Postprint: Analysis of the Dynamic Behavior of the IKAROS Solar Sail During Phase I Deployment

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Abstract

On-orbit deployment of space structures involves complex high-dimensional strongly nonlinear dynamic problems. The modeling and simulation of these dynamic problems represent challenging issues in the field of spaceflight dynamics, and also constitute prerequisite conditions for implementing control over the on-orbit deployment process. This study takes the first-stage on-orbit deployment process of the IKAROS solar sail as a case study, establishes a coupled dynamic model of a central rigid body with actively extending flexible beams based on Hamilton's variational principle, employs structure-preserving analysis methods to focus on the local dynamic behavior of the system, and simulates the first-stage deployment process of the IKAROS solar sail under two operating conditions: constant torque drive and constant power drive. It is found that the evolution laws of the central rigid body's rotational angular velocity differ significantly between these two conditions; constant torque work leads to deteriorated rotational stability of the central rigid body, while under constant power drive, the first deployment stage of the IKAROS solar sail achieves better energy efficiency.

Full Text

Preamble

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Figures

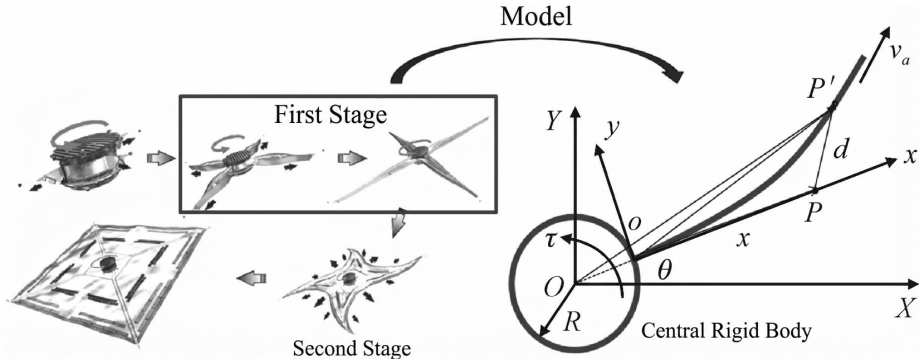

Figure 1: Figure 1

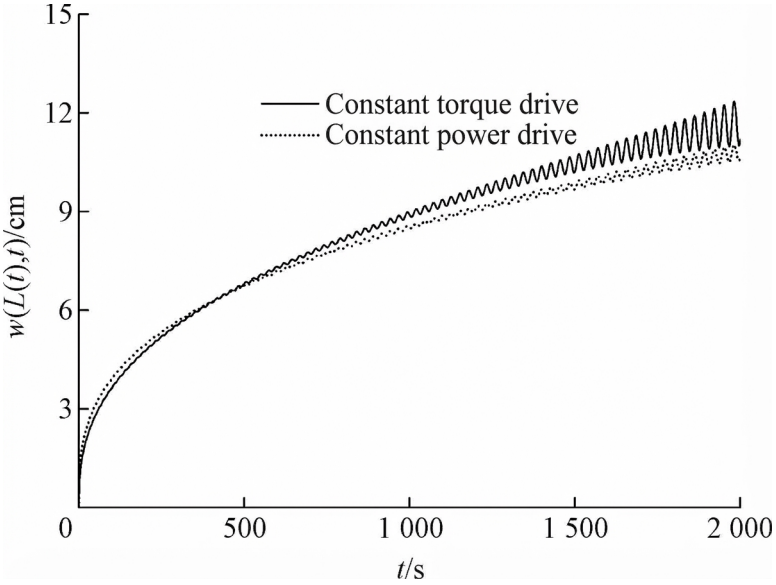

Figure 2: Figure 3