Optimal Trajectory Design For Human Outer Planet Exploration

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An optimal interplanetary trajectory design is presented for Human Outer Planet Exploration (HOPE) to visit Callisto, one of Jupiter's moons, by using an advanced magnetoplasma spacecraft. A detailed optimization approach is formulated to utilize Variable Specific Impulse Magnetoplasma Rocket (VASIMR) engine with capabilities of variable specific impulse, variable engine efficiency, and engine on-off control. To design a round-trip trajectory for the mission, the characteristics of the spacecraft and its trajectories are analyzed. Optimal trajectories are significantly depend upon relative geometric positions and distances between the Earth and the targeted planet. If a powerful engine and more advanced reactor are feasible, the round-trip time and fuel required can be significantly reduced. It is mainly illustrated that a 30 MW powered spacecraft can make the mission possible in five-year round trip constraint around year 2045. The trajectories obtained in the present study can provide an overall concept for the HOPE mission. The formulations in this paper can be also used to generate outbound and inbound trajectories for any round-trip interplanetary missions with VASIMR type propulsion system.