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Experimental observation of self-excited co-rotating multiple vortices in a dusty plasma with inhomogeneous plasma background

Mangilal Choudhary*, S. Mukherjee, and P. Bandyopadhyay

Institute for Plasma Research, Bhat, Gandhinagar – 382 428, India

*mangilal@ipr.res.in

The presence of sub-micron to micron sized dust particles in two component plasma either modifies the collective modes of the plasma or shows entirely new collective modes such as linear and nonlinear waves and vortices [1-4]. In the plasma, these particles get negatively charge of the order of 10^3- 10^5e due to the collection of highly mobile electrons than slower ions on their surface. Because of higher charge on the dust particles, the dust-dust interaction as well as dust-plasma species (electrons and ions) interaction get stronger and cause the increase in complexity of the ambient plasma. The dynamics of the dusty plasma is self-consistently linked to the background plasma; therefore, various self-oscillatory motions of dust grains are possible at different discharge conditions. For studying the self-excited motion of dust particles, the experiments are performed in a newly built dusty device [5] in which dust particles are confined in an electrostatic trap which is a formed due to the combination of the E-fields due to the inductively coupled diffused plasma (ambipolar E-field) and glass wall charging (sheath E-field). The confined dust grains exhibit vibrational motion at higher input rf power (P > 8 W), which gives rise to dust acoustic wave patterns. Multiple co--rotating (anti--clockwise) dust vortices are observed in the dust cloud for a particular discharge condition (P < 8 W, p = 0.04 mbar). The transition from multiple to single dust vortex is observed when input rf power is lowered. The occurrence of these vortices is due to the charge gradient of dust particles, which is orthogonal to the ion drag force. The charge gradient is a consequence of the plasma inhomogeneity along the dust cloud length. There is a characteristic size of the vortex in the dusty plasma; therefore, multiple vortices could possibly be formed in extended dusty plasma with inhomogeneous plasma background. The experimental results on the vortex motion of particles are compared with a theoretical model [6] and are found some agreement. The detailed design of dusty device and experimental results on vortex motion will be presented.

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