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ORIGINAL ARTICLE

Existence and stability of the non-collinear libration points in the restricted three body problem when both the primaries are ellipsoid

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Abstract This paper deals with the existence and stability of the non-collinear libration points in the restricted three-body problem when both the primaries are ellipsoid with equal mass and identical in shape. We have determined the equations of motion of the infinitesimal mass which involves elliptic integrals and then we have investigated the existence and stability of the non-collinear libration points. This is observed that the non-collinear libration points exist only in the interval $52° < \varphi < 90°$ and form an isosceles triangle with the primaries. Further we observed that the non collinear libration points are unstable in $52° < \varphi < 90°$.

Keywords Restricted three body problem · Libration points · Stationary solutions · Stability · Elliptic Integrals

1 Introduction

The restricted problem of three bodies is said to describe the motion of the infinitesimal mass if the two bodies (primaries) revolve around their center of mass in circular orbits under the influence of their mutual gravitational attraction and a third body (an infinitesimal mass) which is attracted by the primaries but not influencing their motion, moves in the plane defined by the two revolving bodies. In the classical planar restricted three body problem there exist five libration points out of which two points are non-collinear and three are collinear called triangular and straight line solutions respectively. The collinear libration points L_1, L_2 and L_3 are unstable for all values of μ, while the two triangular libration points $L_{4,5}$ are stable for a critical value of mass parameter $\mu < \mu_c = 0.03852\ldots$, Szebehly (1967). Restricted three body problem has been studied by many mathematicians, who have taken one primary or both the primaries as an oblate body including radiation pressure. Subba Rao and Sharma (1975) discussed that if the bigger primary is an oblate spheroid whose equatorial plane coincides with the plane of motion, the triangular solutions form only nearly equilateral triangles with the primaries, and the range of the mass parameter which leads to stable triangular solutions decreases. Khanna and Bhatnagar (1999) have discussed the stationary solutions of the planar restricted three body problem when the smaller primary is a triaxial rigid body with one of the axes as the axis of symmetry and its equatorial plane coinciding with the plane of motion. The bigger primary is taken as an oblate spheroid and its equatorial plane is also coinciding with the plane of motion. They have shown that there exist five libration points, two triangular and three collinear. The collinear points are unstable, while the triangular points are stable for the mass parameter $0 \le \mu < \mu_{crit}$ (the critical mass parameter) and the triangular points have long or short periodic elliptical orbits in the same range of μ. Sharma et al. (2001) have discussed the existence of the libration points in the restricted three body problem when both the primaries are triaxial rigid bodies and shown that there exist five libration points, two triangular and three collinear. Raheem and Singh (2006) have investigated the stability of equilibrium points under the influence of small perturbations in the Coriolis and centrifugal forces, together with the effects of oblateness and radiation pressures of the primaries. They have found that the collinear points remain unstable while the triangular points are stable for $0 \le \mu < \mu_c$ and unstable for $\mu_c \le \mu \le \frac{1}{2}$, where μ_c is the critical mass parameter depends upon the Coriolis

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