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SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Risk Analysis (2)

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EVOLUTION OF ANGULAR VELOCITY FOR LARGE SPACE DEBRIS AS A RESULT OF YORP

Abstract

The Yarkovsky-O'Keefe-Raszvieskii-Paddack (YORP) effect has been well studied and credited for the change in angular velocity of various asteroids. One component of the YORP effect is due to sunlight being absorbed and re-emitted as energy. The photons that are re-emitted create a net downward force on the body's surface. Another aspect of this effect is the transfer of angular momentum by sunlight reflected by the body's surface. As a result of both of these factors, an overall torque is created on the body yielding a change in the rotational dynamics. While YORP has been extensively studied for asteroids, it has yet to be applied to objects in Earth orbit such as space debris. With the increasing amount of space debris found in orbit, it is important to understand the dynamics governing the motion of this debris. Orbit perturbations are coupled with the body's attitude dynamics; therefore it is necessary to have an understanding of this for orbit predictions of debris. This paper analyzes the effects of YORP on the obliquity and angular velocity of defunct satellites and other pieces of debris found in Earth orbit. The rotational dynamics are first averaged over the rotational period and next over the orbital period of the Earth, about which the debris is assumed to be orbiting. Using these averaged dynamics, long-term predictions of the evolution of both, angular velocity and obliquity, are made. In the analysis simulation results are compared to published observational data. The observed rotational periods are used to compute how much torque would be required to obtain such a period only due to YORP. These required torques are compared to the torques that are believed to be acting on the body. The results of this work show that YORP could be the sole cause for the anomalous and rapid rotation of some satellites that has been seen through observations.