Outer Planet Exploration by the Solar Power Sail: Cruising Observation and In-situ Investigation of Jupiter Trojans

矢野 創 ¹*;  松浦 周二 ¹; 中村 良介 ²; 村田 大輔 ³ ;  豊川 陽子 ⁴ ; 青木 順 ⁵ ; 森 治 ¹;
ソーラー電力セイル WG¹

YANO, Hajime¹*; MATSUURA, Shuji¹; NAKAMURA, Ryosuke²; YONETOKU, Daisuke³; KEBUKAWA, Yoko⁴; AOKI, Jun⁵; MORI, Osamu¹; SOLAR POWER SAIL, Working group⁴

¹  宇宙航空研究開発機構・宇宙科学研究所, ²  産業技術総合研究所, ³  金沢大学, ⁴  横浜国立大学, ⁵  大阪大学

Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, ² National Institute of Advanced Science and Technology, ³ Kanazawa University, ⁴ Yokohama National University, ⁵ Osaka University

After more than a decade of mission studies and front loading technology developments and verifications including IKAROS, the first deep space solar sail in the history, the Solar Power Sail mission has been proposed to JAXA/ISAS in February 2015, as a candidate of the upcoming strategic middle-class mission for a space engineering-driven mission to demonstrate the first outer Solar System exploration of Japan.

While demonstrating the solar power sail technology in the deep space at 1-5.2 AU, it is bound to Jupiter Trojan asteroids, which may hold fundamental clues of the Solar System formation and revolution discussed by two competing hypotheses between the classic model and the planetary migration model. The former suggests that Trojan asteroids are mainly survivors of building blocks of the Jupiter system, while the latter claims that they must be intruders from outer regions after the planetary migration of gas planets settled.

Right after the launch around 2021, the cruising observation will start to produce scientific results. First dust-free infrared astronomical observation beyond the zodiacal light foreground scattering will be conducted to search for the first generation light of the Universe, let alone optical observation of the zodiacal light structure of the Solar System. Extremely long baseline with the observation from the Earth, gamma-ray burst observation can identify their sources. Continuous dust impact detection will reveal the large structure and distribution of the Solar System dust disk by >4 m² of an large-area dust detector array deployed on the sail membrane.

After Jupiter flyby, the spacecraft will reach to a target Trojan asteroid of >20 km in size in 2030s. Both global remote observation and deployment of an autonomous lander will be conducted. On the surface of the Trojan asteroid, sampling will be attempted for in-situ TOF mass spectrometry and passing the sample container to the mothership for a possible sample return option.

This presentation discusses major scientific objectives, mission design and spacecraft system of the solar power sail, together with current development status, in-situ observation instruments and including landing and sample return from the surface of a Trojan asteroid.

Keywords: Solar Power Sail, Cruising Observation, Jupiter Trojan Asteroids, Surface Exploration, In-situ Mass Spectrometry, Sample Return