

From Earth Missions to Deep Space Exploration (05)  
Exploration Research and Technologies (2)

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WORLD'S FIRST SOLAR POWER SAIL, IKAROS, AND EXTENDED SOLAR POWER SAIL  
MISSION FOR JUPITER SYSTEM EXPLORATION**Abstract**

A Solar Power Sail is a Japanese original concept that gets electricity from thin film solar cells on the solar sail membrane in addition to acceleration by solar radiation. A solar power sail craft can save the fuel using a solar sail and it can also gain the necessary electric power using a vast area of thin film solar cells on the membrane even when it is away from the sun. It can be a hybrid propulsion system with a solar sail by activating the ultra-high specific impulse ion engines with the power generated by thin film solar cells. Thus solar power sails are suitable for outer planetary exploration. The authors have studied an Extended Solar Power Sail mission toward Jupiter and Trojan asteroids via hybrid electric photon propulsion. It demonstrates a variety of key technologies requisite for future outer solar system exploration, such as the new reaction control system driven at ultra-low temperature with much less heater power and a sophisticated fuel cell integrated with the propulsion system. It also performs the cruise infrared astronomy observation together with the ecliptic dust detection, and also makes magnetosphere observation in the polar region of Jupiter and visits Trojan asteroids. The mission proposal passed the Mission Definition Review and now is eligible to go into the pre-project phase. In addition, we applied first for the small technology demonstrator mission, IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun) as a Front-Loading of new key technical issues of extended solar power sail craft. IKAROS was launched together with the Venus Climate Orbiter, AKATSUKI in May 2010. The 200m2-span sail was deployed and kept extended by centrifugal force of the spacecraft rotation. IKAROS succeeded in accelerating and controlling the orbit by actively exploiting solar radiation pressure, and thus became the world's first actual solar sailer flying an interplanetary voyage. It also demonstrated thin film solar power generation. In this paper, summary of the development and operation of IKAROS is presented and outline of the extended solar power sail mission is introduced.