ELSEVIER

Physica D 157 (2001) 283–321

PHYSICA D

www.elsevier.com/locate/physd

The dynamics around the collinear equilibrium points of the RTBP

G. Gómez [a], J.M. Mondelo [b,*]

[a] *Departament de Matemàtica Aplicada i Anàlisi, Universitat de Barcelona, Gran Via 585, 08007 Barcelona, Spain*
[b] *Dept. de Matemàtica Aplicada I, Universitat Politècnica de Catalunya, Diagonal 647, 08028 Barcelona, Spain*

Received 18 January 2001; received in revised form 26 June 2001; accepted 26 June 2001
Communicated by Y. Kuramoto

Abstract

This paper is devoted to the analysis of an extended neighborhood of the collinear equilibrium points of the restricted three body problem. The analysis is done using numerical tools for the determination of periodic orbits and invariant 2D tori. All the relevant information of the neutrally stable behavior of the dynamics in the vicinity of the three libration points is given. The results in this paper extend those given in [Physica D 132 (1999) 189], since they avoid the convergence restrictions of the semi-analytical approach used in this reference. © 2001 Elsevier Science B.V. All rights reserved.

PACS: 95.10.Ce; 02.60.Cb; 02.40.Vh

Keywords: Invariant tori; Halo orbits; Lissajous orbits; RTBP; Parallel computing

1. Introduction

Much attention has been paid in the past to the study of motion in the vicinity of the collinear equilibrium points of the restricted three body problem (RTBP). This is because part of the dynamics of the RTBP is “organized” by the equilibrium points and their invariant unstable and stable manifolds (see [13,14]). Another reason, useful for applications, is that near these points there are orbits which have nice properties for spacecraft missions, since they can be used to set permanent observatories of the sun, the magnetosphere of the earth, links with the hidden part of the moon, and others.

The goal of this paper is to perform a systematic and, as far as possible, complete study of the dynamics in a large neighborhood of the three collinear equilibrium points for different energy levels. Because of its interest for spacecraft mission design, all the study has been done for the value of the mass parameter $\mu = 0.012150585$, corresponding to the earth–moon system. In a forthcoming paper, we will show how the dynamics around these equilibrium points evolves with μ as well as how it varies when more perturbing bodies are included in the model.

The collinear libration points behave, linearly, as the product of two centers by a saddle. Hence, one can expect families of periodic orbits which in the limit have frequencies related to both centers: $\omega_{\rm p}$ and $\omega_{\rm v}$ (called planar and vertical frequencies, respectively). This is assured by the Lyapunov center theorem, unless one of the frequencies

* Corresponding author. Tel.: +34-93-401-60-67; fax: +34-93-401-17-13.
E-mail addresses: gomez@cerber.mat.ub.es (G. Gómez), mondelo@ma1.upc.es (J.M. Mondelo).

PII: S0167-2789(01)00312-8