EPSC Abstracts
Vol. 13, EPSC-DPS2019-1026-2, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Photometric properties of Pluto's main surface units

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Abstract

We report here a detailed study of disk-resolved photometric properties of Pluto using New Horizons Ralph/MVIC images in the visible wavelength range 400-910 nm acquired during the Pluto's flyby [1]. The derivation of a regionally-based photometric model permits us to (1) decouple the intrinsic surface albedo variability from effects related to the observing geometry, and therefore investigate quantitatively the true heterogeneity of Pluto's surface; (2) combine visible (MVIC) and near-IR observations (LEISA) accounting for the different viewing geometries at which these data were acquired; (3) model visible and near-infrared measurements of Pluto to derive quantitative information of its surface composition.

1. Introduction

The chemistry of Pluto's atmosphere and surface has become a key factor in understanding the origin and evolution of this icy dwarf planet, and by extension that of a vast number of similar sized and smaller bodies in the Kuiper Belt, beyond the terrestrial and giant planets. A pixel-by-pixel Hapke radiative transfer model has been developed by [2] and applied to two resolved scans of Pluto's encounter hemisphere acquired by the New Horizons (NH) infrared imaging spectrometer, LEISA [3]. This model yields compositional maps defining the spatial distribution of the abundance and textural properties of the materials present on the surface of Pluto. This has been by far the most successful approach to date in terms of providing quantitative information about the composition of Pluto. However, this analysis has some limitations, namely:

- Important compositional information is hidden in the visible wavelength range where low albedo organic compounds known as *tholins* present the most diagnostic spectral signatures [4]. High quality filter band imagery in this range exist from the NH Ralph/MVIC instrument [3], but have yet not been studied with this technique. One of the main findings of the Protopapa et al. study [2] is the correlation between Pluto's coloration and the abundance of *tholins* used in the best-fitting models. As an example, the highest concentration of these dark compounds is found in Cthulhu Macula, the lowest albedo and reddest unit of Pluto's observed surface [5, 6]. On the other hand, Lowell Regio, which displays a golden coloration, was found to be highly depleted in *tholins*. This result is a clear example of how the true contribution of the coloring agents cannot be assessed if the visible spectral domain is disregarded.
- The estimates of the concentration and particle size of each surface compound strongly rely on the choice of Pluto's photometric properties (Hapke parameters as the cosine asymmetry factor ξ, compaction parameter h, amplitude of the opposition effect B_0, and mean roughness slope θ). These properties have previously been treated as global quantities, constant across all of Pluto's terrains [7]. However, given the high degree of surface variations on Pluto [5, 6], this approximation is likely incorrect.

2. Summary and Conclusions

We present a multi-wavelength, regionally dependent photometric analysis of Pluto's surface. We will perform a comparative analysis and use these properties to quantitatively infer the composition of Pluto's different terrains and investigate the different coloring agents across Pluto's surface.

Acknowledgements

This work was supported by the New Horizons project. S. Protopapa gratefully thanks the NASA NFDAP Grant for funding that supported this work (grant # 80NSSC19K0821).

References

[1] Stern S. A. et al. Science, 350, aad1815, 2015.

[2] Protopapa S. et al. Icarus, 287, 218–228, 2017

[3] Reuter D. C. et al. Space Science Reviews, 140, 129-154, 2008

[4] Cruikshank D. P. et al. Advances in Space Research, 36, 178–183, 2005.

[5] Grundy W. M. et al. Science, 351, aad9189, 2016.

[6] Olkin C. B. et al. AJ, 154, 258, 2017.

[7] Buie M. W. et al. The Astronomical Journal, 139, 1117–11127, 2010.