# NEWS IN FOCUS



NASA/JPL-CALTECH

**The Juno spacecraft will probe the Jovian atmosphere for water and look for signs of a solid core.**

PLANETARY SCIENCE

# Closing in on Jupiter's past

*NASA's Juno mission aims to reveal how the Solar System's largest planet was formed.*

**BY ERIC HAND**

It will be one wild ride. After arcing over Jupiter's north pole, the spacecraft will rip past the planet's equator at 60 kilometres per second, threading the gap between swirling cloud tops and a zone of high-energy radiation that would fry its delicate electronics. It will then swing out into space and repeat the harrowing journey 32 times more.

That's the plan for Juno, a US$1.1-billion NASA mission that is due to launch on 5 August or soon after. If all goes well, five years from now the spacecraft will drop into the highly elliptical orbit, which at closest approach will allow it to probe Jupiter's murky depths. The polar orbit will limit Juno's exposure to the worst of the radiation belt encircling Jupiter's equator, where the planet's magnetic field whips up electrons to nearly the speed of light. It also gives the spacecraft a Janus-like view. Instruments aimed away from Jupiter will map the radiation belts and magnetic fields, whereas those trained on the planet will probe its opaque layers for chemical and gravitational clues to its origins.

Crucial in that search will be an inventory of oxygen — sequestered as water vapour in Jupiter's atmosphere — and what it says about where and when the planet formed. Because Jupiter is likely to have formed first among the planets and because its powerful gravity has held its initial ingredients in place, Juno's results will also have broader significance. "Understanding the history of water across the early Solar System is a fundamental question, and Jupiter is going to give you the first clue," says Scott Bolton of the Southwest Research Institute in San Antonio, Texas, ▶

and principal investigator on the mission.

In 1995, a probe dropped by the Galileo mission found many volatile elements, such as nitrogen and argon, in higher proportions than expected at Jupiter's distance from the Sun. This suggested that Jupiter either migrated to its current location after forming elsewhere, or that it incorporated many comet-like building blocks from the Solar System's colder reaches. But because the probe descended through a rare dry spot with little water vapour, Galileo could not get a global read for Jupiter's oxygen. That left "a big hole" in what researchers know about the planet, says Tobias Owen at the University of Hawaii in Hilo, an investigator on the Galileo and Juno missions. This time, Juno will try to measure water content by detecting microwaves emitted by Jupiter's atmosphere. The amount of water present at different depths in the atmosphere alters the strength of the emission at different frequencies.

If Jupiter proves to be as enriched in oxygen as it is in other volatiles, that could lend support to a colder, more distant origin. Alternatively, the presence of even more oxygen would bolster models proposing that Jupiter formed close to its present orbit, with water ice trapping other volatiles. And if the global oxygen abundance is as low as that found by Galileo, "then we really have to open ourselves up to new ideas," says Bolton.

Another key Juno experiment will try to identify whether Jupiter has a core — the roughly ten Earth masses of ice and rock that many theorists say would have been necessary to allow the runaway accretion of the hydrogen and helium gases that make up most of the planet. The experiment will look for the subtle effect that a core's gravitational pull would have on the flight of the spacecraft.

*"Understanding the history of water across the early Solar System is a fundamental question."*

But Alan Boss, a theorist at the Carnegie Institution for Science in Washington DC, says that the presence or absence of a core won't determine Jupiter's origin conclusively. There is an alternative formation model, called disk instability, in which a perturbation in a thick cloud of gas can cause it to shrink rapidly to form a giant planet — and this model works with or without a core. Moreover, Boss says, Jupiter's core could have changed over time. And, he says, laboratories on Earth are just beginning to understand the behaviour of the highly compressed hydrogen that makes up the bulk of Jupiter's interior, and which matters most in understanding its structure. "To claim that Juno will solve the question of Jupiter's formation doesn't seem to be supported by what we know right now," he says. But Bolton says that the data will certainly help to constrain the theorists. "Slowly, you can put the handcuffs on these guys," he says.

All the debate assumes that Juno will survive long enough to get the data. Engineers have tried to protect it from the intense radiation, placing instruments behind elaborate periscope-like mirrors, and putting the most vulnerable electronics into a titanium box known as 'the vault'. Even so, Juno's design limits it to just 33 polar orbits, one every 11 days, before it is sent plunging into Jupiter, to avoid the risk of its hitting the moon Europa and possibly contaminating it with terrestrial microbes.

Within those precious orbits, Bolton hopes that his team can begin to understand how Jupiter was made — a question that has grown more relevant with the discovery of many Jupiter-mass planets in distant solar systems. "Jupiter is our archetype," Bolton says. "It's the only one we have." ■

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REGENERATIVE MEDICINE

# Court quashes stem-cell lawsuit

*US judge throws out case meant to halt federal funding, but research remains vulnerable.*

**BY MEREDITH WADMAN**

Was the case a fluke or a forewarning? Now that a federal judge has thrown out a lawsuit that sought to halt US government funding of research using human embryonic stem cells, scientists who depend on that support are left wondering whether the battle is truly over, or is merely moving on to a different arena.

Chief Judge Royce Lamberth of the US District Court for the District of Columbia issued his decision on 27 July, acknowledging a higher court's opinion that overruled a preliminary injunction that he had placed to suspend the funding last August (see 'Trying times'). That injunction was in effect for only 17 days, but it threw the stem-cell research community into turmoil as hundreds of scientists faced a funding cut-off. All research on human embryonic stem cells at the US National Institutes of Health (NIH) in Bethesda, Maryland, was shut down and reviews of grant applications were left in limbo.

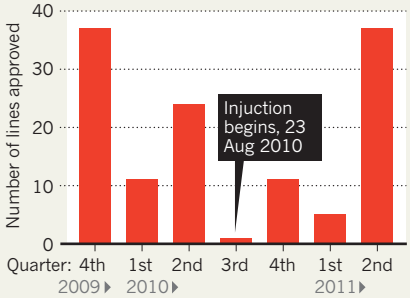
Last week's ruling decisively affirms the government's legal ability to fund research on human embryonic stem cells. It is a significant blow to the plaintiffs in the case — James Sherley, a biological engineer at the Boston Biomedical Research Institute in Massachusetts, and Theresa Deisher, who runs AVM Biotechnology in Seattle, Washington. Both work with adult stem cells, which are isolated from tissues or organs rather than embryos. Speaking to *Nature* on the day of Lamberth's decision, Deisher said: "It seems to be a complete reversal from his ruling last summer, so obviously it's quite a surprise."

"We intend to review all of our options for appeal of this decision," says Steven Aden, a lawyer for the plaintiffs.

Legal experts say that any appeal by the plaintiffs will probably not be successful, given the strength of Lamberth's written opinion and the fact that the appeals court overturned the preliminary injunction. "They are likely to lose at every stage," says Alta Charo, who studies law and bioethics at the University of Wisconsin–Madison. She adds that the injunction may come to be seen as an anomaly, rather than as encouragement for those who aim to starve human embryonic stem-cell research of funding. "I think it's a one off," she says.

But for scientists who laboured under the threat of a funding shutdown for 11 months as the case unfolded, the outcome is bittersweet. Although NIH approval of new stem-cell lines has resumed, and even accelerated (see 'Bouncing back'), some say that it will

**BOUNCING BACK**
The NIH has approved 42 stem-cell lines this year, ending a lull that followed the 2010 injunction.

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