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Microparticle Dynamics in the Presence of Externally Imposed, Ordered Structures in a Magnetized Low-Temperature Plasma[1]

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A complex, or dusty, plasma is a four-component plasma comprised of electrons, ions, neutral gas atoms, and microparticles of several tens of nanometers to tens of micrometers in diameter. In laboratory settings these microparticles can collect hundreds to thousands of elementary charges on their surface. However, because the mass of the microparticles is much larger than the mass of the electrons and ions, the charge-to-mass ratio of the microparticles is very small. Because of this small charge-to-mass ratio, large magnetic fields ($B \geq 1$ T) are required in order to observe the direct effect of the magnetic field on the microparticles. The Magnetized Dusty Plasma Experiment (MDPX) at Auburn University is a 4 Tesla class superconducting magnet system that is used to study dusty plasmas in these extreme magnetic field environments. One of the early discoveries on MDPX was the observation of imposed, ordered structures within the dust cloud. This is because the microparticles followed a patterned structure of a conducting wire mesh embedded in one of the bounding electrodes, a behavior which was strikingly different from the typical self-organization of a dusty plasma crystal. This presentation will summarize recent studies of this ordering phenomenon that use a two-dimensional parameter space to describe the particle organization and confinement of the imposed, ordered structures and to identify the experimental conditions at which these structures are observed [1]. New results of dust behavior in experiments which use a large grid-like electrode will also be discussed. This new electrode allows for various spatially resolved probe diagnostics to measure properties such as electric fields, temperatures, and densities beneath the electrode which give a more detailed understanding of the imposed, ordered structure phenomena. Finally, preliminary PIC and fluid simulations of these plasma conditions will be shown. This work is a collaboration of the author with Edward Thomas, Jr. (Auburn), Lenaic Couëdel (Univ. of Saskatchewan), Khare Avinash (Univ. of Delhi), Robert Merlino (Univ. of Iowa), Marlene Rosenberg (UCSD), and members of the Magnetized Plasma Research Laboratory at Auburn University. [1] T. Hall, E. Thomas, K. Avinash, R. Merlino, and M. Rosenberg, Phys. Plasmas 25, 103702 (2018).

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