ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (2) (4)

Author: Prof. Ryu Funase
University of Tokyo, Japan, funase@space.t.u-tokyo.ac.jp

Dr. Osamu Mori
Japan Aerospace Exploration Agency (JAXA), Japan, mori.osamu@isas.jaxa.jp
Dr. Yuichi Tsuda
Japan Aerospace Exploration Agency (JAXA), Japan, tsuda.yuichi@jaxa.jp
Dr. Yoji Shirasawa
Japan Aerospace Exploration Agency (JAXA), Japan, shirasawa.yoji@jaxa.jp
Dr. Takanao Saiki
Japan Aerospace Exploration Agency (JAXA), Japan, saiki.takanao@jaxa.jp
Dr. Yuya Mimasu
Japan Aerospace Exploration Agency (JAXA), Japan, mimasu.yuya@jaxa.jp
Dr. Junichiro Kawaguchi
Japan Aerospace Exploration Agency (JAXA), Japan, Kawaguchi.Junichiro@jaxa.jp

ATTITUDE CONTROL OF IKAROS SOLAR SAIL SPACECRAFT AND ITS FLIGHT RESULTS

Abstract

JAXA has been proposing a concept of "Solar Power Sail" for future deep space exploration. It combines the concept of solar sail (photon propulsion) with a larger power generation by flexible solar cells attached on the sail membrane. An interplanetary solar sail demonstration spacecraft is planned to be launched by JAXA in the summer of 2010, which is named "IKAROS" (Interplanetary Kite-craft Accelerated by the Radiation Of the Sun). IKAROS is the precursor mission to demonstrate the key technologies for the solar power sail concept, which are (1) deployment of large sail in space, (2) solar power generation by means of thin film solar cells attached on the sail, (3) confirming the acceleration by solar radiation pressure attracted on the sail and (4) demonstration of the interplanetary guidance and navigation of the solar sail spacecraft. IKAROS will deploy a 20m-span sail within one month after the launch, and performs interplanetary solar-sailing from the Earth to Venus.

This paper focuses on the 4th mission, or attitude control of flexible spinning solar sail for the guidance and control of the solar photon sail. This paper first introduces and verifies two attitude dynamics model of spinning solar sail. The first one is a simplified analytical model which is to be used for the attitude controller design. The other one is a precise numerical model incorporating the flexibility of the membrane and is to be used for performance verification of the controller. Then, several attitude controllers are designed using the analytical model which takes into consideration the flexibility of the large membrane, and the performance of the controllers is verified by numerical simulations using the precise numerical model. The controllers are implemented on the IKAROS spacecraft and finally the paper will discuss the up-to-date flight results.