One year since the New Horizons flyby of Pluto

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It has been one year since the New Horizons spacecraft finished its historic flyby of Pluto and its system of moons, taking the most detailed images ever of the dwarf planet and its companions. Since then, the probe has been steadily sending back every bit of data it collected in its 22-hour encounter, revealing an increasingly complex system.

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New Horizons was launched on January 19, 2006 by an Atlas V 551 rocket, a configuration with five solid rocket boosters designed to give New Horizons the speed necessary to reach Pluto in "only" nine years (which even then required a gravitational boost from Jupiter). As a result, New Horizons is the fastest spacecraft ever launched and the only one to have been launched directly into a trajectory that will escape the solar system. It is expected to leave the solar system sometime around 2040.

There are seven instruments aboard New Horizons used to conduct science operations. There are three optical instruments (LORRI, Alice, Ralph), two plasma detectors (SWAP, PEPPSI), a dust sensor (VBSDC) and a radio science receiver (REX). Collectively, these collected data on Pluto's geological history, the composition and temperature of the dwarf planet's surface and atmosphere, and the escape rate of matter from Pluto and its largest moon Charon.

Instruments also took measurements of the charged particles in and around the Pluto system. Radio signals were used to look for deviations in the spacecraft's expected flight path to get a better estimate of the mass and thus inner composition of Pluto and Charon.

A wide range of full-resolution images from New Horizons can be viewed at nasa.gov.

One of the main areas observed is the "heart" feature on Pluto, named Sputnik Planum. It is a bright, smooth plain about the size of the Hudson Bay. Spectra taken by New Horizons indicate that it consists mostly of nitrogen ice, with smaller amounts of carbon monoxide and methane ice. The relatively smooth nature of the region correlates with polygonal structures which are likely convection cells of ice, powered by Pluto's warmer interior. As ice is brought to the surface, older features are brought under. As a result, astronomers estimate that no part of the area is more than 10 million years old.

Pluto was also discovered to have a variety of mountain ranges, some of which approach the height and length of the Rocky Mountains. Instead of rocks, however, mountains on Pluto consist of water ice, some capped with layers of methane snow. Similar to the Sputnik Planum, the mountain ranges on Pluto indicate that there is not just a geological history but current geological activity on the dwarf planet.

Tholins have also been discovered all across Pluto. These are complex carbon molecules that occur when ultraviolet light from the Sun interacts with methane, stripping those molecules down and reforming them into something larger. Under certain conditions, such as those on Saturn's moon Titan, tholins have been shown to be the precursor to organic molecules such as amino acids.

The atmosphere of Pluto has also been the subject of a great deal of study. Earlier studies have shown that the atmosphere does not always exist, but rather condenses to the surface when Pluto's orbit takes it farthest from the Sun. What New Horizons has discovered is a much more precise knowledge of the composition of the atmosphere, temperature and distribution of the molecules. There is also more data on the interaction between the atmosphere and the surface, the winds on Pluto. The probe also found

layers of haze in the atmosphere as it passed behind Pluto, haze which has a distinctly blue character.

Perhaps the most interesting observation from the data gathered by New Horizons is the possibility for an ocean of liquid water under Pluto's surface. The initial evidence comes from a series of cracks in Pluto's surface, an effect that you get when a rigid surface expands. One of the possibilities for this expansion is a subsurface ocean of liquid water warmed by radioactive elements in Pluto's interior and insulated by the rock and frozen nitrogen. More data (likely another mission) is needed to confirm or refute this idea, but it does show that conditions to make liquid water are showing themselves to be more and more varied.

While the mission's focus has been on Pluto, equally interesting discoveries have been made about Pluto's moons, particular Charon. The first major discovery about Charon is that it has a canyon system that is more than fifty percent longer than the Grand Canyon in the United States and likely more than five times as deep. Moreover, some of the sheer cliff faces observed might be three miles high, rivaling Verona Rupes on Uranus' moon Miranda for the tallest known cliff face in the solar system.

Color images of Charon have revealed the north polar region to be much darker than the surrounding regions, likely a condensation of gases that have escaped from Pluto's atmosphere. The gases, including nitrogen, methane, carbon dioxide and tholins, condense on Charon in the system's winter. In the summer, everything but the tholins evaporate off, creating a layer thick enough to obscure the icy crust.

One feature Pluto and Charon may potentially share are cryovolcanoes, places where ice (water, methane and/or nitrogen) erupts from the surface. While New Horizons did not capture any active eruptions, areas on both bodies indicate places where material from beneath the surface could have been violently ejected.

New Horizons has also returned data on Pluto's four smaller moons, Hydra, Nix, Kerberos and Styx. They were discovered by the Hubble Space Telescope while preparing for the mission in 2005 and later on while looking for potential hazards for New Horizons traveling through the Pluto system. Similar to Pluto and Charon, the four moons consist of water, nitrogen and methane ice in varying proportions. One of the mysteries of the moons is why Nix and Hydra have different ice textures on their surface despite being similarly sized. Another is the higher reflectivity of Hydra as compared to Nix, which is puzzling considering that Nix appears to have an icier surface.

Though New Horizons will soon finish transmitting its Pluto data back to Earth, its mission is not over. Last October and November, the spacecraft performed four trajectory corrections in order to fly past the Kuiper Belt object 2014 MU69, a body considered to be one of the early building blocks of the solar system. Two weeks ago, NASA formally approved the funding and personnel for the mission extension. New Horizons will encounter its new target on January 1, 2019.

That it took so long to get the funding to extend this mission highlights the contradictions of doing basic science under capitalism. There is no other spacecraft with the sort of capabilities of New Horizons even in the planning stages, much less out beyond Neptune's orbit. No other mission has returned such spectacular data on one of the solar system's most distant objects. Yet, because there is no direct profit to be made or military advantage to be gained, New Horizons was not guaranteed to be funded past its primary objective. This is despite the fact that the mission as a whole has yet to exceed the cost of a single B-2 stealth bomber.

No doubt more will be discovered about Pluto, Charon and the other moons in the coming months and years. Every new batch of data has taught us something new about a world that was once only several pixels wide. All this has occurred under funding constraints imposed by both Republican and Democratic administrations. A great deal more will be achieved when science no longer has to operate within the framework of imperialism.