Scientists offer a new explanation for a mystery surrounding Jupiter's two massive asteroid swarms

January 17 2023

Credit: Unsplash/CC0 Public Domain

An international team of scientists, including NYU Abu Dhabi researcher Nikolaos Georgakarakos and others from the U.S., Japan, and China, led by Jian Li from Nanjing University, has developed new insights that may explain the numerical asymmetry of the L4 and L5

Jupiter Trojan swarms, two clusters containing more than 10,000 asteroids that move along Jupiter's orbital path around the sun.

For decades, scientists have known that there are significantly more asteroids in the L4 swarm than the L5 swarm, but have not fully understood the reason for this asymmetry. In the current configuration of the solar system, the two swarms show almost identical dynamical stability and survivability properties, which has led scientists to believe that the differences came about during earlier times of our solar system's life. Determining the cause of these differences could uncover new details about the formation and evolution of the solar system.

In the paper, "Asymmetry in the number of L4 and L5 Jupiter Trojans driven by jumping Jupiter," published in the journal *Astronomy & Astrophysics*, the researchers present a mechanism that can explain the observed number asymmetry.

"We propose that an outward—in terms of distance to the sun—fast migration of Jupiter can distort the configuration of the Trojan swarms, resulting in more stable orbits in the L4 swarm than in the L5 one," said Li.

"This mechanism, which temporarily induced different evolution paths for the two asteroid groups that share the orbit of Jupiter, provides a new and natural explanation for the unbiased observation, that the L4 asteroids are about 1.6 times more than the asteroids in the L5 swarm."

The model simulates the orbital evolution of Jupiter, caused by a planetary orbital instability in the early solar system. This led to the outward migration of Jupiter at a very high speed; a migration that the researchers hypothesize was the possible cause of the changes in the stability of the nearby asteroid swarms. Future models could expand on this work by including additional aspects of the evolution of the solar

system, which could depict it with improved accuracy. This could include simulating the fast migrations of Jupiter at different speeds, and the effects of nearby planets.

"The characteristics of the current solar system hold as-yet unsolved mysteries into its formation and early evolution," said Georgakarakos.

"The ability to successfully simulate an event from an early stage of the solar system's development and apply those results to modern day questions can also be a key tool as astrophysicists and other researchers work to learn more about the dawn of our world."

More information: Jian Li et al, Asymmetry in the number of L4 and L5 Jupiter Trojans driven by jumping Jupiter, *Astronomy & Astrophysics* (2022). DOI: 10.1051/0004-6361/202244443

Provided by New York University