A Survey on Space Trajectories in the Model of Three Bodies

A.F.B.A. Prado*

Instituto Nacional de Pesquisas Espaciais,
São José dos Campos, 12227-010, Brazil

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Abstract: This paper presents a survey on space trajectories in the circular restricted three-body problem. In this situation, a spacecraft moves under the gravitational forces of two bodies, which are assumed to be in circular orbits. First of all, there is a search for orbits that can be used to transfer a spacecraft from one body back to the same body or to transfer a spacecraft from one body to the respective Lagrangian points $L_4$ and $L_5$. The method employed is to solve the Two-Point Boundary Value Problem. The close approach between the spacecraft and the celestial bodies involved is also studied in the three-dimensional space. Then, the gravitational capture is studied. It is a characteristic of some dynamical systems, like the three- or four-body system, where a hyperbolic orbit around a celestial body can be transformed in an elliptic orbit without the use of any propulsive system.

Keywords: Astrodynamics; orbital maneuvers; restricted problem; gravitational capture; swing-by; Lagrangian points.

Mathematics Subject Classification (2000): 70F07, 70F15, 70M20.

1 Introduction

This paper has the goal of making a survey of trajectories to make orbital transfers of a spacecraft that is travelling in space under the gravitational forces of two bodies. It presents some results available in the literature, as well as some unpublished results in the direction.

First of all, it is considered the problem of finding transfer orbits in the restricted problem. Several situations are studied individually. A family of transfer orbits that can transfer a spacecraft from the Moon back to the Moon again (passing close to the...