

SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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IKAROS EXTENDED MISSION AND ADVANCED SOLAR POWER SAIL MISSION

Abstract

This paper presents IKAROS extended missions and advanced solar power sail mission. A Solar Power Sail is a Japanese original concept that gets electricity from thin film solar cells on the solar sail 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. Solar Power Sail Demonstrator, IKAROS was launched on May 21, 2010 and it deployed the sail successfully and demonstrates photon propulsion and guidance, navigation and control using solar sail during its interplanetary cruise for the first time in the world. IKAROS achieved full success criteria in seven months and entered its extended operation phase at the beginning of 2011. IKAROS does not have the mast and uses spinning centrifugal force to maintain the shape of the sail. The attitude behavior depends on the solar radiation pressure strongly. The spin rate was controlled to be larger than 1rpm and the sun angle was controlled to be smaller than 30deg for safety in normal operation phase. However, these limitations were removed in order to change sail deformation and motion largely in extended operation phase. This paper refines the sail dynamic model by the results of slow-spin, reverse-spin and large-attitude-maneuver operations. IKAROS RCS adopted Gas-Liquid Equilibrium Propulsion System with chlorofluorocarbon alternative HFC-134a which is non-flammable and non-toxic. This system stores HFC-134a as liquid phase in the tank, extracts the vapor of HFC-134a from the tank, and ejects

the vapor from the thruster nozzle. This is suitable for small satellite propulsion system from the point of view of cost, schedule and safety. The major technical problem is thrust loss due to the condensation of vapor during its expansion in the nozzle. This paper also evaluates the performance of the thruster by the results of extended operation. A solar power sail 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. Advanced Solar Power Sails are suitable for outer planetary exploration. The authors are studying an advanced solar power sail mission toward Jupiter and Trojan asteroids via hybrid electric photon propulsion. This paper introduces the mission, finally.