NEW HORIZONS: THE EXPLORATION OF THE PLUTO SYSTEM AND THE KUIPER BELT BEYOND. S.A. Stern[1] and the New Horizons Team[2], Southwest Research Institute, 1050 Walnut Street, Suite 300, Boulder, CO 80302, astern@swri.edu.

Introduction: NASA's *New Horizons* spacecraft made the first exploration of Pluto, culminating on 14 July 2015; it collected numerous remote sensing and in situ measurements of Pluto and its system of five moons [1]. The New Horizons spacecraft completed it close approach to the Pluto system at a distance of 13,691 km from Pluto's center. The mission carries a comprehensive set of scientific instruments, including the Ralph multicolor/panchromatic mapper and mapping infrared composition spectrometer; the LORRI long focal length panchromatic visible imager; the Alice extreme/far ultraviolet mapping spectrograph; twin REX radio science experiments; the SWAP solar wind detector; the PEPSSI high energy charged particle spectrometer; and SDC—a dust impact detector. Together these instruments collected over 50 Gigabits of data Pluto and its satellites.

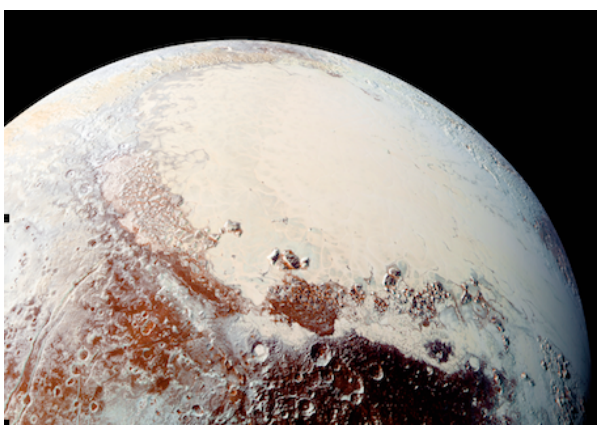

Figure 1. Pluto as seen in enhanced color from New Horizons on 14 July 2015. This view is projected from a point 1,800 km above Pluto's equator, looking northeast over the dark, cratered, informally named Cthulhu Regio toward the bright, smooth, expanse of icy plains informally called Sputnik Planum. Pluto's north pole is off the image to the left.

Results: Pluto's diameter was measured to be 2376±2 km, firmly establishing it as the largest planet in the Kuiper Belt. Pluto's surface was found to display a wide variety of landforms and terrain ages, as well as dramatic albedo, color, and compositional variegation. Evidence was found for a water-ice rich crust, a geologically young surface units, tectonic extension, surface volatile ice convection, glaciers, volatile transport, and cryovolcanos. Pluto's atmosphere is less extended than predicted prior to the flyby, and contains trace hydrocarbons, numerous haze layers, and exhibits a surface pressure near 10 microbars. The atmosphere was found to be escaping in a Jeans mode, like Earth, rather than the hydrodynamic mode previously anticipated.

The encounter revealed that Pluto displays a surprisingly wide variety of geological landforms—including those resulting from glaciological and surface-atmosphere interactions, as well as impact, tectonic, possible cryovolcanic, and mass wasting processes. This finding suggests that other small planets of the Kuiper belt, such as Eris, Makemake, and Haumea, could express similarly complex histories that rival those of terrestrial planets. Pluto's diverse surface geology and its wide range of crater retention ages (spanning <0.01 to 4+ Gyr) raises fundamental questions about how it has remained active throughout its history.

Pluto's large satellite Charon displays large-scale extensional tectonics and extensive resurfacing, surface water-ice and ammonia, as well as evidence for a heterogeneous subsurface crustal composition, but no signature of an atmosphere, with base a pressure constraint well below 1 nanobar pressure; its north pole displays puzzling dark, red terrain.

Figure 2. The encounter hemisphere of Pluto's largest moon, Charon; diameter: 1214±2 km.

The sizes and shapes of Pluto's four small satellites were measured for the first time, as were their surface reflectivities, which are puzzlingly higher than Charon's. Resolved imagery reveals a variety of feature types and craters on the small satellites. All four small satellites were found to spin rapidly compared to their orbital periods—an unanticipated result indicating they must be currently excited out of tidal equilibrium. No new satellites were detected.

Kuiper Belt Exploration: In late 2015, with NASA's permission, New Horizons burned its engines to target the flyby of a small (~40 km diameter), cold classical Kuiper Belt Object (KBO) designated 2014 MU69. The spacecraft will fly past this object, at much closer range than it did Pluto, on 1 January 2019. If NASA approves this extended mission, this KBO will be mapped for geology, albedo, topography, color, composition, and photometric properties. Coma, satellites, and rings will be searched for, and its interaction with the heliosphere will be measured. This proposed extended mission would also flyby and study ~20 similarly small KBOs from greater distance, and will create phase curves for 4-5 dwarf planets; soon, searches will be made for KBO stellar occultation and mutual events that can be observed from New Horizons. During this hoped-for mission phase, the heliospheric plasma, dust, and neutral gas environment will also be mapped from 35 to 50 AU across the Kuiper Belt.

References: [1] Stern, S.A. et al (2015), *Science, 350,* 292.