

## Origin of Jupiter Trojan asteroids: To be explored by OKEANOS

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The Jupiter Trojan asteroids are expected to be a key to understand planet formation and solar system evolution. The Jupiter Trojan asteroids are an asteroid group at the Lagrangian point (L4 and L5) on the Jupiter's orbit, and their spectral types are mainly D and P type, also called "Red" and "Less red", respectively [1,2]. The origin of these asteroids was considered to be trapped by Jupiter according to the classical planet formation theory [3,4]. On the other hand, according to a relatively new theoretical study such as Nice model, the small bodies formed at the Kuiper belt region are disturbed by giant planet migrations, and some of them trapped at the current Jupiter orbit [5]. Thus, constraining planetary formation theories can be possible by investigating whether the Jupiter Trojan asteroids originated from the outer region of the solar system such as the Kuiper belt area or originated from the current Jupiter orbit region (the extension of the main belt asteroids). The stable isotopic ratios of light elements are expected to be an indicator of the origin of the Jupiter Trojan asteroids. Because heavy isotopes such as <sup>2</sup>H (D) and <sup>15</sup>N tend to incorporate into water and organic matter in low temperatures (<10-100 K) such as in the outer region of the solar system [6,7]. In fact, heavy isotopes are concentrated in materials from the outer region of the solar system such as comets, and materials from main belt asteroids such as chondrites often show relatively light isotopic ratios [8].

The OKEANOS (Outsized Kite-craft for Exploration and AstroNautics in the Outer Solar system) is a candidate for the upcoming strategic middle-class space exploration to rendezvous with and land on a Jupiter Trojan asteroid using a Solar Power Sail (SPS). The mission concept includes sampling and in-situ analysis of the materials of a Jupiter Trojan asteroid [9]. We plan to analyze isotopic and molecular compositions of volatile materials from organic matter, hydrated minerals, and ice, in order to understand origin and evolution of the Jupiter Trojan asteroids, using a multi-turn time-of-flight type high-resolution mass spectrometry (HRMS) system. Our goal is to improve our understanding of (1) planet formation/migration theories, (2) distribution and evolution of volatile substances in protoplanetary disks, (3) origins and evolution of organic matter, and (4) origin and evolution of the Solar System small bodies beyond the snow line.

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