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Jupiter Trojan's shallow subsurface: direct observations by radar on board OKEANOS mission

Alain Herique (1), Pierre Beck (1), Patrick Michel (2), Wlodek Kofman (1,6), Atsushi Kumamoto (3), Tatsuaki Okada (4), Dirk Plettemeier (5)

(1) Univ. Grenoble Alpes, IPAG, F-38000 Grenoble, France, (alain.herique@univ-grenoble-alpes.fr)
(2) UNS-CNRS-Observatoire de la Cote d'Azur, Nice, France
(3) Tohoku University, Sendai, Japan
(4) Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Japan
(5) Technical University Dresden, 01187 Dresden, Germany
(6) Space Research Centre PAS, Warsaw, Poland

Abstract

What are the Jupiter Trojans asteroids? Are they rocky asteroids accreted in the vicinity of Jupiter? Captured Icy bodies? Understanding the genetic of The Jupiter Trojans is the goal of the OKEANOS / JAXA understudy mission. The monostatic radar onboard OKEANOS will be the unique opportunity to directly access the shallow subsurface of the body, imaging its internal structures.

Trojans' Genetic

Dark and red objects (P- & D-types) dominate this small population of objects orbiting the Sun at Jupiter L4 and L5 Lagrange points. They are suspected to have originated further away from the Sun. Particularly, the Nice model predicts that they were born in a Trans-Neptunian planetesimals disk and were implanted in their current orbit during the late-heavy-bombardment (LHB) [1]–[3].

Understanding the genetic of The Jupiter Trojans, their composition and formation region is therefore a high-value science goal to unravel the dynamical history of the Solar System. This is the goal of the OKEANOS (Oversize Kite-craft for Exploration and AstroNautics in the Outer Solar system) mission under study by JAXA to cruise to the outer solar system using a large-area solar power sail, and to rendezvous with and land on a Jupiter Trojan asteroid [4]. This body will be observed by imaging, NIR, X-ray spectroscopy and radar while collected samples will be studied by microscopy and mass spectroscopy.

Planetary radar

In complement to the optical remote sensing, radar sounding of the shallow subsurface would improve our understanding of these unexplored bodies [5], [6]. The sounding of the first tens of meters of the surface would give the structure of the near surface and allows identifying layers, ices lenses covered by a regolith, spatial variability of the constitutive material and possible migration processes of volatile or organic materials. It would support the identification of exogenous materials aggregated in the Lagrange-point gravitational trap in order to understand the relation of Trojans with their environment.

A radar sounder onboard a Jupiter Trojan mission will strongly benefit to the lander or sample-return part of the mission. A Radar will be the only instrument that can probe the target asteroid down to a significant depth; this will support sampling and landing site selection by providing geological context, and making sure that the site selected is well representative of the asteroid as a whole.

This goals which are crucial to understand the Trojan's origin can be achieved by a radar with a frequency bandwidth ranging from 300 MHz to 800 MHz as the High Frequency Radar (HFR) developed in the frame of the mission study AIDA/AIM [7]. An additional channel at lower frequency (60MHz) could allow a larger penetration depth [8]. This instrument might be used as an altimeter supporting a controlled descent to the Trojan asteroid surface.

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