Dusty Plasma Effects on Surfaces in Space

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Dust covered surfaces exposed to plasmas and UV radiation occur on the Moon, Mars, Mercury, asteroids, distant comets, the main rings of Saturn, as well as on the moons inside planetary magnetospheres. Common to all of these environments is the underlying physics of how these dusty surfaces collect electrostatic charges, develop a charge density distribution, and subsequently develop an interface region to the background plasma and radiation.

A prime example of these issues is the lunar surface. On the day side it is directly exposed to the solar wind plasma flow as well as solar UV radiation. The later dominates, hence on the day side the lunar surface is expected to charge positively, due to the photoelectric effect. Typical values for the surface potential are on the order of a few volts positive. The conditions on the night-side are drastically different. The typical solar wind speed of 400 km/s is much below the electron thermal speed (subsonic flow), as opposed to the case of ions, where the thermal speed is below the flow speed (supersonic flow). Electrons maintain access to the night side, and charge it negatively to possibly ˜ kV negative potentials, so that the ion-flow can be returned to the surface to achieve charge equilibrium. In addition, the Moon also traverses the Earth's magnetotail, where its surface is exposed to high energy electrons and, during eclipses, no UV radiation. The continuous charging and discharging of the lunar surface regolith leads to a time dependent plasma environment, where both horizontal and electric fields are expected to develop. These fields are likely to be capable of lofting and transporting charged lunar fines.

The talk will address the common physics in all of these environments to describe a) surface versus single grain charging; b) the surface plasma/UV sheath interface (plasma density distribution, electric fields); c) dust adhesion; and d) the possible mobilization and lift-off of grains form these surfaces.