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Yarkovsky-Schach effect on space debris motion

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Abstract

The Yarkovsky-Schach effect is a small perturbation affecting Earth satellites and space debris illuminated by the Sun. It was first applied to the orbit of LAGEOS satellites as an explanation of the residuals in orbital elements. In this work, we carry out several numerical integration tests taking into consideration various orbit and rotation parameters, in order to analyse this effect in a broader context. The semi-major axis variations remain small and depend on the spin axis attitude with respect to the Sun. We show that the force amplitude is maximised for orbits inclined with $i \approx 20\text{-}30^\circ$. We also observe the influence on other orbital elements, notably on the orbit inclination. However, these effects are clearly observed only on long timescales; in our simulations, we propagated the orbits for 200 y. The Yarkovsky-Schach effect is thus confirmed to have a minuscule magnitude. It should be taken into account in studies requiring high-precision orbit determination, or on expanded timescales.

Keywords:

Space debris; Yarkovsky effect; Thermal forces; Satellite dynamics

1. Introduction

Over the years, along with the technological advancement, the Earth space surroundings have become more and more congested. In such an environment, it is important to consider possible crashes between both active and inactive satellites or space debris, and to be able to minimise the risk. A

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