EPSC Abstracts
Vol. 8, EPSC2013-412, 2013
European Planetary Science Congress 2013

Volatile Transport on Pluto and Triton

B. J. Buratti (1), M. D. Hicks (1) , P. A. Dalba (1), J. K. Hillier (2), D. S. Chu (1), A. O'Neill (1), S. Banholzer (1). Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA; (2) Grays Harbor College, Aberdeen, WA. (Bonnie.Buratti@jpl.nasa.gov; 1-818-354-7427.

Abstract

Seasonal transport of volatiles should occur on both Triton and Pluto, and it should be detectable through temporal changes in their rotational light curves, once all changes due to viewing geometry have been modelled. Rotational light curves of Pluto and Triton through time have been created for static frost models based on images from *Voyager 2* (for Triton) and from the *Hubble Space Telescope* (for Pluto). These models, which account for changes in viewing geometry, have been compared with observed light curves obtained between 1950 and 2013. Volatile transport has been detected on Triton, while for Pluto the case is more ambiguous. New observations of Pluto's light curve from the 2013 season from Table Mountain Observatory, which were designed to clarify this ambiguity, will be presented. These data will extend the time-base and context for the *New Horizons* flyby of Pluto in July 2015.

1. Introduction

Because of their non-zero obliquities, Triton and Pluto should both exhibit seasonal transport of volatiles on their surfaces [1,2]. This effect is pronounced for Pluto because of its high eccentricity. Accompanying these surface changes are variations in atmospheric pressure, which have been observed for both bodies [3,4]. The rotational light curve, which is the brightness of a celestial body as a function of subobserver longitude, is a sensitive indicator of surface volatile distribution. Changes in the amplitude, shape, or color of the light curve, once all corrections for viewing geometry between the Earth, sun, and the target have been taken into account, are a sensitive indicator of changes in the frost pattern on the surface. For both Triton and Pluto, these changes should occur over one seasonal cycle – 165 years for Triton and 246 years for Pluto - so the persistent acquisition of astronomical light curves is the best way to detect them. Decribing seasonal changes through decades, these measurements are complementary to spacecraft flybys such as those of *Voyager 2* for Triton and *New Horizons* for Pluto.

2. Observations

Figure 1 shows the measured amplitude of Triton's light curve through time, compared with a static frost model created from *Voyager 2* images. These results demonstrate that volatile transport has occurred on Triton after the *Voyager* flyby in 1989.

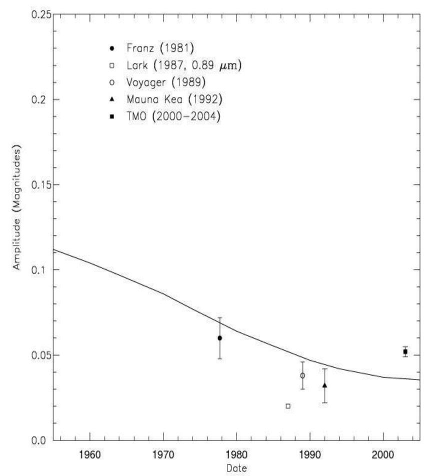

Figure 1. The light curve of Triton through time; the recent point is consistent with volatile transport. The solid line is the static frost model. (The observation by Lark et al. in 1987 was obtained in the methane filter, which has a substantially smaller amplitude that the visible filter.) Based on [5].

Hubble Space Telescope (HST) observations of Triton also show albedo changes when compared with the *Voyager 2* images [6]. The *Voyager* images clearly show a south polar cap on Triton which seems to be receding (see Figure 2).

Figure 3 shows the available light curve observations of Pluto compared with a static frost model based on *HST* images [7,]. Observations obtained during the 2007-2008 season seemed to signal the onset of volatile transport [8], which was confirmed by *HST* observations [9]. Measurements obtained at TMO during the 2012 season are consistent with the static frost model; these observations were based on only four nights of data, but measurements for both light curve minimum and maximum were acquired.

Figure 2. An image of Triton from *Voyager 2*, showing what appears to be a receding polar cap on the left. The dark streaks are plumes that appear only on the cap and may be associated with volatile sublimation and release.

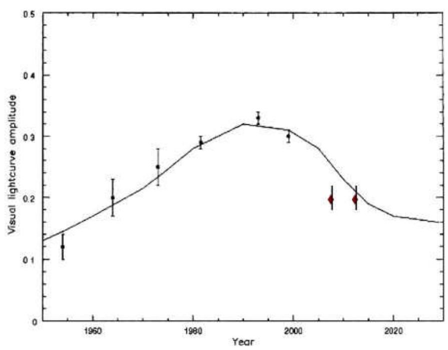

Figure 3. The amplitude of Pluto's light curve through time, based on historical observations. The solid line is a static frost model. The last two points are recent measurements from Table Mountain Observatory showing seemingly contradictory results. Based on [7], with recent data added in.

Clearly, a new light curve of Pluto with closely spaced observations that cover the full range of subobserver longitudes is needed. Such observations are planned for the summer of 2013. Because Pluto is at opposition during summer (in the northern hemisphere), and because of its low declination, it can be observed for no more than 7 hours each night. With a 6.4 day rotation period, we require at least 20 nights of observing. We were granted 12 nights in June 2013 and will seek additional nights in July. A team of students will do much of the observing.

3. Summary and Conclusions

Observations of the light curves of Triton and Pluto through time show that the former is undergoing seasonal volatile transport while the latter may be doing so. A dedicated program to observe Pluto during its opposition in early July 2013 is underway at JPL's Table Mountain Observatory. These observations will enhance the results from the upcoming encounter of *New Horizons* with Pluto in July 2015, as they will extend the time base and provide context.

Acknowledgements

This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology under contract to the National Aeronautics and Space Administration.

References

[1] Trafton L. Large seasonal variations in Triton's atmosphere. *Icarus* **58**, pp. 312-324, 1984.

[2] Stern, S. A., Trafton, L. Constraints on bulk composition, seasonal variation, and global dynamics of Pluto's atmosphere. *Icarus* **57**, pp. 231-240, 1984.

[3] Elliot, J. et al. Global warming on Triton. *Nature* **393**, pp. 765-767. 1998.

[4] Elliot, J. et al. Changes in Pluto's atmosphere: 1988-2006. *Astron. Journal* **134**, pp. 1-13, 2007.

[5] Buratti, B. J. et al. Photometry of Triton 1992-2004: Surface volatile transport and discovery of a remarkable opposition surge. *Icarus* **212**, pp. 835-846, 2011.

[6] Bauer, J. et al. Direct detection of seasonal changes on Triton with *HST. Ap. J. Lett.* **723**, pp. L49-52, 2010.

[7] Buratti, B. J. et al. Photometry of Pluto in the 1990's and before: Evidence for volatile transport? *Icarus*.**162,** pp. 172-183, 2003.

[8] Hicks, M. et al. Support observations for *New Horizons B.A.A.S.* **40**, 460, 2008.

[9] Buie, M., et al. Pluto and Charon with *HST*. II. Resolving Changes on Pluto's Surface and a Map for Charon. *Astron. J.*, **139**, pp. 1128-1143, 2010.