

# TO PLUTO AND BEYOND

By Henry M. Holden

**A**NOTHER EXCITING, pioneering journey began on July 14, 2015, as NASA's New Horizons spacecraft made its successful flight through the Pluto system. It is heading ever deeper into space to a distant and largely unknown area on the edge of our solar system.

The New Horizons spacecraft was originally designed to fly beyond the Pluto system and explore additional Kuiper Belt objects (KBO). The spacecraft carries extra hydrazine fuel for a KBO flyby; its communications system is designed to work from far beyond Pluto; its power system is designed to operate for many years, and its scientific instruments were designed to operate in light levels much lower than it will experience.

NASA's Hubble Space Telescope selected a potential next destination for the New Horizons mission. The destination is a small Kuiper Belt object known as "2014 MU69" that orbits nearly a billion miles beyond Pluto.

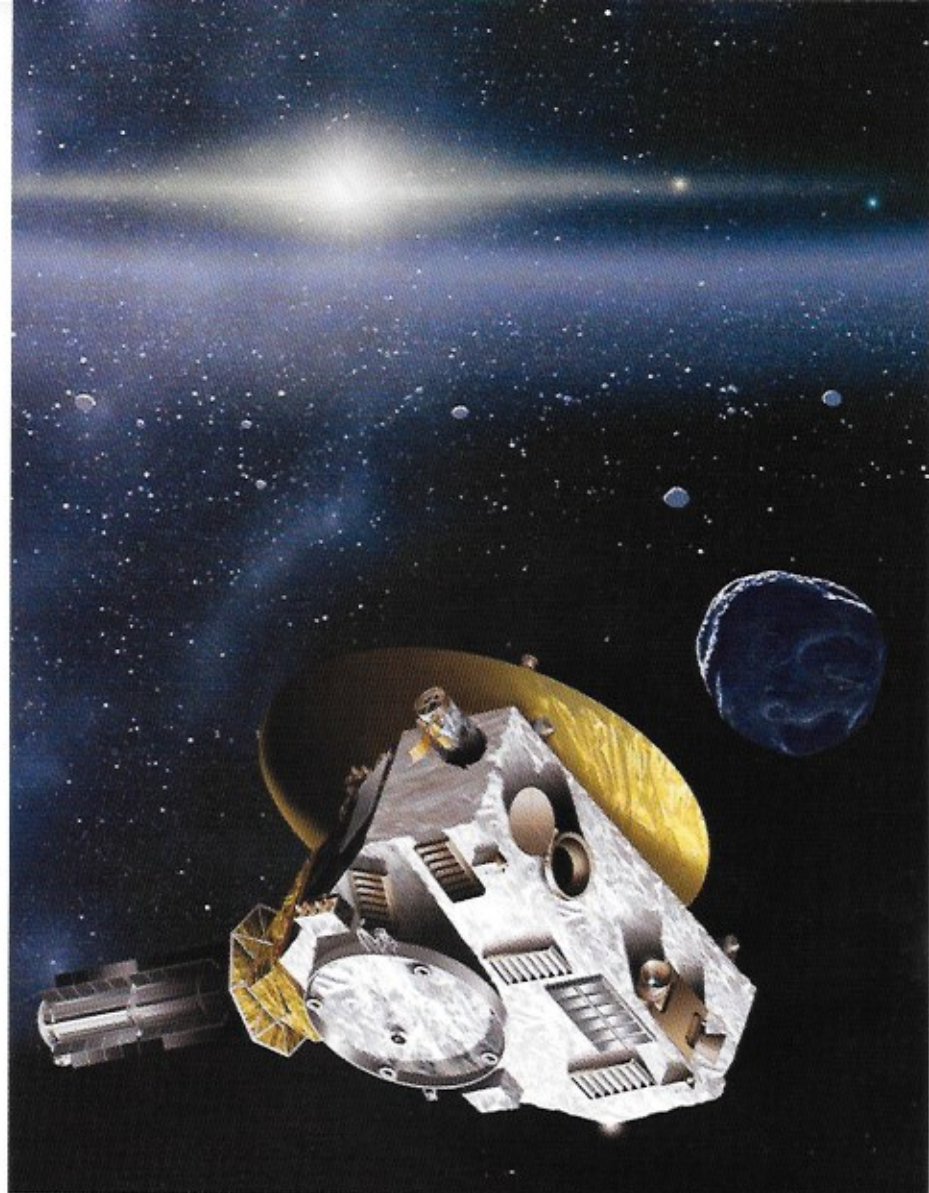
The Kuiper Belt is a vast debris field of icy bodies left over from the solar system's formation 4.6 billion years ago. A KBO has never been seen up close because the belt is so far from the sun, stretching out to a distance of five-billion miles into a never-before-visited frontier of the solar system.

"Even as the New Horizons spacecraft speeds away from Pluto out into the Kuiper Belt, and the data from the exciting encounter with this new world is being streamed back to Earth, we are looking outward to the next destination for this intrepid explorer," said John Grunsfeld, astronaut and chief of the NASA Science Mission Directorate at the agency headquarters in Washington.

"While discussions whether to approve this extended mission will take place in the larger context of the planetary science portfolio, we expect it to be much less expensive than the prime mission while still providing new and exciting science."

Early target selection was important; the team needs to direct New Horizons toward the object this year in order to perform any extended mission with healthy fuel margins.

New Horizons performed a series of



*This is an artist's rendering of the New Horizons spacecraft encountering a Kuiper Belt object — a city-sized icy relic left over from the birth of our solar system. The sun, more than 4.1 billion miles (6.7 billion kilometres) away, shines as a bright star embedded in the glow of the zodiacal dust cloud. Jupiter and Neptune are visible as orange and blue "stars" to the right of the sun. (Image: JHUAPL/SwRI)*

four manoeuvres in late October and early this month to set its course toward 2014 MU69 — nicknamed "PT1" (for "Potential Target 1") — which it expects to reach on January 1, 2019. Any delay would cost precious fuel and add mission risk.

Unlike asteroids, KBOs have not been heated by the Sun, and are thought to represent a pristine, well preserved, deep-freeze sample of what the outer solar system was like following its birth 4.6-billion years ago. The KBOs found in the Hubble data are thought to be the building blocks of dwarf planets such as Pluto.

In early September, the team identified one KBO that is "definitely reachable" and two other potentially accessible KBOs that will require more tracking over several months to know whether they, too, are accessible by the New Horizons spacecraft (see Pages 52 - 56 — *A Heartful of Stars*).

## NEEDLE IN A HAYSTACK

This was a needle-in-a-haystack search for the New Horizons team because the elusive KBOs are extremely small, faint, and difficult to pick out against countless background stars in the constellation Sagittarius, which is in the present direction of Pluto. The three KBOs identified are each a whopping one-billion miles beyond Pluto.

Though Hubble is powerful enough to see galaxies near the horizon of the universe, finding a KBO is a challenging search.

A typical KBO along the New Horizons' trajectory may be no larger than Manhattan Island and as black as charcoal.

Finding a suitable KBO flyby target was no easy task. Starting a search in 2011 using some of the largest ground-based telescopes on Earth, the New Horizons



team found several dozen KBOs, but none was reachable within the fuel supply available aboard the spacecraft.

The powerful Hubble Space Telescope came to the rescue in summer 2014, discovering five objects, since narrowed to three, within New Horizons' flight path.

Scientists estimate that PT1 is just under 30 miles (about 45 kilometres) across; that's more than 10 times larger and 1 000 times more massive than typical comets, like the one the Rosetta mission is now orbiting, but only about 0,5 to one percent of the size (and about 1/10,000th the mass) of Pluto.

"There's so much that we can learn from close-up spacecraft observations that we'll never learn from Earth, as the Pluto flyby demonstrated so spectacularly," said New Horizons science team member John Spencer. "The detailed images and data that New Horizons could obtain from a KBO flyby will revolutionise our understanding of the Kuiper Belt and KBOs."

The space telescope will scan an area of sky in the direction of the constellation Sagittarius to try and identify any objects orbiting within the Kuiper Belt. To discriminate between a foreground KBO and the clutter of background stars in Sagittarius, the telescope will turn at the predicted rate that KBOs are moving against the background stars. In the resulting images, the stars will be streaked, but any KBOs should appear as pinpoint objects.

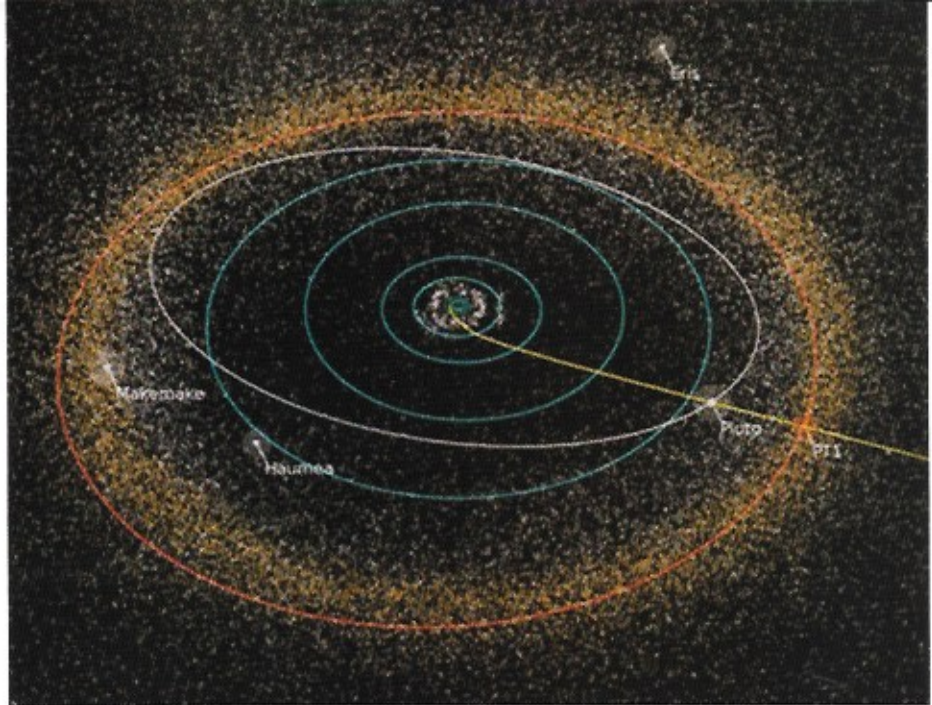
#### TELESCOPE TIME

Astronomers around the world apply for observing time on the Hubble Space Telescope. Competition for time on the telescope is intense and the requested observing time significantly exceeds the observing time available in a given year.

Proposals must address important astronomical questions that can only be addressed with Hubble's unique capabilities, and are beyond the capabilities of ground-based telescopes.

The proposals are peer reviewed annually by an expert committee, which looks for the best possible science that can be conducted by Hubble and recommends to the Space Telescope Science Institute director a balanced programme of small, medium, and large investigations.

In addition to the Pluto exploration, recent Hubble solar system observations have discovered a new satellite around Neptune, probed the magnetospheres of the gas-giant planets, found circum-



*Path of NASA's New Horizons spacecraft toward its next potential target, the Kuiper Belt object 2014 MU69, nicknamed "PT1" (for "Potential Target 1") by the New Horizons team. NASA must approve any New Horizons extended mission to explore a KBO.*

*(Image: NASA/JHUAPL/SwRI/Alex Parker)*



*Artist's impression of NASA's New Horizons spacecraft encountering a Pluto-like object in the distant Kuiper Belt. (Image: NASA/JHUAPL/SwRI/Alex Parker)*

stantial evidence for oceans on Europa, and uncovered several bizarre cases of asteroids disintegrating before our eyes.

"The planned search for a suitable target for New Horizons further demonstrates how Hubble is effectively being used to support humankind's initial reconnaissance of the solar system," said Matt Mountain, director of the Space Telescope Science Institute (SwRI), in Baltimore, Maryland.

"Likewise, it is also a preview of how the powerful capabilities of the upcoming

James Webb Space Telescope will further bolster planetary science. We are excited by the potential of both observatories for ongoing solar system exploration and discovery."

Even moving at light speed, the radio signals from New Horizons spacecraft need more than 4,5 hours to cover the three-billion miles to reach Earth, and signals from Mission Control equally long.

The transmission time will only get longer as the New Horizons spacecraft flies deeper into space. →