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LOW ENERGY DEPARTURE TRAJECTORIES LINKING THE COLLINEAR AND TRIANGULAR SUN-EARTH LIBRATION POINT REGIONS

Abstract

Considering circular two body dynamics the transfer towards the triangular Sun-Earth libration points is a rather simple problem. Two impulsive manoeuvres provide the required v_∞ at Earth departure and an impulse of the same magnitude stops the spacecraft at the Sun-Earth Libration point 4/5 (SEL 4 and SEL 5) arrival. The magnitude of the v_∞ required at Earth departure and the arrival impulse depend on the selected transfer duration, which is typically a multiple of years + two months, and on the selected Libration point: transfers to SEL 4 are more expensive than transfers to SEL 5, because of the non-linear character of the two-body problem.

These initial guesses serve also well for an optimization of transfer trajectories towards SEL 4/5 in a full ephemeris problem, taking the actual orbits of the planets into account. However, a transfer option without a high departure v_∞ exists. Indeed, the launch of the spacecraft to be transferred towards SEL 4/5 does not require a positive v_∞, but the launch can be towards the SEL 1/2 region, where the spacecraft will loiter for a prolonged period of time and the still acting gravitational pull of the Earth will build up the required v_∞ for an accelerated drift towards the region of the triangular libration points.

This transfer opportunity is of special interest, because now a dual launch can place spacecrafts into orbits about the collinear libration points 1 and 2 and at the same time towards 4 and 5 without a significant additional boost between the two separations and thus allowing for higher payload masses to be launched. This feature would also allow a single launch to deploy two spacecraft to travel to SEL 4 and 5 via the heteroclinic connection between SEL 1 and 2.