



*Astronomy News for Bluewater Stargazers*  
*July 14, 2015*

## Pluto Special: Contents

- p 1: Pluto From Closeup at Last!
- p 2: Pluto and Charon Composite
- p 3: Pluto has Geology
- p 4: Charon closeup; Methane ice on Pluto
- p 5: Ice Plains in "Heart" of Pluto
- p 6: Beyond Pluto; Naked Eye Viewing
- p 7: Pluto's Moons
- p 8: Mission Graphics
- p 9: Talking to Pluto is Hard: Lakdawalla Blog  
Planetary Society
- p 10: Mission Science
- p 11: Pluto Mission Brought to you by...
- p 12: Pluto Humour c/o Randall Munroe



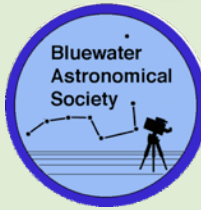
## Pluto From Closeup At Last!

Pluto nearly fills the frame in this image from the Long Range Reconnaissance Imager (LORRI) aboard NASA's New Horizons spacecraft, taken on July 13, 2015 when the spacecraft was 768,000 km from the surface. This is the last and most detailed image sent to Earth before the spacecraft's closest approach to Pluto on July 14 (7:49 am EDT). The color image has been combined with lower-resolution color information from the Ralph instrument that was acquired earlier on July 13. This view is dominated by the large, bright feature informally named the "heart," which measures approximately 1,600 km across. The heart borders darker equatorial terrains, and the mottled terrain to its east (right) are complex. However, even at this resolution, much of the heart's interior appears remarkably featureless—possibly a sign of ongoing geologic processes.

**Credits: NASA/APL/SwRI**

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## Pluto Special

*This special issue commemorates the successful flyby of the last planet in the original solar system. Pluto will always be a classical planet in our hearts, and judging by the "heart" feature Pluto displayed right off the bat, he is reaching out to us to be re-instated.*

*The 10-yr mission has reached its destination, but it actually started many years before with planning groups working on various incarnations of the "Pluto Mission". **Well done, team Pluto!** On to the Kuiper Belt!*

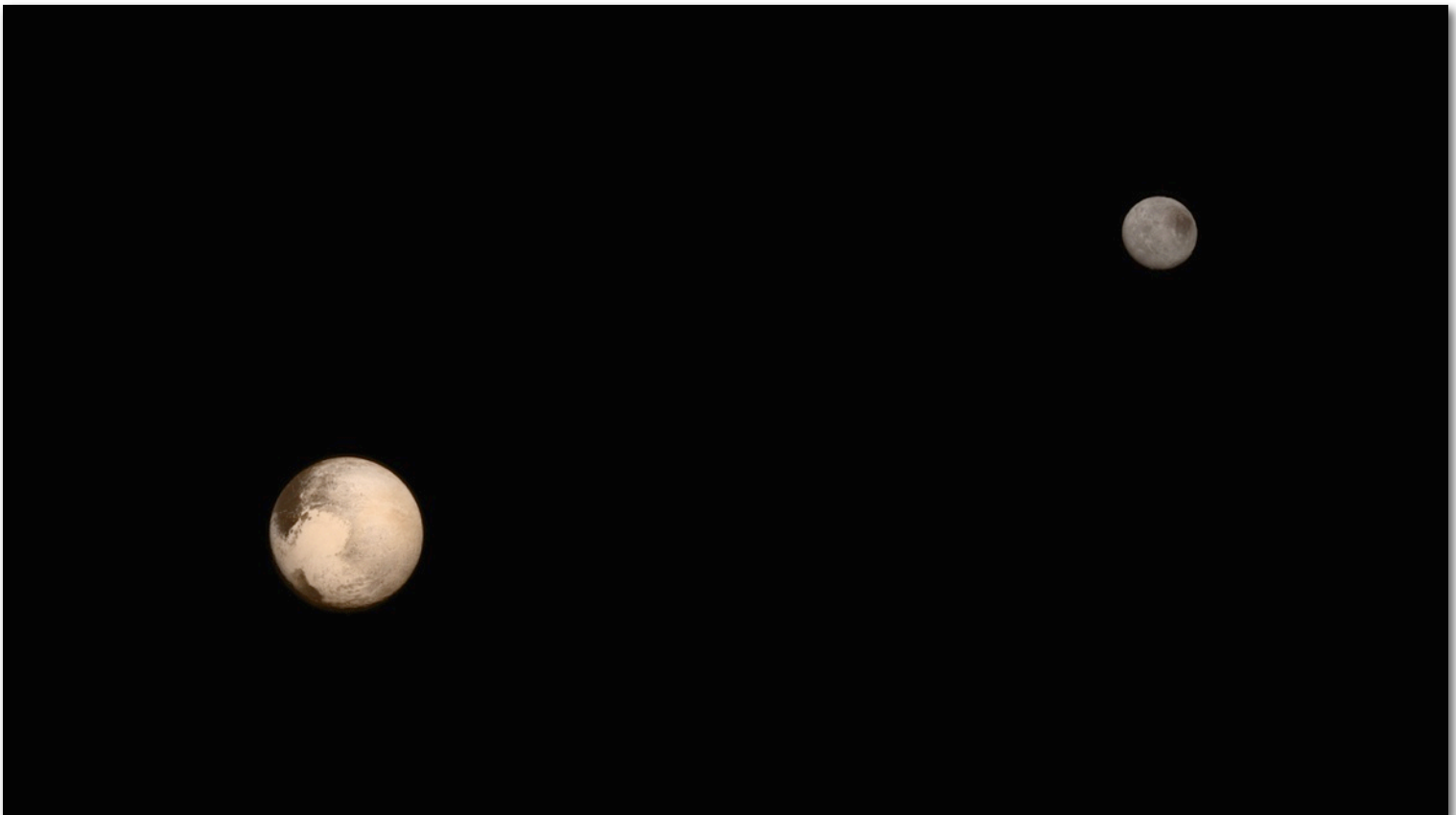
*An excellent summary is provided on Wikipedia here: [https://en.wikipedia.org/wiki/New\\_Horizons](https://en.wikipedia.org/wiki/New_Horizons)*

## Pluto and Charon: Finally Real Worlds

After nearly a decade of traversing the solar system, New Horizons has accomplished its mission! Providing the first closeup look at the dwarf planet Pluto and several of its moons, New Horizons skimmed by at a distance of 12 500 km at 7:49 am EDT July 14, 2015. Images, instrument measurements and housekeeping data will be coming in from the spacecraft over the next several months. The image below is a composite of Pluto and its moon Charon in true colour and shows the interesting feature dubbed the "heart" (tilted on its side). This later proved to be a flat ice-covered plain much like a glacier field on Earth. Features on

Charon also were seen but a interesting lack of impact craters on both objects indicates that the surface is reworked periodically by internal forces. This apparent activity was a bit of a surprise.

The pages that follow document the first results and include images (of course!) and other early scientific data that have been released at this first stage in the analysis. Results will be coming in from New Horizons over the next year or longer so this is just the first taste of new discoveries at the extreme edge of our solar system -an exciting era of Pluto exploration!



The latest two full-frame images of Pluto and Charon were collected separately by New Horizons during approach on July 13 and July 14, 2015. The relative reflectivity, size, separation, and orientations of Pluto and Charon are approximated in this composite image, and they are shown in approximate true color.

**Image Credit: NASA/JHUAPL/SWRI**

## Pluto Geologically Active? Details Surface

New close-up images of a region near Pluto's equator reveal a giant surprise: a range of youthful mountains rising up to 3,500 m above the surface of the icy body.

The mountains likely formed no more than 100 million years ago -- very young relative to the 4.56-billion-year age of the solar system -- and may still be in the process of building, says Geology, Geophysics and Imaging (GGI) team leader Jeff Moore of NASA's Ames Research Center. That suggests the close-up region, which covers less than one percent of Pluto's surface, may still be geologically active today.

Moore and his colleagues base the youthful age estimate on the lack of craters in this scene. Like the rest of Pluto, this region would presumably have been pummeled by space debris for billions of years and would have once been heavily cratered -- unless recent activity had given the region a facelift, erasing those pockmarks.

"This is one of the youngest surfaces we've ever seen in the solar system," says Moore.

Unlike the icy moons of giant planets, Pluto cannot be heated by gravitational interactions with a much larger planetary body. Some other process must be generating the mountainous landscape.

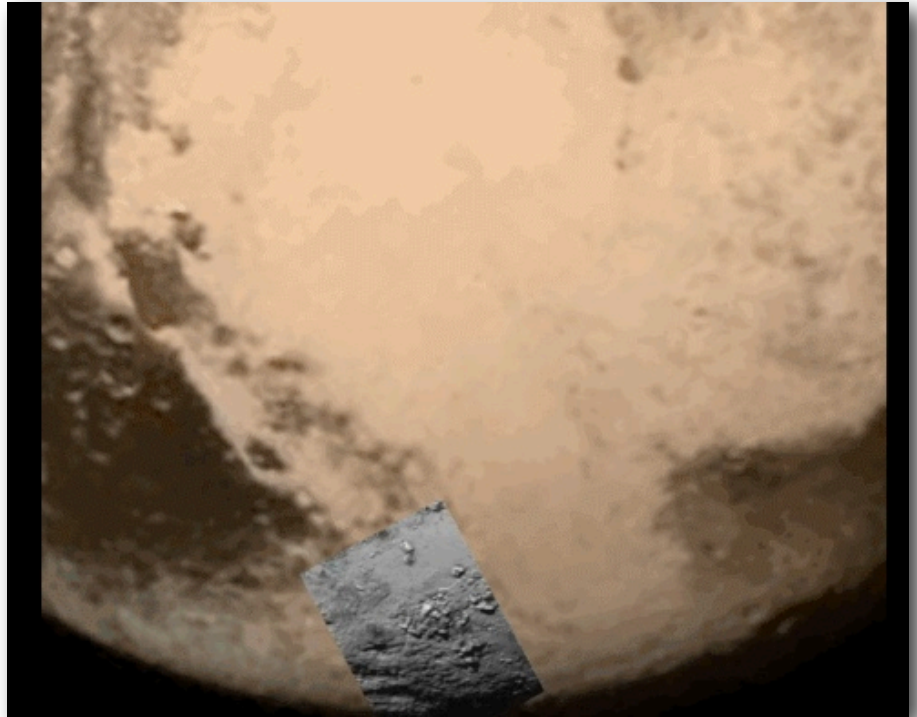
"This may cause us to rethink what powers geological activity on many other icy worlds," says GGI deputy team leader John Spencer of the Southwest Research Institute in Boulder, Colo.

The mountains are probably composed of Pluto's water-ice "bedrock."

Although methane and nitrogen ice covers much of the surface of Pluto, these materials are not strong enough to build the mountains. Instead, a stiffer material, most likely water-ice, created the peaks. "At Pluto's temperatures, water-ice behaves more like rock," said deputy GGI lead Bill McKinnon of Washington University, St. Louis.

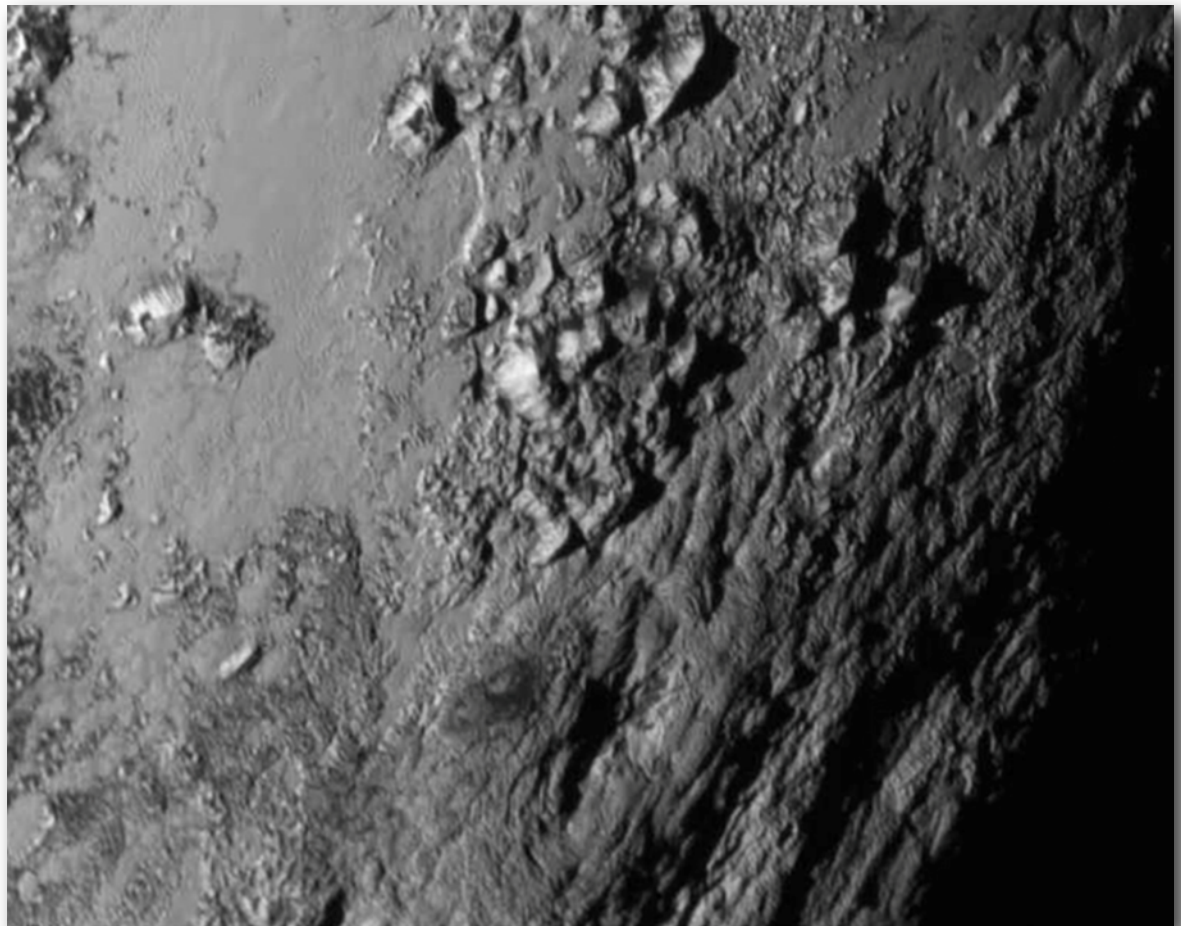
The close-up image was taken about 1.5 hours before New Horizons closest approach to Pluto, when the craft was 77,000 km from the surface of the planet. The image easily resolves structures smaller than a mile across.

**Image Credit: NASA-JHUAPL-SwRI**



Region in the B&W rectangle above superimposed on the lower edge of the the "heart" of Pluto is show in greater detail in the enlargement below. Image above was taken from long range before the close approach. Image below taken shortly before closest approach.

**Image Credits: NASA-JHUAPL-SwRI**



## Pluto's Companion: Charon

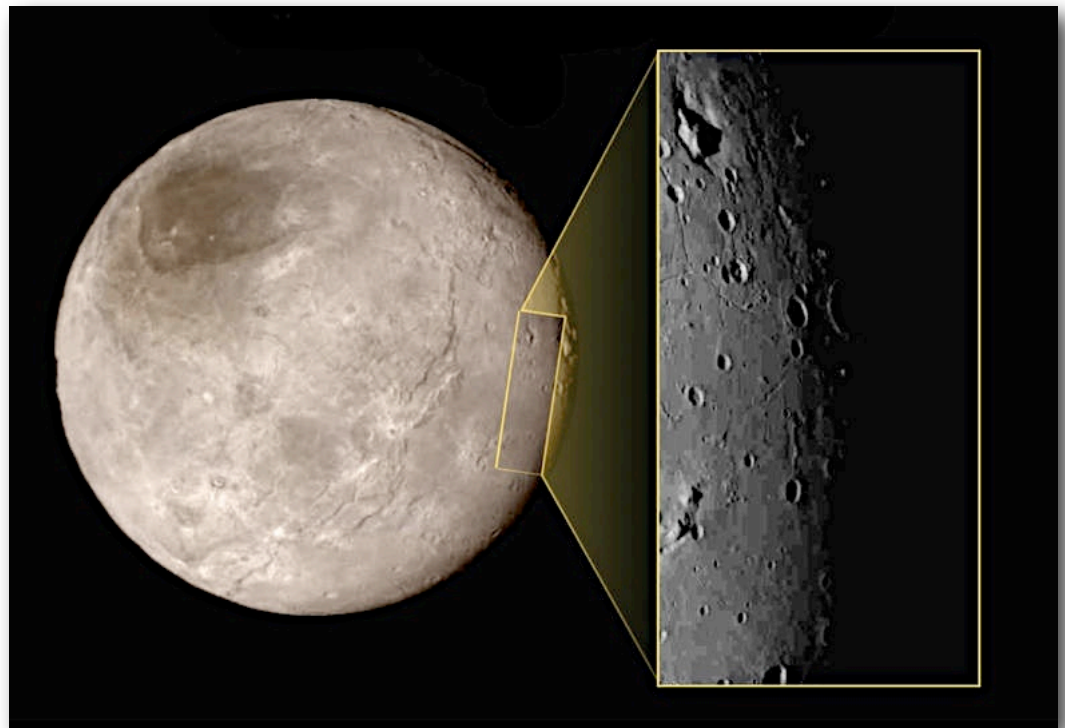
Remarkable new details of Pluto's largest moon Charon are revealed in this image from New Horizons' Long Range Reconnaissance Imager (LORRI), taken late on July 13, 2015 from a distance of 466,000 km.

A swath of cliffs and troughs stretches about 1,000 km from left to right, suggesting widespread fracturing of Charon's crust, likely a result of internal processes. At upper right, along the moon's curving edge, is a canyon estimated to be 7 to 9 km deep.

Mission scientists are surprised by the apparent lack of craters on Charon. South of the moon's equator, at the bottom of this image, terrain is lit by the slanting rays of the sun, creating shadows that make it easier to distinguish topography. Even here, however, relatively few craters are visible, indicating a relatively young surface that has been reshaped by geologic activity.

In Charon's north polar region, a dark marking prominent in New Horizons' approach images is now seen to have a diffuse boundary, suggesting it is a thin deposit of dark material. Underlying it is a distinct, sharply bounded, angular feature; higher resolution images still to come are expected to shed more light on this enigmatic region.

The image has been compressed to reduce its file size for transmission to Earth. In high-contrast areas of the image, features as small as 5 km across can be seen. Some lower-contrast detail is obscured by the compression of the image, which may make some



This new image of an area on Pluto's largest moon Charon has a captivating feature -- a depression with a peak in the middle, shown here in the upper left corner of the inset. The image shows an area approximately 390 km from top to bottom, including few visible craters. The image was taken at approximately 6:30 a.m. EDT on July 14, 2015, about 1.5 hours before closest approach to Pluto, from a range of 79,000 km. **Credits: NASA-JHUAPL-SwRI**

areas appear smoother than they really are. The uncompressed version still resides in New Horizons' computer memory and is scheduled to be transmitted at a later date.

The image has been combined with color information obtained by New Horizons' Ralph instrument on July 13.

## Methane Ice Detected on Pluto

The latest spectra from New Horizons Ralph instrument reveal an abundance of methane ice, but with striking differences from place to place across the frozen surface of Pluto.

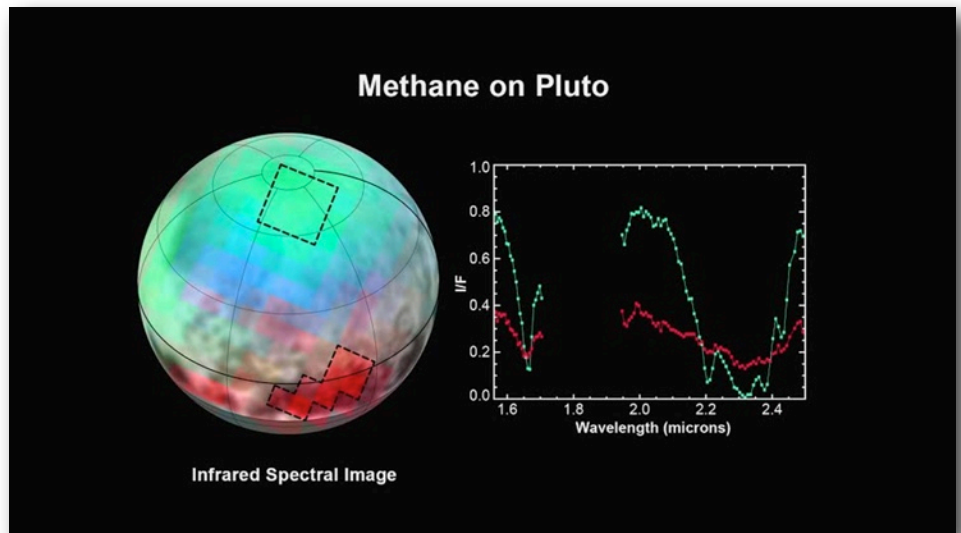
"We just learned that in the north polar cap, methane ice is diluted in a thick, transparent slab of nitrogen ice resulting in strong absorption of infrared light," said New Horizons co-investigator Will Grundy, Lowell Observatory, Flagstaff, Arizona. In one of the visually dark equatorial patches, the methane ice has shallower infrared absorptions indicative of a very different texture. "The spectrum appears as if the ice is less diluted in nitrogen," Grundy speculated "or that it has a different texture in that area."

An Earthly example of different textures of a frozen substance: a fluffy bank of clean snow is bright white, but compacted polar ice looks blue.

This is the first detailed image of Pluto from the Linear Etalon Imaging Spectral Array, part of the Ralph instrument on New Horizons. The two areas outlined on Pluto show where Ralph observations obtained the spectral traces at the right. Note that the methane absorptions (notable dips) in the

spectrum from the northern region are much deeper than the dips in the spectrum from the dark patch. The Ralph data were obtained by New Horizons on July 12, 2015.

Image Credit: NASA-JHUAPL-SwRI



Infrared Spectral Image

In the latest data from NASA's New Horizons spacecraft, a new close-up image of Pluto reveals a vast, craterless plain that appears to be no more than 100 million years old, and is possibly still being shaped by geologic processes. This frozen region is north of Pluto's icy mountains, in the center-left of the heart feature, informally named "Tombaugh Regio" (Tombaugh Region) after Clyde Tombaugh, who discovered Pluto in 1930.

"This terrain is not easy to explain," said Jeff Moore, leader of the New Horizons Geology, Geophysics and Imaging Team (GGI) at NASA's Ames Research Center in Moffett Field, California. "The discovery of vast, craterless, very young plains on Pluto exceeds all pre-flyby expectations."

This fascinating icy plains region -- resembling frozen mud cracks on Earth -- has been informally named "Sputnik Planum" (Sputnik Plain) after the Earth's first artificial satellite. It has a broken surface of irregularly-shaped segments, roughly 12 miles (20 kilometers) across, bordered by what appear to be shallow troughs. Some of these troughs have darker material within them, while others are traced by clumps of hills that appear to rise above the surrounding terrain. Elsewhere, the surface appears to be etched by fields of small pits that may have formed by a process called sublimation, in which ice turns directly from solid to gas, just as dry ice does on Earth.

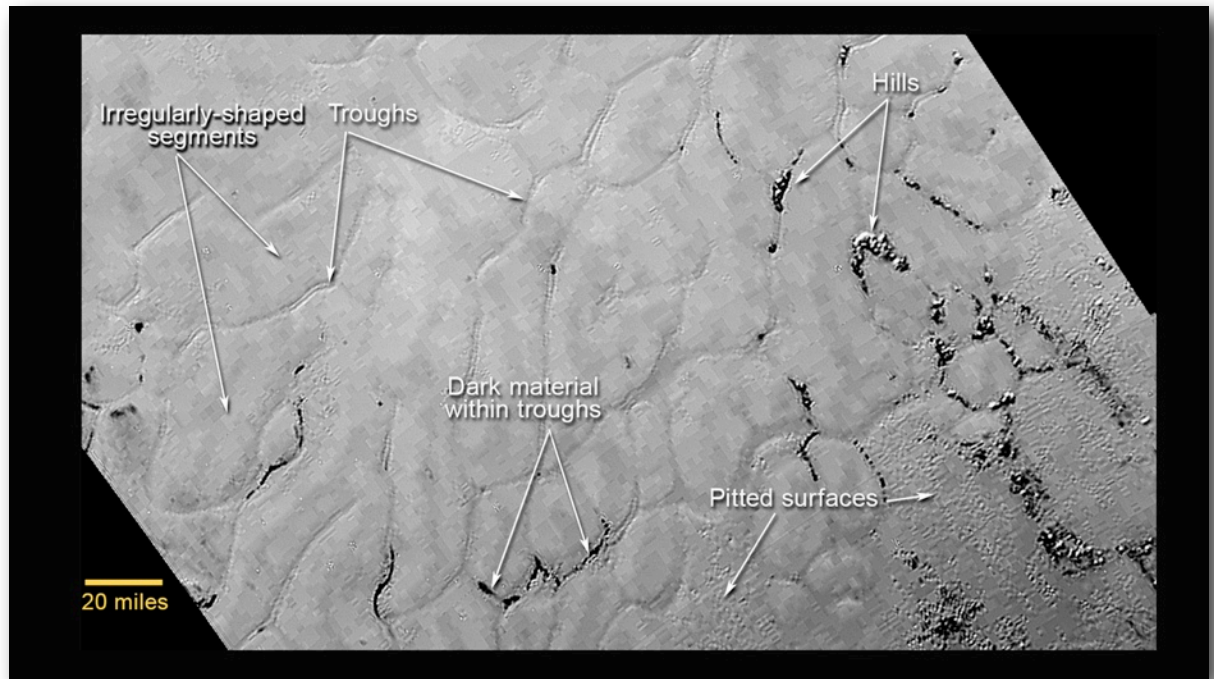
Scientists have two working theories as to how these segments were formed. The irregular shapes may be the result of the contraction of surface materials, similar to what happens when mud dries. Alternatively, they may be a product of convection, similar to wax rising in a lava lamp. On Pluto, convection would occur within a surface layer of frozen carbon monoxide, methane and nitrogen, driven by the scant warmth of Pluto's interior.

Pluto's icy plains also display dark streaks that are a few miles long. These streaks appear to be aligned in the same direction and may have been produced by winds blowing across the frozen surface.

The Tuesday "heart of the heart" image was taken when New Horizons was 77,000 km from Pluto, and shows features as small as 1 km across. Mission scientists will learn more about these mysterious terrains from higher-resolution and stereo images that New Horizons will pull from its digital recorders and send back to Earth during the next year.

The New Horizons Atmospheres team observed Pluto's atmosphere as far as 1,600 km above the surface, demonstrating that Pluto's nitrogen-rich atmosphere is quite extended. This is the first observation of Pluto's atmosphere at altitudes higher than 270 km.

The New Horizons Particles and Plasma team has discovered a region of cold, dense ionized gas tens of thousands of miles beyond



Pluto -- the planet's atmosphere being stripped away by the solar wind and lost to space.

"This is just a first tantalizing look at Pluto's plasma environment," said New Horizons co-investigator Fran Bagenal, University of Colorado, Boulder.

"With the flyby in the rearview mirror, a decade-long journey to Pluto is over --but, the science payoff is only beginning," said Jim Green, director of Planetary Science at NASA Headquarters in Washington. "Data from New Horizons will continue to fuel discovery for years to come."

Alan Stern, New Horizons principal investigator from the Southwest Research Institute (SwRI), Boulder, Colorado, added, "We've only scratched the surface of our Pluto exploration, but it already seems clear to me that in the initial reconnaissance of the solar system, the best was saved for last."

New Horizons is part of NASA's New Frontiers Program, managed by the agency's Marshall Space Flight Center in Huntsville, Alabama. The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, designed, built and operates the New Horizons spacecraft and manages the mission for NASA's Science Mission Directorate. SwRI leads the mission, science team, payload operations and encounter science planning.

Follow the New Horizons mission on [Twitter](#) and use the hashtag #PlutoFlyby to join the conversation. Live updates are also available on the mission [Facebook page](#).

For more information on the New Horizons mission, including fact sheets, schedules, video and new images, visit: <http://www.nasa.gov/newhorizons>

See page 12 for another take on the "heart" of Pluto and other features on the surface of Pluto. Randall Munroe, publisher of [www.xkcd.com](http://www.xkcd.com) a website of daily cartoons, provides his unique perspective of the newly revealed face of our most famous dwarf planet.

**After Pluto -then what?**

After launch a search was begun to determine if there were any Kuiper Belt objects (KBOs) that could be reached by New Horizons after it had passed Pluto. On October 15, 2014, the Hubble ST search uncovered three Potential Targets, designated PT1 , PT2 and PT3. All are objects with estimated diameters in the 30–55 km range, and could be reached in the 2018–2019 period.

**PT1 : 2014 MU69**

PT1 is the most favorably situated object. At 30–45 km in diameter it would be encountered around January 2019. A course to reach it would require about 35% of *New Horizons* available fuel.

**PT2 : 2014 OS393**

This object is no longer under consideration as a target for New Horizons.

**PT3 : 2014 PN70**

PT3 is currently the second choice as a target for New Horizons. It's diameter is between 35–120 km and is positioned for a potential encounter in 2019. A mission to PT3 may be preferable, because it is brighter and therefore probably larger than PT1.

The New Horizons KBO target will be chosen in August 2015.

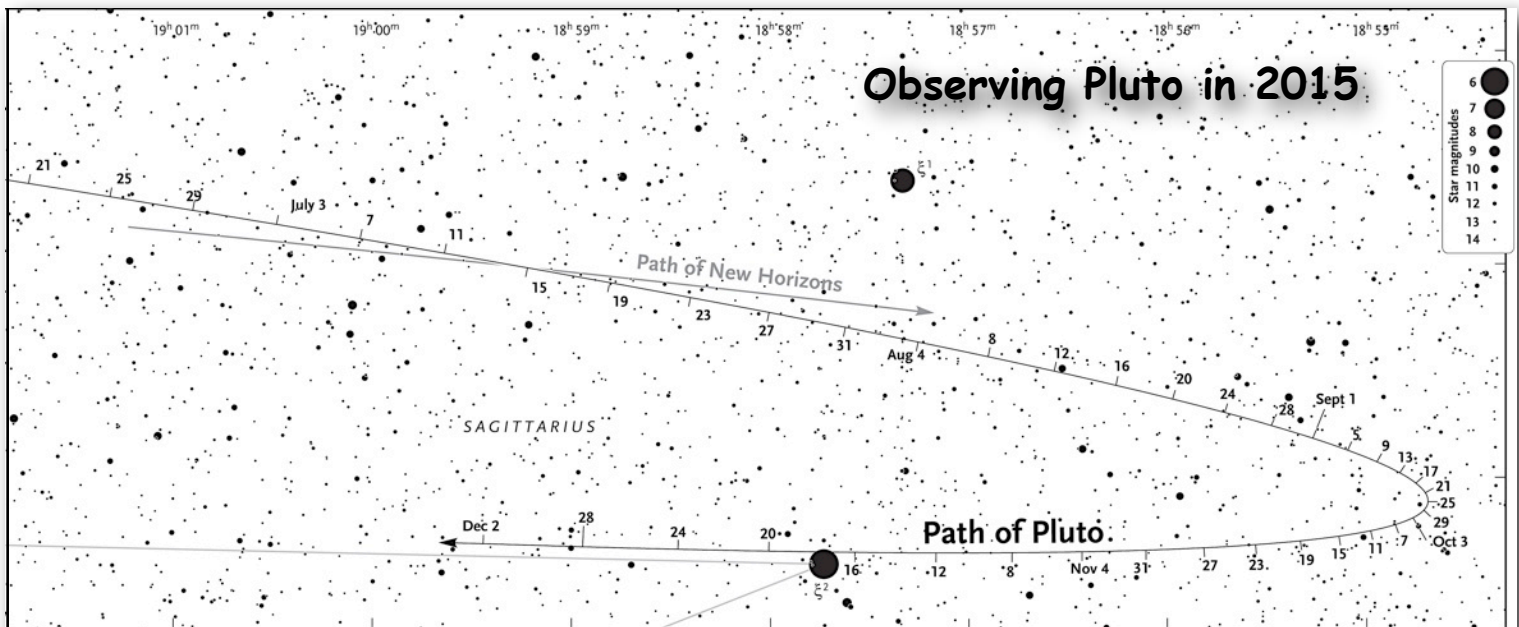
**New Horizons' Current Status**



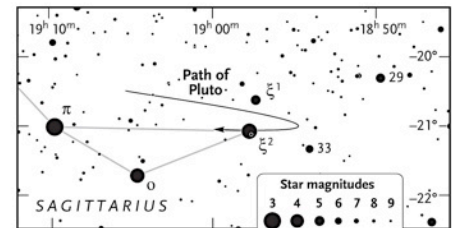
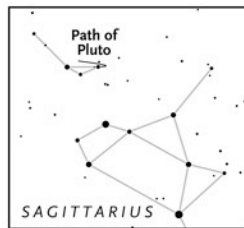
JPL has an ongoing readout that shows NH distance from Earth and the Mission Elapsed Time. New Horizons is now over 10 million km past Pluto and heading out into the Kuiper Belt.

Time for a message to reach the spacecraft (one way) is about 4.5 h

Screen snap July 23 about 8 am



**Path of Pluto  
July 21 to Dec 2 2015**



**Challenge: Pluto in your Telescope**

The map above (a portion of the chart from Sky and Telescope) shows the path of Pluto through the sky from now to the start of December. It is not easy to spot Pluto with you telescope, but it is not impossible. Here are some hints to help you succeed. First you need at least an 8-inch telescope, a 10 or 12 is better. Pick a dark, clear night with no moonlight and print off a copy of the chart for the area you will observe. Get a paper copy and a red flashlight, you do not want to spoil your night vision with a computer or cell

phone screen. Know the field of view of your favourite low and medium power eyepiece so you can match the star field with what you see. Forget the high power eyepieces, you are not going to see any surface features or even a disc. Once you spot Pluto make a note of the location on your chart, then come back a few nights later to see that it has moved. This is the only way to confirm that you really did see Pluto. Those that have seen it twice this way will scoff at you if you do not do likewise. Only then will you be allowed to join the "Pluto-at-last!" club.

## New Horizons 'Captures' Two of Pluto's Smaller Moons

While Pluto's largest moon, Charon, has grabbed most of the lunar spotlight, two of Pluto's smaller and lesser-known satellites are starting to come into focus via new images from NASA's New Horizons spacecraft.

Nix and Hydra – the second and third moons to be discovered – are approximately the same size, but their similarity ends there.

New Horizons' first color image of Nix, in which colors have been enhanced, reveals an intriguing region on the jelly bean-shaped satellite, which is estimated to be 26 miles (42 kilometers) long and 22 miles (36 kilometers) wide.

Although the overall surface color of Nix is neutral grey in the image, the newfound region has a distinct red tint. Hints of a bull's-eye pattern lead scientists to speculate that the reddish region is a crater.

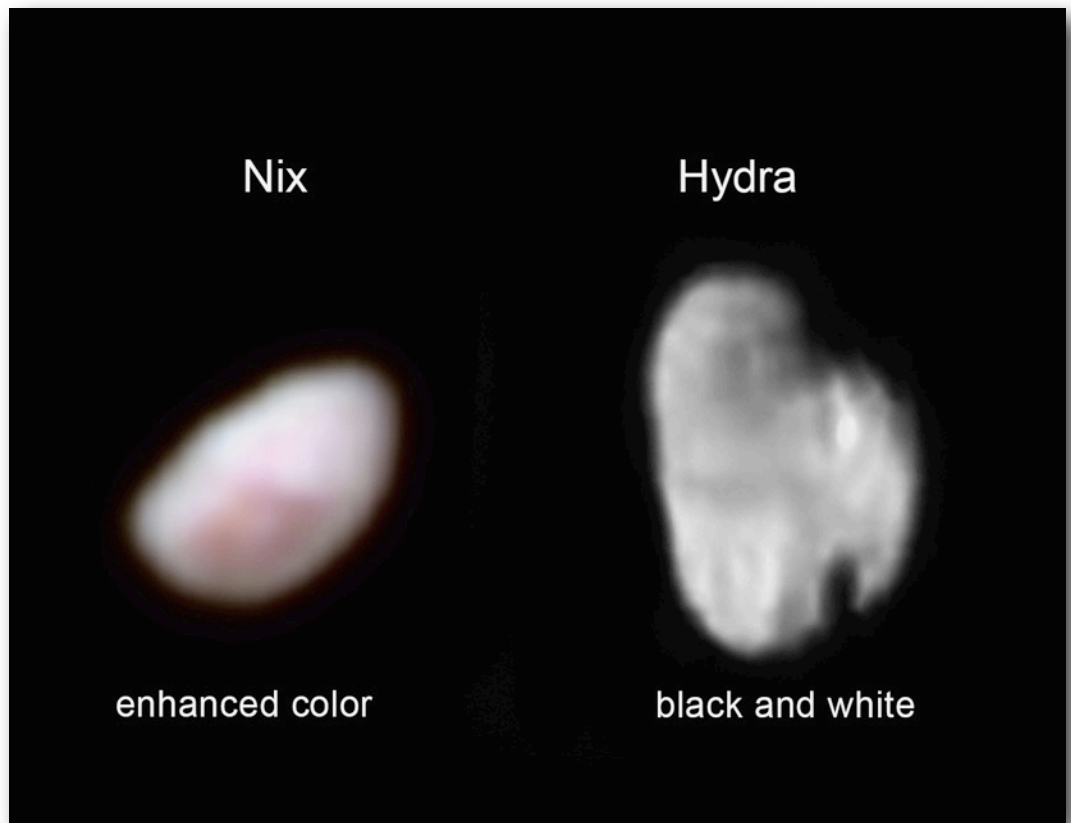
"Additional compositional data has already been taken of Nix, but is not yet downlinked. It will tell us why this region is redder than its surroundings," said mission scientist Carly Howett, of the Southwest Research Institute, Boulder, Colorado. She added, "This observation is so tantalizing, I'm finding it hard to be patient for more Nix data to be downlinked."

Meanwhile, the sharpest image yet received from New Horizons of Pluto's satellite Hydra shows that its irregular shape resembles the state of Michigan. The new image was made by the Long Range Reconnaissance Imager (LORRI) on July 14, 2015 from a distance of 143,000 miles (231,000 kilometers), and shows features as small as 0.7 miles (1.2 kilometers) across. There appear to be at least two large craters, one of which is mostly in shadow. The upper portion looks darker than the rest of Hydra, suggesting a possible difference in surface composition. From this image, mission scientists have estimated that Hydra is 34 miles (55 kilometers) long and 25 miles (40 kilometers) wide.

"Before last week, Hydra was just a faint point of light, so it's a surreal experience to see it become an actual place, as we see its shape and spot recognizable features on its surface for the first time," said mission science collaborator Ted Stryk, of Roane State Community College in Tennessee.

Images of Pluto's most recently discovered moons, Styx and Kerberos, are expected to be transmitted to Earth no later than mid-October.

Nix and Hydra were both discovered in 2005 using Hubble Space Telescope data by a research team led by New Horizons project scientist Hal Weaver, Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland. New Horizons' findings on the surface characteristics and other properties of Nix and Hydra will help scientists understand the origins and subsequent history of Pluto and its moons.



Pluto's moon Nix (left), shown here in enhanced color as imaged by the New Horizons Ralph instrument, has a reddish spot that has attracted the interest of mission scientists. Data were obtained on July 14, 2015, and received July 18. At the time the observations were taken New Horizons was about 165,000 km from Nix. Features as small as 3 km across are seen. Nix is about 42 km by 36 km.

Pluto's small, irregularly shaped moon Hydra (right) was imaged in this B&W by LORRI on July 14, 2015 from a distance of about 231,000 km. Features as small as 1.2 km are visible on Hydra, which measures 55 km in length.

**Credit:** NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute

**Below:** Pluto's Moon orbits and positions at the time of flyby.



NASA provided these illustrations to depict the New Horizons 9-year plus mission. Launch date was Jan 19, 2006. Interestingly, some children that were in the audience at the main press briefing on July 14 were between 9 and 10 years old, being born around the time of the launch. Equally interesting was a comment of one of the project scientists in an interview on the Youtube SciShow. He said that he had not been born when the previous flyby, Voyager at Neptune, occurred in Aug of 1989! I remember well the live views that were provided at Starfest that year. So the Pluto flyby culminates the 50 or so years of reconnaissance of the solar system that started in 1959 with the first closeup images of the Moon by Luna-3. And what a finale!

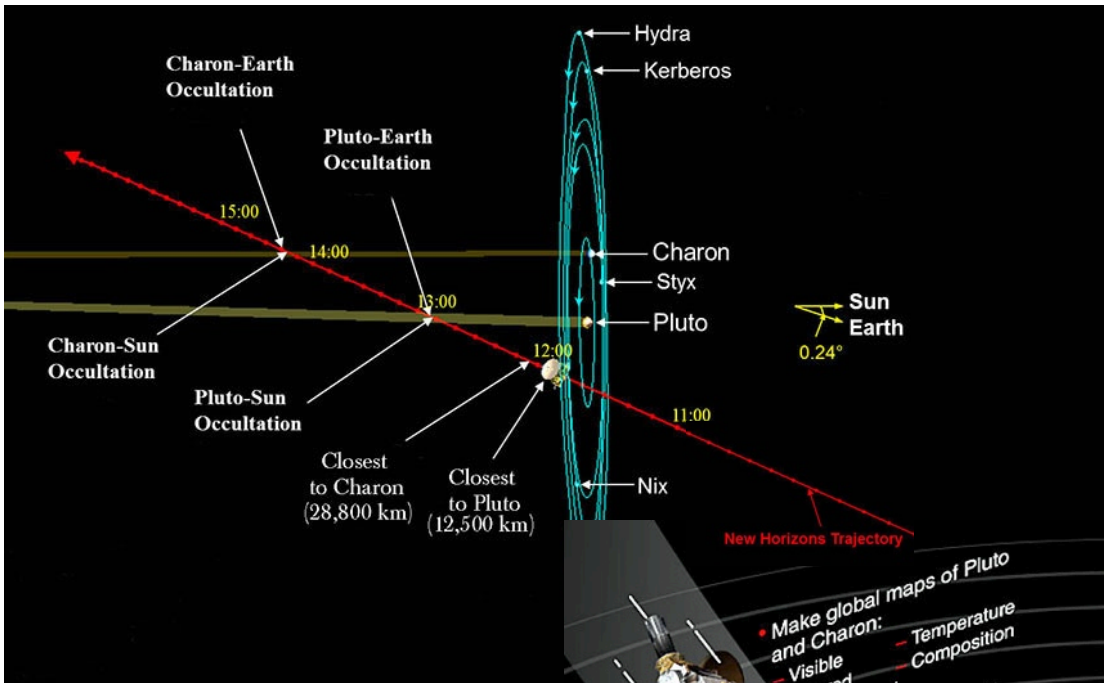
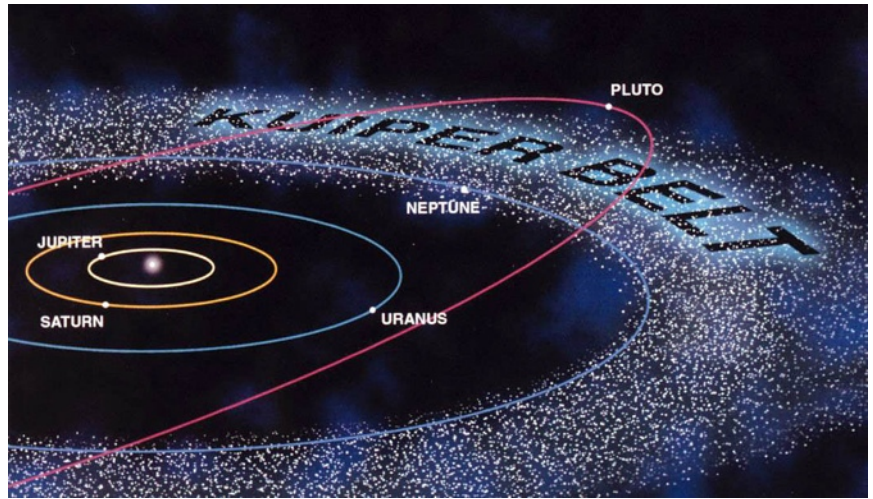
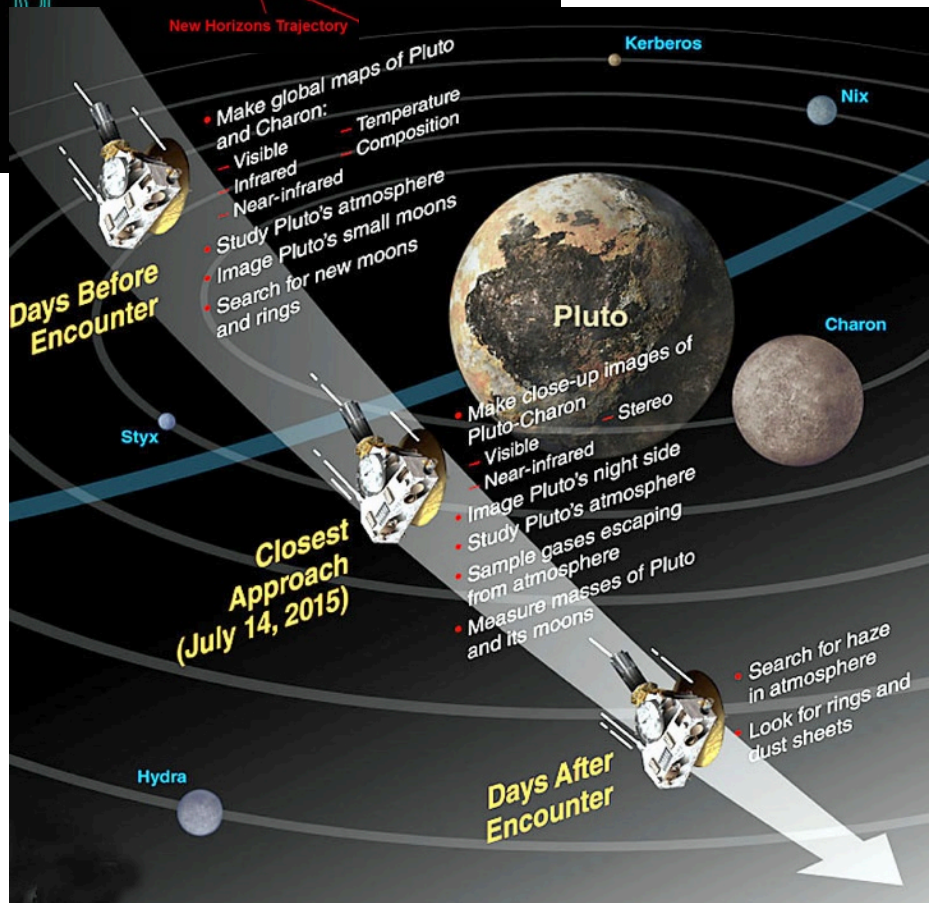


Illustration above shows the path (red line) of the last year or so of the 9½ year mission (which will continue beyond the Kuiper Belt). Launch date was Jan 19, 2006, and New Horizons passed Neptune in Aug, 2014 enroute to a rendezvous with Pluto about a year later. Note that Pluto is one of the outliers of the Kuiper Belt that contains hundreds of small “planets” between the orbits of Neptune and Pluto.

Illustration above shows the last 5 hours or so of the Pluto flyby -such a short time after such a long coast! The closest point of 12 500 km was a busy time for science measurements and imaging, so the vehicle was in radio silent mode to maximize data accumulation. While some of the closeup images will be relayed to Earth fairly quickly, the full resolution images will take longer to transmit and will be sent over the next several months.

Diagram right shows how busy the spacecraft was during the few minutes of the flyby and how much was accomplished by the vehicle in the time available. It successfully imaged Pluto and Charon and several of the smaller moons, as well and measured the atmospheric gases above Pluto and its temperature, mass, composition and a host of other factors. There was enough time in this mission to modify the flight plan as conditions changed and hazards like potentially lethal dust particles in Pluto’s vicinity proved to be non-issues.



## Talking to Pluto is hard!

Why it takes so long to get data back from New Horizons (edited by SGN)  
Posted by [Emily Lakdawalla](#)  
2015/01/30 15:53 UTC



The short answer to that question is: Pluto is far away -- very far away, more than 30 times Earth's distance from the Sun -- so New Horizons' radio signal is weak. Weak signal means low data rates: at the moment, New Horizons can transmit at most 1 kilobit per second. (Note that spacecraft communications are typically measured in bits, not bytes; 1 kilobit is only 125 bytes.) Even at these low data rates, only the Deep Space Network's very largest, 70-meter dishes can detect New Horizons' faint signal.

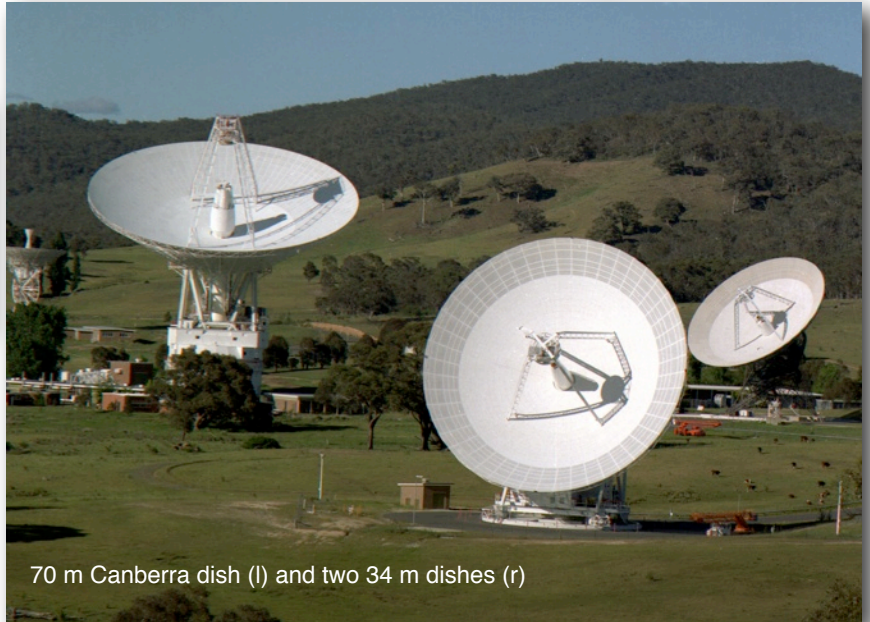
How much data is in a single LORRI image? (Long Range Reconnaissance Imager, is New Horizons' highest-resolution camera.) LORRI's detector is 1024 pixels square. Fortunately LORRI's images are amenable to lossless compression, especially now when they contain mostly black space; they can be zipped up to about 2.5 Megabits without any loss of detail.

So, do the math. 2.5 Megabits, at 1 kilobit per second: it takes 42 minutes to return one LORRI photo to Earth. Most communications sessions last about eight hours. That's eleven images per communications session. And that assumes that New Horizons is transmitting only LORRI data, which it's not; there are other science instruments and spacecraft housekeeping data, too. The Deep Space Network has only three 70-meter dishes, and there is a lot of competition for time on them; New Horizons is lucky to get one communications session per day. And while New Horizons is pointing its dish at Earth, it can't point at anything else, including Pluto. It has to choose between communicating and taking data.

What all of this means is that whenever New Horizons is actively taking science data, it's building up a data backlog, which it fails to transmit completely in its next communications session. The New Horizons team wants to go into the close encounter phase with data recorders as empty as possible, clearing the decks for all that juicy data from the flyby. What to do?

They have a neat trick that can nearly double New Horizons' data transmission rate, but it comes at a cost of doing simultaneous science. New Horizons' radio system includes two Traveling Wave Tube Amplifiers or TWTAs (pronounced "twittas," like a Bostonian would say "twitters"). The TWTAs amplify the radio signals before they get broadcast from New Horizons' 2.1-meter dish. There are two TWTAs for redundancy: if one fails, the mission will still be able to return data to Earth. [Here Lakdawalla goes into the technical details which you can access here: <http://www.planetary.org/blogs/emily-lakdawalla/2015/01300800-talking-to-pluto-is-hard.html> ]

Amazingly, they [controllers] can shut down their guidance and control system and use the saved power to run the second transmitter [to power up the TWTAs]. But how can you point stably at Earth with your guidance system shut down? The answer is to turn New Horizons from a spacecraft whose orientation stays fixed in space to one that spins. Spinning spacecraft have incredibly stable pointing. It's costly in terms of precious hydrazine fuel to spin up and spin down the spacecraft, so they don't want to make



70 m Canberra dish (l) and two 34 m dishes (r)

the transition from three-axis to spin-stabilized very often. And you can't take photos from a spinning spacecraft (not with the cameras New Horizons has, anyway). But it's worth it to spend a little hydrazine and quit taking pictures a couple of times in order to get all the approach data down to Earth before the near-encounter phase starts.

So that's why New Horizons is going to spend two long periods of its Pluto approach taking no image data, with the spacecraft spinning and its high-gain antenna pointed at Earth. The two spin periods are scheduled right after trajectory correction maneuvers, rocket-firings that will fine-tune New Horizons' path past Pluto. And while the spacecraft is spinning, its particles instruments SWAP, PEPSSI, and SDC can all still take data.

New Horizons should be able to use this two-TWTA communication mode until well after the flyby, assuming, of course, that both transmitters remain healthy. It'll still take more than a year to get all the science data from the encounter back to Earth; it's a lot of data, and a skinny pipe. And it won't be able to use the two-TWTA communication mode forever. Eventually, the output of the nuclear power supply will decay to the point that even while spinning, New Horizons won't have enough power to run both transmitters simultaneously, and we'll be back to using just one at a time. The Kuiper belt object flyby will almost certainly require data return through only one transmitter. New Horizons is a lesson in patience!

[Emily Lakdawalla](#) blogs for the Planetary Society whose mission is to empower the world's citizens to advance space science and exploration.

Planetary Society home page is here: <http://www.planetary.org/>



## Doing Science at Pluto

Posted by [Emily Lakdawalla](#)  
2014/12/04 01:40 UTC

It's been a long journey, but it's nearly over: New Horizons is just about ready to begin its science mission to Pluto, Charon, Styx, Nix, Kerberos, and Hydra. The spacecraft has spent most of its decade-long trip napping in a hibernation mode that required little energy from either the spacecraft or its human controllers, but this snoozy phase ends this weekend. On December 7 at 02:30 UT ( December 6 at 18:30 PT), New Horizons will wake up for the final time; it will remain awake and alert for two years. The Planetary Society's Mat Kaplan will be hosting a video event during the wakeup, so you can watch with us as we wait for that all-important beep that signals that New Horizons is ready to begin work.

New Horizons' flyby of Pluto happens on July 14, 2015 at 11:50 UT, but it will begin gathering science data in January and will not finish returning all of the data until late 2016. Let's take a look at the spacecraft we have sent on this journey, and at the work it's about to begin.

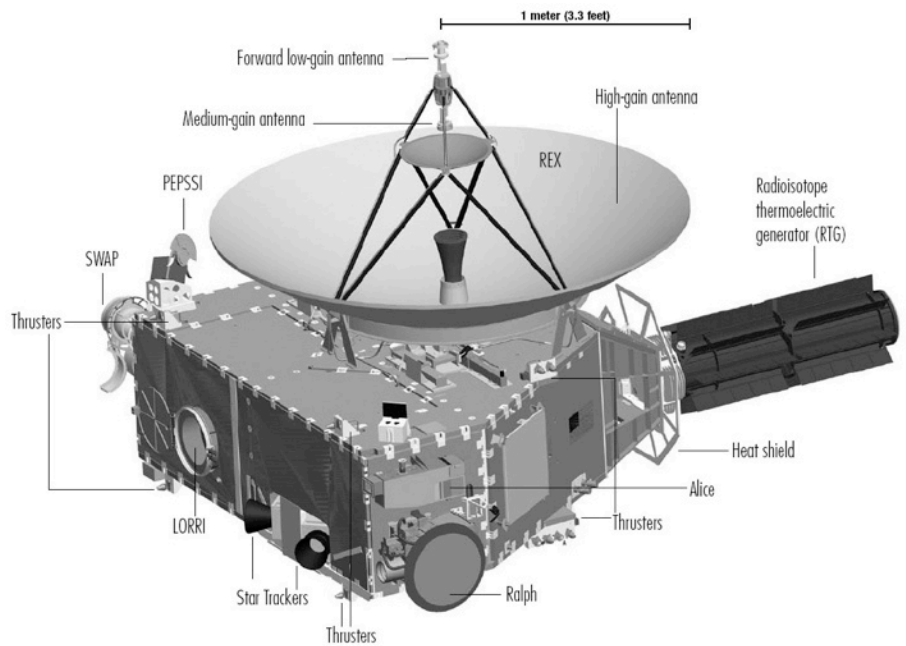
### New Horizons' Instruments

What New Horizons can tell us about the worlds of the Pluto system depends upon the capabilities of its instruments. New Horizons is by far the smallest spacecraft ever sent to the outer solar system, and its instrument package is sized to match, weighing only 30.4 kilograms. For comparison, Cassini's camera instrument alone weighs 57.8 kilograms. In general, mass serves as a proxy for instrument capability, but the New Horizons engineers took advantage of every opportunity to miniaturize components and made careful (and sometimes painful) selections of instrument capabilities in order to make the most of the mission's relatively tiny payload.

New Horizons has seven science instruments. Spacecraft instruments come in two main flavors: remote sensing (which look at things from far away using various parts of the electromagnetic spectrum) and in situ instruments (which measure things directly sensed at the position of the spacecraft, including magnetic fields and ions, dust, or other particles).

Remote sensing instruments include:

- **Alice**, an ultraviolet spectrometer seeing wavelengths from 46.5 to 188 nanometers and a spatial resolution of 5 milliradians per pixel. Primarily for studying Pluto's atmosphere, it is similar to the instrument of the same name on Rosetta.
- **Ralph**, which consists of two sub-instruments, **MVIC** and **LEISA**. MVIC is a multispectral imager with 5 channels in visible and near-infrared wavelengths from 400 to 975 nanometers and a spatial resolution of 20 microradians per pixel. It has a wide field of view and color imaging capability. There are panchromatic, blue, red, methane, and near-infrared channels (note the lack of a green channel, which means that some kind of simulation and/or manipulation of color channels is necessary to produce "true" color images from New Horizons data). LEISA is an infrared imaging spectrometer spanning 1.25 to 2.5 microns, for measuring composition and temperatures of surfaces.



- **LORRI** is a camera sensitive to wavelengths of 350 to 850 nanometers. It has very high resolution of 5 microradians per pixel so is used for detailed imaging as well as long-range optical navigation. It is monochrome, so the best images from New Horizons will be black-and-white, but LORRI images can readily be colorized with lower-resolution MVIC data.
- **REX** can perform 4.2-centimeter radiometry and will perform uplink radio occultations of Pluto's atmosphere (that is, it will send a radio signal through the atmosphere to giant radio dishes on Earth).

In-situ instruments include:

- **PEPSSI** (Pluto Energetic Particle Spectrometer Science Investigation) has 12 channels spanning higher energies of 1 to 1000 keV, designed to study pickup ions from Pluto's escaping atmosphere.
- **SWAP** (Solar Wind at Pluto) is a solar wind analyzer sensitive to lower-energy particles, from 25 eV to 7.5 keV.
- The **Venetia Burney Student Dust Counter** measures size distribution and density of particles with masses greater than a picogram; it has been active throughout the long cruise.

[Emily Lakdawalla](#) blogs for the Planetary Society whose mission is to empower the world's citizens to advance space science and exploration.

Planetary Society home page is here: <http://www.planetary.org/>





**Pluto Has Been Brought to You  
by the Folks at Jet Propulsion Lab (JPL),  
Southwest Research Institute (SwRI),  
John Hopkins University Applied Physics Lab (APL)  
and NASA**

New Horizons Principal Investigator Alan Stern of Southwest Research Institute (SwRI), Boulder, CO. celebrates with New Horizons Flight Controllers after they received confirmation from the spacecraft that it had successfully completed the flyby of Pluto, Tuesday, July 14, 2015 in the Mission Operations Center (MOC) of the Johns Hopkins University Applied Physics Laboratory (APL), Laurel, Maryland.



*Women make up approximately 25 percent of the New Horizons flyby team. The female team members were photographed at Johns Hopkins University Applied Physics Laboratory on July 11, 2015, just three days before the spacecraft's closest approach to Pluto. Kneeling from left to right: Amy Shira Teitel, Cindy Conrad, Sarah Hamilton, Allisa Earle, Leslie Young, Melissa Jones, Katie Bechtold, Becca Sepan, Kelsi Singer, Amanda Zangari, Coralie Jackman, Helen Hart. Standing, from left to right: Fran Bagenal, Ann Harch, Jillian Redfern, Tiffany Finley, Heather Elliot, Nicole Martin, Yanping Guo, Cathy Olkin, Valerie Mallder, Rayna Tedford, Silvia Protopapa, Martha Kusterer, Kim Ennico, Ann Verbiscer, Bonnie Buratti, Sarah Bucior, Veronica Bray, Emma Birath, Carly Howett, Alice Bowman. Not pictured: Priya Dharmavaram, Sarah Flanigan, Debi Rose, Sheila Zurvalec, Adriana Ocampo, Jo-Anne Kierzkowsk Sheila Zurvaleci.*

**Credits: SwRI/JHUAPL**

Pluto Humour  
c/o Randall Munroe

**Randall Munroe** is the author of the #1 New York Times bestseller *What If?*, the science question-and-answer blog *What If*, and the popular webcomic *xkcd*. A former NASA roboticist, he left the agency in 2006 to draw comics on the Internet full-time.

# PLUTO

SOME OF THE FEATURES ALREADY IDENTIFIED IN TODAY'S NEW HORIZONS IMAGE

