Self-confined structures of dusty particles. Experimental possibilities and first results.

A.Usachev, A. Zobnin, O. Petrov,

Institute for High Energy Densities Russian Academy of Sciences, Moscow, Russia

M. Thoma[2], H. Höfner[2], M. Kretschmer[2], M.Fink[2],

Max-Planck-Institut für extraterrestrische Physik, Garching, Germany

The dusty plasma clouds usually are confined due to a presence of external electric fields (ambipolar diffusion field or presheath field). So, a form, density, and structure of such clouds are depended on configuration of the plasma source but not only on local parameters of plasma at the place of cloud. It is interesting to obtain dusty structures confined by internal attractive forces between dusty particles. The attractive forces arise due to flow of plasma on the neighbouring particle an can be considered as ion drag forces. The attractive forces to dominate over electric repulsion the ion density should be grater then some threshold. A dusty particle concentration should be enough grate also. Only when a dusty particle density exceed critical level a ion flow is directed toward a cloud. Under this condition increasing of plasma density over threshold leads to compression of dust cloud. The position of such cloud at the centre of plasma chamber is equilibrium but unstable therefore self-confined structures can be exist only for a finite time. To form such structures a dynamical compacting of dusty plasma at the centre of plasma chamber just before electron (and ion) density increasing is necessary.

Such kind experiment was performed in the PK-4 chamber during the 41st European Space Agency (ESA) parabolic flight campaign in October 2005 on the board of the A-300 ZERO-G plane. Under microgravity monodisperse melamine formaldehyde dust particles with a diameter of 1.28 μm were injected into the uniform dc discharge plasma. Some amount of heavy dust particle conglomerates presented also. During the experiments the small particles formed an elongated uniform dust cloud, which was confined along the tube axis by the radial potential of the discharge. When dust cloud comes through observation region the rf discharge pulse with a duration of 180 ms was added. Just after the rf discharge ignition the electron and ion density rapidly increased, and all dust particles drifted away from the tube axis to the tube walls due to the increased radial ion drag forces. Only the heavy conglomerate randomly approaching the tube axis kept it position. During the rf pulse some of the small particles driven by the ion flow were attracted by the big particle, and a stable dust cluster was formed at the axis of the tube. After the pulse the cluster was rapidly disrupted.

This experiment demonstrate possibility of formation of the dusty plasma structures confined by interparticle attraction.