Abstract to be submitted to the 2005 URSI General Assembly, which will be held October 23-29, 2005 in New Dehli, India.

OBSERVATION OF MICROPARTICLE GYROMOTION IN A MAGNETIZED DC GLOW DISCHARGE DUSTY PLASMA*

W. E. Amatucci[(1)], G. Gatling[(2)], E. E. Scime[(3)], and D. N. Walker[(1)]
[(1)]*Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375*
[(2)]*Advanced Technology Division, SFA, Incorporated, Largo, MD 20774*
[(3)]*Department of Physics, West Virginia University, Morgantown, WV 26506*

The magnitude of the charge on dust particles determines the characteristics of a dusty plasma. The process by which dust grains become charged depends upon the particle's ambient environment. In space, dust grains are usually charged by the collected flux of charged plasma particles, by photoionization, or by secondary electron emission due to incident UV radiation. In the laboratory, charging is primarily due to charged particle collection, with the dust typically becoming negatively charged. Due to its fundamental importance, accurate measurement of dust grain charge remains an experimental priority.

In nearly all dusty plasma experiments, a magnetic field is either absent entirely or else it affects only the ions and electrons. In either case, the charged dust is treated as an unmagnetized component. However, there have been several experimental investigations into the role of magnetic fields on dusty plasmas [1, 2]. While each of these experiments provide indirect evidence of the magnetization of nanometer-sized dust particles that hold only one to a few electrons, direct observation of the particle motion was not possible.

Experiments being conducted in the Naval Research Laboratory's DUsty PLasma EXperiment (DUPLEX Jr.) are focused on the effects of a strong magnetic field on the charging and motion of micron-sized dust grains with dust grain charge, $Z \sim 10^4$. We report the direct observations of dust cyclotron motion and demonstrate how the measurements can be used for sensitive noninvasive determination of Z [3]. The observations are made in an argon dc glow discharge plasma. The experimental configuration consists of an anode-cathode pair centered between a pair of neodymium iron boride permanent magnets. The cylindrical axis of the resulting plasma column is directed vertically (i.e., along the direction of the gravitational force). Depending upon the orientation of the magnets, the magnetic field can be directed either upward or downward, with a field strength of approximately 2.5 kG. A pair of Helmholtz magnetic field coils external to the vacuum chamber allows the magnetic field to be varied by approximately ± 75 G in the experimental region. Alumina microparticles (~1.2 μm) placed directly on the grounded cathode provide the source of charged dust in the plasma. Individual dust grains suspended in the plasma can be observed moving in an oscillatory fashion. Measurements of the oscillation frequency and spatial amplitude have been made. The measurements are consistent with the expected gyromotion of magnetized dust grains under the ambient plasma conditions and the data are shown to provide an effective method for the noninvasive determination of the dust grain charge. The observations also seem to indicate that the neutral drag force on the dust grains may be smaller than anticipated from the classical estimation.

*Work supported by the Office of Naval Research.

[1] N. Sato, T. Mieno, T. Hirata, Y. Yagi, R. Hatakeyama, and S. Iizuka, *Phys. Plasmas*, vol. 1, pp. 3480, 1994.
[2] Q-Z Luo and N. D'Angelo, *J. Phys. D: Appl. Phys.*, vol/ 33, pp. 2754, 2000.
[3] W. E. Amatucci, D. N. Walker, G. Gatling, and E. E. Scime, *Phys. Plasmas.*, pp. 2097-2105, 2004.