Planet Nine could be a primordial black hole, new research suggests

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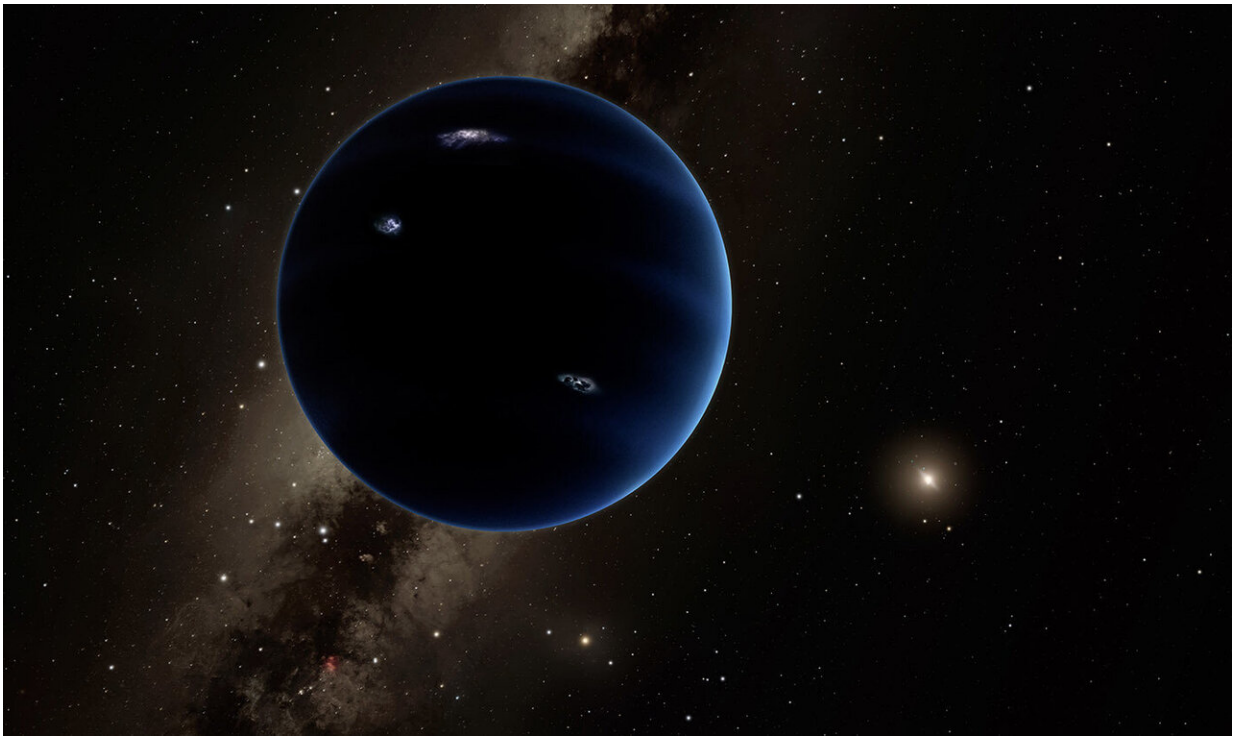

Artist's concept of the hypothetical Planet Nine. Credit: Caltech/R. Hurt (IPAC)

The hypothetical Planet Nine, assumed to be lurking somewhere in the outskirts of our solar system, may not be a planet at all. A new study, published September 24 on the arXiv pre-print server, suggests that the mysterious and still undiscovered object might be a primordial black hole.

Primordial black holes (PBHs) are old and relatively small black holes that emerged soon after the Big Bang. They are thought to have been formed as a result of density fluctuations in the very early universe. It is believed that PBHs with the lowest mass have likely evaporated. However, those with larger masses may still exist, evaporating at the present epoch—even though they have been never directly observed.

Astronomers Jakub Scholtz of Durham University and James Unwin of University of Illinois at Chicago, assume that PBHs could reside even closer to us than we think. In a recently published paper, they ponder the possibility that the elusive Planet Nine, theorized to be orbiting the sun at a distance between 300 and 1,000 AU, could be such an old and compact black hole.

Explaining their intriguing hypothesis, the researchers focus on two unsolved gravitational anomalies of similar mass: anomalous orbits of trans-Neptunian objects (TNOs) and an excess in microlensing events. What is interesting is that both events are due to objects with masses estimated to be between 0.5 and 20 Earth masses.

The anomalies of TNO orbits are assumed to be triggered by a new gravitational source in the outer solar system. While it is widely accepted that this source could be a free-floating planet, Scholtz and Unwin argue that the PBH scenario is not unreasonable and should be taken into account.

"Capture of a free-floating planet is a leading explanation for the origin of Planet Nine, and we show that the probability of capturing a PBH instead is comparable," the astronomers wrote in the paper.

However, it could be difficult to confirm this theory, as such a hypothetical PBH, with a mass of around five Earth masses and a radius of about five centimeters, would have a Hawking temperature of

approximately 0.004 K, making it colder than the cosmic microwave background (CMB). Therefore, the power radiated by a typical PBH alone is minuscule, which makes it hard to detect.

In order to overcome this obstacle, the authors of the paper propose to search for annihilation signals from the dark matter microhalo around a PBH. Such a dark matter halo, if annihilating, is thought to be able to provide a powerful signal that could be identified by observations. Hence, the astronomers suggest dedicated searches for moving sources in X-rays, gamma-rays and also other high-energy cosmic rays, which could provide more evidence supporting the PBH hypothesis.

More information: Jakub Scholtz, James Unwin. What if Planet 9 is a Primordial Black Hole? arXiv:1909.11090v1 [hep-ph]: arxiv.org/abs/1909.11090