IONOSPHERIC DUSTY PLASMA IN THE LABORATORY

Ward Handley and Scott Robertson
Department of Physics, University of Colorado, Boulder CO 80309

The nanometer-scale ice particles responsible for noctilucent clouds (NLC) and polar mesospheric summer echoes (PMSE) create dusty plasma in the D region of the ionosphere. Electron densities can be of order 10^6 cm^{-3} and electron temperatures can be as low as 140 K. Nanoparticles are charged negatively by electron collection and positively by photoemission. We describe two experiments directed at creating dusty plasma in the laboratory with conditions similar to those in the mesosphere. Experiment 1 uses an oven to evaporate Zn metal into 10 Torr of argon to create smoke particles of order 10 nm in size. The particles are illuminated by laser light and detected by a CCD camera in real time. An adjacent differentially pumped chamber with ~10 mTorr argon is illuminated by a UV flashlamp. Photoelectrons from the Zn nanoparticles (and chamber walls) are detected by collection plates. Initial experiments are aimed at detecting the positively charged Zn particles which mobility-drift toward the negative collector plate on a millisecond time scale. Experiment 2 is directed at creating a plasma with electron temperature that is below 300 K. Analysis of the energy balance in a hot-filament discharge has shown that the plasma temperature is maintained by electrons on the tail of the electron distribution function that arise from secondary emission from the wall. In order to suppress this emission and the associated heat input, a double-plasma device has been lined with metal foil painted with colloidal graphite that has a low secondary emission coefficient. Initial results show electron temperatures near 0.05 eV (500 K) and we suspect that this may be a lower bound set by the resolution of the probe. Efforts are presently directed at developing probes with surface potentials uniform to ~1 millivolt that will have sufficient energy resolution to correctly determine the temperature. An afterglow experiment has been set up to show that a well-designed probe can follow a decaying electron temperature to 300 K or less.