Paper ID: 65219
oral

28th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Spacecraft for Deep-Space Exploration (8)

Author: Dr. Alexey Grushevskii
Keldysh Institute of Applied Mathematics of RAS, Russian Federation, alexgrush@rambler.ru

Prof. Yury Golubev
Keldysh Institute of Applied Mathematics of RAS, Russian Federation, golubev@keldysh.ru
Mr. Victor Koryanov
Keldysh Institute of Applied Mathematics of RAS, Russian Federation, korianov@keldysh.ru
Dr. Andrey Tuchin
Keldysh Institute of Applied Mathematics of RAS, Russian Federation, tag@kiam1.rssi.ru
Mr. Denis Tuchin
Keldysh Institute of Applied Mathematics, RAS, Russian Federation, den@kiam1.rssi.ru

SPATIAL MISSION DESIGN OF HIGH-INCLINED SOLAR PROBES USING GRAVITY ASSISTS

Abstract

Standard realization of the deep space projects for the Solar system exploration by spacecraft outside the ecliptic position lead to the costly Delta-V budget because expensive orbit inclination changing. So advanced methods for the spatial mission design of modern projects using gravity assist maneuvers (GAMs) are required. In this paper, we describe algorithms for designing multi-pass chains of GAMs for the Russian "Interheliozond" Solar Probe mission that result in an energy-efficient increase of the inclination of the SC orbit to the ecliptic plane. Main effective approaches in such missions design are described in this paper. Two basic factors of designing orbits with a high inclination (apart from the standard constraints on resource consumption and space mission duration) serve as the basis for this formalism: geometrical constraints on the maximum possible orbital inclination of the spacecraft that is achievable depending on the magnitude of its asymptotic velocity relative to the flyby planet for any sequence of GAMs near this planet; dynamical constraints on the maximum rotation angle of the spacecraft asymptotic velocity vector in a single flyby GAM, which depend on the magnitude of the spacecraft asymptotic velocity and the gravitational parameters of the planet. Joint analysis of the presented factors allows one to deduce the dynamical character of the space mission being planned, but which will require further refinement. A highly accurate algorithm taking into account accurate ephemerides is performed for synthesizing chains of cranking GAMs is performed using the search formalization for scenarios followed by the adaptive involvement of tens of millions of variants. Its use results in a significant change in the orbital inclination of a research spacecraft without significant expenditure of propellant in a reasonable mission time. Applications of its using for the study of concrete options of Russian "Interheliozond" Solar Probe mission design are given.