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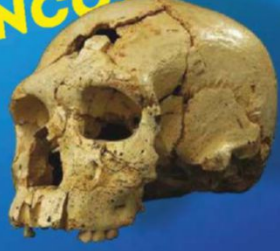

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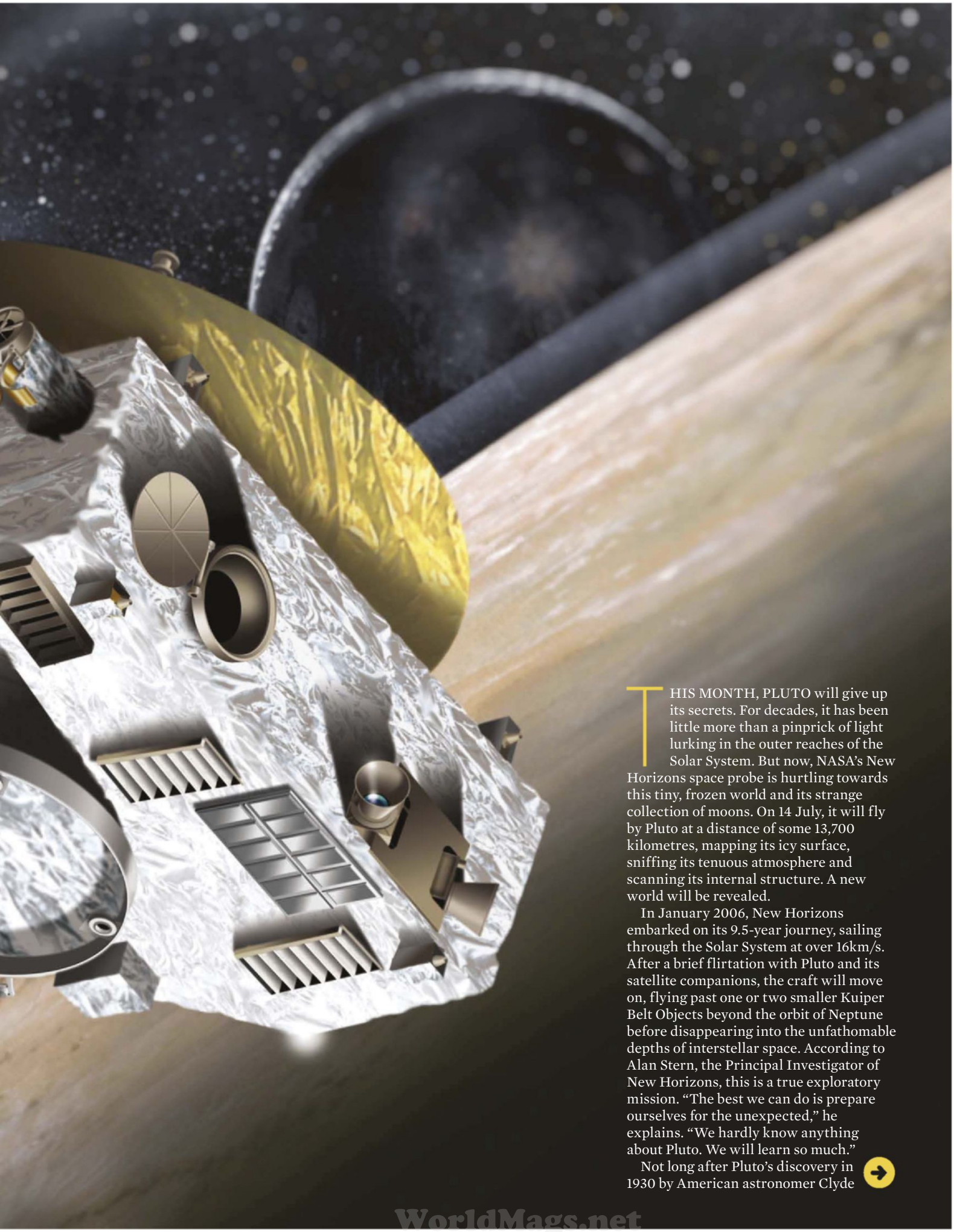
THE FINAL FRONTIER

As NASA's New Horizons spacecraft nears Pluto, **Govert Schilling** explores what we might find waiting for us on this alien world

Artist's impression of New Horizons visiting dwarf planet Pluto

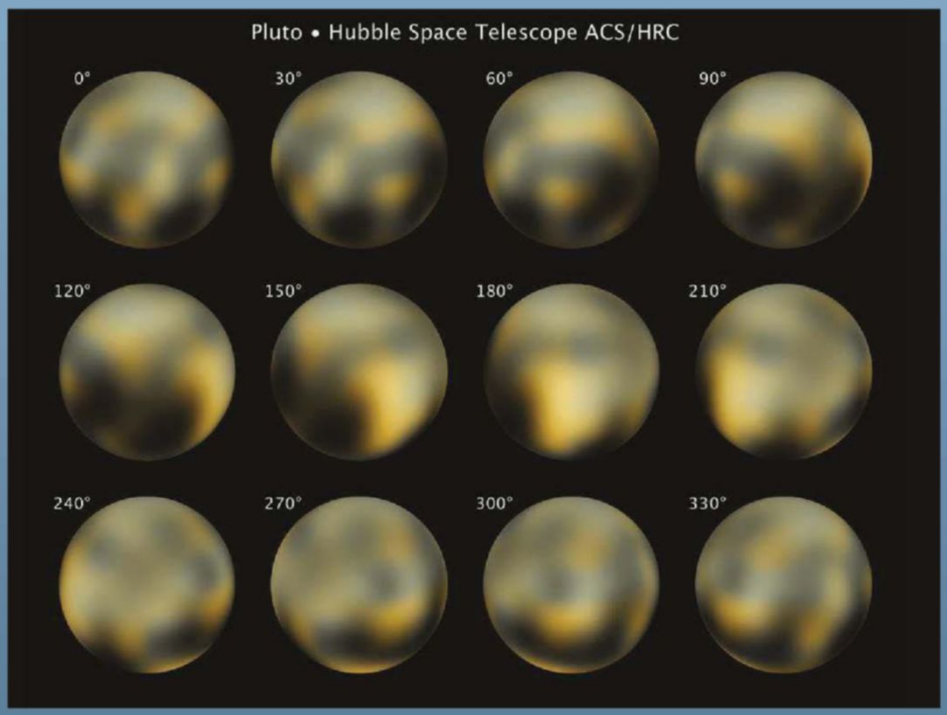
PHOTO: NASA



THIS MONTH, PLUTO will give up its secrets. For decades, it has been little more than a pinprick of light lurking in the outer reaches of the Solar System. But now, NASA's New Horizons space probe is hurtling towards this tiny, frozen world and its strange collection of moons. On 14 July, it will fly by Pluto at a distance of some 13,700 kilometres, mapping its icy surface, sniffing its tenuous atmosphere and scanning its internal structure. A new world will be revealed.

In January 2006, New Horizons embarked on its 9.5-year journey, sailing through the Solar System at over 16km/s. After a brief flirtation with Pluto and its satellite companions, the craft will move on, flying past one or two smaller Kuiper Belt Objects beyond the orbit of Neptune before disappearing into the unfathomable depths of interstellar space. According to Alan Stern, the Principal Investigator of New Horizons, this is a true exploratory mission. "The best we can do is prepare ourselves for the unexpected," he explains. "We hardly know anything about Pluto. We will learn so much."

Not long after Pluto's discovery in 1930 by American astronomer Clyde



Left: Views of the entire surface of Pluto, as captured by the Hubble Space Telescope between 2002 and 2003

Above: Clyde Tombaugh discovered Pluto back in 1930

PHOTO: NASA/HUBBLE, GETTY, NASA X5, IAU, ALAMY

Tombaugh, it became evident that this tiny rock at the edge of the Solar System was odd. First of all, it's small – even tinier than our own Moon. Second, it follows a strange, highly elliptical path around the Sun, strongly skewed with respect to the more circular orbits of the other planets. During part of its 248-year orbit, Pluto is closer to the Sun than Neptune. Last but not least, Pluto's moon Charon, discovered in 1978, is so large that astronomers liked to think of the pair as binary planets.

Even the Hubble Space Telescope has been unable to uncover Pluto's secrets, let alone Charon's. Most of what we know has been deduced from detailed observations of mutual eclipses of the two bodies, and from studies of starlight passing through Pluto's thin atmosphere during rare cases where Pluto passes in front of a distant star. Thus, astronomers have gauged diameters (2,300 kilometres for Pluto and 1,200 kilometres for Charon), and made crude maps of dark and light regions on the surface.

Surprisingly, much more has been revealed by studying the many smaller siblings of Pluto that populate the Kuiper Belt – a thick, broad region beyond Neptune's orbit. The first Kuiper Belt Object was discovered in 1992. Since then, some 1,500 have been found. Pluto turns out to be just one of the largest members of a huge population of icy bodies – remnants from the Solar System's early youth. Mapping the colours and orbital characteristics of Kuiper Belt Objects has enabled scientists to reconstruct the migratory evolution of the giant planets.

As king of the Kuiper Belt, Pluto returned to the scientific spotlight, but it lost its planetary status in the process. Nine years ago, the International Astronomical Union (IAU) decided to reclassify Pluto as a dwarf planet, despite strong opposition from a vocal minority of American planetary scientists, including Stern. At that time, New Horizons had just been launched as NASA's first mission to the ninth planet in the Solar System. At the mission website, it still says that "the definition of a planet continues to be debated" and "most

4,760,000,000

kilometres will be the approximate distance travelled by New Horizons between its launch in January 2006 and the flyby of Pluto on 14 July 2015

PLUTO PAST AND PRESENT

18 February 1930
American astronomer Clyde Tombaugh discovers Pluto on plates taken a few weeks earlier at Lowell Observatory in Flagstaff, Arizona.

24 March 1930
Pluto is named after the Roman god of the underworld, following a suggestion by 11-year-old Venetia Burney from Oxford, UK.

22 June 1978
James Christy of the United States Naval Observatory discovers Pluto's large moon, Charon, which orbits the dwarf planet once every 6.4 days.

May 1989
The first ideas for a space mission to Pluto are put forward by a group of 12 planetary scientists, known as the Pluto Underground.

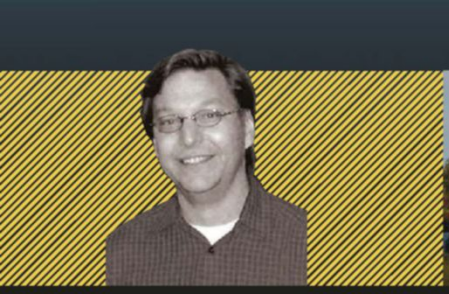
The New Horizons craft was assembled in a clean room prior to its launch aboard an Atlas V rocket

people call Pluto a planet". Stern says he has "no idea" whether or not some astronomers will officially propose to restore Pluto's planethood this summer at the IAU's next triennial General Assembly in Honolulu, Hawaii.

Of course, the scientific output of the New Horizons mission won't depend on how we label its frozen target. The triangular 480kg craft was built by the Johns Hopkins University Applied Physics Laboratory in Baltimore, Maryland and Stern's Southwest Research Institute in Boulder, Colorado. It is outfitted with seven instruments, including a high-resolution camera, two spectrometers to study surface and atmospheric composition, two instruments to study fields and particles, a dust counter, and a radio science

16.26

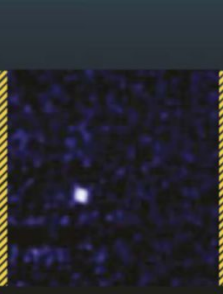
km/s is the launch velocity of New Horizons, the fastest spacecraft ever to leave Earth orbit



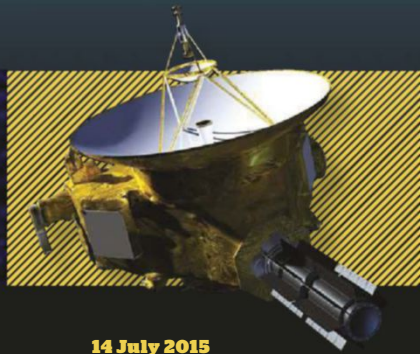
5 January 2005
Caltech astronomer Mike Brown, aka 'Plutokiller', discovers Eris. This Kuiper Belt Object is as large as Pluto, sparking a debate about the definition of the word 'planet'.

19 January 2006
Using an Atlas V rocket, NASA launches the New Horizons craft from Cape Canaveral Air Force Station in Florida. It starts its lengthy mission.

24 August 2006
During its 26th triennial General Assembly in Prague, Czech Republic, the International Astronomical Union votes to reclassify Pluto as a dwarf planet.

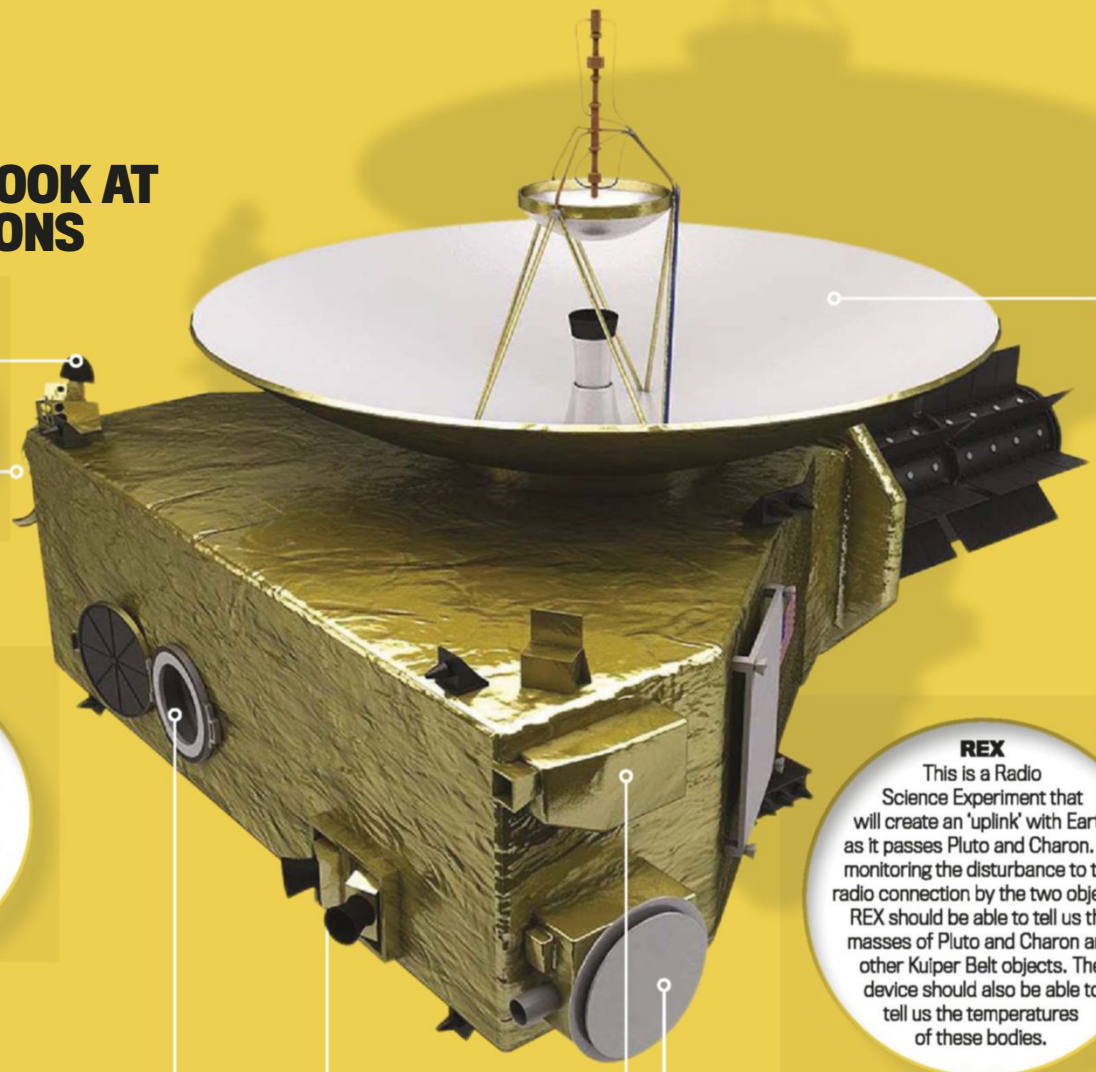


2011/2012
Two more small satellites of Pluto – Styx and Kerberos – are discovered on photos made with the Hubble Space Telescope.



14 July 2015
Around 11:50 UTC, New Horizons flies by Pluto at a distance of some 13,700km and a relative velocity of 13.8km/s.

A CLOSER LOOK AT NEW HORIZONS



PEPSSI
The Pluto Energetic Particle Spectrometer Science Investigation will take a close look at the particles as they leave Pluto.

SWAP
The solar wind that's blowing around Pluto will be tracked by the SWAP device. It will monitor how the wind reacts with particles escaping from the dwarf planet's atmosphere (around 75kg leave every second).

LORRI
The Long Range Reconnaissance Imager device is effectively a digital camera with a large telephoto telescope attached. This will allow us to get up close with Pluto. LORRI will provide the best-ever images of Pluto and the Kuiper Belt, and will look for craters and geysers.

SDC
The Venetia Burney Student Dust Counter is the first science instrument on a NASA planetary mission that's been designed, built and flown by students. As New Horizons glides through the Solar System, it will measure the concentration of dust particles throughout.

ALICE
This UV imaging spectrometer will provide the first complete picture of Pluto's atmosphere. It should be able to tell us what gases cling to the planet and how abundant they are.

REX
This is a Radio Science Experiment that will create an 'uplink' with Earth as it passes Pluto and Charon. By monitoring the disturbance to this radio connection by the two objects, REX should be able to tell us the masses of Pluto and Charon and other Kuiper Belt objects. The device should also be able to tell us the temperatures of these bodies.

RALPH
New Horizons' 'eyes' are situated here. It consists of an array of sensors designed to map Pluto's landscape at a resolution of 250 metres per pixel. It'll also be hunting for features like frozen nitrogen, water and carbon monoxide.

PHOTO: SCIENCE PHOTO LIBRARY, JAMES BYARD/WUSTL

1,873

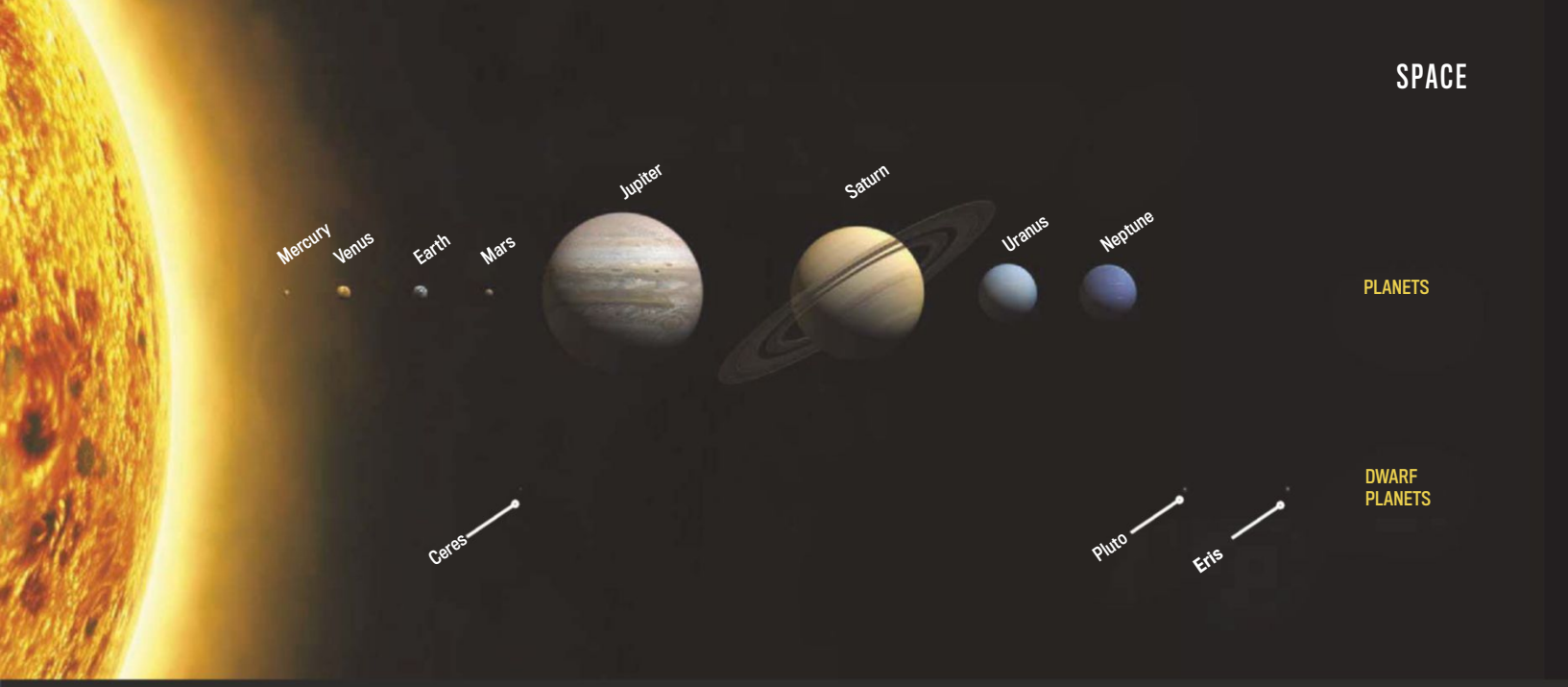
days were spent in hibernation by New Horizons during its trip; it woke up on 6 December 2014

experiment. A plutonium-powered radioisotope thermoelectric generator provides some 200W of power during the Pluto encounter, while communication with Earth will be maintained by a 2.1m high-gain antenna.

New Horizons' radio signals will take some 4.5 hours to reach Earth, and because of the huge distance and the relatively low transmitter power, the craft's data rate will be low. "We'll receive dozens of photos within a day after closest approach," explains Stern. "But we're collecting data a hundred times faster than we are able to transmit them. It will take over a year to send all of it back." Also, because of the delay, the whole encounter has to be pre-programmed into New Horizons' onboard computer. "We've prepared ourselves for over 250 possible contingencies," says Stern. "My biggest worry is that something happens that we haven't thought of."

Apart from Pluto's largest moon, Charon, New Horizons will also study the dwarf planet's four minor satellites, two of which hadn't even been detected at the time of launch. The small satellites are close to, but not exactly in, orbital resonance with Charon. According to Stern, this could mean that the satellite system is relatively young. "We may find additional small satellites, or maybe even a tenuous system of rings."

However, the most exciting finds may stem from the study of Pluto's surface and



Could Pluto become a planet again?

WHEN THE International Astronomical Union (IAU) reclassified Pluto as a 'dwarf planet' back in August 2006, a number of American planetary scientists were quite upset. After all, Pluto orbits the Sun, it is round, it has moons, it has a (tenuous) atmosphere and geology, so why can't it be a proper planet?

The 'degradation' of Pluto was motivated by the discovery of hundreds of Kuiper Belt Objects beyond Neptune's orbit. The IAU came up with a rather vague definition of the word 'planet' that excluded Pluto, based on the fact that it hasn't been able to gravitationally 'clear the neighbourhood around its orbit'.

No one is really happy with the IAU definition, so could critics turn the decision around at the IAU's next General Assembly in Honolulu, Hawaii? IAU General Secretary Thierry Montmerle from the Institut d'Astrophysique de Paris doesn't think so. "There must be a valid scientific reason to reverse an earlier decision," he explains. "Moreover, the deadline for putting forward new resolutions to vote on has passed."

Then again, there are no sanctions for not following the IAU rules, so astronomers such as New Horizons Principal Investigator Alan Stern are free to keep calling Pluto a planet, if they so wish. Meanwhile, Prof David Weintraub of Vanderbilt University in Nashville, Tennessee expects that the New Horizons results will force astronomers to reopen the debate all over again.

"It's just a small group of Americans," sighs Montmerle. "But even there, they are a minority."


Bill McKinnon thinks Pluto could have a hidden ocean

interior. Like some of the icy satellites of Jupiter and Saturn (notably Europa and Enceladus), Pluto may display some form of 'ice volcanism', with active geysers spewing crystals of frozen nitrogen, methane and water into space.

Planetary scientist Bill McKinnon of Washington University in St Louis, Missouri, says he is one of those people who thinks it's even likely that Pluto possesses an internal ocean, hidden beneath a thick layer of ice.

Everyone knows that water is one of the main requisites for the emergence of life as we know it, the other two being organic molecules and energy. So who knows, if Pluto has a subsurface ocean, it might harbour microorganisms, just as astrobiologists have suggested is the case for Europa and Enceladus. Unfortunately, New Horizons won't be able to answer that question, so the existence of Plutonian life will remain speculative for many decades to come.

Even if there is nobody on Pluto to notice the flyby of New Horizons, extraterrestrial civilisations may one day run into the tiny craft. Just in case, Hawaiian artist Jon Lomberg has proposed to upload a 'self-portrait of humanity' into the spacecraft's computer memory after it has completed its mission. Previously, Lomberg worked with American astronomer Carl Sagan to create the famous Voyager Golden Record with its selection of various sounds, images and greetings from Earth. Lomberg says: "Like the Voyager Record, this will be both a message from Earth and a message to Earth. The very act of creating it will be a powerful reminder that we all share a common heritage and future on this 'pale blue dot' we call Earth." ■


The Voyager Golden Record

Find out more

BBC TWO

To watch a clip from *The Planets Revisited* describing how Clyde Tombaugh discovered Pluto, visit **http://bbc.in/yeSmEG**

GOVERT SCHILLING is an astronomer and science author who has written over 50 books