Dust Particle Circulation and Vortices in a DC Glow Discharge Dusty Plasma

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Complex plasmas are systems consisting of four-species: free electrons, ions, neutral gas atoms, and charged dust particles. While much of the phenomena associated with standard plasmas are present in complex plasmas, these phenomena are often quite difficult to observe and measure. The introduction of dust particles, which can be up to a few microns in diameter, allows these phenomena to be observed with the naked eye.

Our goal was to determine the optimal conditions for generating a toroidal (i.e., doughnut- or bagel-shaped) complex plasma exhibiting poloidal rotation in an effort to replicate and expand upon previous experiments. These systems are of interest due to the presence of toroidally-shaped plasmas in fusion energy experiments. A toroidal dusty plasma is well-suited for the study of particle transport in toroidal plasmas. However, before such an investigation may begin, a consistent method for replicating the system is required.

Our results indicate that we are able to consistently generate the system of interest and to utilize particle image velocimetry (PIV) measurements to analyze particle transport in the system. Figure 1(a) shows the counter-clockwise trajectory of the particles. By applying PIV techniques to these data, we can generate velocity fields, such as the one shown in Figure 1(b). In conjunction with probe measurements of plasma density and potential, these velocity fields provide insight into the way particles move through plasma.

The key impact of this research is on the understanding of the fundamental physics of particle transport in complex plasmas. This work shows that by controlling the various forces in plasma, the charged dust particles can be made to form a variety of geometries in the laboratory. This gives us new information on the confinement of the dust particles, the electrostatic potential in plasma, and allows us to infer information on the flows of ions and neutral atoms.

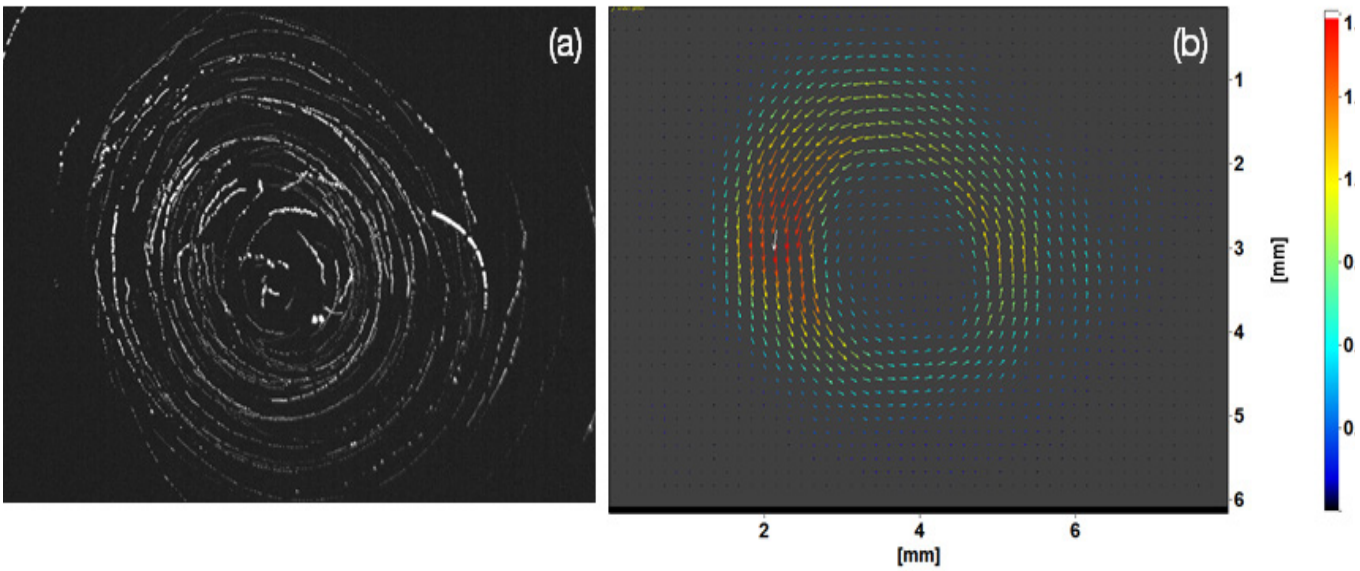

Figure 1

Statement of Research Advisor:

Statement of Research Advisor:A key feature of this work is that this experiment confirms processes that were first tested in a laboratory by dusty plasma researchers at the Institute for Plasma Research in India. By replicating and expanding those experiments, we have been able to gain new insights into the balance between electrostatic and ion drag forces that are acting upon charged microparticles in plasmas.
—*Dr. Edward Thomas, Jr., Physics*