LABORATORY EXPERIMENTS DESIGNED TO INVESTIGATE THE DYNAMICS OF MAGNETIZED DUSTY PLASMAS

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ABSTRACT

A large (1.8-m diameter, 4.0-m length) experimental device is being configured to investigate the behavior and dynamics of dusty plasmas over a range of dust magnetization, concentration, and size distribution. We will describe the device and the planned experiments on instabilities in which the dust-grain dynamics play a significant role.

INTRODUCTION

Plasma that contains, along with the usual electrons and positively charge ions, relatively massive, charged, solid dust grains with a gyroradius much smaller than the plasma dimension perpendicular to the ambient magnetic field is termed "magnetized dusty plasma". We will describe the device and the planned experiments.

EXPERIMENTAL APPROACH

Plans are being made to focus on two instabilities in which the dust grains play a significant role. The electrostatic dust-cyclotron instability, discussed theoretically in the literature [1,2], is analogous to the electrostatic ion-cyclotron mode, with the ions and dust playing analogous roles in the two instability mechanisms. The dust-drift instability, discussed in the literature [3], is likewise analogous to the universal instability. We plan to investigate both broad and narrow distributions in dust-grain size. In the latter case, values of q/m are nearly identical for all dust grains, and the mode characteristics can be studied precisely. In the former case, values of q/m cover a wide range, and resonance between gyromotion and other dusty-plasma processes (*e.g.*, dust charging and discharging during a gyro-cycle) can be studied. To make the magnetic field strong enough to meet the "magnetized dusty plasma" criterion, nine magnetic-field coils with 1.5-m inner diameter will be installed inside the vacuum chamber. The designed magnetic field will be uniform with a maximum strength of 0.1 T along the cylindrical axis. For dust grains with 0.3-μm radius, 0.2-eV random kinetic energy, and 2-g/cm^3 mass density in plasma with 2.5-eV electrons and a 0.08-T magnetic field, the gyroradius would be 3.6 cm, a value that is 2% of the chamber diameter. Collisions of the dust with neutrals cause a viscous drag that will reduce the kinetic energy of the dust without producing any large-angle deflections that would limit the dynamical concept of the gyro-orbit in magnetized dusty plasma. It is expected that these experiments will contribute to a dynamical understanding of dusty plasmas in a regime previously unexplored in the laboratory.

ACKNOWLEDGEMENTS

We gratefully acknowledge useful discussions with R. Merlino, E. Thomas, and J. Spann. This work supported by the National Science Foundation, NASA, and the West Virginia Space Grant Consortium.

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