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SUN-EARTH LIBRATION POINT TRANSFER OPTIONS WITH INTERMEDIATE HEO

Abstract

The Sun-Earth Libration Points (SEL) are an attractive location for many astronomy missions. The transfer towards a libration point orbit requires in many cases an immediate insertion, meaning the launch system accelerates the spacecraft into its desired transfer orbit. The limited number of available launcher programs and the launcher dispersion then require a time-critical correction manoeuvre in order to deliver the spacecraft to its intended orbit. This manoeuvre can only be performed after the state of the spacecraft has been determined in a tracking campaign and usually takes place two days into the mission. The drawbacks of this strategy are on the one hand the increased ΔV requirement, since a tangential perigee velocity error has by then been amplified by a factor of approximately eight, and on the other hand the risk of not being able to perform the manoeuvre at day two, further increasing the DeltaV requirements or even losing the mission due to the limited thrust capability.

This study investigates a strategy to mitigate the criticality of the first correction manoeuvre: the utilisation of an intermediate highly elliptical parking orbit (HEO). The goal of this strategy is to increase the robustness of the mission design and to ease the spacecraft operation after launch. While the risk mitigation of the first mission critical manoeuvre is the primary motivation for this study there is also potential for increasing the payload mass due to the staging effect. The paper will demonstrate which perturbations have an influence on the intermediate HEO and how the resulting SEL orbit and transfer trajectory will be affected with respect to: time to first manoeuvre, time window for execution of the first manoeuvre, reachable amplitudes of the target libration orbit, ΔV budget, and mass to the target orbit.

Two examples for missions going to a small amplitude Lissajous and a large halo-type libration orbit will be used to demonstrate this.