IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Utilization & Exploitation of Human Spaceflight Systems (3)

Author: Dr. Irina Kovalenko
Space Research Institute (IKI), Russian Academy of Sciences (RAS), Russian Federation

Dr. Natan Eismont
Space Research Institute (IKI), RAS, Russian Federation

CREWED SERVICING MISSIONS TO SPACE OBSERVATORIES IN LAGRANGIAN POINT ORBITS

Abstract

Space-based telescopes have been remarkably advancing space exploration. Comparing to ground-based telescopes, the space environment offers various advantages, such as absence of light pollution and effects of the Earth's atmosphere, which blocks X and gamma rays and distorts electromagnetic radiation. In particular, favorable locations for many scientific objectives are orbits the vicinities of collinear Lagrangian points, L1 and L2, of the Sun-Earth system. The L1 point, keeping stable geometry on the line between the Earth and the Sun, is a perfect location for solar observatories, such as SOHO, ACE or DSCOVR. The L2 point possesses stable thermal conditions, and has been chosen for space telescopes, such as Gaia, Herschel, Plank or future James Webb Telescope (JWST) and Spektr-RG (SRG). An outcome of vantage space location, however, is a high cost of missions. Space observatories are also expensive and difficult to maintain. For instance, the Hubble Space telescope (HST) required five manned servicing missions, to repair failed or degraded components and to install new instruments. Maintenance of telescopes in Lagrangian point orbits (LPO), situated at distances of about 1.5 mln km from the Earth, might be much more challenging, than of the HST in low Earth orbit. Taking into account the budget of current and future Lagrangian points observatories (e.g. the estimated JWST cost exceeds 10 milliards USD), a manned servicing mission might be an effective solution in case of any spacecraft malfunctions. In this work, possibilities of manned servicing missions are considered for LPO spacecraft. A flight toward LPO might make a servicing mission too long (at least 30 days of one-way flight), and too risky for a crew. Instead, in this work we consider a rendezvous of a crew with an automated spacecraft on a highly-elliptical orbit (HEO). Attention is payed not only to the required delta-V budget for automated spacecraft, but also to the crew safety reasons, including time of flight, and specific constraints and requirements of the launch and reentry of the crew. From the experience of previous HST servicing missions and also manned missions to the Moon, we consider a 14 days-period HEO as a rendezvous operational orbit. The test case selected is SRG space telescope, planned to be launched in June 2019, and the future reusable piloted spacecraft Federation or a Soyuz spacecraft. The analysis is performed in both a simplified and a high-fidelity dynamical model.