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LOW ENERGY TRAJECTORY OPTIMIZATION FOR CE-2'S EXTENDED MISSION AFTER 2012

Abstract

CE-2, the second lunar satellite of China, has been the first satellite in the world to transfer from lunar polar orbit to the Sun-Earth L2 libration point. CE-2 will remain in the L2 Lissajous trajectory until the end of 2012, when about 120 m/s delta-v will be left. This paper studies trajectory optimization for CE-2's extended mission after 2012. The primary goal of this work is to design a suitable trajectory that maximizes science data return in different regions of the Sun-Earth-Moon system. The mission design should encompass as many regions as possible. Both the invariant manifolds of libration point and lunar gravity assist are used to design the low energy trajectories. A multiple regions exploration scenario including four main phases is proposed. First, the satellite follows the unstable manifolds to leave the Sun-Earth L2 Lissajous trajectory. After the first lunar flyby, the satellite enters into an Earth high elliptic orbit, from which geomagnetic tail and space environment could be studied. With another one or two lunar flyby, the spacecraft follows the stable manifolds to the Sun-Earth L1 Halo orbit, from which solar physics could be studied. Finally, the spacecraft follows the unstable manifolds to leave the Sun-Earth L1 Halo orbit, and fly towards the Sun-Earth L4 libration point. The spacecraft encounters an asteroid on the way to the L4 point. This work demonstrates practical applications of advanced astrodynamic concepts in the Sun-Earth-Moon system, including chaotic three-body orbits, periodic three-body orbits, gravity assist, and the patch conic. The result is a practical mission design of a grand tour for the Sun-Earth-Moon system using imitated fuel resources.