EXPERIMENTS ON PHASE TRANSITIONS IN 3D DUSTY PLASMA UNDER MICROGRAVITY CONDITIONS

Molotkov V.I.[1], Naumkin V.N.[1], Lipaev A.M.[1], Zhukhovitskii D.I.[1], Usachev A.D.[1], Fortov V.E.[1], Thomas H.M.[2]

[1]Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bld 2, Moscow 125412, Russia, molotkov@ihed.ras.ru
[2]Institute of Materials Physics in Space (DLR-MP) German Aerospace Center, 51147 Cologne, Germany

The investigations have been performed onboard the International Space Station (ISS) with the help of the PK-3 Plus laboratory. 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. First observations of a transition of the dusty plasma system state due to variations of the plasma component density are presented.

Complex (dusty) plasmas are composed of weakly ionized gas and charged microparticles and represent the plasma state of soft matter [1]. Due to the "heavy" component, microparticles, and the low density of the surrounding medium, the rarefied gas and plasma, it is necessary to perform experiments under microgravity conditions to cover a broad range of experimental parameters which are not available on ground. The investigations have been performed onboard the International Space Station (ISS) with the help of the PK-3 Plus laboratory [2]. 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. One of the important results achieved using the PK-3 Plus laboratory was the first observation of the electrorheological effect in complex plasmas or a phase transition from an isotropic fluid into a so-called electrorheological string fluid. We performed experimental investigations of the fluid-solid phase transitions in large 3D complex plasmas under microgravity conditions. These phase changes were driven by manipulating the neutral gas pressure. It was observed that the system of charged particles can exhibit melting upon increasing the gas pressure, in contrast to the situation in ground-based experiments where plasma crystals normally melt upon reducing the pressure. The other quite a new observation concerns a study of transitions of the dusty plasma system state due to variations of the ion density. It was demonstrated a rather complicated character of the dependence of the system order upon the ion density.

The work is supported by the Russian Science Foundation, grant 14-12-01235.

REFERENCES

1. V.E. Fortov, G.E. Morfill (eds). *Complex and Dusty Plasmas: From Laboratory to Space Series in Plasma Physics*. Boca Raton, FL: CRC Press, 2010.
2. H.M. Thomas et al. *New J. Phys.* **10** (2008) 033036.