Methods for the characterization of imposed, ordered structures in MDPX

T. Hall*(1), E. Thomas(1)
(1) Physics Department, Auburn University, Auburn, AL

It is well understood that the microparticles in complex, or dusty, plasmas will form hexagonal patterns (plasma crystals) under the appropriate operating conditions. These crystal structures form self-consistently from interparticle interactions when the Coulomb coupling parameter is large. This coupling parameter is formulated as the ratio of the interparticle potential energy to the average particle kinetic energy. Because of the ability to experimentally tune the coupling parameter, dusty plasmas are often used as a model system to study the various phases of matter such as the solid plasma crystal phase as well as liquid-like and gaseous-like phases, as well as phase transitions between these phases.

While the mutual interactions of the particles lead to different phases, the dust particles are not a closed system as in a classical crystal. The structure and ordering of particles in dusty plasmas is often highly dependent on the background plasma. One example of this is the electrorheological dusty plasma where dust particles have been observed to form strings of particles is the presence of ion wakes. Another is the presence of self-induced voids in dust clouds under microgravity or clouds of nanosized particles. In these clouds the balance between inter-particle forces, an outward electrostatic force, and an outward ion drag force that leads to the formation of void regions in these dusty plasmas.

In the Magnetized Dusty Plasma Experiment (MDPX), studies have been made of imposed, ordered structuring of the dust particles to a two-dimensional square grid. In these experiments the dust particles are observed to become spatially oriented to the structure of a conducting wire mesh embedded in the upper electrode. At high magnetic fields ($B > 1.5$ T), the particles become more confined to this structure with their motion limited to “hopping” through the grid, or being confined to a single grid point. A reliable and meaningful method of describing the degree to which the dust particles are restricted to this grid pattern is needed and several potential methods for doing so are presented. An application of these techniques to characterize the plasma parameters at which these imposed, ordered structures appear will be shown.