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UTILIZATION OF THE PROGRESS TRANSPORT CARGO VEHICLE CAPABILITIES TO PERFORM MICROGRAVITY EXPERIMENTS

Abstract

After the Progress transport cargo vehicles (TCV) finish their joint work with the ISS, the vehicle basic systems still retain unused resources sometimes sufficient for a long-duration flight. It makes sense to use these resources when possible to perform research in free flight of TCV after departure from the ISS.

Characteristics of TCV and possibilities of its flight control allow performing of various space experiments including microgravity experiments. One of the researches planned for the Progress TCV mission will use the DACON research equipment to study flows of gas medium both uniform and nonuniform in density under conditions of microgravity.

The DACON research equipment is intended to solve the following tasks:

- Recording and measuring of convective heat and mass transfer in gas and liquid medium caused by quasi-constant and low-frequency microgravity disturbances;
- Investigation of heat convection in microgravity for various boundary conditions, geometry of investigated objects and environmental parameters;
- Monitoring of efficient microgravity parameters, etc.

To perform experiments to study gas medium flows in microgravity it is required to provide certain microgravity levels. Specified microgravity levels on the Progress TCV are achieved by special rotational modes of the vehicle in its free flight. For the purpose of testing of possible modes, a number of experimental rotations of TCV in single axis solar attitude were performed in 2012-2013.

To interpret the results of the experiments a reconstruction of TCV rotational motion was made for the executed modes. It was made on the basis of telemetry of TCV angular velocity components related to TCV structural coordinate system and current feed from TCV solar arrays. Data of measurements obtained on certain time interval were processed simultaneously by different statistical methods with the help of integrating of motion equations with regard to the vehicle center of mass. Initial motion data and parameters of used mathematical models were also estimated.

To deliver research results to the ISS or to return research equipment the second docking of TCV to the ISS can be required. Possibility of such operation has been demonstrated in several missions of the Progress TCV.

The paper describes tasks of TCV mission with microgravity experiments included into mission plan, the schemes of the experiments and the second docking are given, specific features of the vehicle flight control in the experiment are considered. The paper also includes the results of experiments with rotational modes executed in free flight of TCV.