The effect of asymmetric surface topography on dust dynamics in the lunar plasma environment

Marcus Piquette,[1,3] Mihály Horányi,[2,3]

[1] *Astronomy and Planetary Sciences Department, University of Colorado, Boulder, CO*
[2] *Physics Department, University of Colorado, Boulder, CO*
[3] *Institute for Modeling Plasma, Atmospheres, and Cosmic Dust, University of Colorado, Boulder, CO*
marcus.piquette@colorado.edu

Abstract. Without a significant atmosphere or global magnetic field, the lunar surface is exposed to micrometeoroid bombardment, ultraviolet (UV) radiation, and the solar wind. Micrometeoroid bombardment grinds the surface into a regolith comprised of dust grains ranging in size from 10 nm to 1 mm.[1] Incident UV radiation and solar wind particles electrically charge the surface forming a plasma sheath whose structure is dependent on the plasma and surface properties.[2,3,4,5] Furthermore, dust grains that are liberated from the surface can collect additional charge and interact with the plasma sheath. These interactions have been suggested to explain a variety of phenomena observed on airless bodies including horizon glow and dust ponding. [6,7,8,9] The effect of surface topography on the plasma environment and ensuing dust dynamics is poorly understood and serves as the focus of this paper. We present the results of a three-dimensional particle-in-cell (PIC) code used to model the dayside near-surface lunar plasma environment at a variety of solar zenith angles (SZA) in the presence of two topographies. Using the results of the PIC code, we model the effects on dust dynamics and bulk transport.

---

[1] Gru¨n, E., Horanyi, M., Sternovsky, Z., 2011. The lunar dust environ- ment. Planetary and Space Science 59, 1672–1680

[2] Campanell, M.D., 2013. Negative plasma potential relative to electron-emitting surfaces. Physical Review E 88, 033103.

[3] Guernsey, R.L., Fu, J.H.M., 1970. Potential distribution surrounding a photo-emitting, plate in a dilute plasma. Journal of Geophysical Re- search 75, 3193–3199.

[4] Poppe, A., Hor´anyi, M., 2010. Simulations of the photoelectron sheath and dust levitation on the lunar surface. Journal of Geophysical Research 115, A08106.

[5] Nitter, T., Havnes, O., Melandsø, F., 1998. Levitation and dynamics of charged dust in the photoelectron sheath above surfaces in space. Journal of Geophys- ical Research: Space Physics 103, 6605–6620.

[6] Colwell, J.E., Gulbis, A.A., Hor´anyi, M., Robertson, S., 2005. Dust trans- port in photoelectron layers and the formation of dust ponds on eros. Icarus 175, 159–169.

[7] Hughes, A.L., Colwell, J.E., DeWolfe, A.W., 2008. Electrostatic dust transport on eros: 3-d simulations of pond formation. Icarus 195, 630–648.

[8] Poppe, A.R., Piquette, M., Likhanskii, A., Hor´anyi, M., 2012. The effect of surface topography on the lunar photoelectron sheath and electrostatic dust transport.

[9] Wang, X., Hor´anyi, M., Robertson, S., 2009. Experiments on dust transport in plasma to investigate the origin of the lunar horizon glow, Journal of Geophysical Research 114, A05103.