OKEANOS –Jupiter Trojan Asteroid Rendezvous and Landing Experiments Using a Solar Power Sail

*Tatsuaki Okada[1,2], Takahiro Iwata[1], Yoko Kebukawa[3], Motoo Ito[4], Jun Aoki[5], Yosuke Kawai[5], Shoichiro Yokota[5], Yoshifumi Saito[1], Kentaro Terada[5], Michisato Toyoda[5], Hikaru Yabuta[6], Hisayoshi Yurimoto[1,7], Shuji Matsuura[8], Kohji Tsumura[9], Daisuke Yonetoku[10], Tatehiro Mihara[11], Ayako Matsuoka[1], Reiko Nomura[12], Hajime Yano[1], Takayuki Hirai[13], Atsushi Kumamoto[9], Ryosuke Nakamura[14], Stephan Ulamec[15], Ralf Jaumann[15], Jean-Pierre Bibring[16], Noel Grand[17], Cyril Szopa[18], Ernesto Palomba[19], Jorn Helbert[15], Alain Herique[20], Matthias Grott[15], Hans-Ulrich Auster[21], Goester Klingelhoefer[22], Fumi Yoshida[13], Makoto Yoshikawa[1], Jun Matsumoto[1], Toshihiro Chujo[1], Masanori Matsushita[1], Takanao Saiki[1], Hideki Kato[1], Osamu Mori[1], Junichiro Kawaguchi[1]

1. Japan Aerospace Exploration Agency, 2. University of Tokyo, 3. Yokohama National University, 4. Japan Agency for Marine-Earth Science and Technology, 5. Osaka University, 6. Hiroshima University, 7. Hokkaido University, 8. Kwansei Gakuin University, 9. Tohoku University, 10. Kanazawa University, 11. RIKEN, 12. National Astronomical Observatory of Japan, 13. Chiba Institute of Technology, 14. National Institute of Advanced Industrial Science and Technology, 15. German Aerospace Center, 16. Institut d’ Astrophysique Spatiale, 17. LISA, 18. LATMOS, 19. INAF-IAPS, 20. IPAG, 21. TU Braunschweig, 22. Leibniz Universität Hannover

The OKEANOS (Oversize Kite-craft for Exploration and AstroNautics in the Outer Solar system) is a mission under study to rendezvous with and land on a Jupiter Trojan asteroid [1]. The target is a Jupiter Trojan but will be the Saturnian system in the future. It is an engineering mission to demonstrate advanced technologies such as the hybrid thrusting with the enhanced ion engine powered by a 40 x 40 m class large area solar cells to explore the outer solar system cost-effectively. With the new technology, the mission will conduct in-depth scientific measurements for understanding the origin and evolution of the solar system and life. The concept is complementary to NASA Lucy mission [2], multi-flybys to six Jupiter Trojans for understanding the variation of Jupiter Trojans.

Jupiter Trojans are D/P-types enriched in volatiles. They might have experienced almost no or only a low degree of alteration. Their origin and evolution, as well as chemical and physical state still remain unknown. Jupiter Trojans should be a missing link of materials that originate from the inner or the outer solar system by gravity scattering due to migration of giant planets [3]. They are key targets to understand the evolution of astromaterials and the radial distribution of elements and isotopes in the early solar system.

The OKEANOS has been downscaled from the previous proposal [4] due to the severe cost cap. The spacecraft of 1400 kg including a 40 kg lander will be launched in 2027 or later, assisted by gravity of Earth and Jupiter. It will arrive at the target asteroid after a 13-year cruise. 30 kg is allocated for science, 12 kg of which is reserved for international collaboration. Bus instruments such as the optical navigation cameras (ONC-T and -W), LIDAR, and radio science are used for scientific purposes. The lander is like Mascot with uprighting capability on the asteroid surface and 12 kg is allocated for science mission.

During the cruise, science experiments will be carried out from the “deep-space platform”. Measurements of IDPs and magnetic fields will continuously monitor their radial distribution in the solar system and sudden events. The gamma-ray polarimeter will be used for precise positioning of gamma-ray bursts using a very long baseline. Visible to near-infrared telescope will map the zodiacal lights and observe the deep sky under a dust-free condition from outside of the asteroid main belt.

After arrival, global mapping is carried out to characterize the asteroid and select the landing site. The asteroid shape, size, rotation state, and geologic features are imaged by ONC. Gravity is measured by radio tracking and LIDAR. Near-infrared spectroscopy characterizes red or less red patterns, the degree of hydration, mineralogy, and abundance of ices, organics, and brines. Thermal infrared multi-bands inform on thermophysical properties, mineralogy and amorphous phases. A radar probes the surface physical state and also contributes to altimetry. *In situ* experiments with the lander will characterize the footprint and surrounding area by imaging and spectroscopy, followed by measurements of mineralogical, elemental, and organic composition as well as physical, thermal, and magnetic properties at the site. The asteroid surface sample is collected to conduct high-resolution mass spectroscopy (HRMS) based on MULTUM system (infi-TOF type mass spectrometer [5]), especially to determine the isotopic ratios of δD and $\delta^{15}N$ and the volatile species contained in the sample. Details will be decided during the critical joint study in 2019. Those experiences will be inherited to future missions.

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