



Space Research Journal

ISSN 1819-3382



Academic
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Astronomers Find Newly Discovered Asteroid Is Earth's Companion

Astronomers from the Armagh Observatory in Northern Ireland have found that a recently discovered asteroid has been following Earth in its motion around the Sun for at least the past 250,000 years, and may be intimately related to the origin of our planet.

Their work appears in a paper in the journal *Monthly Notices of the Royal Astronomical Society*.

The asteroid first caught the eye of the scientists, Apostolos "Tolis" Christou and David Asher, two months after it was found by the WISE infrared survey satellite, launched in 2009 by the United States. "Its average distance from the Sun is identical to that of the Earth," says Dr Christou, "but what really impressed me at the time was how Earth-like its orbit was." Most near-Earth Asteroids -- NEAs for short -- have very eccentric, or egg-shaped, orbits that take the asteroid right through the inner solar system. But the new object, designated 2010 SO16, is different. Its orbit is almost circular so that it cannot come close to any other planet in the solar system except Earth.

The researchers set out to investigate how stable this orbit is and how long the asteroid has occupied it. To do that, they first had to take into account the current uncertainty in the asteroid's orbit. "Not knowing precisely the location of a newly-discovered NEA is quite common," explained Dr. Asher. "The only way to eliminate the uncertainty is to keep tracking the asteroid for as long as possible, usually months or years." But the two scientists overcame that problem by creating virtual "clones" of the asteroid for every possible orbit that it could conceivably occupy. They then simulated the evolution of these clones under the gravity of the Sun and the planets for two million years into the past and in the future.

They found that all the clones remained in a so-called "horseshoe" state with respect to Earth. In this configuration, an object mimics very closely the orbital motion of our planet around the Sun, but as seen from

Earth it appears to slowly trace out a horseshoe shape in space. Asteroid 2010 SO16 takes 175 years to make the trip from one end of the horseshoe to the other. So while on the one hand its orbit is remarkably similar to Earth's, in fact "this asteroid is terraphobic," explains Tolis. "It keeps well away from the Earth. So well, in fact, that it has likely been in this orbit for several hundred thousand years, never coming closer to our planet than 50 times the distance to the Moon." This is where it is now, near the end of the horseshoe trailing Earth.

Currently, three other horseshoe companions of Earth are known to exist but, unlike 2010 SO16, these linger for a few thousand years at most before moving on to different orbits. Also, with an estimated diameter of 200-400 metres, 2010 SO16 is by far the largest of Earth's horseshoe asteroids. The team have already used the Las Cumbres Observatory's Faulkes Telescope in an ongoing campaign to track the object and refine its orbit further. "It is not that difficult to spot with a medium-sized professional telescope," says Dr Asher. "It will remain as an evening object in Earth's skies for many years to come."

Ultimately, Christou and Asher would like to know where it came from, and they have already thought of several possibilities. It could be an ordinary asteroid coming from the Main Belt between Mars and Jupiter. In that case, the random gravitational pull of the different planets would be responsible for its present orbit; something that Tolis and David think is an unlikely proposition. It could also be a piece of the Moon that escaped the gravity of Earth-Moon system and went into an independent orbit around the Sun. However, the very stability of its orbit means that there is currently no way to transport it from the Moon to where it

is now. Finally, 2010 S016 could represent leakage from a population of objects near the so-called triangular equilibrium points 60 degrees ahead of and behind Earth in its orbit. Such a population has been postulated in the past but never observed as such objects are always near the Sun in the sky. If they do exist, they may represent relic material from the formation of Earth, Moon and the other inner planets 4.5 billion years ago.

For the time being, the astronomers would like to see the physical properties of the object studied from the ground,

especially its colour. "Colour, a measure of an asteroid's reflectivity across the electromagnetic spectrum, can tell you a lot about its origin," they explain. "With this information we can start testing possible origin scenarios with hard data. If it proves to be unique in some way, it may be worth sending a probe to study it up close, and perhaps bring back a sample for laboratory scrutiny."

Journal Reference: 1. A. A. Christou and D. J. Asher. A long-lived horseshoe companion to the Earth. *Mon. Not. R. Astron. Soc.*, 1 April 2011 <http://arxiv.org/abs/1104.0036>