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MAIN APPROACHES OF THE RUSSIAN MISSION CONTROL CENTER TO NAVIGATION SUPPORT OF CURRENT AND ADVANCED DEEP SPACE EXPLORATION MISSIONS

Abstract

Currently the Russian Federation gradually implements the Moon exploration program. On July 13, 2019, Spektr-RG SC was launched from the Baikonur Cosmodrome and placed into quasi-periodic orbit around L2 point in the Sun-Earth system, the orbital period about 180 days. In 2022 Luna-Glob SC is planned to be launched, its major mission is to demonstrate soft landing and explore lunar surface in the South Pole region. Afterward a number of unmanned spacecraft are planned to be launched in order to demonstrate maneuvering and explore the lunar surface and environment to support the manned mission. Mission control of scientific spacecraft, operating in environment, which is located at a considerable distance from the Earth, requires a specific approach to all the types of support. Considering ever-growing requirements to accuracy, efficiency, and reliability of navigation support for scientific SC control, the Mission Control Center developed and put into practice innovative and efficient methods to solve the entire range of navigation tasks for Spektr-RG mission control. During all the flight phases Spektr-RG navigates using data of trajectory control, implemented by the ground radio aids (range measurements, range-rate measurements) and optical observations (right ascension and declination measurements). Continuous corrections are required to keep SC on the quasi-periodic orbit, given the need to save propellant and considering possible limitations on a number of trajectory measurements and unmodelled disturbances in SC motion. Navigation support tasks, addressed by MCC to support Spektr-RG mission control, as well as software systems, specifically developed to implement this task, make it possible to make steady progress towards solving the entire range of navigation support tasks for the Russian Moon exploration program. The Spektr-RG mission control experience, as well as main approaches to the navigation support, which are being gradually upgraded, will be used both for Luna-Glob SC mission control and for control of all the future SC, designed to explore the Moon and other objects of the Solar System. The paper provides information about the elements of the navigation tasks, as well as characteristics of the main methods and resources used to solve these tasks. It covers special navigation aspects to support a spacecraft transfer to L2 region and its flight around L2 point in a quasi-periodic orbit. The paper addresses issues related to Luna-Glob mission control, including the lunar non-uniform gravitational field impact on navigation support. The impact is the strongest in the low pre-landing orbit.