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DESIGNING SPACECRAFT TRAJECTORIES FROM LIBRATION POINT ORBIT TO NEAR-EARTH ASTEROIDS

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The paper proposes an approach to designing transfer trajectories of a spacecraft from its initial orbit in the vicinity of the Sun-Earth libration point to near-Earth asteroids. The features of motion in bounded orbits around libration points, as well as invariant manifolds associated with them, open up the possibility of redirecting a spacecraft to trajectories of rendezvous with near-Earth asteroids almost without fuel consumption. The main focus of the research is to develop flight trajectories that involve a spacecraft initially approaching a celestial body and subsequently returning to the vicinity of the initial libration point.

The potentially hazardous asteroids Apophis and 2001 WN_5 were selected as target celestial bodies. The next close approaches of these asteroids to the Earth will take place in 2029 and 2028, respectively. It is worth noting that both near-Earth asteroids will first pass near the L_2 Sun-Earth libration point before approaching the Earth, and near the L_1 after the approach.

The James Webb Space Telescope, the Euclid spacecraft and the Spectrum-Roentgen-Gamma space observatory are spacecraft for which a concept of an asteroid exploration mission is proposed. All three spacecraft operate in orbits near the L_2 Sun-Earth libration point. As a result of the construction of invariant manifolds associated with halo orbits of these spacecraft, trajectories have been identified along which these spacecraft can approach the potentially hazardous asteroids Apophis and 2001 WN_5. Based on the analysis of obtained trajectories, necessary impulses for the close passage to these celestial bodies were calculated. Trajectories leading to bounded orbits in the vicinity of the L_2 Sun-Earth libration point, after asteroids approaching, were also calculated. Preliminary results show that there are a number of possible scenarios for such flights, in which the total cost of the characteristic velocity does not exceed 50 m/s. It is shown that in all cases, all three spacecraft do not leave the area bounded by the so-called Kislik sphere of influence of the Earth – a sphere with a radius of 2.5 million km centered at the center of mass of the Earth.

The proposed concept may be useful for future missions at the libration points of the Sun-Earth system, especially for small spacecraft due to the low fuel costs for such flights.

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