Eighty-five years after its discovery, humankind has for the first time had a close look at the Solar System’s most distant member, Pluto, now classified as a dwarf planet. The NASA space probe New Horizons flew past Pluto on 14 July, sending back the clearest images of it till date and revealing its detailed structure showing several features unknown till now.

Launched in 2006, New Horizons travelled for more than nine years and covered a distance of more than 4.8 billion kilometres only to spend under three minutes near Pluto as it sped past its target at a speed of more than 58,000 kilometres per hour. But it was the most rewarding brief encounter in space history. Icy mountains on Pluto and a new, crisp view of its largest moon, Charon, are among the several discoveries the probe was able to make during the brief flyby.

The success of the mission is by itself an unprecedented achievement of human ingenuity and endeavour, especially if we remember that the target was so incredibly far away and that the tiny spacecraft was using technology which was decades old. Moreover, because New Horizons hurtled through the Pluto system at more than 58,000 kilometres per hour, a collision with a particle as small as a grain of rice could incapacitate the spacecraft.

After visiting Pluto the probe is headed towards deeper reaches of the Kuiper Belt – a vast region of icy objects beyond the orbit of Neptune that stretches at least 1.6 billion kilometres beyond Pluto – and will keep sending even more discoveries back to Earth. Researchers speculate it could continue operating well into the 2030s. Eventually it will escape the solar system entirely and join NASA’s four other spacecraft that are also headed to or already in interstellar space: Pioneers 10 and 11, and Voyagers 1 and 2.

Because New Horizons is so far away, it takes about 4.5 hours for any data from the spacecraft to reach Earth. Even when it arrives at Earth, the signal is so faint that NASA has to use 61-metre-wide radio dishes (one each in Australia, California, and Spain) to pick it up. This means an extremely low rate of data transmission: just about 1 kilobit per second, which makes New Horizons take more than 42 minutes to fully transmit an image that is 1024 pixels wide. According to NASA, at this rate, the entire data collected by New Horizons will take 16 months to be transferred to Earth.

One important outcome of the New Horizons mission has been the revised estimate of Pluto’s diameter, which was shown to be about 3 percent larger – 2,370 km rather than 2,302 km estimated earlier. This makes Pluto larger than Eris, which has a diameter of 2,336 km. Before this discovery Eris was taken to be larger than Pluto and was a key factor for reclassifying Pluto as a dwarf planet. This new size estimate also implies that the lowest layer of Pluto’s atmosphere is much thinner than thought, probably a kilometre or two, at most.
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Discovery of Pluto

Pluto was not discovered till 1930. After the discovery of Uranus and Neptune beyond Saturn, American astronomer Percival Lowell first found hints of the existence of an unknown planet beyond Neptune in 1905 from odd deviations he observed in the orbits of Neptune and Uranus. The deviations could be explained only by the gravitational pull of a planet beyond Neptune. Lowell could predict its location in 1915, but died before he could find it.

Then in 1929, a 22-year-old American farm boy and amateur astronomer named Clyde W. Tombaugh used the predictions made by Lowell and other astronomers and photographed the sky with a more powerful, wide-field telescope at the Lowell Observatory in Arizona. On 18 February 1930, he found Pluto’s image on three of the photographs. The newly discovered planet was named Pluto, as suggested by an 11-year-old schoolgirl, Venetia Burney of Oxford, England. The name also honours Percival Lowell, whose initials are the first two letters of Pluto. Pluto became the ninth planet of the Solar System. It was found to go round the Sun once every 248 Earth years, with its distance from the Sun ranging from 4.4 billion kilometres when closest to 7.4 billion kilometres when farthest.

However, right from the beginning after its discovery, there appeared to be something odd with Pluto. It is extremely small in size – with a diameter of only 2,274 kilometres – smaller than our Moon and too small for a planet. Its orbit is the most unusual among those of the other solar system planets, tilting at an angle of 17° to the plane of the ecliptic, while the orbits of the other planets are almost co-planar. Pluto’s orbit is also highly eccentric, which brings it closer to the Sun than Neptune for part of its orbital period.

By the 1950s, some astronomers, most notably Dutch-American astronomer Gerard Kuiper, had suggested that Pluto was not a lone oddity but may be the largest and brightest of a vast collection of objects orbiting beyond Neptune, which was known as the Kuiper Belt.

New Horizons was launched on 19 January 2006, with the primary objective of exploring Pluto and other Kuiper Belt Objects. After launch it sped towards its destination at a breakneck speed of 48,000 kilometres per hour, becoming the fastest spacecraft ever to leave Earth. It crossed the orbit of the Moon nine hours after launch – a journey that took the Apollo-11 astronauts about three days.

In the meanwhile, more powerful telescopes began to reveal far-off objects beyond Neptune that rivalled Pluto in size, which put astronomers in a quandary. The need for a strict definition of planets was deemed necessary. Without a new definition, the discoveries of the new objects raised the prospect that there would soon be 50 or more planets in the Solar System. Astronomers did not like the idea. Finally, after years of discussions the International Astronomical Union (IAU) voted in 2006 to strip Pluto of its planet status and to classify it as a ‘dwarf planet’.

For a celestial body to qualify as a planet IAU set forth the following criteria: (i) It must be in orbit around the Sun; (ii) It must be large enough that it takes on a nearly round shape; (iii) It must have cleared its orbit of other objects.

While Pluto fulfilled the first two criteria, it failed to satisfy the last one, as it shares its orbital neighbourhood with other icy Kuiper Belt objects. So, Pluto was re-classified as a dwarf planet. Other than Pluto, four other dwarf planets are currently officially recognised in our Solar System. These are Ceres, Haumea, Makemake, and Eris. With the exception of Ceres, which is located in the asteroid belt, the other dwarf planets are found beyond Neptune. Astronomers estimate that there could be as many as 200 dwarf planets in the Solar System and Kuiper Belt.

Being extremely distant and small, not much could be learnt about Pluto from Earth-based observations. A major discovery about Pluto was made in 1979, when James Christy of the United States Naval Observatory noticed that photographs of Pluto taken earlier showed a bulge on one side. When he looked at photographs taken a few days before, he noticed the bulge was on the other side. He immediately guessed that Pluto had a moon. Christy named the new moon Charon after his wife Charlene.

Charon has a diameter of about 1,200 kilometres; that is, more than half of Pluto’s. It is the largest moon in the solar system compared to the planet it

New Horizons image of Charon taken when the craft was closest to the Pluto system on 14 July 2015 from a distance of 466,000 km. It shows a collection of vaguely-defined features on the surface of Pluto’s biggest moon. Now, with this latest capture, the New Horizons team has confirmed that the big dent in the icy surface of the moon shows a large impact crater, surrounded by a couple of deep canyons – one larger than Earth’s Grand Canyon.
orbits. Because the two bodies are so close in size, and they orbit about a centre of mass that is outside Pluto’s surface, the Pluto-Charon pair is considered a double planet – the only one in our Solar System. Besides Charon, Pluto has four smaller moons named Nix, Hydra, Styx, and Kerberos.

Pluto spins on its axis from east to west once in 6 days 9 hours; the same time it takes its largest moon Charon to go round once. As a result, like a geostationary satellite of Earth, Charon appears motionless in Pluto’s sky. If you were on Pluto, you would see Charon in the sky only from a certain area of the dwarf planet, always in the same position in the sky, without ever rising or setting. From the surface of Pluto, the view of Charon would be fantastic – it would appear 100 times larger than our Moon – but motionless in the sky!

But astronomers could find little about Pluto’s size or surface conditions from telescopic observations because of its extreme distance from Earth. The first glimpses of Pluto’s surface with some hazy details were available only in 1996 from images taken by the Hubble Space Telescope, which showed about 12 large bright and dark areas. But the Hubble images could not reveal much about Pluto.

**New Horizons Mission**

One reason why Pluto is of such interest to scientists is that it is different from every other planet in the Solar System. It is not a rocky planet like Earth, nor is it a gas giant like Jupiter. Instead, it is an ice dwarf; that is, a dwarf planet that is composed largely of ice.

The New Horizons mission to Pluto was officially selected out of two proposals for funding as part of NASA’s New Frontiers programme in November 2001. The estimated cost of the mission (including spacecraft and instrument development, launch vehicle, mission operations, data analysis, and education/public outreach) was to be approximately $650 million over 15 years (2001–2016). The spacecraft was originally planned to explore the only unexplored planet in the Solar System, as Pluto was still considered a planet when New Horizons was launched in January 2006. It is an irony that later in the same year, IAU relegated Pluto to the status of a dwarf planet.

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New Horizons was indeed in a hurry. Since 1989, Pluto has been moving farther away from the Sun along its highly elliptical orbit. And as it moved farther from the Sun, Pluto could get so cold that its atmosphere might freeze for most of its 248-year trip around the Sun. Its daytime temperature was already a frigid -223°C and was dropping. New Horizons needed to get there before 2020, when the atmosphere could become a giant ice shell, blocking the probe from studying the dwarf planet’s surface and the dynamics of its atmosphere.

But the high speed also meant that it would be impossible for the spacecraft to slow down and observe Pluto for a longer time. That is why it sped past Pluto at a distance of 12,400 kilometres (roughly the distance from New York to Mumbai) in just under three minutes, but was close enough to map the surface in some detail. Earlier, to prepare for the Pluto encounter, New Horizons was woken up from hibernation on 6 December last year as a pre-set alarm clock roused it from its electronic slumber.

New Horizons carried seven instruments: three optical instruments, two plasma instruments, a dust sensor, and a radio science receiver/radiometer. The instruments were used to investigate the global geology, surface composition and temperature, and the atmospheric pressure, temperature of Pluto and its moons.

In addition to the science equipment, the spacecraft carried several cultural artefacts including a collection of 4,34,738 names stored on a CD, and a flag of the USA, along with other mementos. It also carried about 30 grams of ashes of Clyde Tombaugh, the discoverer of Pluto. The New Horizons spacecraft was designed, built, and is being operated and managed by the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland, USA, for NASA’s Science Mission Directorate.
Mountains on Pluto

Close-up images sent back by New Horizons during the flyby were revealing. So far, a series of pictures from the spacecraft have revealed curious surface features, from a dark shadowy whale figure to a bright heart shape. But just what these shapes are, or what kind of terrain they represent, remains unclear. A close-up image of an equatorial region near the base of Pluto’s bright heart-shaped feature showed a mountain range with peaks as high as 3,500 metres above the surface of the icy body. The mountain ranges have been named Norgay Montes after Tenzing Norgay, one of the first climbers to summit Mount Everest.

The close-up of Pluto also makes clear that the dwarf planet has water ice that is as hard as rock. According to mission scientists, the mountains on Pluto were likely formed no more than 100 million years ago, making them among the youngest mountains – younger than the Himalayas – in a 4.56-billion-year-old Solar System. This suggests the region, which covers about one percent of Pluto’s surface, may still be geologically active today.

What surprised the scientists was the fact that there was no sign of craters, despite Pluto being part of the Kuiper Belt, the region beyond Neptune where cosmic debris is constantly pelting the dwarf planet and its five moons. The scarcity of craters suggests that both Charon and Pluto have seen geological activity in the relatively recent past that erased the traces of earlier impacts, the researchers said.

Among other images taken during the flyby is one showing Charon, the largest moon of Pluto. The image showed a youthful and varied terrain, with a belt of troughs and cliffs that extends about 1,000 kilometres across the surface, which according to the scientists, suggests widespread fracturing of Charon’s surface, probably the result of internal geological processes.

The icy surface of the moon shows a large impact crater, surrounded by a couple of deep canyons – one larger than Earth’s Grand Canyon. Charon’s north polar region shows a dark marking which scientists believe is a thin deposit of dark material. This dark polar area stretches for about 300 km. Scientists have dubbed this dark pole on Charon with the nickname “Mordor,” after a fictitious location in the novel The Lord of the Rings. The images also show a canyon estimated to be 7 to 9 kilometres deep north of the moon’s equator.

Apart from unravelling the most distant member of the solar family, New Horizons’ flyby of Pluto and its five known moons has also opened up the Kuiper Belt, an outer region of the Solar System populated by icy objects ranging in size from boulders to dwarf planets, for further exploration. Kuiper Belt objects, such as Pluto and Eris, preserve evidence about the early formation of the Solar System, which New Horizons and other missions may help unearth in future.

The renowned theoretical physicist and cosmologist Stephen Hawking has congratulated the New Horizons team and NASA following their successful mission to the dwarf planet Pluto. In a message to the team he said: “Revelations of New Horizons may help us to understand better how our Solar System was formed.”

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