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NEW METHODS OF LOW COST MISSION DESIGN FOR JOVIAN MOONS EXPLORATION WITH THE SPATIAL ACCOUNT OF THE TOTAL IONIZING DOSE OF RADIATION

Abstract

The future space missionsthe Laplace-P project of Roskosmos with the possible cooperation with the JUICE project of the ESA that involve a landing on one of the Jovian moons must be very refined. This is caused by the fact that the necessary cruise, flyby, and landing on the Jovian moon imply multiple reductions in the approach velocity of the spacecraft (SC), which, in view of contemporary restrictions for propellant consumption, can be ensured only by using of gravity assist maneuvers (GAMs) near Galilean moons. For these projects the execution of limitations on the mission duration, minimization of the level of total ionizing dose (TID) of radiation, and the delta V budget are required. The urgency of creating a regular procedure for the construction of optimal scenarios or schedules of flybys of the appropriate celestial bodies and the development of conditions for executing of these schedules becomes evident. Advanced of the methodology of the 3D construction of such scenarios taking into account the three-dimensional model of the Jovian radiation is descripted. The reduction of the asymptotic velocity of the spacecraft with respect to the satellite for the moon's capture is impossible. A valid reason is in the invariance of Jacobi integral and Tisserand parameter in a restricted three-body model (R3BP). Formalized spatial beam's algorithm of multibody GAMs with the refined ephemeris model using has been implemented. Advanced modifications of the Tisserand-Poincare graph for this purpose are introduced taking into account the 3D model of the Jovian radiation. Tisserand parameters of SC relative some small bodies in several local R3BP for this purpose are used. The Multi-Tisserand graphs based on them are built. It is shown that the "cross" gravity assists at the early stage of SC orbital energy reduction for TID-comfortable tour are required. As a result, a reasonable increase in the duration of the missions of Jovian moons exploration can be exchanged on a sharp decline TID and "comfortable"(less than 70 Krad for standard SC protection 8-10 mm Al) 3D tours can be found in the Jovian system.