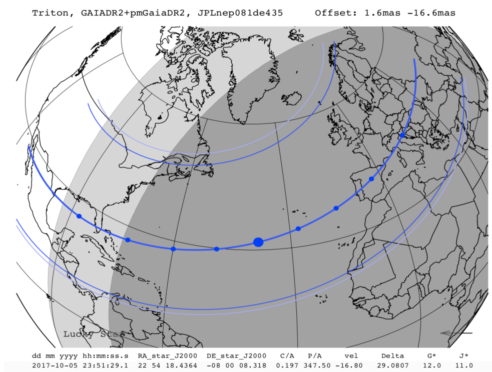

Figure 2 - Path of Triton's shadow during the event.

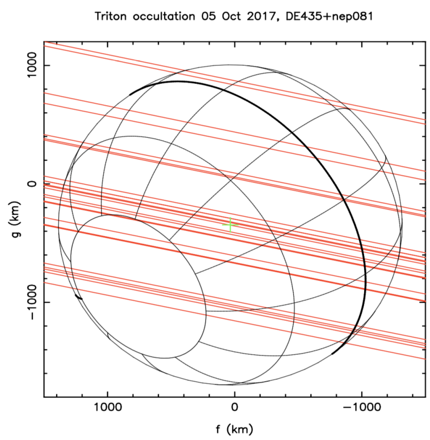

Figure 3 – Occultation chords for 26 stations across Triton's atmosphere. The green cross marks Triton's center.

3. Preliminary results

Refraction of stellar rays by the atmosphere causes a stellar flux drop (Fig. 4), which provides Triton's atmospheric profiles (density, temperature, pressure, including p_{surf}) from altitudes of 10 km (7 μbar) to about 100 km (0.1 μbar). Stations near centrality experienced the so-called central flash (Fig. 4) which constraints the sphericity of Triton's atmosphere and possible presence of hazes. Moreover, combining all observations, one can perform a fit to all the light curves and derive global properties of the atmosphere.

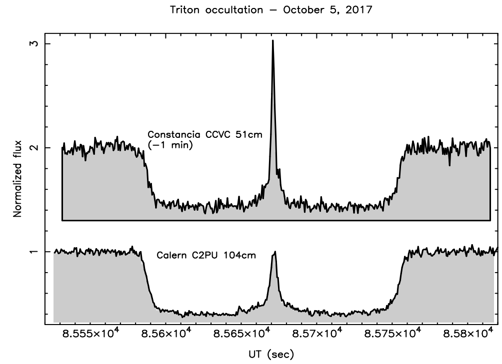

Figure 4 - The occultation event and central flash observed at two stations: south-east France and Constância in Portugal. The total duration of the event is about 3 minutes.

In particular, we will discuss the evolution of Triton's atmospheric pressure from 1989 up to present, as well as the upper limit for the atmospheric oblateness using the central flash, from which constraints on zonal winds and hazes will be given.

Acknowledgements

This work has received support from the Portuguese Foundation for Science and Technology (FCT) through the PhD grant SFRH/BD/131700/2017. The work leading to these results has also received funding from the European Research Council under the European Community's H2020 2014-2020 ERC grant Agreement n° 669416 "Lucky Star". We acknowledge the Gaia project for pre-releasing DR2 stellar positions that greatly improved the prediction of the event.

References

[1] Tyler et al.: "Voyager radio science observations of Neptune and Triton", *Science* 246, 1466, 1989.

[2] Elliot et al.: "Global warming on Triton", *Nature* 393, 765, 1998.