Astrophys Space Sci (2012) 337:107–113
DOI 10.1007/s10509-011-0821-8

ORIGINAL ARTICLE

On the triangular libration points in photogravitational restricted three-body problem with variable mass

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Received: 19 April 2011 / Accepted: 30 July 2011 / Published online: 31 August 2011

Abstract This paper investigates the triangular libration points in the photogravitational restricted three-body problem of variable mass, in which both the attracting bodies are radiating as well and the infinitesimal body vary its mass with time according to Jeans' law. Firstly, applying the space-time transformation of Meshcherskii in the special case when $q = 1/2$, $k = 0$, $n = 1$, the differential equations of motion of the problem are given. Secondly, in analogy to corresponding problem with constant mass, the positions of analogous triangular libration points are obtained, and the fact that these triangular libration points cease to be classical ones when $\alpha \neq 0$, but turn to classical L_4 and L_5 naturally when $\alpha = 0$ is pointed out. Lastly, introducing the space-time inverse transformation of Meshcherskii, the linear stability of triangular libration points is tested when $\alpha > 0$. It is seen that the motion around the triangular libration points become unstable in general when the problem with constant mass evolves into the problem with decreasing mass.

Keywords Celestial mechanics · Variable mass · Restricted three-body problem

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1 Introduction

Generally, we assume that the masses of celestial bodies don't change with time during the mechanical motion. However, in fact many celestial bodies vary their masses with time continuously, such as the isotropic radiation or absorption in stars makes their masses variable. Many scientists have paid attention to the variable mass problem. As early as 1928, Jeans (1928) considered the two-body problem with variable mass when studying the evolution of double star. Meshcherskii (1949, 1952) studied the mechanics of bodies of variable mass. Shrivastava and Ishwar (1983) deduced the differential equations of motion of the restricted three-body problem with decreasing mass, under the assumption that the mass of the satellite varies with time. Analogous to the classical case, Singh and Ishwar (1984, 1985) investigated the effect of small perturbations on the location of libration points and stability of triangular points in the restricted three-body problem with variable mass under the assumption that the third infinitesimal mass is variable and the primaries are spherical with constant masses. And Lu (1990) further studied the stability of triangular points in this restricted three-body problem with variable mass by introducing a space-time transformation again. Using space-time transformation of Meshcherskii (1949) and adopting pulsating coordinating system, Zheng and Yu (1992) studied the elliptic restricted three-body problem with variable mass. Singh (2008, 2009) further examined stability of libration points and the effect of perturbations on nonlinear stability of triangular points in the restricted three-body problem with variable mass.

As we know it, stars (including the Sun) have not only gravitational interaction, but also radiation pressure on celestial bodies moving around them. These two actions can be expressed as an equivalent force, called a photogravitation. It is practical and important to study the motion