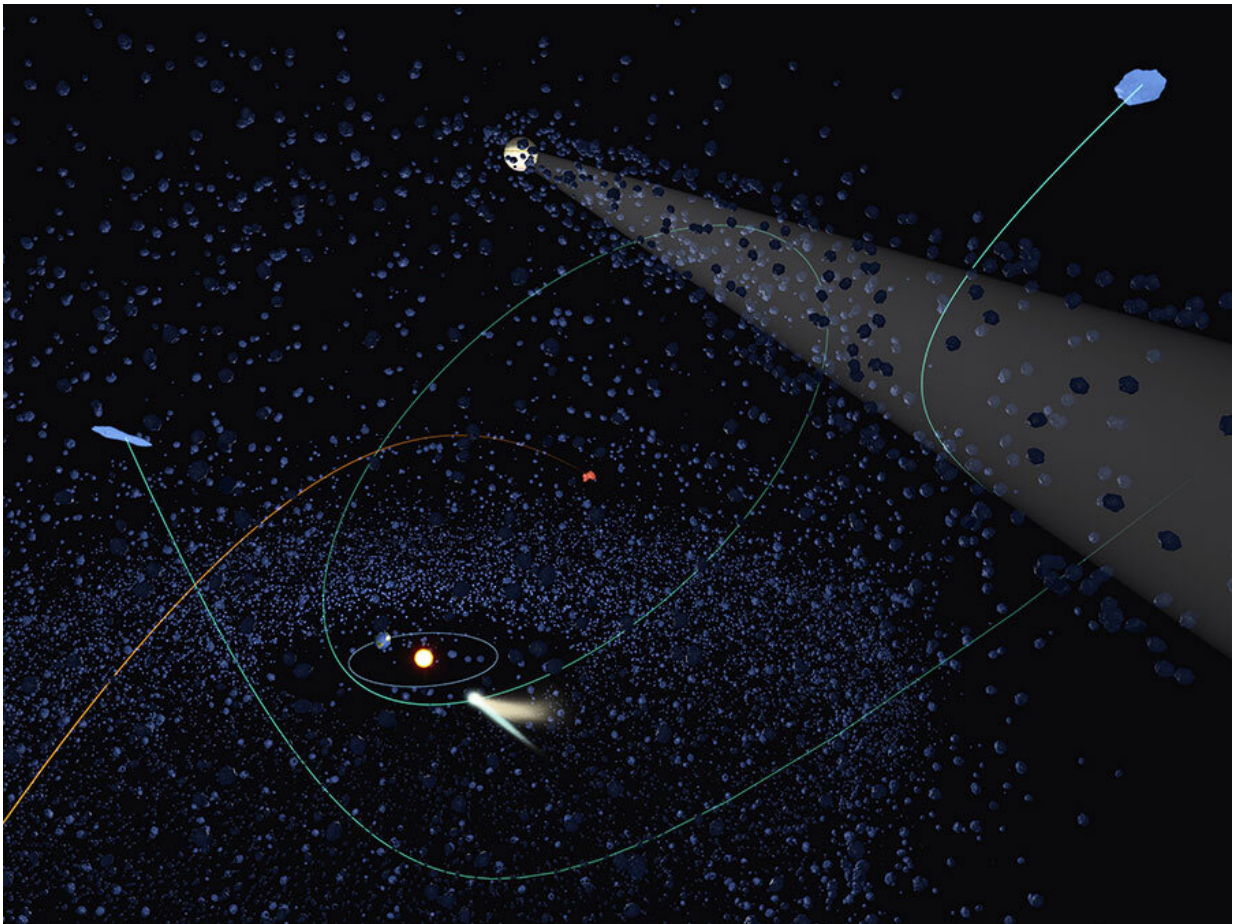


Here and gone: Outbound comets are likely of extra-solar origin

January 17 2020



Conceptual diagram of this research. Researchers calculated the typical paths of long-orbit comets (blue) perturbed by a passing gas-giant-sized object (white) and objects of interstellar origin (red). Credit: NAOJ

Astronomers at the National Astronomical Observatory of Japan (NAOJ) have analyzed the paths of two objects heading out of the Solar System forever and determined that they also most likely originated from outside of the Solar System. These results improve our understanding of the outer Solar System and beyond.

Not all comets follow closed orbits around the Sun. Some fly through the Solar System at high speed before heading out to interstellar space, never to return. Although it is simple to calculate where these comets are going, determining where they came from is more difficult.

There are two possible scenarios. In the first scenario, a comet is originally in a stable [orbit](#) far from the Sun, but gravitational interactions with a passing [object](#) pull the comet out of its orbit. The comet then falls into the inner Solar System where it can be observed before being flung out into interstellar space. In the second scenario, a [comet](#) originates someplace very far away, perhaps a different planetary system, and as it flies through [interstellar space](#), by random chance it passes through the Solar System once before continuing on its way.

Arika Higuchi and Eiichiro Kokubo at NAOJ calculated the types of trajectories which would typically be expected in each scenario. The team then compared their calculations to observations of two unusual outbound objects, 1I/'Oumuamua discovered in 2017 and 2I/Borisov discovered in 2019. They found that the interstellar origin scenario provides the better match for the paths of both objects.

The team also showed that it is possible for gas-giant-sized bodies passing close to the Solar System to destabilize long-orbit comets and set them on paths similar to the paths of these two objects. Survey observations have not uncovered any gas-giant-sized bodies which can be linked to these two outbound objects, but further study, both theoretical and observational, of small interstellar objects is needed to better

determine the origins of these objects.

These results appeared online as "Hyperbolic orbits in the Solar system: interstellar origin or perturbed Oort cloud comets?" in the *Monthly Notices of the Royal Astronomical Society* on November 11, 2019 and will be printed in the February 2020 issue.

More information: Arika Higuchi et al. Hyperbolic Orbits in the Solar System: Interstellar Origin or Perturbed Oort Cloud Comets?, *Monthly Notices of the Royal Astronomical Society* (2019). [DOI: 10.1093/mnras/stz3153](https://doi.org/10.1093/mnras/stz3153)

Provided by National Astronomical Observatory of Japan

Citation: Here and gone: Outbound comets are likely of extra-solar origin (2020, January 17) retrieved 9 April 2024 from <https://phys.org/news/2020-01-outbound-comets-extra-solar.html>

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