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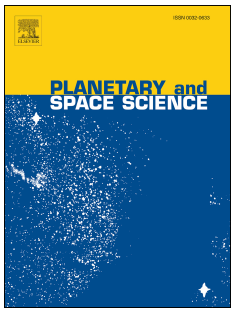

Strategies to engineer the capture of a member of a binary asteroid pair using the planar parabolic restricted three-body problem

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STRATEGIES TO ENGINEER THE CAPTURE OF A MEMBER OF A BINARY ASTEROID PAIR USING THE PLANAR PARABOLIC RESTRICTED THREE-BODY PROBLEM

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ABSTRACT

This paper investigates two strategies to engineer the capture of one member of a binary asteroid pair by a planetary body after close encounter with that planetary body. It is assumed that the binary pair consists of a smaller minor asteroid in orbit about a larger main asteroid, which encounters a planetary body. In order to develop an engineering model of the problem, first we neglect the mass of the smaller minor asteroid in the binary pair and approximate the model as planar parabolic restricted three-body problem (PPRTBP). Second, the related regularised dynamical equations for the problem are developed. An approximate analytical solution to the problem is then obtained for motion in the vicinity of the main asteroid using the regularised coordinates through a linearized model. This provides insight into the motion of the minor asteroid about the main asteroid, allowing strategies to engineer the capture process to be developed. Based on the topology of the zero velocity curves (ZVCs) for the PPRTBP, we determine the capture region for the problem by developing initial condition maps (ICMs) and investigate the details of the dynamical process for capture. Two capture strategies are then proposed to engineer and extend the possibility for capture of the minor asteroid in binary pair. One is a re-phasing manoeuvre before encounter, which guarantees that the particle is within the capture region of the ICMs. The other is an optimal, single-impulse transfer during encounter to ensure transfer through the ZVC bottleneck and capture of the minor asteroid by the planetary body. The purpose of the paper is to explore such engineering strategies, rather than to provide new insights into natural capture dynamics.

Key words

Planar parabolic restricted three-body problem · Binary asteroids · Zero velocity curves · Initial condition maps · Asteroid capture

1 Introduction

Asteroids can provide important information on how the solar system both formed and evolved [1-3]. Thought to be leftover planetesimals, asteroids have a close relation to the processes shaping the formation of the planets in the solar system. Among them, the most primitive asteroids may contain original material from the solar nebula where the solar system formed [4]. Recent studies demonstrate that asteroids may also be able to provide other key clues on the formation of the solar system, which cannot be derived from any other source [5, 6].

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