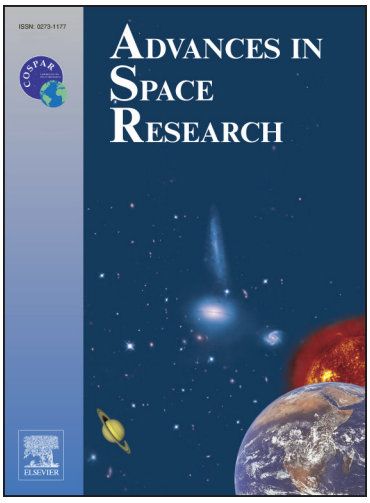

Low-energy near Earth asteroid capture using Earth flybys and aerobraking

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Low-energy near Earth asteroid capture using Earth flybys and aerobraking

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Abstract

Since the Sun-Earth libration points L_1 and L_2 are regarded as ideal locations for space science missions and candidate gateways for future crewed interplanetary missions, capturing near-Earth asteroids (NEAs) around the Sun-Earth L_1/L_2 points has generated significant interest. Therefore, this paper proposes the concept of coupling together a flyby of the Earth and then capturing small NEAs onto Sun–Earth L_1/L_2 periodic orbits. In this capture strategy, the Sun-Earth circular restricted three-body problem (CRTBP) is used to calculate target Lypaunov orbits and their invariant manifolds. A periapsis map is then employed to determine the required perigee of the Earth flyby. Moreover, depending on the perigee distance of the flyby, Earth flybys with and without aerobraking are investigated to design a transfer trajectory capturing a small NEA from its initial orbit to the stable manifolds associated with Sun-Earth L_1/L_2 periodic orbits. Finally, a global optimization is carried out, based on a detailed design procedure for NEA capture using an Earth flyby. Results show that the NEA capture strategies using an Earth flyby with and without aerobraking both have the potential to be of lower cost in terms of energy requirements than a direct NEA capture strategy without the Earth flyby. Moreover, NEA capture with an Earth flyby also has the potential for a shorter flight time compared to the NEA capture strategy without the Earth flyby.

Keywords: Circular restricted three-body problem; Lyapunov orbit; stable manifolds; Earth flyby; aerobraking

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