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A dissipative model of solar system and stability of stationary rotations

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In classical model of Solar system the planets are represented by the material points cooperating under the law of universal gravitation. This model remains fair if planet to consider as absolutely rigid spheres with spherical distribution of density. The gravitational potential of such body coincides with potential of a material point, and rotation of each sphere concerning his centre of mass occurs to constant angular velocity. The motion of the centers of mass of spherical planets identically to motion in the appropriate problem of points.

Let's notice, that forms of planets of Solar system are close to spherical as dominant forces at formation of planets are gravitational forces to which forces of molecular interaction in substance of a planet counteract.

The model of the isolated Solar system submitted in a not indignant condition by homogeneous viscoelastic spheres is considered. Under action of own rotation and tidal gravitational forces the spherical planet changes the shape: there is "flattening" of a planet in a direction of a vector of its angular velocity and formation of tidal bulgs on the lines connecting the centre of a planet with the centers of other planets. From a variational principle of Hamilton the full system of the equations describing movements of the centers of mass of planets, rotations of systems of coordinates, by integrated image connected with planets, and deformations of planets be relative these of systems of coordinates has been obtained. It is supposed, that tidal gravitational, centrifugal and elastic forces result in small change of the spherical form of a planet. In system there are small parameters - inversely proportional of the Young modules of materials of the planets, providing small deformations of planets at influence on them of the centrifugal forces produced by own rotation of planets, and the small tidal deformations arising under influence of gradients of gravitational forces.

The method of division of movements receives the equations describing movements of the centers of mass of planets and their own rotations. In the offered model takes place a dissipation of the energy which source are internally viscous forces of each planet. The system supposes the first integral - the law of preservation of the kinetic moment concerning the centre of mass of system. As a result of deformations of planets in the law of the universal gravitation which has been written down for material points, there are small conservative amendments. The equations of motion describe motions of the centers of mass of planets and their rotation around of the centers of mass in view of the tidal phenomena and the dissipative forces. The connected system of the equations consists of 3 the vector equations of the second order representing the theorems of motion of the center of mass of planets, and the vector equations of the first order determining changes of the own kinetic moments of each planet.

Stationary values of full mechanical energy on the variety set in integral of the kinetic moment, correspond to stationary motions - to rotations of system as rigid body with constant angular velocity around of the centre of mass of all system. Angular velocity of stationary rotation is directed along a constant vector of the kinetic moment, and the axis of rotation is the principal central axis of inertia of system. We shall notice, that deformations of planets in stationary motion are constant, as in system of coordinates rotating with constant angular velocity centrifugal forces and forces of gravitational interaction of planets are constant.

Stationary configurations of system are determined according to Routh's technique as stationary points of the changed potential energy submitted by the sum potential energies of centrifugal and gravitational forces. The first variation of the changed potential energy addresses in zero on a stationary configuration.

The judgment about stability stationary configurations is based on research of marks of the second variation of the changed energy in a vicinity of a stationary configuration. According to Kelvin-Tchetaev theorem the stationary configuration is unstable at presence of the dissipative forces provided that the second variation of the changed potential energy can accept negative values in a vicinity of a stationary configuration. In the work it is proved, that all stationary configurations when number of planets more than two, are unstable as in a vicinity of any stationary configuration the second variation of the changed potential energy has negative values. Stability is possible only in a problem of two deformed planets rotating around of the common center of mass with a resonance 1 : 1 between orbital and own angular velocities.

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