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ORIGINAL ARTICLE

Periodic orbits in the generalized photogravitational Chermnykh-like problem with power-law profile

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Abstract The orbits about Lagrangian equilibrium points are important for scientific investigations. Since, a number of space missions have been completed and some are being proposed by various space agencies. In light of this, we consider a more realistic model in which a disk, with power-law density profile, is rotating around the common center of mass of the system. Then, we analyze the periodic motion in the neighborhood of Lagrangian equilibrium points for the value of mass parameter $0 < \mu \leq \frac{1}{2}$. Periodic orbits of the infinitesimal mass in the vicinity of equilibrium are studied analytically and numerically. In spite of the periodic orbits, we have found some other kind of orbits like hyperbolic, asymptotic etc. The effects of radiation factor as well as oblateness coefficients on the motion of infinitesimal mass in the neighborhood of equilibrium points are also examined. The stability criteria of the orbits is examined with the help of Poincaré surfaces of section (PSS) and found that stability regions depend on the Jacobi constant as well as other parameters.

Keywords Periodic orbits · Photogravitational · Oblateness · Disk · Chermnykh-like problem · Poincaré surfaces of section

1 Introduction

For the last few years, many authors have studied the periodic orbits of restricted three body problem (RTBP) due to its wide range of applications in space dynamics. One of them was Plummer (1901) who studied the planar circular RTBP with arbitrary mass parameter μ and found that there are two families of periodic motion near the Lagrangian points. It was Szebehely (1967) who described complete results regarding the periodic motion of planar circular RTBP. A systematic classification of periodic orbits for $0 < \mu \leq \frac{1}{2}$ in the neighborhood of Lagrangian points presented by Broucke (1968). The periodic orbit about triangular point with mass parameter as critical mass of Routh studied by Meyer and Schmidt (1971) whereas Markellos (1974) investigated the problem numerically. Ragos et al. (1991) examined the periodic motion around the collinear equilibrium points in the photogravitational RTBP. However, Elipe and Lara (1997) discussed the same motion by taking both the primaries of RTBP as radiating. Further, Perdios (2003) studied critical symmetric periodic orbits of RTBP taking one primary as an oblate spheroid. Whereas, Henon (2003, 2005) investigated new families of periodic orbits during the study of Hill's problem of the three body. On the other hand, Mittal et al. (2009) examined the periodic motion of RTBP with oblateness by taking displacements along tangent and normal to the mobile coordinates.

To analyze stability of the orbits, there are several methods like Lyapunov's, Poincaré Map or Poincaré surfaces of section (Poincaré 1892), Henon's horizontal-vertical indices etc. The PSS method has been used by many authors like (Ragos et al. 1997; Winter and Murray 1997; Winter 2000), to study the nature of orbits around the equilibrium points in the restricted three body problem. Safiya Beevi and Sharma (2011) studied the periodic orbits in the Saturn-Titan problem using the numerical technique of PSS and found that the orbits around Saturn remain around it and their stability increases with the increase in the value of Jacobi constant.

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