Is There a Planet Nine in Our Solar System?

There is a lot more to our solar system than eight planets going around the Sun. For example, between Mars and Jupiter, there is an asteroid belt filled with small rocky objects. These objects are leftover bits that didn't get swept up when the planets were forming. Out beyond Neptune, there's another belt of small bits of icy debris, known as the Kuiper Belt. All those icy objects in the Kuiper Belt are simply known as Kuiper Belt Objects (KBOs), the most famous of which is the dwarf planet (and former planet number nine) Pluto.

Although the planets orbit in near perfect circles around the Sun, not everything in our solar system is so well-behaved. Kuiper Belt Objects and comets tend to have very **eccentric** orbits, meaning their paths are like stretched out ovals, dipping close to the Sun and then traveling much further away. All small objects of the solar system—comets, KBOs, asteroids—change their orbits as they encounter each other and the larger things of the solar system, like the planets. Earth's orbit changes a bit, too, as it is pulled on by the gas giants Jupiter and Saturn. Our solar system is always changing, even if it might not seem like it from Earth!

Because KBOs are so far away and so small, not much sunlight is reflected off them and they appear quite dim from our point of view. Only recently, have we had telescopes powerful enough to let us track the KBO orbits—and it turns out they're pretty strange. All the KBOs we see beyond a very large distance (about 2.3×10^{20} km or 1.4×10^{10} miles) are clustered together and have very eccentric orbits. Specifically, the points where these oddball KBOs are closest to the Sun in their orbits are all close together, as shown in **Figure 1**. This is very strange! We would expect that those points of closest approach to the Sun would be random...unless there's something else out there.

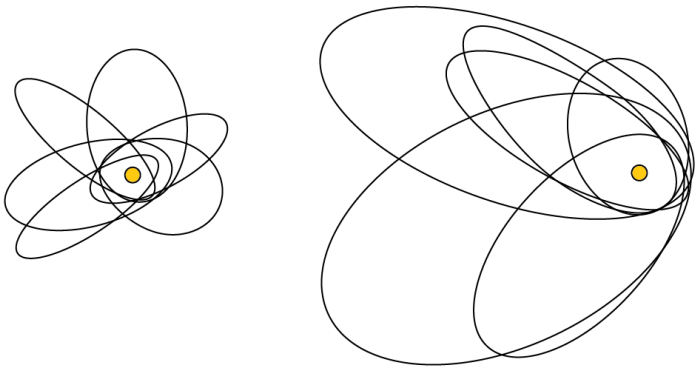

Figure 1. Clustered Orbits of Kuiper Belt Objects. Each ellipse represents the orbit of a particular KBO. The sun is marked by a circle (not to scale—these orbits are hundreds of times larger than the orbit of the Earth around the sun). On the left, we see what we'd expect if there was no Planet 9. On the right, we see what's actually observed.

What could be causing this clustering of KBOs? Researchers have found that the best explanation so far is that there is another giant planet out there, as shown in **Figure 2**, pulling on these KBOs through gravity so that their orbits are clustered together like we observe. They ran computer simulations to model how these objects interact through gravity, and confirmed that a large planet could explain what we see. What kind of planet, though? By their calculations, it would have to be more than 10 times the mass of Earth, orbiting very far out in our solar system—3.2×10^{20} km (2.0×10^{10} miles) or beyond. A planet this far out would take 18,000 years to orbit the Sun, and the sunlight there would be 62,000 times dimmer than what we feel on Earth. Since it's so far away, its gravitational pull on Earth wouldn't be very noticeable either, although it has a large effect on the tiny KBOs that are closer to it.

What's next? Although the math suggests there is something out there, we haven't actually *seen* this planet yet. (Since it's so far away from the Sun, not much light reaches it to illuminate its surface, making it hard to image.) Researchers are using large telescopes to search the night sky for Planet 9. This is actually the same way we discovered Neptune–predictions based on unexpected wobbles in Uranus's orbit led to actual observations of Neptune. So, there's definitely hope we'll bring the solar system's planet count back up to nine sometime soon!

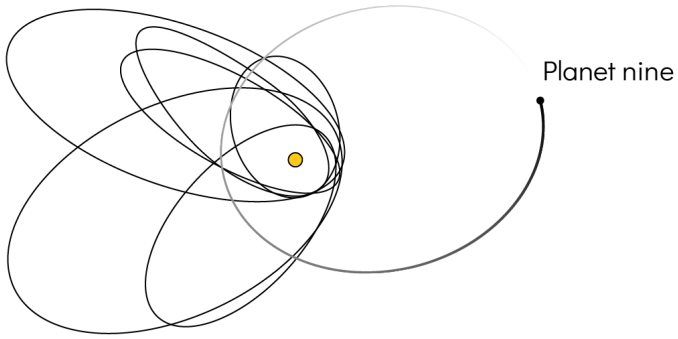

Figure 2. The Possible Orbit of Planet 9. Each of the ellipses on the left is one of the clustered Kuiper Belt Objects, and the ellipse on the right is the possible orbit of Planet 9. The yellow circle in the center represents the Sun (not to scale—the orbits are MUCH larger than shown).

Reference

Batygin, Konstantin, and Michael E. Brown. 2016. "Evidence for a distant giant planet in the solar system." *The Astronomical Journal* 151(2):22.

BiteScientist Profiles

Briley Lewis is a soon-to-be-graduating PhD Candidate in astronomy and astrophysics at UCLA. She is researching how to find and image planets around other stars, known as exoplanets. She also writes science journalism articles, as found in Scientific American, Popular Science, SPACE.com, and more. Outside of work, she enjoys reading, playing beach volleyball, and quality time with her precious senior rescue dog, Rocky.

Shannon Morey teaches physics at Abbott Lawrence Academy in Lawrence, Massachusetts. She is a 2015 Knowles Teacher Initiative Fellow and the 2022 MA STEM Teacher of the Year. In her free time she enjoys spinning, cooking, and yarn crafts. She also loves to travel for fun and to learn more about the world. She is pictured here on Isabela Island in the Gálapagos Islands as part of a Knowles Teacher Initiative professional development.