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OPTIMAL BI-IMPULSIVE EARTH-MOON TRANSFERS

Abstract

A number of different Earth-Moon bi-impulsive solutions are available in literature. According to the model in which they are defined, these solutions range from the classic patched-conics transfers to the more recent low energy transfers. It can be shown that the latter involve a reduced cost (i.e., ΔV) when compared to the patched-conics transfers, provided that a longer flight time is admitted. The issue of finding solutions requiring intermediate cost and flight time remains open, though such information would be useful to mission designers.

In this work an extensive search of optimal bi-impulsive Earth-to-Moon transfer is carried out. A four-body problem is chosen to describe the motion of the spacecraft. This model takes into account the gravitation attractions of the Earth, the Moon, and the Sun, all instantaneously acting on the spacecraft. This four-body problem is the simplest model in which both high and low energy transfers can be designed. A direct transcription and multiple shooting strategy is implemented to derive optimal solutions. As first guesses are formed by using just four scalars, a systematic search is performed.

Thousands of bi-impulsive Earth-Moon transfers are derived, all having a flight time less than 100 days. These are reported on a $(\Delta T, \Delta V)$ plane, being Delta-T the transfer time. Once on this plane, the Earth-Moon transfers can be classified into families, according to the geometry of the transfer. Solutions belonging to the same family have similar values of ΔT, ΔV. With this approach, known solutions can be seen as special solutions of a more general picture.