Journey to the Solar System's Third Zone

When New Horizons reaches Pluto in July, it will close one era of space exploration and open an exciting new one.

S. Alan Stern
This July, NASA’s *New Horizons* spacecraft will complete a 9-year, 5-billion-kilometer journey from Earth to the frontier of the Solar System, where it will undertake the first close study of Pluto and its astonishingly diverse system of satellites. It will be a raw act of exploration unparalleled since NASA’s *Voyager* missions to the giant planets in the late 1980s. Nothing quite like it has occurred in decades, and nothing like it is set to happen again in our lifetimes.

When most of us were taught basic astronomy in grade school, we learned that the Solar System consists of 4 inner rocky planets (the “terrestrials”), four outer giant, gaseous planets (“the Jovians”), and one small misfit: Pluto. But that was old-school science, limited by mid-20th century technologies that prevented us from seeing the cosmos as it truly is.

Beginning in the 1990s, planetary scientists—by then armed with large telescopes, high-sensitivity digital cameras, and fast computers—discovered that Pluto is no misfit at all. It is simply the brightest member of a vast population of objects orbiting beyond the Jovians: an entire third zone of the solar system. This region, first hypothesized in the 1940s by Gerard Kuiper, is now called the Kuiper Belt. It is littered with a diverse array of comets and small planets, of wildly varying sizes. Pluto is both the largest (2,350 kilometers wide) of them and the first discovered, decades before the rest. The Kuiper Belt is, in turn, by far the largest zone of our planetary system.

*New Horizons* has flown for more than nine years to reach this distant shore. In the months around its closest approach on July 14 of this year, the probe will conduct a detailed survey of Pluto, its array of moons, and its surroundings. In doing so it will also perform the first exploration of the Kuiper Belt—the opening of an entirely new astronomical frontier.

Right now we know ridiculously little about Pluto. We know it has an atmosphere consisting largely of nitrogen, like our Earth’s though drastically less dense. It has an ultra-cold crust covered with ices of nitrogen, carbon monoxide, and methane. It has at least five moons, polar caps, and an interior that is primarily composed—surprisingly—of rock. Most important, we know that Pluto is the archetype for an entire class of planets that have never been explored. Beyond that, it is a mystery, a virgin world. Who knows what discoveries await?

The great lesson of planetary exploration—from the 1960s flybys of Mars and Venus to the initial explorations of Mercury and Jupiter, Saturn, Uranus, and Neptune—is to expect the unexpected. No one expected dry riverbeds on Mars. No one expected Mercury to be an exposed planetary core with its mantle stripped away, or to find volcanoes and geysers on the moons of giant planets. No one expected oceans inside Jupiter’s moon Europa, or ice in the clouds of Venus. All of these surprising truths emerged from the early reconnaissance missions.

As my team and I prepare for *New Horizons*’s encounter with Pluto, we are preparing to be surprised yet again by the richness of nature and the grandeur of seeing a new, faraway planet for the first time. *New Horizons* is a small spacecraft. It is dwarfed by *Voyager* 1 and 2 that preceded it to open up the exploration of giant worlds, and it costs barely one fifth as much as the *Voyager* project. Nevertheless, it carries much more powerful scientific instruments. By analogy with the computing revolution we’ve witnessed since the 1970s when the *Voyagers* were built, *New Horizons* is like a tablet computer compared to Voyager’s mainframe, packing much greater capability into a much smaller volume, and at a much lower price.

Beginning in May, *New Horizons* will deliver higher-resolution images of Pluto and its satellites than are possible from any telescope on Earth—even the Hubble Space Telescope. For 10 weeks before and after the day of encounter, it will “own” the system. At closest approach *New Horizons* will sample Pluto’s atmosphere, search for new moons, look for possible rings, map the composition and temperature distribution across all the bodies in the Pluto system, and take images so good that if it were making an equivalent pass over New York City it could spot whirls on the Hudson River.

I have worked for 25 years to make the *New Horizons* mission happen, because the scientific promise is so great. The exploration of Pluto will mark both the opening of the exploration of the Solar System’s third zone and the historic closing of the initial reconnaissance of our planetary system as a whole.

Where will you be when humankind makes its farthest-ever landfall? What will you tell your children and grandchildren you learned about space because you were there with *New Horizons*, riding along virtually on television or the Internet? And what will you tell them you learned about ourselves, this wonderful species that seeks to know the universe from which it was born?

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NEW HORIZONS INSTRUMENTS

**Ralph** is the visible and infrared imager/spectrometer on *New Horizons*. It will provide color, composition, and thermal maps.

**Alice** is an ultraviolet imaging spectrometer. It will analyze the composition and structure of Pluto's atmosphere and look for atmospheres around Charon and any Kuiper Belt objects visited after the Pluto encounter.

**REX** (Radio Science Experiment) will measure atmospheric composition and temperature by detecting distortions to radio signals from Earth.

**LORRI** (Long Range Reconnaissance Imager) is a telescopic camera that will map Pluto's far side and provide high resolution remote geologic data.

**SWAP** (Solar Wind Around Pluto) will measure the escape rate of Pluto's atmosphere and observe Pluto's interaction with the solar wind.

**PEPSSI** (Pluto Energetic Particle Spectrometer Science Investigation) will measure composition and density of ions escaping from Pluto's atmosphere.

**SDC** (Student Dust Counter), built and operated by students, is measuring the space dust peppering *New Horizons* as it travels across the Solar System.
RELATIVE SIZE: Pluto is small compared to Earth. Its size and location within the Kuiper Belt are why the International Astronomical Union reclassified it as a "dwarf planet," but Pluto is enormous compared to most other Kuiper Belt Objects, such as PT1. Pluto also has a unique relationship with Charon, which is by far the largest moon relative to its parent planet. Pluto is the key to understanding the outer Solar System and its connection to the evolution of Earth and the other planets.

REPRESENTATIVE-MEASURE: A 40-kilometer-wide object known as PT1 could be New Horizons's next stop after Pluto (PT1 stands for "potential target 1"). It was discovered by the Hubble Space Telescope during a dedicated search for a follow-on destination; it was identified by its motion (red circles) relative to the stars. Pluto is the largest member of the Kuiper Belt, the zone of icy bodies beyond Neptune. Little PT1 is more typical of the myriad objects out there. It is probably unchanged since the birth of the Solar System.

PT1
40 kilometers diameter

Charon
1,210 kilometers diameter

Pluto
2,360 kilometers diameter

Earth
12,742 kilometers diameter

EXTENDED MISSION: These blurry globes, painstakingly constructed using data from the Hubble Space Telescope, are the best views of Pluto—for now. Its markings have changed considerably since a decade earlier, indicating a dynamic surface. The bright area in the middle image is covered with carbon monoxide frost; it will be a high-priority target for New Horizons.