Paper ID: 67225
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations & Optimization (2) (7)

Author: Mr. Vladislav Zubko
Space Research Institute (IKI), Russian Academy of Sciences (RAS), Russian Federation

Dr. Alexander Sukhanov
Space Research Institute (IKI), RAS, Russian Federation
Mr. Andrey Belyaev
Bauman Moscow State Technical University, Russian Federation
Mr. Konstantin Fedyaev
Space Research Institute (IKI), RAS, Russian Federation
Dr. Vsevolod Koryanov
Bauman Moscow State Technical University, Russian Federation

MISSION OPPORTUNITIES TO SEDNA AND EXTREME TRANS-NEPTUNIAN OBJECTS

Abstract

The presented research is devoted to the analysis of the flight trajectories to the trans-Neptunian object (TNO) (90377) Sedna for launch windows starting in 2029. Sedna is the object of significant interest for study since its discovery in 2003. This large object may be the key component to expand the knowledge of the earliest stages of the Solar System evolution including protoplanetary disc and related mechanisms of its evolution. There are also objects whose orbital parameters are close to Sedna's ones. This may be the evidence of the existence of a large perturbator in our planetary system, so-called Planet Nine hypothesis. Also, there has been plenty of other facts that advocate such a mission for example of the study of Sedna since it has not come closer than 75 AU to the Sun, may serve as the next steps of humanity towards the stars and the interstellar flight.

We focus on two possible ways of reaching the object: a direct flight and a flight including gravity assist maneuvers. The gravity assist maneuvers considered in the research can reduce the required value of total ΔV and flight duration. Gravity assist maneuvers near Venus and Earth, as well as near Jupiter, Saturn and Neptune are considered. It is shown that for launch windows in 2029-2034, the use of Venus-Earth-Earth-Jupiter (-Neptune) gravity assists allows to significantly reduce the total ΔV (down to 4 km/s), under restriction on the time of flight (TOF) from up to 50 years (the options with TOF less than 20 years are considered as well). The flight schemes including Earth-Earth-Jupiter gravity assists and Earth-Jupiter part as in the New Horizons mission also were checked. In all the maneuvers the use of ΔVEGA maneuver was considered as well. Also, expansion of the mission scenarios to TNOs have been proposed by combining scientific missions to explore the outer planets with a flight to the trans-Neptunian region. Another option could be a simultaneous flight to two or more trans-Neptunian objects. Five TNOs have been discovered under such scenario, the flight to which is possible during a simultaneous flight to Sedna, by schemes involving maneuvers near Jupiter and Neptune.In addition the scenario of extending the mission to Sedna with the passage of the main belt asteroids is considered. It is worth noting that in this scenario, a flyby of large main-belt asteroids such as (16) Psyche, (20) Massalia and (152) Hilda is possible.