

OKEANOS –the Solar Power Sail Mission for Science exploration of Jupiter Trojan Asteroid by Rendezvous and Landing

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The Solar Power Sail OKEANOS (Oversize Kite-craft for Exploration and AstroNautics in the Outer Solar system) is under study in Japan to rendezvous with and land on a Jupiter Trojan asteroid [1]. It is primarily an engineering mission but also a key science mission for understanding the solar system origin and evolution by conducting in-depth investigations, complementary to LUCY [2], which flybys six Jupiter Trojans to understand the variation and diversity of them. The OKEANOS lander and science experiments are jointly studied between Japan and Europe [3]. The scientific objectives and the strawman payloads for this mission are described here.

Jupiter Trojan asteroids are classified as volatile-rich D- or P-types. They might be moved from outer region of solar system due to planetary migration [4]. Those bodies should have 20 to 30 km in size for landing site selection (LSS) since it is large enough to classify its taxonomy by ground observations but small enough for landing on it easily due to its low escape velocity.

The spacecraft consists of a main orbiter and a lander. The orbiter has a large area solar power sail which rotates at 0.1 rpm and weighs ca. 1,400 kg. The lander within the mass of 100 kg has the main body size within ϕ 650 x 400 mm, with the extensible legs and sampling devices. The life time of the lander is 22 hours, using a primary battery of 600 W-Hour for the mission. The bitrate of 1 Mbps from the lander to the main orbiter enables to transfer more than 500 Mbytes of data in 5 hours. The spacecraft will be launched in mid-2020s, accelerated by gravity assists of Earth and Jupiter. It will take ca. 13 years to arrive at the target asteroid. Plan-A is a one-way trip to the target asteroid, and Plan-A' adds another Trojan asteroid rendezvous. Plan-B is a return trip from a Jupiter Trojan asteroid to Earth. Mission payloads should be within 30 kg on the main orbiter and within 20 kg on the lander.

Physical, mineralogical, and isotopic studies of surface materials and volatile compounds could provide a clue to understanding the origin and evolution processes of the target body, as well as the solar system formation. To achieve these goals, *in situ* surface experiments with the lander as well as global mapping from the main orbiter are required. After arrival, the target asteroid will be globally investigated through remote sensing, and for the landing site selection. The asteroid will be characterized and investigated such as high-resolved surface global mapping by using an optical telescopic imager, and a near-infrared and a thermal-infrared hyperspectral imager. A lander will observe the surface materials and physical

properties of the surrounding area, and to conduct *in situ* analysis (hyperspectral microscopy for solids, and high-res. mass spectrometry for volatiles) for the materials sampled from asteroid surface and subsurface. Collected samples will be viewed with a visible to infrared microscope (covering 1 to 4 μm) with a spatial resolution of ca. 20 μm per pixel to identify and classify each grain. Those samples will be heated by step heating, pyrolysis, and gas-chromatography for high resolution mass spectrometry (HRMS). Mass resolution $m/\Delta m > 30,000$ is required to investigate isotopic ratios of D/H, $^{15}\text{N}/^{14}\text{N}$, and $^{18}\text{O}/^{16}\text{O}$ ($M=1\sim 30$), as well as molecules from organic matters ($M = 10$ to 300). In addition, technical feasibility and science requests of sample return is discussed for the Plan-B, especially in thermal design of sample box in the reentry capsule [5].

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