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Evolution of Rotation of a Triaxial Satellite under the Action of Gravitational Torque and Light Pressure Torque

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ABSTRACT

The attitude evolution of a spacecraft under various torques has been studied extensively over the pass few decades. Analytical models can be of great help in obtaining a qualitative understanding of the dynamical features involved. In the case of axisymmetric spinning satellites a fairly complete theory exists. The classical literature contains many special cases of rigid body motion with unfortunately are hardly ever directly applicable to particular satellite problems. Evolution of rotation of a nearly dynamically spherical triaxial satellite under the action of gravitational and light pressure torques is investigated. We assume that the spacecraft moves around the Sun along an elliptic orbit and that the satellite surface is surface of revolution. The light pressure torque has a force function depending only on the orientation of the symmetry axes of the body. The coefficient of the light pressure torque is approximated by a trigonometric polynomial of an arbitrary order. Assume that the principal central moments of inertia of the satellite are close to each other. Assume also that both the light pressure torques and the gyroscopic torques are of the order of a small parameter . εWe apply the averaging method to investigate the motion of a spacecraft with respect to the center of mass. We perform the averaging with respect to the precession angle and true anomaly independently, as for nonresonance cases. We arrive at the average system of the first approximation. The angular momentum is constant in magnitude and inclined at a constant angle to the normal to the plane of the orbit. The first integral of the system of equations for the nutation and the proper rotation angle are found. We represent the coefficient of the light pressure torque in the approximation taking into account the third and all even harmonics. We qualitatively investigate the phase plane of system for the nutation and the proper rotation angles with the first integral. The critical points of this system are determined. The face portraits of the average system are constructed numerically, the phase curves describe oscillations and rotations. Special cases of motion of the body are investigated. Some qualitative effects have been demonstrated. New qualitative properties of the rotation of the satellite are established.