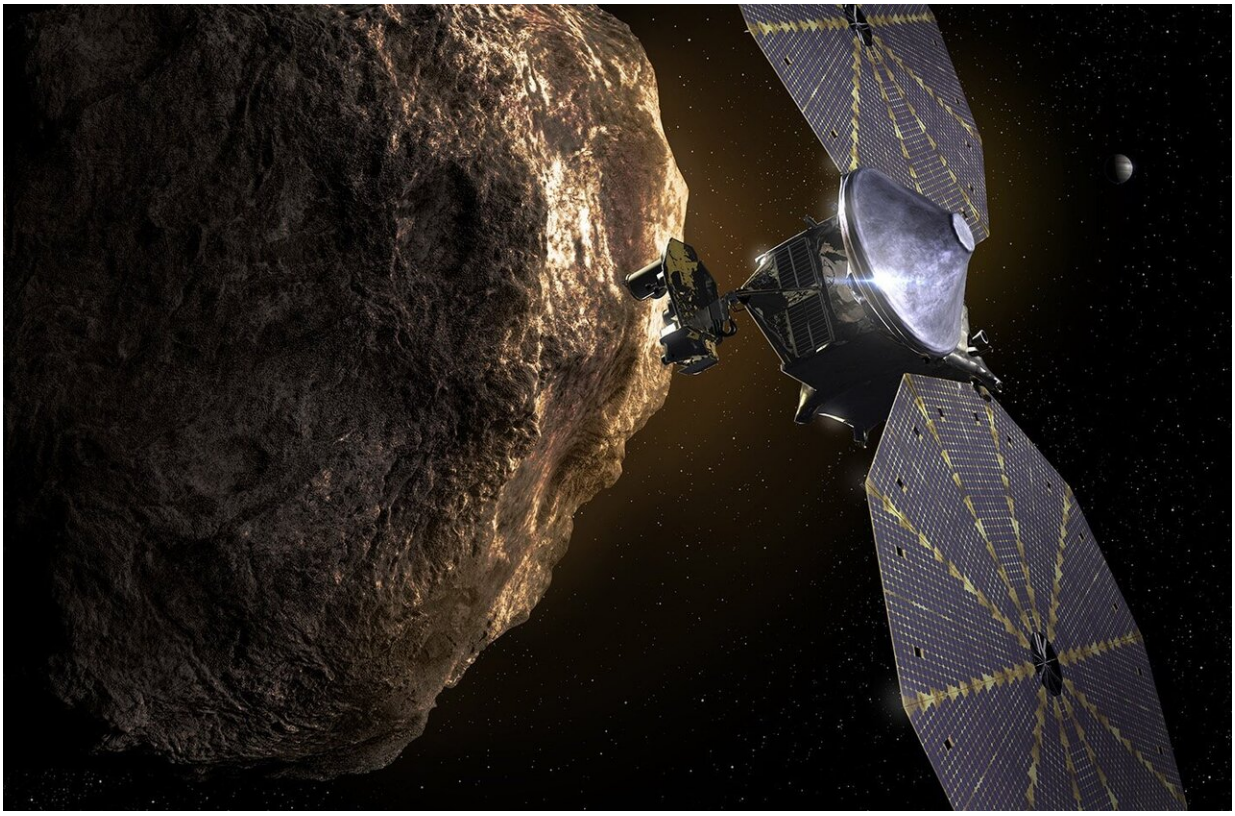
Jupiter's Trojan asteroids offer surprises

February 9 2021, by Scott Johnston



Credit: Southwest Research Institute

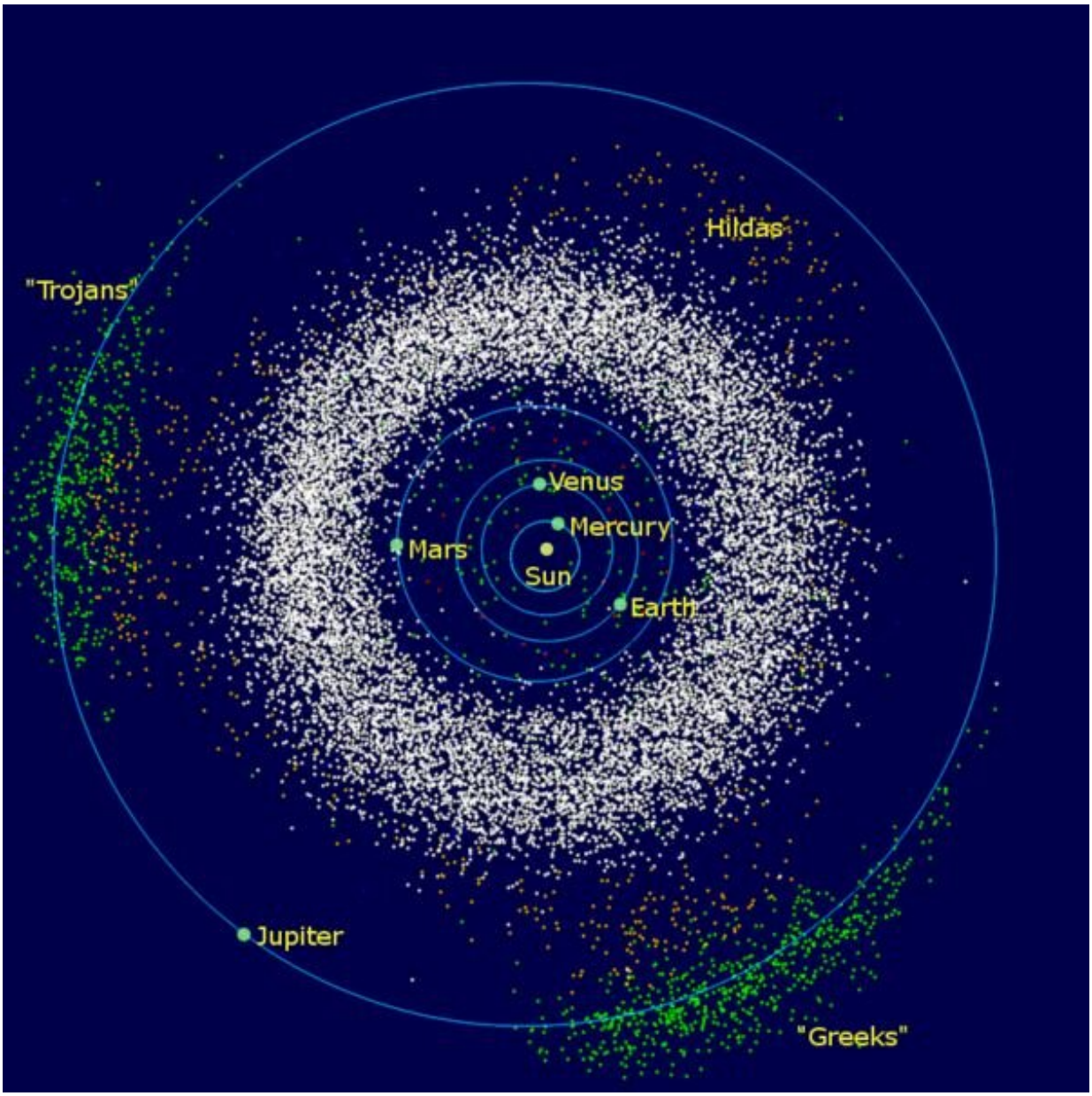
A new study out this month suggests that Jupiter's Trojan asteroids may be more peculiar than previously thought. The Trojan asteroids are rocky objects which orbit the sun just ahead of and just behind the gas giant, in gravitational sweet spots known as Lagrange points. The swarm ahead of Jupiter, known as the L4 (Greek) group, is slightly larger than the L5

(Trojan) swarm behind, but until now, astronomers believed that there was otherwise little differentiation between the two swarms. The paper released this month appears to change that.

The research team, using data from the Asteroid Terrestrial-impact Last Alert System (ATLAS) based in Hawaii, has discovered unexpected variations in the shape of the Trojans. This new study suggests that objects in the L4 population are actually more elongated than those in the L5 population, on average.

Why does this matter? Well, the difference "may imply a different collisional evolution within each cloud," the paper suggests. The L4 swarm's larger population means objects within it have had had more opportunities to collide with one another. As one Trojan slams into another, larger objects are worn down or broken into smaller pieces. Over billions of years of impacts, the result is that more L4 objects have been battered into eccentric shapes than those in L5.

This discovery is a lesson learned regarding the evolutionary history of the solar system, and the Jupiter Trojans may have plenty more to offer scientists in that respect in the near future. In order to get a closer look at these primordial remnants of the early solar system, NASA is set to launch a robotic spacecraft to visit the Trojans later this year. The mission is named Lucy, after the fossilized remains of an early human ancestor found in Ethiopia in 1974. Lucy taught paleontologists about the evolution of humans, and in a similar way, the Lucy spacecraft will be able to teach astronomers about the early history of the solar system.

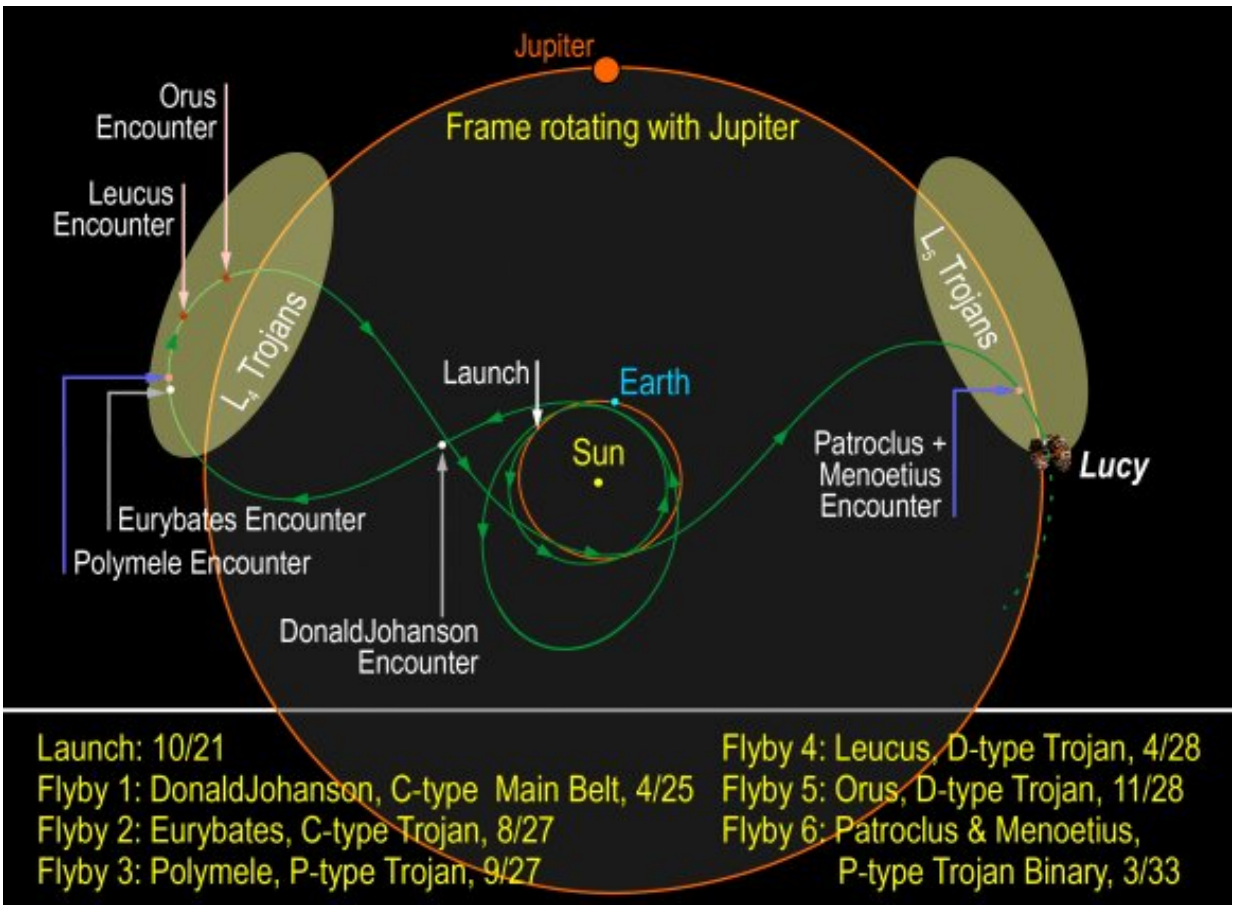


In this image, Jupiter's Trojan asteroids are shown in Green. The L4 group is labelled 'Greeks', because these objects are usually named after Greek heroes of the Trojan War, while the L5 asteroids are labelled 'Trojans,' as they are named after Trojan heroes. Credit: Wikipedia Commons

One of Lucy's key objectives is to understand the composition and

diversity of Trojan objects. It is believed that these asteroids represent the leftovers of planet formation, so learning about their structure, age, and component materials will help us to understand the ingredients which went into making the planets we see today, possibly including the organic materials that found their way to Earth in its infancy.

Lucy will take advantage of lessons learned from previous missions, carrying instruments similar to those flown on NASA's New Horizons, which flew past Pluto in 2015, and OSIRIS-Rex, which is currently bringing a sample back to Earth from Asteroid Bennu. Using a series of clever gravity assists, Lucy will be able to visit more targets in a single mission than any solar system probe before it, flying past at least eight asteroids over 12 years, starting with one in the main asteroid belt, then bouncing back and forth between objects in the L4 and L5 swarms.



Lucy's orbital trajectory. Credit: Southwest Research Institute

Careful planning and a bit of astronomical luck means that Lucy will even get the chance to visit two targets in the L5 swarm that travel in high-inclination orbits, making them normally very difficult to reach. The binary pair, Patroclus and Menoetius, will pass within reach of Lucy in 2033, making for a spectacular finale to Lucy's primary mission.

Lucy will launch from Cape Canaveral, Florida on an Atlas V rocket in October. The complete mission timeline is as follows:

- October 16, 2021: The three-week long launch window opens.
- April 20, 2025: Main asteroid belt object (52246) Donaldjohanson.
- August 12, 2027: L4 object (3548) Eurybates and its satellite, Queta.
- September 15, 2027: L4 object (15094) Polymele.
- April 18, 2028: L4 object (11351) Leucus.
- November 11, 2028: L4 object (21900) Orus.
- March 2, 2033: L5 object (617) Patroclus and its partner, Menoetius.

Whatever else Lucy might discover, it is clear that a combination of ground-based astronomy and spacecraft flybys are opening up a new chapter in our understanding of planetary formation, and the Trojans probably have more surprises in store for us in the years to come.

More information: Comparison of the physical properties of the L4 and L5 Trojan asteroids from ATLAS data. arxiv.org/abs/2101.04602

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