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Periodic solutions in the spatial elliptic restricted three-body problem

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Abstract

We show the existence of a new class of periodic orbits in the three-dimensional elliptic restricted three-body problem in the case of equal masses of the primaries. The doubly symmetric periodic solutions found are perturbations of very large circular Keplerian orbits lying in a plane perpendicular to that of the primaries. They exist for a discrete sequence of values of the mean motion, irrespective of the values of the eccentricity of the primaries orbit.

Keywords: Periodic orbits; Spatial restricted three-body problem; Doubly symmetric; Continuation method

1. Introduction

The study of periodic orbits of a non-integrable dynamical system is a very useful tool to obtain information on the topology of phase space. In the vicinity of a periodic orbit, the study of the phase space can be reduced to the study of the invariant curves of a Poincaré map on a surface of section and then the fixed points, together with their stability character, determine critically the topology of the problem. For this reason, the computation of periodic orbits plays an important role in the study of dynamical systems.

In the circular restricted three-body problem, in spite of the large amount of numerical work available, there are relatively few analytical results on the whole subject of periodic solutions. The analytic continuation method has been used by several authors to show the existence of such orbits. A classic result is that of Arenstorf [1] showing the existence of second kind periodic solutions (i.e. which come from analytic continuation of unperturbed elliptic Keplerian orbits, with arbitrary eccentricity) in the planar circular restricted three-body problem in a neighbourhood of one of the primaries, irrespective of the mass ratio. In the three-dimensional circular restricted problem, Jefferys [2] showed there exist doubly symmetric, almost circular periodic solutions if one of the primaries is sufficiently small. He showed as well [3] the existence of families of elliptic orbits for any value of the eccentricity and a critical

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