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THE EVOLUTION OF THE MOTION OF TWO VISCOELASTIC PLANETS IN THE FIELD OF GRAVITATIONAL INTERACTION

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Abstract

This work features the translational-rotational motion of two planets, modeled as viscoelastic balls, in the force field of gravitational interaction. In natural non-deformed state each of the planets is a sphere. A particular case is studied: the planets' centers of mass move in a fixed plain and their rotational axes are orthogonal to this plain. Each of the planets deforms under the influence of their own rotation and their movement in relation to the common center of mass: the planet is compressed along its axis of rotation and tidal humps appear along the line, joining the planets' centers of mass. The presence of internal viscous friction leads to the delay of the tidal humps. All of these processes are accompanied with dissipation of energy, which leads to the evolution of the orbital and rotational motion of the planets.

The problem is being solved in the context of the linear model of the linear theory of viscoelasticity. The functional of internal dissipative forces corresponds to the Kelvin-Voigt model. Applying the motion separation and averaging methods, using the Anduaye-Delone canonical variables, we deduce the approximate set of ordinary differential equations concerning action variables, describing the evolution of the system's motion.

It was shown, that depending on the value of the angular momentum modulus of the system relatively to the common center of mass, the evolutionary set of equations may have n stationary motions, n=0,1,2. In case of n=1 the corresponding stationary motion is unstable. In case of n=2 the stationary motion, corresponding to the greater stationary distance between the planets, is asymptotically stable, to the lesser – unstable. In stationary motion (if it exists) the energy dissipation is equal to zero and the system under study rotated uniformly in relation to the common center of mass as a comprehensive whole, i.e. the planets are facing each other one-sidedly.

There was deduced an equation, describing the evolution of the slow angle variable - the longitude of perihelion. The observed Mercury perihelion shift was compared to the results, deduced in the model problem under study. It was found crucial, that the planet of a lesser mass (Mercury) moves not in the central newtonian force field, but in the gravitational force field, created by the rotating viscoelastic planet (Sun).

References

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Additional Information

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