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CHANGES IN AN ORBITAL MOTION FOR SMALL SPACE DEBRIS DUE TO ELECTROMAGNETIC PERTURBATIONS

Abstract

This study aims to construct an orbital model for small-sized space debris and provide qualitative understanding of perturbations derived from electromagnetic fields of the Earth. With the increasing number of debris in the space environment surrounding Earth, it is extremely important to make the orbital model so as to keep track of these defunct objects and to avoid collisions with active satellites and travelling spacecrafts. Many orbital models for large-sized debris have been developed by various research institutions, however, there are few orbital models for small debris, and this is the big problem for further space developments. In order to develop the orbital model for small-sized debris, perturbations considered in existing model for large objects should be reviewed because the magnitude of perturbing acceleration depends on their size. Especially, electromagnetic perturbing force should be included in an orbital model for small space debris. This is because their motion can be affected by the electromagnetic environments of the Earth since the space debris are charged by interacting with the ambient plasma. In addition, the changes in the orbit caused by the electromagnetic perturbing force can be relatively remarkable for small space debris. Therefore, electromagnetic perturbations on debris should be taken into consideration in order to precisely understand the orbital motion for small space debris, and the qualitative understandings of their effects on orbital motion for small debris should be important.

As of now, the orbital model for small debris have been completed, and qualitative understandings of orbital changes due to electromagnetical perturbations have been made clear by running simulations. In this model, the effects of higher harmonics of earth's gravity, atmospheric drag, solar radiation pressure, third bodies effect of the Sun and Moon are considered. Moreover, the magnetic field, corotation electric field, and convection electric field are included as an electromagnetic environment of the Earth. In order to calculate precise orbital propagation, 14th-order Adams-Bashforth-Moulton method, one of the predictor-corrector method, is employed as a numerical integration scheme. Running orbital calculations in the case with or without electromagnetic perturbations, the simulations have revealed the tendency of orbital changes due to electromagnetic fields of the Earth.