# Solar Power Sail Trajectory Design for Jovian Trojan Exploration

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A solar sail is a space yacht that uses the pressure of sunlight on a large membrane for propulsion. It offers fuel-free space travel and it is considered to be one of the most essential propulsion systems for future deep space exploration. However, the small forces exerted by photons make huge membranes necessary to obtain sufficient propulsive force, but such membranes are difficult to fabricate and deploy. A feasible size membrane provides only small propulsive force which is insufficient for rendezvous and orbiter missions and the small force makes the mission duration very long.

Solar power sail which is an extended concept of the pure solar sail is able to overcome these difficulties. It combines a solar sail with electric power generation capability and high efficient ion engines. Thin flexible solar cells attached on a sail membrane generate electric power that drives highly efficient ion engines. The solar power sail is not fuel free, but it can realize flexible and efficient orbital control capability, even at outer planetary regions of the solar system, without relying on nuclear technology. And it provides high transportation capacity as well because ultra-high specific impulse ion engines can be derived by its abundant power supply.

The key technologies for the solar power sail were demonstrated by IKAROS, the solar power demonstration spacecraft. IKAROS is the world's first deep space solar sail spacecraft. It was launched on May 21, 2010 and it deployed its sail membrane on June 10, 2010. The sail deployment was the most important mission of IKAROS. Other important technologies like the thin solar cells were also confirmed.

JAXA has been preparing for a Jovian Trojan asteroid exploration mission via solar power sail. Jovian Trojan asteroids represent one of the few remaining frontiers in our solar system and may hold fundamental clues to its formation and evolution. We are now conducting a conceptual study of the spacecraft. We anticipate its launch in the middle of 2020's. The spacecraft is 1.0-1.5 class and it includes the 100kg class lander. It has a 50m class large membrane with thin solar cells. We are now performing of the prototype design of the large membrane by making use of the experiences of IKAROS and We are developing the high efficient ion engine with 7000 sec class specific impulse by improving the Hayabusa2's ion engines. We are also designing the trajectory to target asteroids.

Our paper presents the outline of the trajectory design method and results for the Jovian Trojan asteroid exploration. The spacecraft goes to Jupiter first and then Jovian Trojan asteroids after Jupiter swing by to reduce the required delta-V. The low thrust trajectory design is performed considering the restriction of the power supply and thrust force of the ion engines. The results of the preliminary study were presented at ISTS 2015, but several updates are shown this time. The launch year is updated and new target asteroids are searched. The low thrust trajectory is also updated by considering the new configuration of the spacecraft system. This paper also shows some optional missions like an asteroid flyby before the rendezvous with the main target and multiple rendezvous missions.

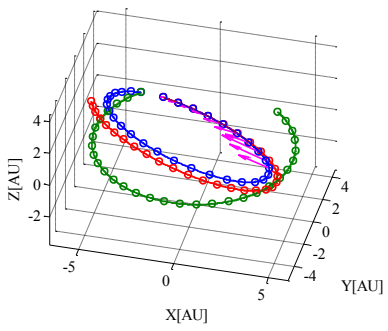


Fig. 1. Examples of the trajectories to an asteroid