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COULOMB SYSTEMS OF DIAMAGNETIC PARTICLES IN CUSP MAGNETIC TRAP UNDER GROUND AND MICROGRAVITY CONDITIONS

Abstract

Strongly coupled Coulomb systems (SCCS) are of considerable fundamental and applied interest. They have been theoretically and experimentally investigated during many decades. Recently we proposed a new way for formation and investigation of SCCS. It is based on the known possibility of the levitation of diamagnetic bodies in a nonuniform steady-state magnetic field that was earlier applied only for levitation of single macroscopic bodies. We have experimentally and theoretically shown that a trap for a cluster of charged diamagnetic particles can be created. However, under conditions of terrestrial laboratory, using magnetic fields 1 T, we have formed only small clusters consisting of a few graphite particles. And our next step is the investigation of rather extended three-dimensional Coulomb clusters under conditions of microgravity. First experiment on the formation of strongly nonideal systems containing a large number of charged diamagnetic (graphite) particles in a cusp magnetic trap was performed on the board of the International Space Station (ISS). Experimental setup consists of a specially designed electromagnet and replaceable containers with graphite particles. A cusp magnetic field is generated by two identical coils located on the same axis, in which currents circulate in the opposite directions. We used four containers with particles of different sizes: 100, 200, 300 and 400 μm. Charging of the particles was carried out using a central wire electrode of diameter 200 μm that passed along the axis of the cell. Initially, the particles were on the walls of the glassy cell, and after shaking they filled its volume. When a potential was applied to the central electrode, particles were charged in collisions with it. When the current in one

of the electromagnet coils was increased (decreased), all the particles acquired dynamic momentum. After a certain time (2 to 4 s), the current in the other coil was increased (decreased) by the same value. The dynamic momentum excited oscillations of the particle ensemble as a whole. Observing the oscillations, we found their initial amplitude, period and damping decrement. From these data we have obtained the specific magnetic susceptibility χ of the particle matter. From the balance of magnetic and electrostatic forces we have estimated the charge on the particles. This work was supported by the Research Program of the Presidium of the Russian Academy of Sciences “Matter under High Energy Densities” and by the Russian Foundation for Basic Research, Project No. 10-02-01428.