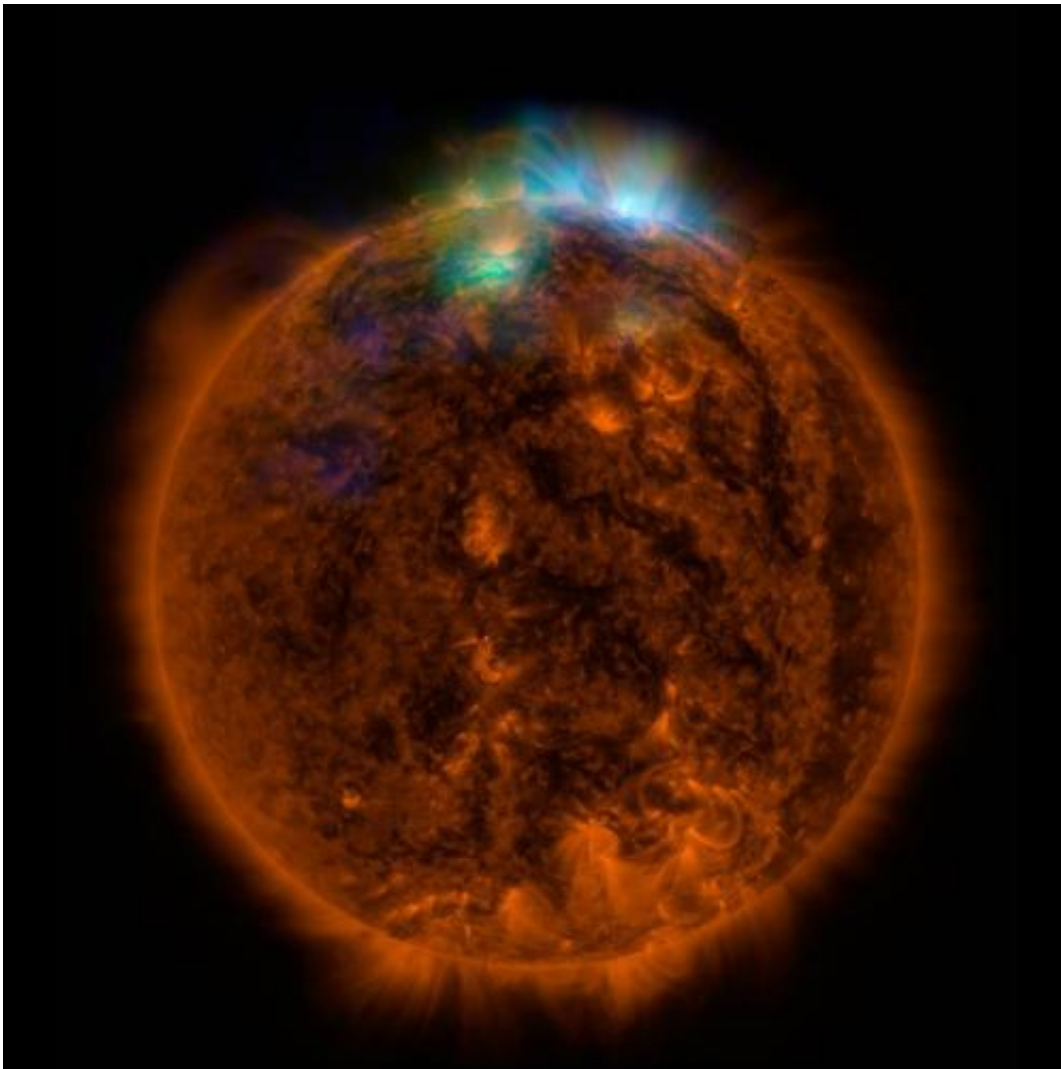


# Curious tilt of the sun traced to undiscovered planet

October 19 2016

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X-rays stream off the sun in this image showing observations from by NASA's Nuclear Spectroscopic Telescope Array, or NuSTAR, overlaid on a picture taken by NASA's Solar Dynamics Observatory (SDO). Credit: NASA

Planet Nine—the undiscovered planet at the edge of the Solar System that was predicted by the work of Caltech's Konstantin Batygin and Mike Brown in January 2016—appears to be responsible for the unusual tilt of the sun, according to a new study.

The large and [distant planet](#) may be adding a wobble to the solar system, giving the appearance that the sun is tilted slightly.

"Because Planet Nine is so massive and has an orbit tilted compared to the other [planets](#), the solar system has no choice but to slowly twist out of alignment," says Elizabeth Bailey, a graduate student at Caltech and lead author of a study announcing the discovery.

All of the planets orbit in a flat plane with respect to the sun, roughly within a couple degrees of each other. That plane, however, rotates at a six-degree tilt with respect to the sun—giving the appearance that the sun itself is cocked off at an angle. Until now, no one had found a compelling explanation to produce such an effect. "It's such a deep-rooted mystery and so difficult to explain that people just don't talk about it," says Brown, the Richard and Barbara Rosenberg Professor of Planetary Astronomy.

Brown and Batygin's discovery of evidence that the sun is orbited by an as-yet-unseen planet—that is about 10 times the size of Earth with an orbit that is about 20 times farther from the sun on average than Neptune's—changes the physics. Planet Nine, based on their calculations, appears to orbit at about 30 degrees off from the other planets' orbital plane—in the process, influencing the orbit of a large population of objects in the Kuiper Belt, which is how Brown and Batygin came to suspect a planet existed there in the first place.

"It continues to amaze us; every time we look carefully we continue to find that Planet Nine explains something about the solar system that had

long been a mystery," says Batygin, an assistant professor of planetary science.

Their findings have been accepted for publication in an upcoming issue of the *Astrophysical Journal*, and will be presented on October 18 at the American Astronomical Society's Division for Planetary Sciences annual meeting, held in Pasadena.

The tilt of the solar system's orbital plane has long befuddled astronomers because of the way the planets formed: as a spinning cloud slowly collapsing first into a disk and then into objects orbiting a central star.

Planet Nine's [angular momentum](#) is having an outsized impact on the solar system based on its location and size. A planet's angular momentum equals the mass of an object multiplied by its distance from the sun, and corresponds with the force that the planet exerts on the overall system's spin. Because the other planets in the solar system all exist along a flat plane, their angular momentum works to keep the whole disk spinning smoothly.

Planet Nine's unusual orbit, however, adds a multi-billion-year wobble to that system. Mathematically, given the hypothesized size and distance of Planet Nine, a six-degree tilt fits perfectly, Brown says.

The next question, then, is how did Planet Nine achieve its unusual orbit? Though that remains to be determined, Batygin suggests that the planet may have been ejected from the neighborhood of the gas giants by Jupiter, or perhaps may have been influenced by the gravitational pull of other stellar bodies in the solar system's extreme past.

For now, Brown and Batygin continue to work with colleagues throughout the world to search the night sky for signs of Planet Nine

along the path they predicted in January. That search, Brown says, may take three years or more.

Provided by California Institute of Technology

Citation: Curious tilt of the sun traced to undiscovered planet (2016, October 19) retrieved 19 April 2024 from <https://phys.org/news/2016-10-curious-tilt-sun-undiscovered-planet.html>

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