Are we nearly there yet?

The journey out of our solar system was never going to be straightforward. **Nigel Henbest** jumps aboard

HEARD the joke about déjà vu? Several times. Then you've probably heard the news about NASA's Voyager 1 spacecraft leaving the solar system. Its departure has hit the headlines many, many times – only for NASA to change its mind. Over the past decade, the veteran space probe has been in, out and even shaken all about.

Last September, though, it looked like this game of space hokey-cokey was finally over. Voyager 1's normally cautious project scientist Ed Stone declared that, after 35 years, the probe had left for real. "This is humankind's historic leap into interstellar space."

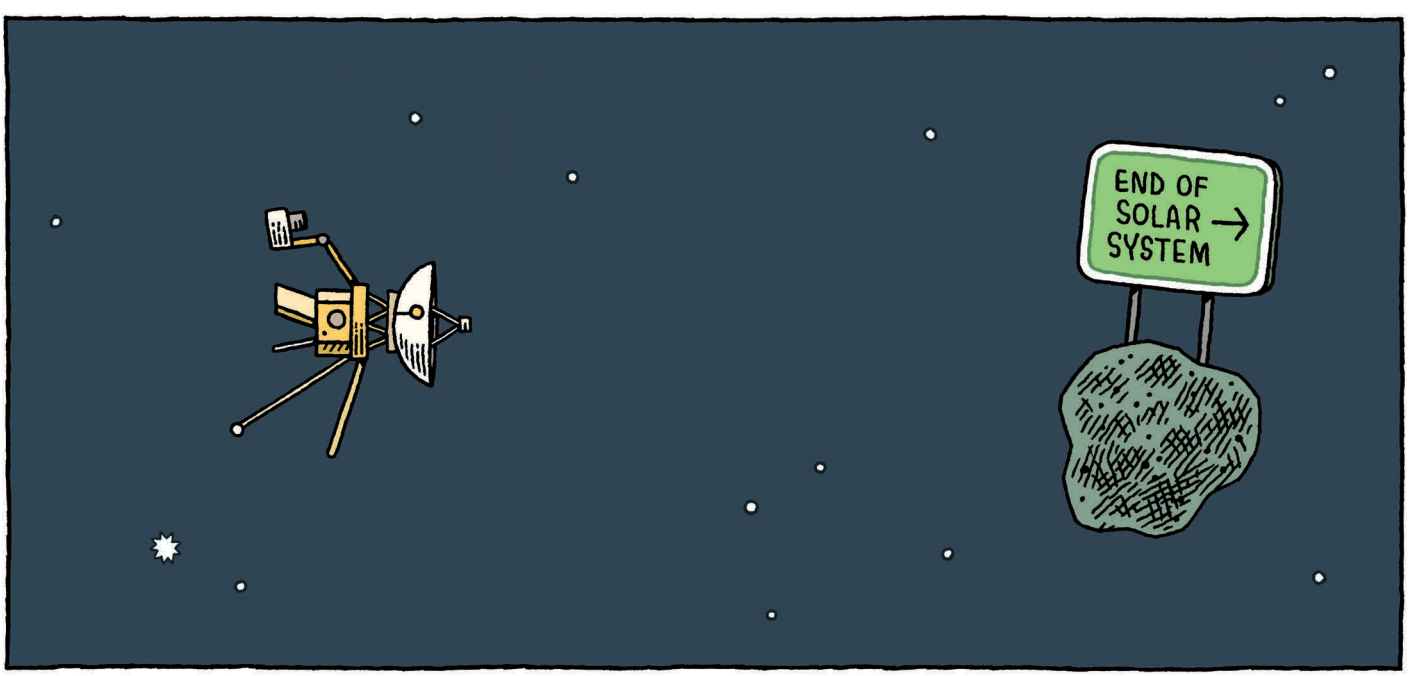
So why has it been so hard to tell if Voyager 1 has crossed the border from the solar system to interstellar space? And can we be sure that it has really made it this time? If the latest results are anything to go by, the story of Voyager 1 is far from over.

Mission control isn't what you might imagine. Forget the cavernous darkened room with rows of anxious engineers and scientists intently watching giant screens on the walls. What I'm ushered into is a single-storey building next to a busy traffic junction just north of Pasadena in California. Inside, there's a small open-plan office. It is empty apart from two pairs of computer screens aglow with tables of figures, one set green, the other blue. From the ceiling hangs a sign: "Mission Controller".

It hasn't always been so low-key. When NASA launched its twin Voyager 1 and 2 spacecraft in 1977, mission control was at the Jet Propulsion Laboratory in Pasadena. But times change: "We've been here since 2003, when NASA needed the control room for the Spirit and Opportunity rovers on Mars," says Suzy Dodd, the Voyagers' project manager.

What haven't changed are the giant radio ears around the globe picking up faint whispers from the distant probes. They beam data to the control room for sending on to the science teams. The two blue screens are displaying messages from Voyager 1; the green screens are full of posts from Voyager 2.

For all the similarity in the displays, ›



TOM GAULD

NASA

Way to go: Voyager 1 blasted off in September 1977

there's one huge difference. Voyager 2 is telling us about conditions in the heliosphere – the giant magnetic bubble surrounding the sun where we and all the planets reside. But Voyager 1 is flying higher, through a region of the universe where no probe has ever been before: the space between the stars.

Or is it? The hinterland of the solar system is a confusing place. For a start, where does it end? Voyager 1 has passed all the planets – it crossed Neptune's orbit back in 1988 – and is now 127 times further out from the sun than Earth. Yet it's still well within the sun's gravitational embrace, and won't break free for thousands of years when it passes the remote Oort cloud, homeland of the comets.

To settle the matter, the Voyager 1 team would like to find out whether the probe has burst through the heliosphere. This is formed from the hot wind of particles, laced with magnetic fields, pumped out by our star. The solar wind sweeps past Earth and travels beyond Neptune until it eventually loses its oomph when it hits interstellar space – marking the edge of our solar system.

Although nothing has visited interstellar space before now, Priscilla Frisch at the University of Chicago has been able to characterise it by looking at its imprint on light from nearby stars. Far from being a featureless void, interstellar space contains clouds of gas and dust that are being blown about by the force of ancient supernova explosions. Frisch has shown that our solar system lies inside a cloud about 40 light years across, called the Local Interstellar Cloud. Here a teaspoon of space contains about half a dozen atoms, which is far denser than the solar wind when it reaches the edge of the solar system.

This difference helps us tell if Voyager 1 has left the heliosphere and crossed into interstellar space. Amazingly, most of its scientific instruments are still working, though to save power NASA controllers long ago switched off the cameras that took close-up images of Jupiter and Saturn.

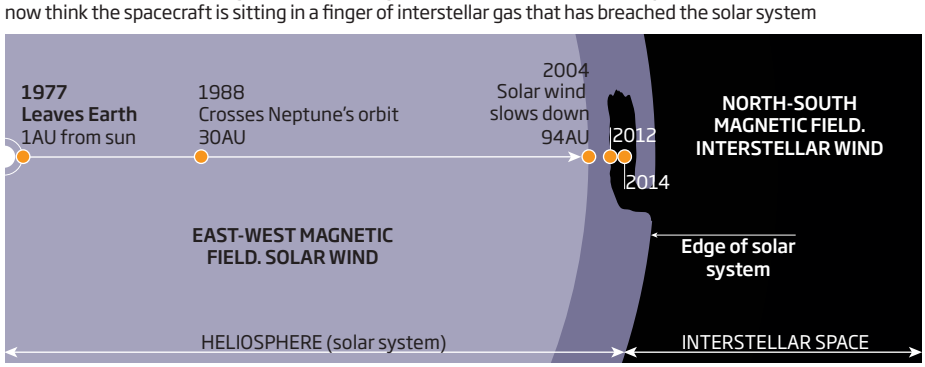
In August 2012, Voyager 1's instruments measured a dramatic drop in the number of solar-wind particles. At the same time, they detected a much higher rate of arrival of cosmic rays – high-energy particles from interstellar space that struggle to penetrate the heliosphere's magnetic shield. Things seemed pretty clear-cut: Voyager 1 had left the solar system.

However, a third indication refused to fall into place. Voyager 1's on-board compass should have picked up an abrupt change in the magnetic field at the edge of the heliosphere. "Yet the field direction was just really incredibly flat," says Alan Cummings, who was the last person to see Voyager 1 before lift-off.

Faced with this contradiction, early last year

Heading for the edge

The edge of the solar system is a confusing place. In 2012, Voyager 1 seemed to have crossed into interstellar space but its magnetic field reading still matched that of the solar system. Some researchers now think the spacecraft is sitting in a finger of interstellar gas that has breached the solar system



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