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An Experimental Study of Plasma Grain Interactions

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Dust grains occur throughout the universe in many systems such as protostellar dust clouds, planetary ring structures and in a near earth environment as the result of man's activities. These grains interact with the local plasma and radiation environment and this interaction certainly influences the evolution of the dust grains. In the present work, an initial, experimental effort has been made to study the interaction of bismuth dust particles with a background plasma.

The approach developed was to pass a beam of bismuth particles through a plasma and detect the charge accumulated on the particles emerging from the plasma using a retarding potential analyzer. The experiment is therefore defined by three specific functions:

1. Production of the beam.
2. Production and diagnosis of the plasma.
3. Detection and analysis of beam charging.

The beam was produced by melting bismuth in a moderate pressure oven (20 - 100 Torr), condensing particles in a cooled chamber and accelerating the particles through differentially pumped orifices into the main vacuum chamber.

The plasma is produced by a hot cathode discharge in a background of 1 - 10 x 10^{-4} Torr of argon. The plasma parameters are determined with a Langmuir probe and a retarding potential analyzer.

The charged beam is diagnosed with a retarding potential analyzer. Because of the large background flux of electrons from the plasma, phase sensitive detection techniques are required. This was achieved by physically chopping the beam and measuring the output of the RPA with a lockin amplifier. Measurements indicate the existence of two distinct, modulated signals. The first is due to the beam of charged bismuth particles while the second is due to modulated electrons emerging from the plasma.

RPA curves of the bismuth beam provide a measure of the relative charging rate of the particles as a function of particle size and velocity and plasma density and temperature. Analysis of the RPA curves indicates a good correlation of the data with simple theory based upon independent measurements of particle size distributions, particle velocity and plasma parameters.

The modulated electrons are produced by the perturbation of the background electron density and plasma potential. Therefore, analysis of these curves is expected to provide a measure of the perturbation of the plasma parameters for comparison with theory.

A new direction is now being taken to measure the interaction of positively and negatively charged particles in order to determine the effect of charging on coalescence of particles. In order to accomplish this, two beams will be produced, with one charged negatively by a low energy electron beam and one charged positively by uv radiation. These beams will be collided at 90^{o} and coalesced particles will be detected along the midline between the beams using laser scattering techniques.