

The effect of photogravitational force and oblateness in the perturbed restricted three-body problem

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Abstract The model of restricted three-body is generalized to include the effects of the oblateness, the radiation pressure and fictitious forces. The positions of libration points, their stability, the critical mass ratio and periodic orbits emanating from these points are analyzed under the influence of these effects. The results obtained are more generalized. In addition the locations of the out of plane equilibrium points are studied. We also observe that there is no explicit effect for the perturbation of Coriolis force on the positions of the out of plane equilibrium points. It is worth mentioning that this model can be degraded into 128 special cases.

Keywords Photogravitational restricted three-body problem · Coriolis and centrifugal forces · Oblateness · Radiation pressure · Libration points · Stability · Periodic orbits · Out of plane equilibrium points

1 Introduction

In the second half of the twentieth century and even today the study of the restricted three-body problem has been enriched by a great and different number of the papers. These papers were addressed in many topics in this problem. For example but not limited to study of influences of perturbed forces such as oblateness, radiation pressure, Coriolis and centrifugal forces. Furthermore variation of masses, the

Pointing-Robertson and Yarkovsky effects, the atmospheric drag and solar wind received considerable attention.

The photogravitational restricted three-body problem was studied by Radzievskii (1950, 1953). He investigated that besides five libration points of classical problem, there exist out-of-plane equilibrium points L_6 and L_7 . Chernikov (1970) extended his work by introducing the Pointing-Robertson effect. Many authors like Perezhogin (1976), Schuerman (1980), Simmons et al. (1985), Murray (1994), Roman (2001), Kushvah and Ishwar (2004) and Das et al. (2009) developed and extended this work to introduce more understandable issues related to the motion of particle in the field of radiating primaries.

Some of the significant studies related to the libration points in the restricted three-body problem with one or both primaries are oblate spheroids when the equatorial plane is coincident with the plane of motion are studied by Danby (1965), Sharma (1975), Sharma and Subba Rao (1978), Markellos et al. (1996) and Douskos and Markellos (2006). Also Abouelmagd (2012) studied the effects of oblateness J_2 and J_4 for the more massive primary in the planar restricted three-body problem on the locations of the triangular points and their linear stability. He found that these locations are affected by the coefficients of oblateness. Furthermore he investigated that the triangular points are stable for $0 < \mu < \mu_c$ and unstable when $\mu_c \leq \mu \leq 1/2$, where μ_c is the critical mass parameter which depends on the coefficients of oblateness, he produced some numerical values for the positions of the triangular points, μ and μ_c using planets systems in our solar system which emphasis that the range of stability will decrease. Also he gave some examples which investigate that there is no influence for J_4 on the range of stability for some planet systems as in Earth–Moon, Saturn–Phoebe and Uranus–Caliban systems. Furthermore the existence of libration points and their linear stability as well as

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