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POSSIBILITIES OF USING A SPACECRAFT CURRENTLY OPERATING AT A VICINITY OF A
COLLINEAR SUN-EARTH LIBRATION POINT TO STUDY NEAR-EARTH OBJECTS

Abstract

In this paper, various possibilities of extending the mission of a spacecraft operating at a vicinity of the Sun-Earth libration point to determining physical characteristics of near-Earth celestial bodies are considered. The extension of the mission is possible if main onboard spacecraft systems are still functioning and there is a sufficient amount of propellant in the fuel tanks to carry out the necessary orbital maneuvers. An example of such an approach is the ICE-3 (ISEE-3) project, goal of which in extension mission was reaching the Giacobini-Zinner and Halley comet from vicinity of the Sun-Earth libration point L1. After multiple gravity assist maneuvers near Moon the spacecraft had been put onto a transfer trajectory to these comets in 1983 and successfully reached them.

The Spectrum-Roentgen-Gamma Space Observatory (SRG), which was successfully launched in July 2019 and is currently in an orbit around the Sun-Earth libration point L2, and the Deep Space Climate Observatory (DSCOVR) spacecraft, located in the vicinity of the Sun-Earth libration point L1, are considered as spacecraft that can be redirected to the trajectories of a close approach to potentially hazardous objects. Using the existing navigation capabilities, orientation and orbital control systems of spacecraft data, we get the opportunity to conduct a number of additional experiments, including estimating mass of an asteroid or comet by measuring changes in spacecraft trajectory parameters caused by gravitational attraction.

According to preliminary estimates, after completing the main tasks of the project by 2029, there will be enough fuel in tanks of the SRG observatory to carry out orbital maneuvers necessary for a sufficiently close flyby of some asteroids and comets. The year 2029 is of particular interest, since this year the next close approach to the Earth of the asteroid Apophis will take place. In addition, it is possible to consider a number of other celestial bodies as candidates for such a mission, namely the asteroids 1990 MU and 1997 XF11 approaching the Earth in 2027 and 2028, respectively, as well as comets 289P/Blanpain and 300P/Catalina, which can be approached by the SRG in 2035 and 2036, respectively. It is also shown that the DSCOVR can approach the asteroid 1997 XF11 under the same restrictions on the required characteristic velocity as for the SRG observatory.

Preliminary calculations show the prospects of such an approach, the main advantages of which are the efficiency of the mission and the saving of terrestrial resources.