PLASMA DIAGNOSTICS USING MICROPARTICLE MOTION IN A DUSTY PLASMA UNDER MICROGRAVITY CONDITIONS*

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Diagnostic methods are developed to measure plasma electron temperature T_e and ion density n_i. We do this without making any direct observations of the electrons or ions. Instead, we observe motion of microparticles, or dust, levitated in the plasma.

Microparticles immersed in an ionized gas form a dusty plasma (also known as a complex plasma). The microparticles develop a negative charge, and they can be confined electrically. When confined stably, their positions sometimes oscillate.

In an experiment aboard the International Space Station, performed using the PK-3 Plus instrument, a glow-discharge plasma was generated by RF voltages at 13.56 MHz. Microparticles of 6.8-micron diameter were introduced into the plasma using a mechanical shaker. The microparticles settled in a main plasma region, not in a sheath, due to the microgravity conditions. Using video cameras and laser illumination, microparticles were imaged in situ, revealing a thin layer of particles at the edge of a central void [1].

Tracking microparticle motion yields a resonance frequency, which along with a charging model allows an estimation of Q and T_e. (Unlike more common uses of charging models, here we use particle-motion measurements as inputs; plasma parameter values are our outputs, not our inputs.) The resonance frequency measurement can also be used with an ion drag model to estimate n_i.

1. B. Liu et al., Phys. Plasmas, vol. 16, no. 8, Aug. 2009, p. 083703.

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