Computing invariant manifolds for libration point missions

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May 2018

Abstract

The goal of this lecture is to review several methodologies for the computation of invariant manifolds, having in mind the needs of preliminary mission design of libration point missions. Because of this, the methods reviewed are developed for and applied to the circular, spatial restricted three-body problem (RTBP), although most of them can be applied with few changes, or almost none, to general dynamical systems. The methodology reviewed covers the computation of (families of) fixed points, periodic orbits, and invariant tori, together with the stable and unstable manifolds of all these kinds of invariant objects, and also homoclinic and heteroclinic connections between them. The methods reviewed include purely numerical and semi-analytical ones. No background is assumed except for a graduate level knowledge of calculus, differential equations and basic numerical methods. In particular, the notions from the theory of dynamical systems required for the development of the methods are introduced as needed.

1 Introduction

In libration point missions, spacecraft are sent to orbits that stay close to the fixed points of the circular, spatial, restricted three-body problem (RTBP) with primaries the Sun and a planet, or a planet and a moon. The RTBP model describes the motion of an infinitesimal particle under the attraction of two massive bodies known as primaries, that are assumed to revolve uniformly in circles around their center of mass. In rotating coordinates, this model has five equilibrium points:

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