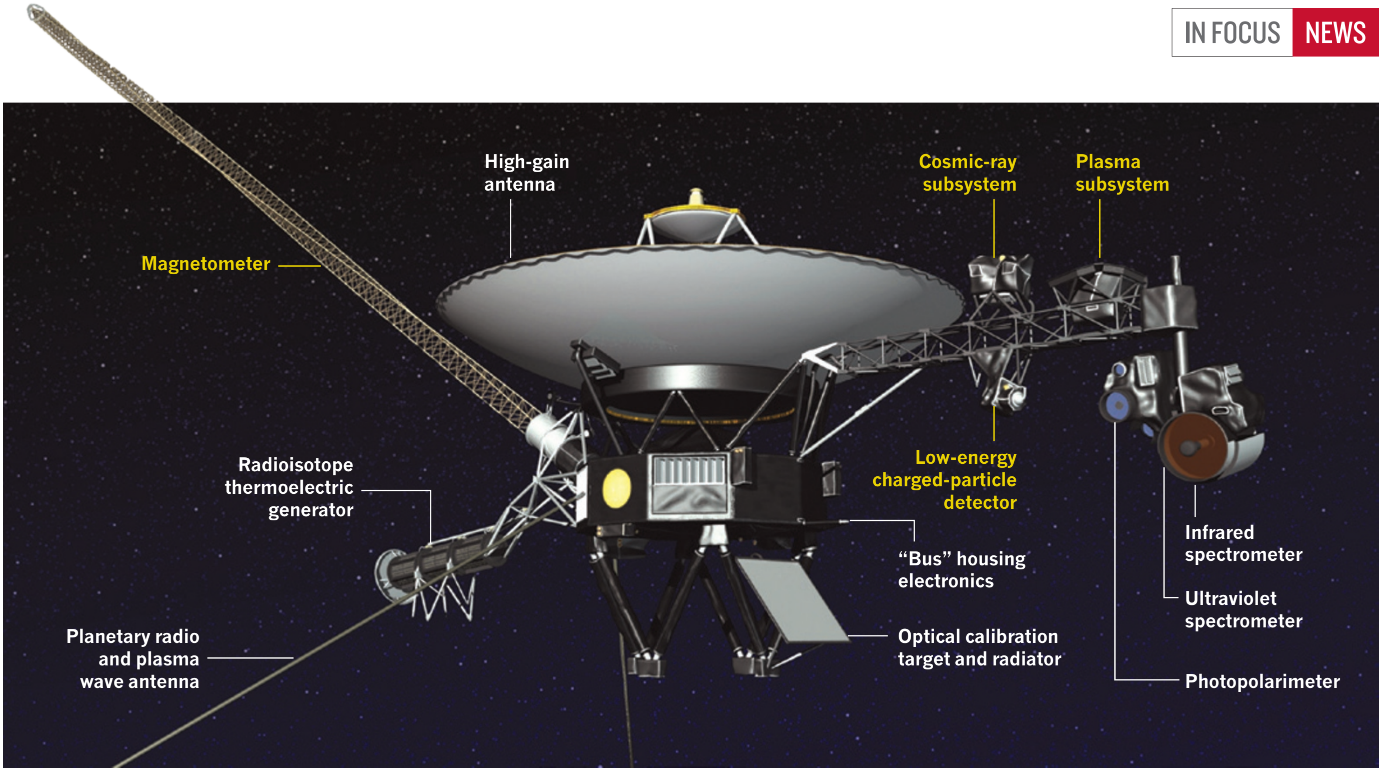

Voyager 1 was launched in 1977. Four of its original instruments (labelled in yellow) are still returning data on conditions at the edge of the Solar System.

cannot happen at the heliopause, says Decker. "We therefore conclude … that Voyager 1 is not at the present time close to the heliopause, at least in the form that it has been envisioned," the team writes[1].

Decker and his colleagues now think that since 2010, when the craft first recorded a velocity drop, it has been in an antechamber to the heliopause, at least 1 billion kilometres thick. Why the particles are becalmed remains a mystery, says Stamatios Krimigis, a space scientist at Johns Hopkins and a co-author of the paper. This leaves theorists in a bind. "There no longer exists any guidance on what constitutes getting out of the Solar System and into the Galaxy," says Krimigis.

Gary Zank, a theoretical physicist at the University of Alabama in Huntsville, disagrees. "I don't regard the paper as forcing us to revise our models," he says. His team and others theorize[3] that a magnetic wall in the outer heliosphere, caused by a pile-up of magnetic field lines, could slow down the flow of charged particles and account for the near-zero velocities recorded by Voyager 1.

Although the craft has not yet made it to the heliopause, the boundary may be within reach. This May, Voyager 1 recorded unprecedented bursts of cosmic rays — highly energized protons and atomic nuclei — coming from outside the Solar System. The spikes returned in July, this time along with a drop in the incidence of lower-energy cosmic rays thought to be accelerated in the Solar System. The changes suggest that Voyager 1 is nearing the fringe of the Solar System, and could cross the heliopause by the end of the year, says Krimigis. But, he adds, "nature seems to be much more imaginative than we are, so I could be quite wrong".

Indeed, David McComas, a physicist at the Southwest Research Institute in San Antonio, Texas, and Nathan Schwadron, a plasma physicist at the University of New Hampshire in Durham, suggest an alternative explanation. In an article in press in *The Astrophysical Journal*, they propose that Voyager 1 is in a region where magnetic field lines running through the outer heliosphere link up with the magnetic field of the rest of the Galaxy. Here the field would create a conduit for galactic cosmic rays, causing the spikes in detection. Cosmic rays accelerated within the heliosphere would tend to move along other field lines and be less likely to get to Voyager. If this model is correct, say McComas and Schwadron, the heliopause may still be years away.

"There no longer exists any guidance on what constitutes getting out of the Solar System."

When Voyager 1 does leave the Solar System, it may meet further surprises. Researchers have long assumed that a bow shock lies outside the heliopause. Similar to the shock wave around a supersonic aircraft, the bow shock is thought to form as the Solar System ploughs through the interstellar medium, forcing the local ionized gas to change density abruptly and discontinuously. But in May, McComas and his colleagues reported[4] that data from NASA's Interstellar Boundary Explorer (IBEX) mission cast doubt on this picture. From Earth orbit, IBEX probes the interstellar medium by detecting electrically neutral atoms that slip into the Solar System through the heliopause. Its measurements suggest that the Sun and planets are moving through the interstellar medium about 12% slower than previously calculated — too slow to generate a bow shock.

None of this uncertainty bothers Stone, who expects both Voyagers to cross the heliopause well before 2025, when the craft are due to go silent as the plutonium isotopes that supply their power run out. On the contrary, Stone adds, he is pleased that the one-way journey has taken so many unexpected turns. "One thing Voyager has taught us is to be prepared to be surprised." ■ SEE EDITORIAL P.6

1. Decker, R. B., Krimigis, S. M., Roelof, E. C. & Hill, M. E. *Nature* **489,** 124–127 (2012).
2. Krimigis, S. M., Roelof, E. C., Decker, R. B. & Hill, M. E. *Nature* **474,** 359–361 (2011).
3. Zank, G. P. *Space Sci. Rev.* **89,** 413–688 (1999).
4. McComas, D. J. *et al. Science* **336,** 1291–1293 (2012).

CORRECTIONS

The News Feature 'Making the links' (*Nature* **488,** 448–450; 2012) misspelt David Lazer's name and wrongly located him. He is at Northeastern University in Boston.

The News Feature 'Man of the desert' (*Nature* **488,** 272–274; 2012) got the details of Kröpelin's 2005 trip wrong. The heavy gunfire heard by the team was caused by Darfur rebels killing 20 Sudanese soldiers (not the other way round).

The News Feature 'Armed resistance' (*Nature* **488,** 576–579; 2012) conflated the Puebla campuses of the University of the Americas and the Monterrey Institute of Technology and Higher Education. The former was home to the first nanotechnology lab in Mexico, the latter was the first institute in Latin America to offer an undergraduate programme in the field and had a false bomb alert last August.