Paper ID: 78096
oral

21st IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Orbit Determination and Propagation - SST (9)

Author: Mr. Aleksandr Kuznetsov
Moscow Institute of Physics and Technology (MIPT), Russian Federation, kuznetsov.aa@mipt.ru

Mr. Evgenii Ilyin
Moscow Institute of Physics and Technology (MIPT), Russian Federation, ilin.evgenii.a@mipt.ru
Mrs. Natalia Zavialova
Moscow Institute of Physics and Technology (MIPT), Russian Federation, zavialova.na@mipt.ru
Mr. Ilya Fukin
Moscow Institute of Physics and Technology (MIPT), Russian Federation, fukin.ii@mipt.ru
Dr. Sergei Negodiaev
Moscow Institute of Physics and Technology (MIPT), Russian Federation, snegod@mail.ru

RADIATIVE ACCELERATION ACTING ON NON-SPHERICAL OBJECTS IN NEAR- EARTH SPACE

Abstract

Nowadays the number of objects in near-Earth space is rapidly increasing. Most of these objects are space debris. Forecasting and preventing collisions of active spacecraft with space debris requires high precision trajectory prediction. For this reason, various models are continuously created and improved.

In high orbits, radiation pressure plays an important role. Direct radiation of the Sun, albedo, thermal radiation of the Earth and the satellite's own radiation can significantly change the trajectory.

To simulate these effects, most modern models approximate a space object with a sphere. Radius of this sphere is determined together with the orbit parameters. However, neglecting the shape of a space object and its attitude motion can lead to significant errors.

The present work is divided into three parts. In the first part, the authors analyzed the radiation effect on the space object movement. For objects with different shapes and different initial orientations, Cauchy problems for the equations of orbital motion, rotational motion and heat balance equation were solved. It was assumed that the gravitational forces of the Earth and other celestial bodies, direct solar radiation, radiation reflected from the Earth, and thermal radiation of the Earth acted on a space object. The thermal radiation of the object was also taken into account. Direct modeling of all these effects has made it possible not only to evaluate their contribution to the trajectory evolution, but also to analyze the dependencies of perturbing accelerations on orbital parameters and the sun position.

The second part is devoted to the analysis of perturbing accelerations. The authors showed that radiative accelerations are periodic function of phase angle for a wide range of space objects shapes. Therefore, the authors proposed an approximation of these accelerations by truncated Fourier series.

In the third part, the proposed Fourier approximation was tested. At first trajectory measurements were generated for a space object of known shape. Then the procedure for determining the parameters of the orbit and the coefficients of the Fourier expansion was performed. (The shape of the object, its trajectory and rotational motion were considered unknown). Tests have shown that the proposed approach allows to determine the position of the object more accurately in comparison with the sphere approximation.