And finally – our first mission to the last planet

by Gerard van de Haar and Philip Corneille

The artist's concept above shows the Pluto system from the surface of one of the candidate moons. The other members of the Pluto system are just above the moon's surface. Pluto is the large disk at centre, right. Charon, the system's only confirmed moon, is the smaller disk to the right of Pluto. The other candidate moon is the bright dot on Pluto's far left. ***NASA***

Since mankind started sending robots to other planets circling our Sun we know a lot more about them and their moons than by just using telescopes here on Earth. We have made maps of their surfaces and investigated their atmospheres and inner compositions, even tried to find life, whether ancient or present. Of the official nine planets only the most distant one, Pluto, remains mostly a mystery – but NASA is about to change that with a visit to the last (acknowledged) planet in our solar system. It will take at least nine years to reach but when the recently launched New Horizons craft does, scientists at last hope to learn a lot more of the small icy bodies at the far end of our Sun's territory.

Pluto – is it a planet?

Pluto was discovered by Clyde Tombaugh (1906-1997) at the Lowell observatory in Arizona in February 1930 after an extensive search during which he compared photographic plates. Planets and asteroids appear in a different position against the background of stars on two different photo plates taken days apart.

The name chosen for the ninth planet was that of the Roman god of the underworld but was also intended to evoke the initials of astronomer Percival Lowell (1855-1916), who predicted that a planet would be found beyond Neptune. Since its discovery Pluto has been officially treated as the ninth planet in our solar system. However, is it a real planet?

We know that Pluto – made of rock and ice and with a reddish colour – has a diameter of only about 2320 km, making it the smallest planet by far. It circles the Sun in 248 Earth-years and follows an eccentric orbit between 29.5 and 49 AE (1 AE = 150 million km).

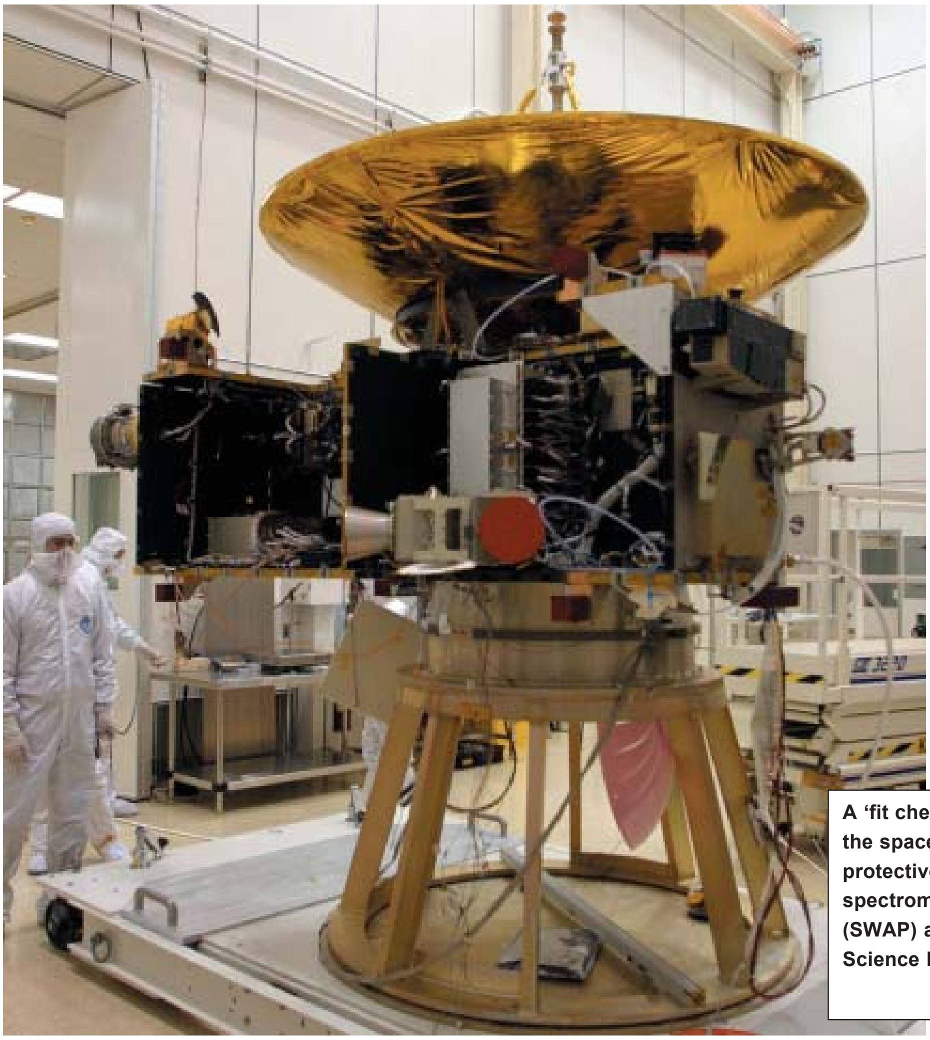
Pluto has a relatively large moon, discovered in 1978 by American astronomers James Christy and Robert Harrington. They named it Charon, after the ferryman of the underworld. It is about half the size of Pluto and orbits the planet every 6.4 days and half the size of Pluto so the pair are often considered a 'double-planet'system. Also, in May 2005, two smaller moons, each 100 km large, were discovered.

Pluto is very different from all other eight planets and more resembles the objects in the so-called Kuiper-Belt, the enormous ring of rocks that roam the outer rim of our solar system.

It is not even the largest of these objects. In July 2005 several Kuiper-Belt bodies with 1500 km diameters were announced but also one as large as 2860 km across. The latter was tentatively dubbed 'Lila' (after a daughter of its discoverer Mike Brown) and circles the Sun between 38 and 97 AE in 560 years; it also has a small moon of 270 km. Astronomers now debate whether Lila is the tenth planet or if they should stop calling Pluto a planet.

On plutonium to Pluto

NASA launched its newest solar system explorer 'New Horizons' on 19 January 2006 from the Kennedy Space Centre, Florida.



New Horizons roared into a bright afternoon sky aboard the powerful Atlas V rocket at 1400 local time.

It separated from its solid-fuel kick motor 44 minutes, 53 seconds after launch, and mission controllers received the first radio signals from New Horizons a little more than five minutes later. The radio communications, sent through NASA's Deep Space Network antennas in Canberra, Australia, confirmed to controllers that the spacecraft was healthy and ready to begin initial operations.

The Pluto-bound spacecraft weighs 500 kg, measures 2.7 by 2.2 m big and is mainly powered by a thermonuclear generator producing 240 Watts using 11 kg of plutonium.

It was built for NASA by the Applied Physics Laboratory (APL) of Johns Hopkins University in Maryland which earlier made several other NASA probes – including Messenger which is now enroute to the most inner planet Mercury (*Spaceflight*, October

A 'fit check' of the 2.1 m dish antenna. Also visible on the spacecraft body are its star-tracking cameras (with protective red covers), the Alice ultraviolet imaging spectrometer (at right) and the Solar Wind at Pluto (SWAP) and Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI) instruments (at left).
JHUAPL/SwRI

2004, p382).

After an initial okay in November 2002, formal approval of the New Horizons project was in April 2003 and, after only two years of construction, the robot craft was transported on 13 June 2005 to Goddard for testing.

It arrived at KSC on 24 September for final servicing before launch. Its last trip on Earth was in mid-December when it was placed on the Atlas V rocket, with five solid boosters flying in its most powerful configuration so far. One of the boosters had to be replaced on the pad after it was damaged during hurricane Wilma in October.

New Horizons is a dual stabilisation mode probe and can operate in three-axis or spin-stabilised attitude control mode, a common feature for outer planet missions. The triangular 'thermos bottle' design of the space bus allows the maintenance of 'safe' operating temperatures in deep space.

The Radioisotope Thermoelectric Generators (RTG) are mounted on an extended boom to minimise effects on the science suite. The RTGs convert heat from the radioactive decay of Plutonium-238 into electricity and provide continuous power in regions of space where the use of solar energy is not feasible.

The power output of the RTG will keep New Horizons working for about 10 years after the 2015 Pluto flyby and the craft carries backup devices for major electronics, star-tracking navigation cameras and data recorders.

Spacecraft specifications

New Horizons is specially equipped for the investigation of small, dark and cold (-230 C) objects far away from Earth. It therefore has high resolution instruments and a big 2.1 m antenna to communicate with distant Earth (signals take some 4.5 hours to arrive).

The Jet Propulsion Laboratory (JPL) mission operations team will communicate with the spacecraft via NASA's Deep Space Network (DSN) of antenna stations. These DSN stations are spaced 120 degrees apart on the globe ensuring that the spacecraft can be observed constantly as Earth rotates.

The X-band will be used for telecommunications and the New Horizons' transmitter will have an overall bit rate of 768 bps but the use of the redundant radio system might double the data rate. Two onboard data recorders have a capacity of 8 Gigabits and the onboard computer is responsible for managing the overall spacecraft functioning and science data handling.

The mission objectives, using seven onboard instruments, are:

- analyse surface composition of Pluto and Charon
- characterise geology and morphology ("the look") of Pluto and Charon
- characterise the neutral atmosphere of Pluto and its escape rate
- search for an atmosphere around Charon
- map surface temperatures on Pluto and Charon
- search for rings and additional satellites around Pluto
- and, to conduct similar investigations of one or more Kuiper Belt objects.

Team members at the Johns Hopkins University Applied Physics Laboratory (APL) attach the high-gain antenna assembly to the New Horizons spacecraft. Also visible on the left side of the spacecraft below the dish are (clockwise, from top) the Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI), LOng Range Reconnaissance Imager (LORRI) and Solar Wind at Pluto (SWAP) instruments. *JHUAPL/SwRI*

Technicians install the Long Range Reconnaissance Imager (LORRI) on New Horizons spacecraft. The telescopic camera is one of seven science instruments designed for the Pluto flyby mission. *JHUAPL/SwRI*

Ralph (10 kg) – visible imager (MVIC) and infrared spectrometer (LEISA) to provide 3D high resolution (maximum 1.5 km) colour, composition and thermal maps of the surface of Pluto and Charon (likely made of methane and water frosts).

Alice (5 kg) – ultraviolet mapping spectrometer to analyse the composition and structure of Pluto's very thin atmosphere (mainly nitrogen) and look for evidence of an atmosphere around Charon.

REX (0.1 kg) – (Radio science EXperiment) a passive radiometer to measures atmospheric composition and temperature.

LORRI (9 kg) – (Long Range Reconnaissance Imager) telescopic camera to obtain encounter data at long distances, map Pluto's farside and provide high resolution geologic data (resolution max 30 m).

SWAP(3 kg) – (Solar Wind Around Pluto) a solar wind and plasma spectrometer; to measure atmospheric 'escape rate' and observe Pluto's interaction with the solar wind.

PEPSSI (1.5 kg) – (Pluto Energetic Particle Spectrometer Science Investigation) to measure the composition and density of plasma (ions) escaping from Pluto's atmosphere and determine if Pluto has a magnetosphere.

SDC (2 kg) – (Student Dust Counter) was built by students from the University of Colorado to measure and count the space dust peppering New Horizons during its entire voyage across the solar system.

The total science payload weighs some 30 kg and needs some 20 Watts of power. Project leader is Hal Weaver of APL and science team leader is Dr Alan Stern. The pair discovered Pluto's two new moons using Hubble pictures.

Mission profile

After its launch, New Horizons follows the fastest route possible – at a record speed of 36,000 mph – passing the orbit of the Moon in just nine hours and then going on for a scheduled fly-by of Jupiter in February/ March 2007, to add further speed and test the science instruments.

The boost from the giant planet's gravity will increase the cruising speed to 47,000 mph and cut the journey to Pluto by four years in the process. During this time the probe will continue in a state of hibernation until its arrival at Pluton in July 2015.

At Pluto, the spacecraft will perform a flyby only (to within about 9,000 km of the surface) as it will have a velocity of 30,000 mph and reducing that speed would require over thousand times the propellant the probe can carry.

However, some 12 weeks before the historic encounter, New Horizons will already be able to view Pluto at a better resolution than images obtained from the Hubble Space Telescope.

The busiest part of the Pluto-Charon encounter will last a full Earth day, from 12 hours before closest approach to a half-day after. Inbound to the binary planet, New Horizons will check ultraviolet emission from Pluto's atmosphere and make global maps of the planet and its satellite in red, green, blue and a special wavelength sensitive to methane frost on the surface.

During the half-hour when the space probe will be closest to Pluto, it will take close-up pictures in both visible and near-infrared wavelengths. The best pictures should depict surface features down to 60 metres across. As it moves rapidly way from the Pluto-Charon system, it will look back to spot haze in the atmosphere, conduct radio occultation experiments and look for rings. Pending NASA approval of an extended mission, the spacecraft would then re-target itself for an encounter with a Kuiper Belt object.

"We'll be able to map Pluto uo to football field dimensions," said Dr Hal Whitehead, project scientist. "We'll be able to see what it really looks like – does it have high valleys, mountains and cryogenic geysers?

"Because it is so far from the Sun, it has been very, very cold for its entire existence. So it's preserved the material that was around 4.65 billion years ago. In that sense it will give us a window back to the past, to the original of the solar system," he added.

As the very first voyage to the farthest zone of the solar system, New Horizons is a historic mission of exploration. Including all mission operations, the total project cost is estimated at $700 million. For that relatively modest sum of money the edge of our solar system will be better understood than ever before.