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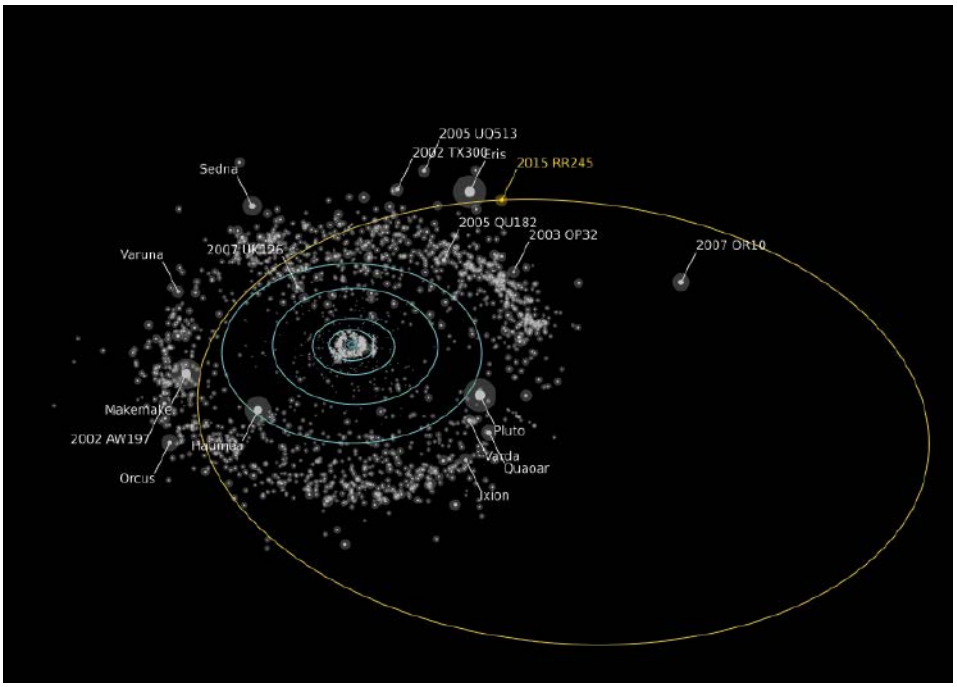
Newly Found Dwarf Planet Points to Solar System's Chaotic Past



Alex Parker/OSSOS

The likely orbit of the newly discovered dwarf planet 2015 RR245, depicted by the yellow ellipse. The orbits of the planets are depicted in turquoise, and every object brighter than RR245 that's not a planet is labeled.

Our orderly solar system hints at a violent past, if you know where to look. Telltale signs—from the battle wounds that scar Mercury's surface to the icy objects beyond Neptune that orbit the Sun in wacky paths—point toward a period of mayhem. Hundreds of millions of years after the giant planets formed, they swept into new orbits, flinging smaller objects every which way.

For decades, scientists have been trying to pin down the details of the solar system's hectic evolution. Now a newly discovered dwarf planet with a diameter about the length of Florida could do just that.

A Slow but Bright Speck

Astronomers first noticed the new world, dubbed 2015 RR245, in February 2016 when it appeared as a bright speck of light slowly moving across a sequence of images shot the previous year by the Canada-France-Hawaii Telescope on Mauna Kea. Its lethargic movement compared to that of bodies relatively close by meant that it must lurk in the fringes of the solar system. Any small object located so far away is going to be faint, but this object was relatively bright, suggesting that it was surprisingly massive.

The combination could mean only one thing: "Looking at it, I immediately knew that it was a dwarf planet," said J. J. Kavelaars, an astronomer on the team at the University of Victoria in Canada who made the discovery. Kavelaars, who was scanning the sky as part of the Outer Solar System Origins Survey (OSSOS), quickly called his postdoc Michele Bannister. She rushed downstairs to his office to look at the data and agreed: Only a dwarf planet could fit the bill. "It stood out like a searchlight," she said.

A Highly Elliptical Orbit

Within a day the team searched through other images of the object and teased out 2015 RR245's highly elliptical orbit. Over the course of 700 years it swings to as close as 5 billion kilometers from the Sun—a mere 500,000 kilometers beyond Neptune's average distance from the Sun. Then it heads out to nearly 20 billion kilometers—more than twice as far as Pluto's farthest point from the Sun. The team published the dwarf planet's orbital characteristics online and announced its discovery on 11 July (see http://bit.ly/DwarfRR245).

Currently located nearly 10 billion kilometers away toward the constellation Pisces, 2015 RR245 is swooping inward for a close-up in 2096. Extrapolating from its estimated distance and likely composition, 2015 RR245 is roughly 700 kilometers in diameter. At just one third the size of Pluto and one fifth the size of the Moon, the newfound object is on the low end of the dwarf planet spectrum.

The International Astronomical Union coined the term dwarf planet in 2006 to describe objects, like Pluto, that aren't proper planets. A dwarf planet must circle the Sun and be massive enough to pull its own weight into a rough sphere. Although the research team hasn't observed 2015 RR245's shape, its diameter suggests that it's likely heavy enough to be roughly spherical. But unlike the proper planets, it hasn't necessarily cleared the orbital neighborhood of debris.

Synchrony with Neptune?

Perhaps what is most exciting about the discovery is the fact that the dwarf planet could be in resonance with Neptune, Bannister said. Pluto, too, is in resonance with the ice giant, meaning that for every three times Neptune orbits the Sun, Pluto orbits twice. Such synchrony suggests that the two interacted in the past.

In fact, it was this exact resonance between Neptune and Pluto that led researchers to discover our solar system's violent history. To create the orbits of the icy outer solar system bodies that exist beyond Neptune today, the general consensus holds that Neptune likely formed closer to the Sun, then migrated to its current position.

> The dwarf planet could be in resonance with Neptune.

As Neptune swept outward, "poof—[it] snowplowed everything out of the way," explained Bannister. But every action triggers a reaction: Every small object thrown around would have slightly tweaked Neptune's orbit until they were in resonance with one another.

Still, scientists don't understand the specifics of Neptune's early migration. "Did it happen fast?" asks Bannister. "In less than a few tens of millions of years? Or did it take as much as several hundreds of millions of years?"

To answer these questions, scientists have to build models of the early solar system, run each through 4.5 billion years of history, and see if it creates the thousands of orbits—of planets, dwarf planets, asteroids, and comets—pinpointed today. If one of these models lands on today's snapshot, researchers may have their solution. But until then, every extra orbit helps.

A Cold Start

These icy objects can shed light on not only the solar system's chaotic evolution but also its frigid formation. Unlike the inner planets, which have been warmed by the Sun or their own internal heat, the distant and small objects are cold enough to have preserved some of the chemical ingredients that were present when the solar system formed.

"It's like archeology," said Scott Sheppard, an astronomer at the Carnegie Institution for Science in Washington, D. C., who has discovered many outer solar system objects but was not a part of this discovery. Outer solar system bodies "have a fossilized imprint of what happened in the past."

But these objects are rare. Even Pluto is so large that it has some internal heat. However, 2015 RR245 is what Bannister calls "Pluto's little sister," meaning that it's small enough and distant enough that it's the perfect laboratory to preserve the makeup of the solar system's ingredients.

Typically, such a small and distant object would be faint, but the latest discovery is bright enough that astronomers will be able to take follow-up images and peel away what ices might still exist on its frozen surface, said Bannister. But Sheppard warns that this likely won't be possible until the James Webb Space Telescope launches in 2018 or the next generation of giant, ground-based telescopes comes online within the next decade.

Kavelaars, however, is most excited about similar discoveries to come. "I had previously thought that all the things this bright and this large must have already been detected," he said. The fact that the team looked in such a small patch of sky—only 10%—and easily found one means that there could be perhaps nine more discoveries waiting to be found.

"So let's get on it," Kavelaars said. "Let's find some more!"

By **Shannon Hall,** Freelance Writer; email: hallshannonw@gmail.com

USGS Seeks to Contain Damage from Scientific Misconduct at Lab

Associated Press/David Zalubowski

The main entrance to the Federal Center in Lakewood, Colo., where the inorganic section of the Energy Geochemistry Laboratory was located until the lab closed this spring. The U.S. Geological Survey found evidence of scientific misconduct in the lab section.

Two separate but related "scientific integrity incidents" at a U.S. Geological Survey (USGS) laboratory have rattled the agency, which, officials told *Eos,* is striving to contain and repair the damage, fix management flaws, and protect the Survey's science reputation. A 15 June report by the Department of the Interior's Office of the Inspector General (OIG) found that "the full extent of the impacts are not yet known but, nevertheless, that they will be serious and far ranging," according to Deputy Inspector General Mary Kendall.

According to the OIG report (http://bit.ly/DOI-OIG-report), during the period 2008–2014, employees at the inorganic section of the Survey's Energy Geochemistry Laboratory in Lakewood, Colo., improperly manipulated mass spectrometer data. After learning of the improper activity in October 2014, USGS convened a Scientific Integrity Review Panel that concluded that the lab had a "chronic pattern of scientific misconduct." The agency self-reported the matter to OIG and shuttered the inorganic section of the lab this spring, according to USGS. In 2008, USGS had discovered an earlier spell of scientific misconduct at the same lab, from 1996 through 2008, but involving different staff. The 15 June OIG report focused on the newer, 2008–2014 episode.

The lab's inorganic section, which provided scientific support for the USGS Energy Resources Program (ERP), used its mass spectrometer to conduct chemical inorganic analyses of water samples and solid samples, including coal and rock, according to the agency.

Two Dozen Projects Potentially Affected

"Since ERP data is used to support both scientific decision-making and understanding, inaccurate data has significant scientific consequences," the OIG report stated. With regard to the 2008–2014 period, 24 research and assessment projects with national and global interest "were potentially affected by erroneous information," according to OIG. The projects represent about $108 million in funding from fiscal years 2008 through 2014, with the inorganic section of the laboratory receiving $4.1 million in funding since fiscal year 2008.

Potentially affected projects listed by OIG include a toxic trace metals analysis of water in the greater Everglades ecosystem in Florida, an analysis of metals released into waters associated with coal bed natural gas produc-