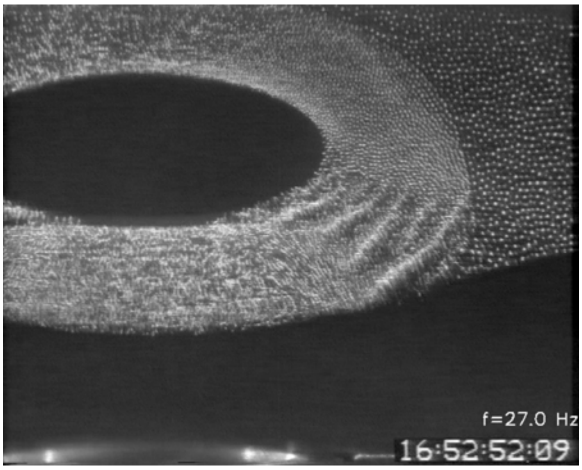
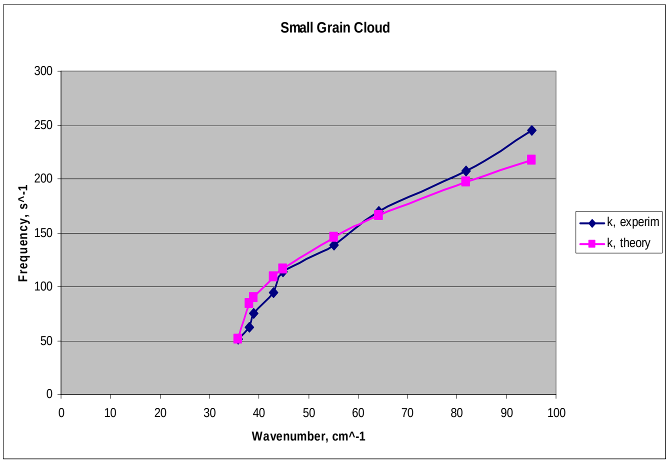
Electrostatic Modes in Collisional Complex Plasmas under Microgravity Conditions

A linear dispersion relation, which allows for a highly collisional complex plasma and includes an ion drift was revised in the light of the recent PKE-Nefedov wave experiments performed under microgravity conditions on board of the International Space Station.

We have revised a dispersion relation, describing dust density perturbations in a highly collisional complex plasma with an ion drift, thus adapting this for realistic conditions in recent complex plasma experiments performed under microgravity conditions on board of the International Space Station.





The dust density perturbations have been studied for the wave frequencies larger than the dust-neutral momentum transfer frequency.

Taking into account a relation between plasma parameters in an equilibrium state, two unstable modifications of the dust-acoustic modes have been obtained. The relevance of these perturbations to space observations of dust density waves in a specific wave channel (Fig.1) has been analyzed. It is shown that a new mode characterized by a square-root dependence of the wave frequency on the wavenumber can satisfy the propagation conditions in the given range of wavenumbers and thus can explain the peculiarities of the measured dispersion relation.

The comparison of theory and observations was made separately for two different complex plasma domains formed by small and large microparticles (SGC and LGC, respectively). Good qualitative agreement is found between the measured dispersion relations and the theoretically predicted square-root dependence of the wave frequency on the wavenumber in both complex plasma regions (Fig.2 relates to the SGC). This allows a determination of the basic complex plasma parameters. The theory predicts that the grain charges in SGC and LGC are smaller than estimations of the OML theory, and the complex plasma formed by two different grain species is nonuniform: the plasma density is lower, while the electric field is higher in the part of the complex plasma formed by larger microparticles.

V.V. Yaroshenko B. M . Annaratone, S.A. Khrapak, H.M. Thomas, G.E. Morfill
V.E. Fortov, A. Lipaev, V.I. Molotkov, O.F.Petrov and M. Turin