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Neptune on tiptoes

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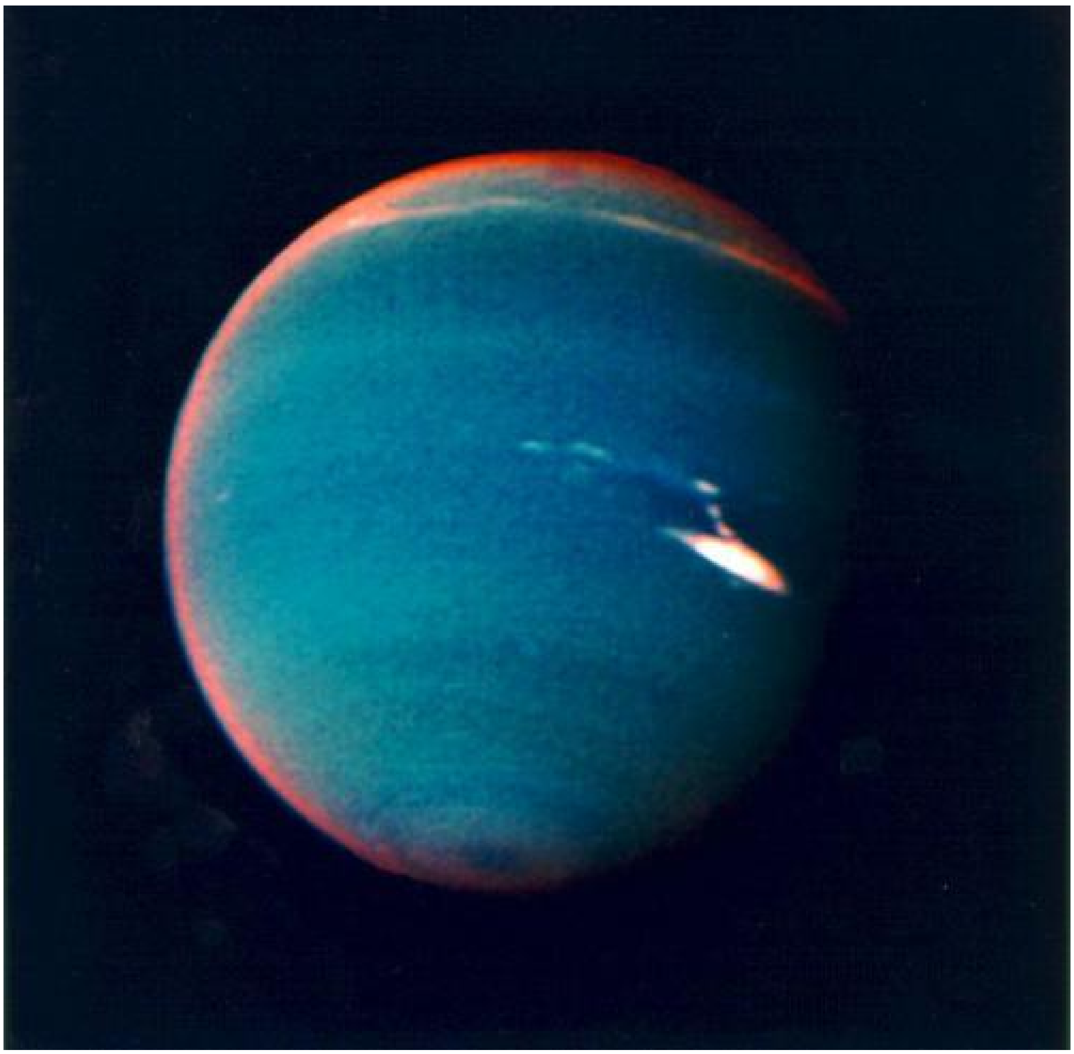

A false-color image of Neptune using data taken by the Voyager satellite. New models constrain for the first time the orbital parameters of Neptune in the early days of the solar system. Credit: NASA

(PhysOrg.com) -- The formation and development of the solar system, long a topic of study for philosophers and scientists, is today often used as a case study for the formation and development of planetary systems around other stars. One probe of the early history of the solar system is the current configuration of the Kuiper Belt, a disc-shaped region of icy objects beyond the orbit of Neptune that stretches between about thirty to fifty astronomical units (AU) from the Sun. Pluto and Eris are the best known Kuiper Belt Objects (KBOs), and there are thought to be as many as one hundred thousand bodies larger in diameter than about 100 km out there.

The spatial distribution of KBOs provides a kind of map for how the orbital evolution of the giant planets in our solar system sculpted the disk of small bodies. In particular, it is possible to use KBOs to constrain how the orbits of the giant planets -- especially Neptune -- evolved in the early solar system. There are currently two basic models that have enjoyed some success in reproducing KBO orbits, but they are unable to reproduce the observations in one of two basic respects: either they cannot explain the circularity of the orbits, or the fact that one subset of KBOs lies in the plane of the solar system while a second subset has orbits more inclined to the plane.

CfA astronomers Rebekah Dawson and Ruth Murray-Clay, with a colleague, have developed new algorithms and computer codes to address these and other limitations of the current models. In the first of three papers on the topic, they show that they can place robust constraints on the history of Neptune's orbit. For example, they conclude that if Neptune migrated rapidly to its current distance from the Sun, 30AU, then its orbit must have originally been somewhat circular. In particular, its distance from the Sun throughout one of its revolutions would have varied by less than about 30%; for comparison, the value for Pluto today is about 65%. The new results are an important improvement in our understanding not only of how the solar system formed, but how planets might form around other stars.

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