Dusty plasma microparticle control and rapid expansion in a magnetized glow discharge

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Microparticles in plasma discharges rapidly charge up, typically collecting a net negative charge due to the relatively high mobility of electrons compared to ions. Electrostatic and magnetic forces can be utilized to control charged particle behavior and motion in a plasma discharge.

In these experiments a magnetized DC parallel plate glow discharge is created with the magnetic field aligned primarily parallel to the electric field. Dielectric microparticles are placed on the bottom electrode. When the discharge is ignited, the particles charge up and will levitate in the discharge above the lower electrode. A metal wire loop located near the edge of the electrodes is supplied with an electric potential that can be controlled independently from the plasma glow discharge electrodes. By varying the voltage on the wire loop we can attract, trap, manipulate, suspend, and/or repel microparticles that originate in the magnetized DC glow discharge. An expanded laser beam illuminates the microparticles, and images captured with a high frame-rate camera were utilized to track the illuminated micrparticles at a known frame rate. Experiments studied the properties of electrostatic self-repulsion and magnetized plasma effects on a cloud of charged microparticles. By pulsing the plasma and wire loop potentials off, trapped microparticles are released and allowed to rapidly expand in a static magnetic field.

A simple force balance simulation code is used as a model to compare and benchmark actual experimental results. Experimental results regarding microparticle expansion velocity, acceleration, and characteristics are compared to the results obtained from the computational model.

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