

## DRILLING IN A LUNAR POLAR CRATER: TRIBOELECTRIC CHARGE REGULATION

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**Introduction:** Drilling for volatile materials is of particular interest in the lunar polar regions. Accumulation of triboelectric charge can pose a substantial challenge to exploration equipment in a lunar polar crater, which provides few sources of charge dissipation [1]. With a highly insulating surface and no direct access to solar photoemission or solar wind, the main source of grounding in this permanently shadowed region is the tenuous residual plasma from a solar wind wake [2].

The present study applies a new plasma wake model to characterize the crater electrical environment [3] and examines implications for triboelectric charge accumulation on human equipment while drilling in the lunar regolith. We present predictions for the rate of charge accumulation, for different triboelectric material properties. Two possible solutions for regulating charge accumulation are (i) artificial UV radition and (ii) extended wiring to the neutral region.

As a secondary implication of the triboelectric charging of equipment interacting with the lunar regolith, we examine lofting of tribo-charged dust grains. We predict the steady-state dust cloud levitation effects in a plasma-generated electric field.

A brief illustration of these results is presented below.

**Electrical environment characterized by plasma wake:** As the solar wind flows over a crater on an airless body, the resulting non-neutral plasma wake creates a non-neutral region known as the *electron cloud* (Fig. 1). Owing to low surface conductivity, the diffuse electrons provide the sole source of electrical grounding in this region, and only for positively charged objects. Farther downstream, the quasi-neutral plasma wake arrives at the surface and provides grounding for both positive and negatively charged objects.

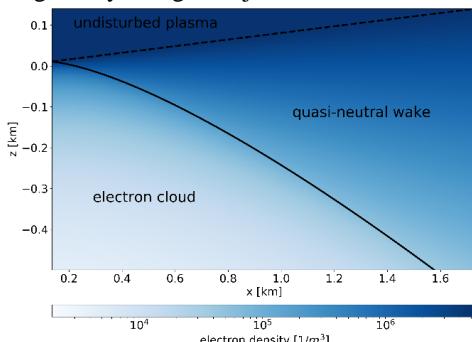


Fig 1: Electron cloud density characterizes electrical grounding in a lunar polar crater.

**Charge accumulation on drill differs across plasma domains and triboelectric material properties:** A preliminary analytic calculation (based on Ref. [1]) of the electric potential on a drill – relative to the surface – shows substantial difference between the electron cloud and the quasi-neutral region. Equally important are the triboelectric properties of the drill and lunar regolith. Fig. 2 presents four different charge accumulation scenarios, based on the drilling location and materials.

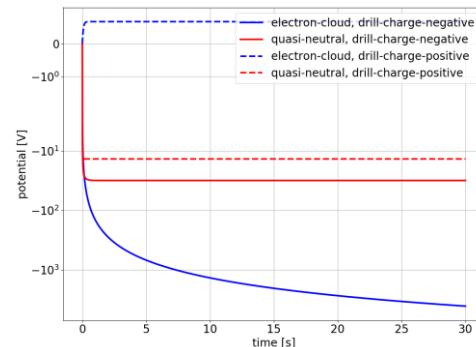


Fig. 2: Drill potential relative to surface, for different location and triboelectric material properties.

**Dust cloud steady-state may result from drill ejecta:** In the case where the drill charges positive and the dust negative, ejected grains can be caught in the electric field created by the plasma wake. Results in Fig. 3 suggest that the typical micron-size grains may aggregate near the upper leeward edge, where the solar wind enters the crater.

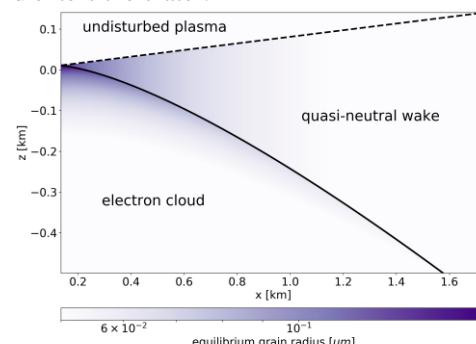


Fig. 3: Dust cloud steady-state grain size distribution, resulting from a positive-drill negative regolith charge exchange.

**References:** [1] Jackson, et. al., *Discharging of roving objects in the lunar polar regions*, Spacecraft and Rockets (2011). [2] Farrell, et. al., *Anticipated electrical environment within permanently shadowed lunar craters*, JGR (2010). [3] Rhodes and Farrell, *Steady-state solution of a solar-wind generated electron cloud in a lunar crater*, JGR – Space Physics (submitted).