Seminar

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Institute for Plasma Research

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Title: Estimation of charge on small objects in plasma environment

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Date: 20th August 2024 (Monday)

Time: 04.00 PM

Venue: Committee Room 4, IPR

Abstract

Small objects get negatively (or positively) charged in the plasma environment by different charging mechanisms such as collecting electrons and ions, photoemission, secondary electron emission, etc. When the dust fluid flows over this charged object with a supersonic velocity, it excites solitons in the upstream direction whereas the wakes in the downstream direction. The amount of charge, shape, and size of the object play a crucial role in the propagation characteristics of solitons and the wake structure. In the first set of experiments, we aimed to measure the charge of an object through the charging and discharging process through an electronic circuit in the Dusty Plasma Experimental (DPEx-II) device. Spherical objects of diameters of 6.72 mm and 7.92 mm are floated from the top in DC discharge plasma to measure their charge. The capacitor model is used to estimate the charge of this spherical object. The issue of detecting the tiniest capacitance of an object and continuous charging in the plasma environment makes it difficult to precisely measure the charge.

In another set of experiments, we have estimated the charge (Q) of micron-sized dust particles in the presence of hot electrons. Initially, the plasma potential is measured using an emissive probe over a range of discharge conditions. The radial electric field (E) is then estimated from the numerical solution of the Poisson's equation and the measured potential profile. The charge on the particles is obtained by balancing the electrostatic force with the gravitational force ($QE=mg$, where m is the mass of charged dust particles and g is the acceleration due to gravity). The charge acquired by each particle comes out to be ~10^4e to 10^5e over the range of discharge condition. The same exercise is followed to measure the potential profile in the presence of hot electrons generated from another hot filament. It is observed that the sheath potential profile and hence the sheath electric field get modified in the presence of hot electrons. We then put nine dust particles in the plasma, they get negatively charged, and formed a small ordered Coulomb cluster. The structural properties of this Coulomb cluster and its levitation height change with the increase of the filament current. It essentially indicates that either the variation of the charge on the particles or the electric field or both are responsible for the change in the dust levitation height and the structural changes. A detailed experimental study will be carried out to understand the dynamics of dust particles in the presence of hot electrons.