Observation of a boundary-free dust cluster in a homogeneous gas discharge plasma under microgravitation (experiment “Plasma Crystal - 4 ”)

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The formation of so-called boundary-free dust structures, i.e., dust clouds in a uniform bulk plasma without external electrostatic traps, is of great scientific interest [1]. Such structures would exist if attractive forces between negatively charged dust particles are present in the bulk plasma. To the present time there are no direct experimental observations of attraction between negatively charged dust microparticles. It is explained by that such forces in discharge chambers are shielded by stronger forces caused by directed plasma streams on the chamber walls. Besides, attraction forces, as a rule, are proportional to the sizes of dust particles, but the particles do not levitate in laboratory conditions

The mentioned experimental difficulties have been overcome by use of dynamic modes of the gas discharge and microgravity conditions onboard of special airplane A300-ZeroG. The results of direct experimental observation of a boundary-free dust cluster in a homogeneous gas discharge plasma under microgravitation are presented in this report. In this, the experimental conditions have been completely determined. The physical model adequately describing observable cluster, in particular, observable cluster size is proposed. Influence of many factors on cluster structure – ion drag forces, electrostatic repulsion of charged dust particles in a slightly collisional plasma, thermophoretic forces, plasma ionization, etc – is analyzed.

1. Tsytovich V.N. // UFN, 2007, **177**, 4, P. 427.