SPACE EXPLORATION SYMPOSIUM (A3)
Poster Session (P)

Author: Prof. Mikhail S. Konstantinov
Moscow Aviation Institute, Russian Federation, mkonst@bk.ru

Dr. Viacheslav Petukhov
RIAME, Russian Federation, vgpetukhov@gmail.com
Prof. Garri A. Popov
Research Institute of Applied Mechanics and Electrodynamics (RIAME), MAI, Russian Federation, riame@sokol.ru
Dr. Min Thein
Moscow Aviation Institute, Russian Federation, minnntheino@gmail.com

MISSION ANALYSIS FOR SUN EXPLORATION USING THE SYSTEM OF HELIOCENTRIC WORKING ORBITS

Abstract

The possibility of spacecraft (SC) insertion into the system of working heliocentric orbits is analyzed. We propose to use the system of working heliocentric orbits which are characterized by small perihelion radius and large inclination in order to study the polar region of the Sun that are not visible from vicinity of Earth. SC makes one or more revolutions around the Sun on each working orbit. Transfer from one orbit to another is implemented by using passive Venus gravity assists. The transportation system based on launcher "Soyuz-2" with chemical upper stage (ChUS) "Fregat" and electric propulsion (EP) is considered. The SC with ChUS is delivered into the near Earth orbit by launcher "Soyuz-2"and the ChUS provides the hyperbolic excess velocity and is separated from SC. EP provides heliocentric trajectory to encounter Earth with large hyperbolic excess velocity. Earth gravity assist provides the passive flight to Venus. Then a series of Venus gravity assists are implemented. Each gravity assist delivers the SC into sequence of heliocentric orbits. The purpose of the study is to analyze different systems working heliocentric orbits, into which the SC can be delivered by the considered transport system. Using the maximum principle, optimization problem of the parameters of the transport system and motion control is formulated. Optimal conditions are emphasized when reducing the multi-point boundary value problem from optimization problem. Several systems of working heliocentric orbits are analyzed. They differ from each other in the perihelion radius and inclination. It is shown that the considered transport system can provide SC into these systems of working heliocentric orbits with large mass (1600 kg). This mass depends on the required inclination of working orbit (at 30 degrees inclination SC mass may be more than 1400 kg). The possibility of using stationary plasma thruster and radio frequency ion thruster (type RIT22) is analyzed. It shows that the use of RIT22 allowing reduce the required propellant mass. The mass delivered into the working orbit varies slightly, but somewhat increased the resource requirements for propulsion. The study shows that it is possible to insert the large SC into some systems of heliocentric orbits, providing good conditions for observing the Sun from short distance, including observing polar regions of the Sun.