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SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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DESIGN OF WEAK STABILITY BOUNDARY TRAJECTORIES TO MOON

Abstract

Belbruno in 1987 discovered a new method to design low energy Earth-to-Moon transfers using weak stability boundary (WSB) at Moon.WSB is region in the phase space where the perturbative effects of Earth-Moon-Sun acting on the spacecraft tend to balance. These transfers take the advantage of Sun's gravity to increase perigee altitude from Low Earth Orbit (LEO) to Earth-Moon distance.The spacecraft reaches Moon with sufficient energy to get temporarily ballistically captured by Moon.Earth-Moon-Sun configuration is important to accomplish such transfers. The V savings is of the order of 150 m/s compared to conventional Hohmann transfer and time of flight is between 60 to 100 days. Japanese Hiten in 1991 successfully demonstrated WSB transfer to Moon.The WSB transfers are first obtained in restricted three- and four-body problem and then refined in full force model to obtain real world trajectory. Studies to obtain optimally patched Earth-Moon trajectories connecting highly elliptical Earth Parking orbits (EPO) and lunar capture orbits under the constrains of time of flight and minimum V are presented in this paper. Lunar capture orbits (direct and retrograde) obtained by back-propagation are represented on the phase space with color code on time of capture. Highly elliptical EPO are propagated forward in time to identify the orbits whose perigee altitude increases from LEO to Earth-Moon distance. The EPO is patched with lunar capture orbit using Finite Time of Arrival targeting method to obtain a WSB trajectory to Moon. These trajectories are evaluated from flight duration and V point of view.Lunar fly-by on the way to apogee is also studied.