MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Sciences Onboard the International Space Station and Beyond - Part 2 (7)

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MICROACCELERATION RESEARCH USING INTERNATIONAL SPACE STATION MISSION

Abstract

The paper presents results of microacceleration research performed onboard the Russian Segment of the International Space Station (ISS RS) within the frequency range of 0...2 Hz. Microaccelerations measured in different flight modes were studied: in flight without dynamic operations, during operations of docking and undocking, in modes with Service Module thrusters burning. Onboard accelerometer measurements, telemetry information about the station attitude and orbital motion were analyzed in research. Quasi-steady microacceleration component (with frequencies of 0...0.01 Hz), which is the most essential for some physical processes investigated on the spacecraft, was of primary interest in research. The quasi-steady microacceleration component was calculated using different techniques to approximate the station attitude motion. Telemetry data of the station angular rate and the quaternion of its attitude with respect to the inertial coordinate system were used for reconstruction of the station attitude motion. The calculations were based on kinematic equations of motion of the station as of an absolutely rigid body. This approach allows to approximate motion of any type and to estimate the quasi-steady microacceleration component at any point of the ISS as a function of time. The results of such calculations were used to verify onboard accelerometers.

The method described above was used to recalculate the low frequency microaccelerations measured by the accelerometers from the point of their location to the required point on the station with the purpose to estimate the level of residual microaccelerations in that point and to get more realistic initial data for microaccelerations mathematical modeling in some space experiments with liquid motion. In particular, the calculated analogs of the real signals incoming into the DAKON convection sensor were generated during the experiments on the ISS. Comparison of calculated input data with real output signals gave good results and proved that sensors of such type can be used for monitoring of low frequency microaccelerations onboard spacecraft. Analysis of the microaccelerations measurements obtained onboard the ISS also allowed to solve some additional problems of its flight control.

Taking into account the results of the ISS RS microaccelerations environment investigation we proposed to perform experiments with the DACON sensor on the Progress transport cargo vehicle upon completion its mandatory functions of the ISS supporting. For that purpose, special methods of the Progress vehicle flight control during microgravity research were developed and series of technical experiments to test the proposed methods were executed with the "Progress M-20M" vehicle in 2014.