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A Mission to Uranus Could Help Find Planet 9

Uranus has a sideways orbit, unique weather patterns, and unusual rings, and its moons might have subsurface oceans. A mission to the ice giant would have a great deal of scientific potential, and now there's another compelling reason to visit: Data gathered on the way to the distant world could aid in the search for an elusive ninth planet suspected to orbit beyond Neptune.

With current technologies, positional data gathered during the mission's Jupiter-to-Uranus cruise stage could shrink the search window a thousandfold and make finding the planet with high-powered telescopes much more feasible, according to a team of doctoral students at the University of Zürich in Switzerland. Their study, which has been submitted for publication in the *Monthly Notices of the Royal Astronomical Society*, demonstrates that NASA's proposed flagship mission to Uranus could yield scientific discoveries beyond the Uranian system.

A hypothesized ninth planet, illustrated above, might lurk in the outer solar system and shape the orbits of tiny icy bodies. Credit: Caltech/R. Hurt (IPAC)

Narrowing the Search Grid

In 2016, two astronomers noticed that the orbits of several small icy objects in the outer reaches of the solar system tracked with each other too well to be random. Computer modeling and subsequent observations suggested that an unseen body far beyond Neptune might be gravitationally shepherding those objects into alignment. The astronomers dubbed the hypothesized body Planet 9 and have been trying to pinpoint its location ever since. (Not all astronomers are convinced of its existence.)

The planet, if it's out there, would be very faint, and the high-powered telescopes that could find it have narrow fields of view, better suited to pinpoint targeting than sweeping searches. Astronomers would need to know exactly where to look, explained coauthor Jozef Bucko, and as of now the search grid covers too large a swath of sky to earn highly coveted telescope time. "To persuade the observational astronomers to focus a telescope and try to search for it—this is very expensive, and we need to have strong arguments," he said.

That's where the proposed Uranus Orbiter and Probe mission comes in. During its travels to the outer solar system, it would occasionally ping a receiving station on Earth to let technicians know where it is, how fast it's going, and the status of onboard systems. This is standard procedure. Mission teams use these kinds of ranging data to keep a spacecraft on course; anything with enough gravitational influence—such as planets, asteroids, or comets—could nudge it off its path.

"If there is a gravitational anomaly in the solar system, in this case, Planet 9, the trajectory of the spacecraft would be affected," said coauthor Deniz Soyuer. The planet's gravity would subtly tug the spacecraft toward it, registering as a small change in speed or direction during the craft's 10- to 15-year cruise toward Uranus. Given the theorized mass and distance of Planet 9—6.3 Earth masses and 460 times the Earth-Sun distance—the planet, if it exists, "will definitely have a nonnegligible effect on the trajectory of a spacecraft," they said.

The idea of using spacecraft ranging data to find Planet 9 has been around for a few years, explained astronomer Mike Brown of the California Institute of Technology, one of the scientists who proposed the existence of Planet 9 in 2016. Astronomers tried using ranging data from NASA's Cassini mission to Saturn to pinpoint the planet but were left with too much of space to check.

"This paper gives a nice twist on the idea by tracking the spacecraft over a wide range of distances," said Brown, who was not involved in the study. The spacecraft would traverse more than 2 billion kilometers (1.2 billion miles) between Jupiter and Uranus. "One bit of good news is that the greater the distance [from Earth], the greater the effect of Planet 9, so making it all the way out to Uranus gives you quite a bit of leverage," he said.

The researchers calculated that if a Uranus mission uses Cassini-era technology, data from its cruise phase could narrow the search grid to 0.2 square degree. It's still a large swath of the sky, the team said, but a thousandfold improvement over the search range possible with Cassini data.

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If more modern technology can reduce the noise level of the ranging data, the search grid could shrink another 20 times smaller, the team said. "You don't really need that much of an improvement to be able to localize [Planet 9] to a place where you can convince people to point their telescopes at it," Soyuer said. This research was presented at the European Geosciences Union General Assembly 2023.

"I think it is great that people are thinking creatively about different ways in which we could eventually track down this elusive planet on the edge of the solar system."

Creative Solutions

A large uncertainty in how precisely ranging data could locate Planet 9 is not found with technology on board the spacecraft, explained coauthor Lorenz Zwick, but, rather, with limitations back on Earth. Ranging data are often gathered infrequently during a long cruise stage as a cost-saving measure.

The more frequently scientists collect ranging data, the more precisely they could home in on Planet 9, Zwick said, as well as accomplishing other science unrelated to Uranus. The benefits of frequent data gathering would far outweigh the costs, the researchers argued.

Bucko acknowledged that his team's model was a simple proof of concept that considered only the gravitational influences of the Sun and outer solar system planets. The group plans to run more complex calculations that include the influences of other solar system bodies and hopes to test the model using data from NASA's New Horizons mission to Pluto, Soyuer said.

"I think it is great that people are thinking creatively about different ways in which we could eventually track down this elusive planet on the edge of the solar system," Brown said.

By **Kimberly M. S. Cartier** (@AstroKimCartier), Staff Writer

Solar Panels Nurse Desert Soil Back to Life

The carpet of the desert. A charismatic crust. A suit of armor.

Biological soil crusts go by many names. A living ecosystem of cyanobacteria, lichen, moss, and algae, the crusts grow on arid soils on all continents, even Antarctica. Biocrust coats 12% of the planet's surface and contains most of a desert's ecological diversity in just the top few centimeters of soil.

But the crust is easily broken (even a footstep can crush it), and operations such as ranching and farming have destroyed crust around the world.

Phoenix, Ariz., feels the toll. There, wind over fallow fields lofts dust hundreds of meters in the air, swallowing roads and blinding drivers. The dust also carries deadly fungi into the city.

Now, a group of scientists has found that solar farms could help accelerate recovery of soil crust by a factor of years. In a new study, the researchers assert that solar farms in the Phoenix metro area could serve as biocrust nurseries at little cost; a large-scale effort could supply enough biocrust to cover most of the fallow farmland in Maricopa County within 5 years (bit.ly/crustivoltaics).

"One wishes one would have thought of this a decade ago," said study coauthor and microbiologist Ferran Garcia-Pichel of Arizona State University.

Beach Umbrellas

The experiment began at a small suburban solar farm in the Sonoran Desert on the edge of Arizona State University's Polytechnic Campus in Mesa. Nestled between homes and a shuttered school, the small plant by Clearway Energy had operated for more than a decade.

Garcia-Pichel and his collaborators discovered biocrust naturally growing under the solar panels on the farm.

The scientists took photographs of the site following a rainstorm to compute the extent of the biocrust. Certain types of tiny photosynthesizing cyanobacteria that live in biocrust migrate to the soil surface after a rainstorm, creating easy-to-see green splotches that delineate biocrust from bare soil. Normally, cyanobacteria stay just a few tenths of a centimeter under the soil to protect themselves from extreme heat and abrasion.

The photographs revealed that biocrust cover underneath the solar panels was triple that of areas outside of the solar panels' shadows. Biomass underneath the solar panels was also double that of neighboring soil.

A dust storm crawls toward Phoenix in 2011. Healthy biocrust suppresses dust. Credit: Alan Stark/Flickr, CC BY-SA 2.0 (bit.ly/ccbysa2-0)