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**Space Mission & Campaign Design**

**POSSIBILITIES OF USING A SPACECRAFT LOCATED IN THE VICINITY OF THE  
LIBRATION POINT FOR NEAR-EARTH OBJECTS EXPLORATION**

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**ABSTRACT**

The current study shows various possibilities for extending the mission of a spacecraft located in the vicinity of the Sun-Earth collinear libration point to determine the physical characteristics of near-Earth objects. Such an extension is possible if the main onboard systems of the spacecraft function properly after the completion of the planned part of the mission, as well as there is a sufficient amount of propellant in the fuel tanks to carry out the necessary impulses. A similar task was successfully solved in the ICE-3 (ISEE-3) project. After the completion of the main flight program, the spacecraft was successfully redirected to the Giacobini-Zinner and the Halley comets. Also of note is the interplanetary station "NEAR Shoemaker", which in June 1997 flew at a distance of 1200 kilometers from the asteroid Matilda at a relative speed of 10 km/s and received more than 500 images of this celestial body, as well as measured its magnetic field and mass.

Currently, there are a number of spacecraft that operate in the vicinity of the Sun-Earth collinear libration points. These include 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  $L_2$ . The paper also considers the possibilities of using the Deep Space Climate Observatory (DSCOVR) and the Gaia spacecraft, which are located in the vicinities of the Sun-Earth libration points  $L_1$  and  $L_2$ , respectively.

According to preliminary estimates, by 2029, after the completion of the main mission, there will be enough fuel on board the SRG to supply the impulses necessary for the

close flyby of some asteroids. The year 2029 is of particular interest, since this year the next close approach to the Earth of the Apophis asteroid will take place. It is confirmed that with appropriate orbital maneuvers satisfying the limitations on the characteristic velocity, the SRG spacecraft can approach the Apophis asteroid at any close distance. It is shown that after the asteroid flyby, the spacecraft can return to an orbit around the Sun-Earth libration point  $L_2$ . Also, the asteroid 1990 MU is considered as a candidate for such a mission, the next close approach to the Earth of which will take place in 2027.

Since the main mission of the DSCOVR satellite has been extended, this spacecraft is also of interest for the study of near-Earth objects. It is shown that the DSCOVR satellite can approach the asteroid 1997 XF<sub>11</sub> under the same restrictions on the magnitude of the transfer impulse as for the SRG observatory. It is also shown that the Gaia spacecraft can be redirected to the asteroid 1997 NC<sub>1</sub> after completing its main mission in 2026.

The possibility of using a spacecraft equipped with a low-thrust engine for the study of near-Earth asteroids is also discussed. Several examples of such a mission are considered.

Preliminary calculations show the prospects of these approaches. The main advantages are the efficiency of such missions and the saving of terrestrial resources.

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**Comments:**

*Oral session*