EPSC Abstracts
Vol. 11, EPSC2017-140, 2017
European Planetary Science Congress 2017


# Results from the New Horizons encounter with Pluto

**C. B. Olkin** (1), S. A. Stern (1), J. R. Spencer (1), H. A. Weaver (2), L. A. Young (1), K. Ennico (3) and the New Horizons Team

(1) Southwest Research Institute, Colorado, USA, (2) Johns Hopkins University Applied Physics Laboratory, Maryland, USA (3) NASA Ames Research Center, California, USA (colkin@boulder.swri.edu)

## Abstract

In July 2015, the New Horizons spacecraft flew through the Pluto system providing high spatial resolution panchromatic and color visible light imaging, near-infrared composition mapping spectroscopy, UV airglow measurements, UV solar and radio uplink occultations for atmospheric sounding, and in situ plasma and dust measurements that have transformed our understanding of Pluto and its moons [1]. Results from the science investigations focusing on geology, surface composition and atmospheric studies of Pluto and its largest satellite Charon will be presented. We also describe the New Horizons extended mission.

## 1. Geology and Size

Highlights from the geology investigation of Pluto include the discovery of a unexpected diversity of geomorpholgies across the surface, the discovery of a deep basin (informally known as Sputnik Planitia) containing glacial ices undergoing mobile-lid convection [2] (Figure 1), evidence of glacial flow from topographic highs into the lower elevation basin, and a great diversity of surface ages ranging from the ancient (~4 Ga) age of the dark region dominating Pluto's equator to the relatively young (<10 Ma) age of the glacial ices. Pluto's radius was determined to be 1188 km [3], firmly establishing it as the largest body in the Kuiper Belt.

On Pluto's largest satellite, Charon, a large tectonic belt runs across its encounter hemisphere from northeast to southwest. There is significant vertical relief across Charon with more than 20 km variation in topography seen on Charon's limb and in stereo imaging [4].

The crater densities on Nix and Hydra, the larger of Pluto's four small moons, suggest ancient surface ages (~4 Ga), which is puzzling considering their high geometric albedos (~55% for Nix and ~80% for Hydra) and the various processes that would darken those surfaces over time [5].

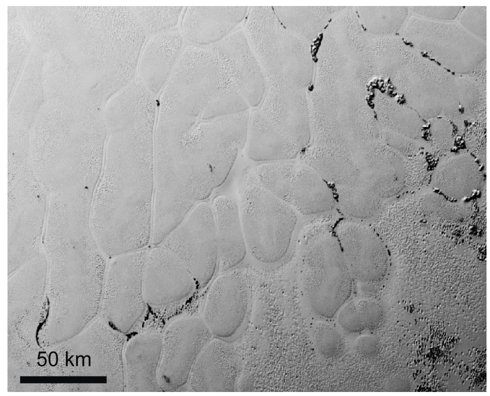


Figure 1: The glacial ices of Sputnik Planitia. The cellular pattern is a surface expression of mobile lid convection. The boundaries of the cells are troughs. Despite it's size of ~900,000 km$^2$, there are no identified craters across Sputnik Planitia.

## 2. Surface Composition

Using New Horizons imaging spectroscopy from 1-2.5 microns, we have created composition maps of volatile ices ($N_2$, $CH_4$, CO), non-volatile ices ($H_2O$), and tholins across the close approach hemisphere at spatial scales of kilometers. New Horizons obtained strong evidence for a water ice crust topped by a relatively thin veneer of volatiles. It was also found that Pluto's surface composition has patterns that depend on latitude. Pluto's equatorial region is dominated by non-volatile red material consistent with tholins, while the north pole is currently predominantly $CH_4$ ice. This can be explained by Pluto's seasonal insolation patterns.

Charon's surface spectra are dominated by absorptions from water ice, but multiple sites show absorption from a band centered near 2.21 microns, which is probably associated with an $NH_3$-bearing molecule. The north pole of Charon is dark and red which, has been explained by atmospheric molecules escaping Pluto, intercepting Charon, becoming cold trapped at Charon's pole, then undergoing photolysis over Charon's ~100 year winter to form a layer of tholin-like material [6].

The near-IR spectra of Nix and Hydra are dominated by crystalline water ice absorption [7], consistent with their high geometric albedos and their formation from the ice-rich debris created during the collision that formed the Pluto-Charon system. The near-IR spectra of Nix and Hydra also show absorptions near 2.21 microns, presumably due to an $NH_3$-bearing species.

## 3. Atmospheres

The New Horizons investigation of Pluto's atmosphere [8] determined the temperature and pressure profiles in the atmosphere, the composition of the atmosphere as a function of altitude, the base surface pressure, the atmospheric escape rate, and the extensive nature of atmospheric haze on Pluto (see Figure 2). The escape rate was surprisingly small due to much lower than expected temperatures in the upper atmosphere.  As a result the pressure balance with the solar wind was within ~6 times the radius of Pluto, much closer to Pluto than expected [9].

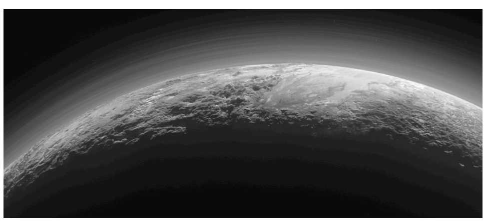

Figure 2: This image was taken by New Horizons just 15 minutes after closest approach. The highly forward scattering haze particles in Pluto's atmosphere are seen in the image. Layers of haze extend more than 200 km above Pluto's surface.

## 4. Extended Mission

New Horizons began a five year long extended mission to study the Kuiper Belt (KB) in October 2016. The goals of this mission are to study the dust, plasma and gas environment in the KB out to 50 AU, to observe numerous Kuiper Belt Objects (KBOs) and Centaurs at phase angles and resolutions unobtainable from Earth, and to conduct a close flyby of the KBO 2014 $MU_{69}$.

2014 $MU_{69}$ is a member of the cold classical family of Kuiper belt objects, whose low orbital inclinations and low eccentricities suggest they are among the most primordial objects in the solar system. The flyby of 2014 $MU_{69}$ will occur on January 1, 2019. Encounter objectives include high-resolution imaging, compositional mapping, stereo imaging, satellite and ring searches, coma searches, and more.

## Acknowledgements

We thank NASA for funding the New Horizons project and this talk.


## References


[1] Stern, S. A. et al.: The Pluto system: Initial results from its exploration by New Horizons, Science, Vol. 350, aad1815, 2015.

[2] McKinnon, W. B. et al.: Convection in a volatile nitrogen-ice-rich layer drives Pluto's geological vigour, Nature, Vol. 534, p. 82-85, 2016.

[3] Nimmo, F. et al.: Mean radius and shape of Pluto and Charon from New Horizons images, Vol. 287, p. 12-29, 2017.

[4] Moore, J. M. et al.: The geology of Pluto and Charon through the eyes of New Horizons, Science, Vol. 351, p. 1284-1293, 2016.

[5] Weaver, H. A. et al.: The small satellites of Pluto as observed by New Horizons, Science, Vol. 351, p. 1281, 2016.

[6] Grundy, W. et al.: The formation of Charon's red poles from seasonally cold-trapped volatiles, Nature, Vol. 539, p. 65-68, 2016.

[7] Cook, J. C. et al.: Composition of Pluto's Small Satellites: Analysis of New Horizons Spectral Images, LPSC, 2478, 2017.

[8] Gladstone, G. R. et al.: The atmosphere of Pluto as observed by New Horizons, Science, Vol. 351, p. 1280, 2016.

[9] Bagenal, F. et al.: Pluto's interaction with its space environment: Solar wind, energetic particles, and dust, Science, Vol. 351, p. 1282, 2016.