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INVESTIGATION OF THE DUSTY PLASMA PHYSICS UNDER MICROGRAVITY CONDITIONS

Abstract

Dusty plasmas are composed of weakly ionised gas and charged microparticles and represent the plasma state of soft matter. Due to the "heavy" component – the microparticles – and the low density of the surrounding medium, the rarefied gas and plasma, it is necessary to perform experiments under the microgravity conditions to cover a broad range of the experimental parameters which are not available on the ground. The investigations have been performed onboard the International Space Station (ISS) with the help of the "Plasma Crystal-3 Plus" (PK-3 Plus) laboratory. Different research achievements of PK-3 Plus on the ISS will be shown. This laboratory was mainly built to investigate the crystalline state of complex plasma, the so-called plasma crystal, its phase transitions and processes in multi-particle mixtures. Due to the manipulation of the interaction potential between the microparticles it is possible to initiate a phase transition from isotropic plasma into electrorheological plasma. The crystal-liquid phase transition was obtained in large 3D isotropic dusty plasma system using a neutral gas pressure as a convenient control parameter to drive crystallization and melting. The compression of the dust particle subsystem can result in melting of the plasma crystal that is attributed to a drop of the absolute magnitude of the particle charge with their density increase. Besides, subsonic motion of a large particle (projectile) moving through the bulk of a dust crystal formed by negatively charged small particles was investigated. In the hydrodynamic approximation, a theory of nonviscous dust particle motion about a large particle was developed.