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Dusty Plasmas: Experiments Reveal the Gravity of the Situation

Tracking the ultra-weak effects of gravity in dusty plasma reveals surprises.

MILWAUKEE, Wis.—For laboratory plasmas, gases of electrically charged particles, the effects of gravity are usually negligibly small. Recent experiments, however, have for the first time measured the deflection of charged micro-particles (also called "dust" particles) in plasma caused by gravity in the presence of a very strong background magnetic field. Measurement of this ultra-weak effect has allowed the precise quantification of the amount of electric charge on the micro-particles by simply detecting its gross motion.

This elegant measurement relies on an experimental configuration in which the direction of the magnetic field is oriented perpendicular to gravity (Figure 1). When the micro-particles are dropped through the plasma and tracked with high-speed video imaging researchers obtained two important results. First, it provides the first experimental confirmation of a hypothesis more than three decades old: that the trajectory of a charged, macroscopic object can be influenced by the combination of gravitational and magnetic fields. Also, the analysis of the deflection has allowed researchers to obtain a direct measurement of the charge on the micro-particle. In so-called "dusty" plasma—a gas of electrons, ions, neutral atoms and charged "dust" particles—this critical parameter is often unmeasurable using conventional plasma diagnostic tools.

The surprising result is that the charge on the micro-particles was much lower than had

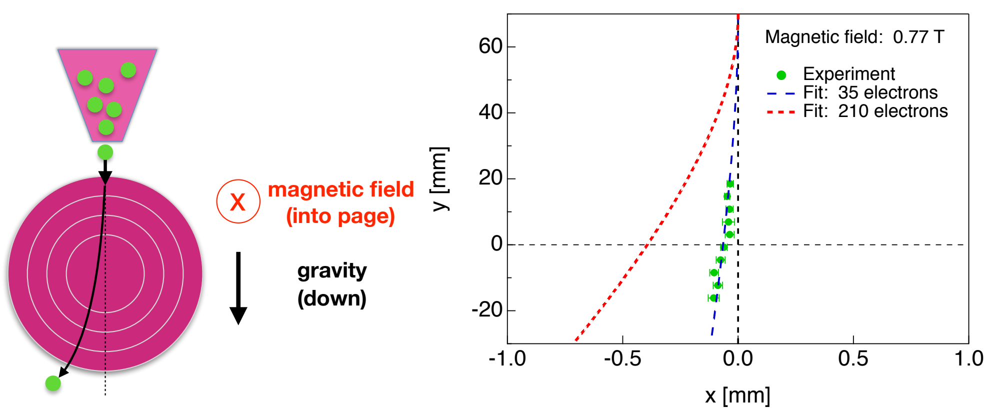

Figure 1: [Left] Model of the experimental geometry. Gravity points downward and the magnetic field is pointing into the page. [Right] Measurement of the particle deflection with two estimates of the value of the charge on the dust particle. The experiment was performed at a magnetic field strength of 0.77 T, over 15,000 times stronger than Earth's magnetic field.

been expected—by a factor of five or greater! While there have been some theoretical efforts to understand this discrepancy, additional modeling and experiments are required.

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Abstract	
CP11.00005	Microparticle Deflection in a Plasmas as a Result of a Strong Magnetic Field
CP11.00004	Research progress and status of the Magnetized Dusty Plasma Experiment (MDPX)
CP11.00006	Effects of external magnetization on probe-induced voids in complex plasmas
CP11.00007	Methods for the characterization of imposed, ordered structures in MDPX
CP11.00009	Pattern formation and filamentation in low temperature, magnetized plasmas – a numerical approach
CP11.00010	Growth of nanoparticles in a strongly magnetized plasma
CP11.00011	Effect of magnetic field on the phase transition in dusty plasma
CP11.00012	Molecular dynamic simulation of weakly magnetized complex plasmas
Session	CP11: Poster Session II: Dusty Plasmas and Sheaths; Z-Pinch, X-Pinch, Dense Plasma Focus, and HED; Stellarator, Disruptions, and MHD Monday, October 23, 2017 Room: Exhibit Hall D