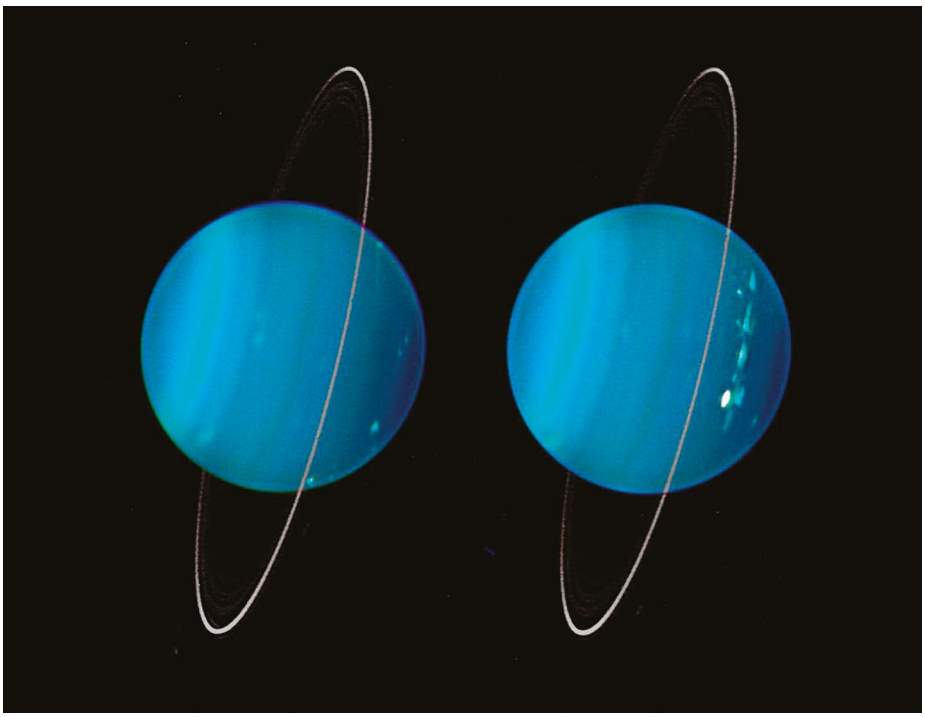
Comment

Why the European Space Agency should join the US mission to Uranus

Olivier Mousis & Robin M. Canup

Without international partnerships, NASA's groundbreaking mission could fail to be ready in time for its optimal launch window.



NASA/JPL

Infrared views of Uranus's two hemispheres reveal the planet's clouds, stripes and rings.

This week, space and planetary scientists are meeting at the Goddard Space Flight Center in Greenbelt, Maryland, to scope out a new flagship NASA mission — the Uranus Orbiter and Probe. Still on the drawing board, the project would entail sending a spacecraft to orbit Uranus and drop a probe into the planet's atmosphere. The spacecraft, which could be built and launched within a decade, would investigate the nature of Uranus, including its unusual tilt and magnetic field. It would also search the planet's moons for signs of hidden oceans and other potentially habitable environments.

Such a mission would be groundbreaking — the first to orbit an 'ice giant' planet. Thought to be made mostly of ices, or perhaps dominated by rocks, ice giants Uranus and Neptune have more exotic chemistry than do Jupiter and Saturn, which as 'gas giants' consist mainly of hydrogen and helium gas[1,2]. Ice giants are also the most common type of exoplanet in the Milky Way[3]. With characteristics that lie between those of gas giants and of Earth and other terrestrial planets, it's crucial to learn how such systems formed and evolved.

That's why the Uranus Orbiter and Probe was given priority status in the 2022 US Planetary Science and Astrobiology Decadal Survey. And NASA is set to lead it. At the Goddard workshop, scientists will scope out the mission and consider its design, technologies and costs.

The mission has been under discussion for some time, and it will be exciting to see it begin to take shape. But, to make sure it is successful and happens as quickly and cost-effectively as possible, we would like to see others involved in its design, too. As a first step, we call for the European Space Agency (ESA) to join the project by, for example, building the entry probe — a possibility that was foreseen in the decadal report and has been assessed by ESA but has not yet been agreed.

The window for such an agreement is closing fast. There is a strong scientific benefit to reaching Uranus near 2050, when its position in its orbit will mean that sunlight will fully illuminate all parts of the spinning planet and its orbiting moons. Given a typical 10-year development time for a flagship mission, paired with long flight times to Uranus (12–15 years, depending on launch date and vehicle), this would require work on the Uranus Orbiter and Probe to commence in the next few years.

NASA has stated that it hopes to start releasing funding for the mission in 2026 or 2027. By contrast, ESA's current budgetary programme does not include any substantial contribution to a NASA flagship mission in the coming years. This is a troubling, and in our view short-sighted, stance with long-lasting repercussions. Here's why.

Distant worlds

The scientific drivers for a Uranus mission are compelling. Dedicated missions to Jupiter and Saturn, including Galileo, Juno and Cassini–Huygens, have made major discoveries, including subsurface oceans on icy moons that might have the potential to harbour life[4]. Yet Uranus and Neptune have so far been snapped only briefly, as the Voyager 2 spacecraft sped past them in the 1980s.

Little is known about how these ice giants formed. Was Uranus a failed gas giant that formed too late to accrete hydrogen and

helium gas before the Sun's gaseous nebula dissipated? Or was it created through a different process, with more in common with Earth's genesis? Did Uranus form closer to Jupiter and then move away, ejecting comets into the inner Solar System that ultimately delivered water to Earth, as theories suggest? Finding answers will teach us about the origin of the Solar System as well as systems around distant stars.

Measuring the composition of Uranus's atmosphere would constrain the conditions under which the planet formed and show how these have changed with time[5]. The puzzlingly large tilt of Uranus's axis of rotation (almost parallel to the plane of the Solar System) could be examined, along with the planet's internal structure and magnetic field[1,2,6,7]. The mission would unravel the origin of Uranus's extensive dusty rings and moons[8]. Repeated fly-bys could check whether Uranus's satellites have subsurface oceans, as those of Jupiter and Saturn do.

Shared goals

With so much fundamental knowledge at stake, we argue for broader involvement of the planetary-science community in planning the Uranus Orbiter and Probe. The 2022 decadal survey emphasized the opportunity for international partnerships for this project. It noted that in 2021, a committee of senior scientists advising ESA on its long-term plan (Voyage 2050) recommended that ESA pursue a 'medium class' contribution to an ice-giant orbiter mission led by an international partner. ESA has evaluated the possibility of providing the entry probe, which it estimates could be done within the medium-sized-mission budget of around €500 million (US$537 million). But no commitment has yet been made.

A partnership between NASA and ESA to explore the Uranian system would offer advantages for both space agencies. For NASA, it would reduce costs and facilitate the provision of instruments. For ESA, it would offer European scientists the opportunity to participate in a groundbreaking, flagship-class mission at a relatively low cost. It would also foster collaboration between the two continents in this long mission, echoing the success of Cassini–Huygens — the most scientifically prolific robotic endeavour so far in the exploration of the outer Solar System.

Furthermore, a lack of substantial European involvement in a perhaps once-in-a-lifetime ice-giant flagship mission would undermine the large community of scientists, engineers and technicians engaged in space exploration across Europe who have strong interest in planets and the search for extraterrestrial life. It could also affect the mission itself, because the need for NASA to fund both the orbiter and the probe could delay the mission's start and arrival, which would diminish its scientific return.

"We urge NASA to swiftly initiate the study of the Uranus Orbiter and Probe mission."

Next steps

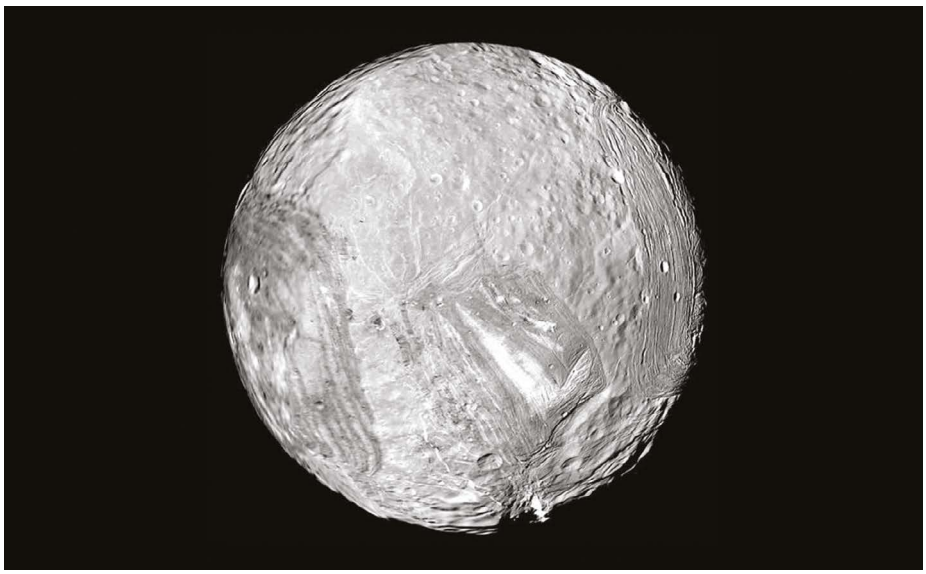
Given the long timelines involved in constructing the mission and its long travel time, we urge NASA to swiftly initiate the study of the Uranus Orbiter and Probe mission. This would generate excitement to foster international cooperation with ESA and with national space agencies that have well-established collaborations with NASA, such as JAXA in Japan and the United Arab Emirates Space Agency.

We also call on ESA to prioritize funding to support this strategic collaboration, building on past successes through Cassini–Huygens and at a fraction of the cost of a European-led ice-giant flagship mission. Contributing an entry probe to the project would accelerate the mission's timeline, add international momentum and reduce the costs for NASA. We would all get these crucial results sooner rather than later, and be able to visit the system when it is fully illuminated rather than in partial darkness.

In the absence of such a commitment from ESA, a promising alternative would be to establish a consortium of individual European countries to be responsible for constructing the probe. Financial-resource constraints would probably limit the instrumentation, and perhaps the depth such a probe could penetrate, but with careful design, the probe could still return crucial data.

Tension between ambitious Solar System exploration goals and budgetary pressures is likely to remain a reality for Europe and the United States in the short term. Increasing international collaboration could be the key that allows NASA and ESA to achieve their plans and maximize scientific return in an era of constrained budgets.

It would also pave the way for other breakthroughs. ESA's programme includes support for a flagship life-detection mission to the surface of Saturn's moon Enceladus in the early 2050s, and a similar mission was the second highest priority flagship mission identified for NASA in the 2022 decadal survey report. A NASA–ESA partnership for Uranus now would set the stage for future joint missions.



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Curious blocks of ice and rock on Uranus's moon Miranda were spied by Voyager 2.

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The authors declare no competing interests.