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SOLAR RADIATION PRESSURE MODEL FOR ATTITUDE MOTION OF HAYABUSA IN RETURN CRUISING

Abstract

After its touchdown on the asteroid Itokawa in November 2005, the Hayabusa (MUSES-C) spacecraft embarked on its return trajectory to Earth. At the end of November in 2005, the chemical fuel for the reaction control subsystem was leaked and X and Y reaction wheels had failed already before. In these adverse conditions for the attitude control system, Hayabusa has succeeded to maintain a spin-stabilized mode by using the Xenon gas for the neutralizer of the ion engines. In the cruising phase that is left until its return to Earth, however, the spin axis of Hayabusa must be tracking Sun direction in order to have the solar cells provide the power for its routine operations. Although the spin axis can be controlled by using the Xenon gas as a cold-gas thruster, it was preferred to preserve this fuel as much as possible for use during the Earth reentry phase in 2010. Therefore, the Hayabusa project team made the spacecraft attitude pointing close to Sun direction by using the solar radiation pressure torques without using any fuel at all. During this cruise phase Sun-pointing mode under the solar radiation pressure effects, the spin-axis of the Hayabusa performs a coning motion. It is thought as the effect of the diffusive element of the solar radiation pressure mainly to the solar array panels. In the simple analysis of this coning motion, however, the diffusion coefficient is inconsistent in comparison to the typical diffusive parameter of the solar array panel. This discrepancy must be clarified by making a more accurate model of the solar radiation pressure in order to be able to dissolve the uncertainty during the return phase of the Hayabusa spacecraft. The accurate model should also be able to support the extremely precise navigation during the return phase to the Earth. This paper presents the precise model of the solar radiation pressure of the Hayabusa spacecraft and the estimation method for obtaining the optical parameters of the solar radiation pressure model.