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ORIGINAL ARTICLE

Periodic orbits in the Chermnykh-like restricted problem of oblate bodies with radiation

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Abstract In this paper, the periodic orbits around triangular points in the range of linear stability of the restricted three body problem, when the smaller primary and the test particle have the shape of an oblate spheroid and the larger primary is a radiation emitter with the allowance for the gravitational potential from the belt, is studied. It is observed that the orbits around these points are elliptical and have long and short periodic orbits. The period, orientation, eccentricities, the semi-major and semi-minor axis of the elliptic orbits are found. The study includes some numerical examples in the case of the Sun-Earth and Sun-Jupiter systems.

Keywords RTBP · Radiation · Oblateness · Mass of Belt · Periodic orbits

1 Introduction

The restricted three body problem (RTBP) constitutes one of the most important problems in dynamical astronomy. The study of this problem is of great theoretical, practical, historical and educational relevance. The study of this problem in its many variant has had important implications in several scientific fields including, among others, celestial mechanics, galactic dynamics, chaos theory and molecular physics. The RTBP is still a stimulating and active research field that has been receiving considerable attention of scientists and astronomers because of its applications in dynamics of the solar and stellar systems, lunar theory and artificial satellites. It is well-known that there are five equilibrium points (Lagrangian points) in the classical restricted three-body problem Szebehely (1967). The collinear points are unstable and the triangular points are conditionally stable in the classical restricted three body problem. These equilibria are very important for astronautical applications. This can be seen in the Sun-Jupiter system where several thousand asteroids (collectively referred to as Trojan asteroids), are in orbits of triangular equilibrium points.

Generally, the shapes of the bodies in the classical RTBP are assumed to be spherical, but we find that in nature, several celestial bodies are not perfect spheres. They are either oblate or triaxial. The Earth, Jupiter, Saturn, Ragulus, Neutron stars and black dwarfs are oblate. Sharma (1987), Singh and Umar (2012), Singh and Leke (2013) are just a few out of many that have included oblateness of one or both primaries in their studies. Abouelmagd and El-Shaboury (2012) examined the equilibrium points and their stability when the three participating bodies are axisymmetric and the primaries are radiating.

Further, the case when at least one or both primaries are radiation sources was not discussed in the classical RTBP. This problem, according to Radzievskii (1950) is called the photogravitational problem. In certain stellar and solar system dynamics problems, it is in general inadequate to consider solely the gravitational force. For example, when a star acts upon a particle in a cloud of gas and dust, the dominant factor is by no means gravity, but the repulsive force of the radiation pressure. In this connection, several papers for instance Kushvah (2008a), Singh (2009, 2011), Singh and

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