IAA Transactions, No. 8, “Celestial Mechanics”, 2002

Periodic orbits in photogravitational three–body problem

A. S. Zimovschikov[1], N. N. Titova[2], V. N. Tkhai[1]

[1]Moscow State Academy of Instrument Making and Computer Science, Moscow, Russia
[2]A. A. Dorodnitsyn Computing Center of Russian Academy of Sciences, Moscow, Russia

In 1619 Ioghann Kepler was the first to propose the hypothesis of light pressure in order to explain the reason of comet–tail's deviation.

Indeed, in a number of cases, when studying the motion of celestial objects one should take into account both gravity and repulsive force of light pressure. This latter force, being qualitatively close to gravity, may also considerably surpass it.

Both repulsive and gravitational forces form the so–called photogravitational force field. A number of researches has been devoted to a motion of celestial objects in such a field.

For the first time it was V. V. Radziewsky who stated and solved some problems in dynamics of particle's of the photogravitational problem. In the photogravitational three–body problem, formulated by him, in contrast to the classical problem, one of primaries or both of them are the sources of light repulsion. In this respect the papers by Radziewsky are of most significance for celestial mechanics.

The restricted photogravitational problem corresponding to a system “star–planet–particle” is under consideration here. The passively gravitating particle is exposed to the influence of gravity from two primaries. Besides, it is sunjected to the repulsive force of light pressure from the star. The gravity F_g and the light pressure force F_p of the star are collinear and opposite in sign. The effect of the repulsive force, which pushes away the particle, is reduced to a “mass reduction” of radiating object involving the effective mass Qm. The coefficient of reduction Q for a given particle is a constant. It determines the total effect both of gravity and of light pressure. This coefficient is defined by formula $Q = 1 - F_p/F_g$.

By analogy to the classical three–body problem in the photogravitational problem there exist seven relative equilibria, i.e. collinear (L_1, L_2, L_3), triangular

(L_4, L_5) and coplanar (L_6, L_7) libration points. The positions of these points are mostly depend on the coefficient of reduction.

The present paper deals with construction and global study of families of symmetric periodic orbits around all collinear libration points. The evolution of orbits from one kind to another one as well as the reverse of stability property are under studying. The method proposed here allows to construct and investigate the stability of all symmetric periodic trajectories of reversible system. The localizing of such a trajectory is reduced to its analysis in the half–period time interval. The stability investigation is performed by solving the joint system which contains the initial equations and the system in variations in the small neighborhood of the orbit under consideration.