Science Experiments on a Jupiter Trojan Asteroid in the Solar Power Sail Mission

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Introduction: A Jupiter Trojan asteroid mission is being studied using a hybrid propulsion system of a large area solar power sail (SPS) and an ion engine [1]. The asteroid will be investigated scientifically and for the landing site selection through remote sensing, followed by *in situ* observations on the asteroid with a lander. A sample-return is also studied as an option. LUCY [2] has been selected as the NASA’s next Discovery class mission which aims at understanding the diversity of Jupiter Trojans by multiple flybys, contrary to the SPS mission which will rendezvous and land on a Jupiter Trojan asteroid and conduct in-depth measurements. The SPS mission has been studied by the Japan-Europe joint team [3]. The key scientific objectives and the strawman payloads are introduced below.
SPS Mission Concept: The SPS is a candidate of the next medium class space science mission in Japan. This mission is based on the technology that generates electric power using a large-area (47m x 47m) thin-film solar panel to activate the ion engine even in the Jupiter orbit. The hybrid propulsion system enables us to visit and explore the outer solar system without using a radioisotope thermoelectric generator (RTG). The 1.3-ton spacecraft will carry a 100-kg class lander which has 20-kg mission payloads.
SPS Mission Design: The SPS will be launched in late 2020s, and it will take at least 11 years to rendezvous a Jupiter Trojan asteroid after the swing by the Earth and Jupiter. During the long-term cruise phase, scientific observations are planned such as the infrared astronomy under a dust-free condition, the very long baseline gamma ray interferometry, and the dust and magnetic field measurements. After arrival, the spacecraft will start observations and a lander will be deployed and descend to the asteroid. It will take ca. 30 years in total if the optional sample-return is conducted.
Science Experiments of a Trojan Asteroid: A classical static model of solar system evolution suggests that the Jupiter Trojans were formed around the Jupiter region and survive until now as the outer end members of asteroids. A dynamical model such as Nice model [4] indicates that they formed at the far end of the solar system and then transferred inward due to a dynamical migration of giant planets. The physical, mineralogical, organics and isotopic studies in regard to the heliocentric distance could solve their origin and evolution processes, so as the solar system formation. To achieve these goals, the measurements of surface materials with the lander are expected, as well as the characterization of the

whole asteroid from the mothership [5]. The asteroid shape and geological features will be characterized by a telescopic imager. The surface mineralogy and the degree of hydration are mapped using a near- and thermal-infrared spectrometer. The landing site will be characterized by geological, mineralogical, and geophysical observations using a panoramic camera, an infrared hyperspectral imager, a magnetometer, and a thermal radiometer. The surface materials will be classified with a Raman spectroscopy, with a close-up imager monitoring the surface. Materials from surface and subsurface (~1m) will be collected with the sampling system. Those samples will be measured by a high resolution mass spectrometer (HRMS) with $m/\Delta m > 30{,}000$ to investigate isotopic ratios of D/H, $^{15}N/^{14}N$, and $^{18}O/^{16}O$, as well as molecules from organic matters (M = 30 to 1000). Parts of those collected samples will be also observed with a microscope.

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