Rover Wheel Charging within a Lunar Crater

T.L. Jackson[1,2] , *W.M. Farrell* [1,2]

[1] *NASA/Goddard Space Flight Center* [2] *NASA's Lunar Science Institute*

Introduction

A roving vehicle will experience tribo-charging while moving along the lunar surface. The rover wheel will dissipate its collected charge through the most conductive path: through the surface or the ambient plasma. Roving within a lunar crater creates a situation where the rover is effectively cut off from the ambient plasma (dominant path), causing dissipation times to increase significantly.

Objective - advance the wheel charging model derived from the astronaut charging model from Jackson et al. 2011, and determine the dissipation times for a continuously rolling rover wheel to bleed off its excess charge into the surrounding plasma.

Considerations – location (i.e. leeward of a lunar crater wall, far edge of a crater, near terminator), lunar dust adhesion (sticking factor), wheel speed, wheel type and regolith grain size.

Regions of Interest

Terminator – is electrically active, driven by current balance between photoelectrons and the solar wind plasma.

Leeward of crater wall – electron rich region where solar wind flow is obstructed

Far edge of crater – ambipolar electric fields draw ions into this region, retarding electron flow

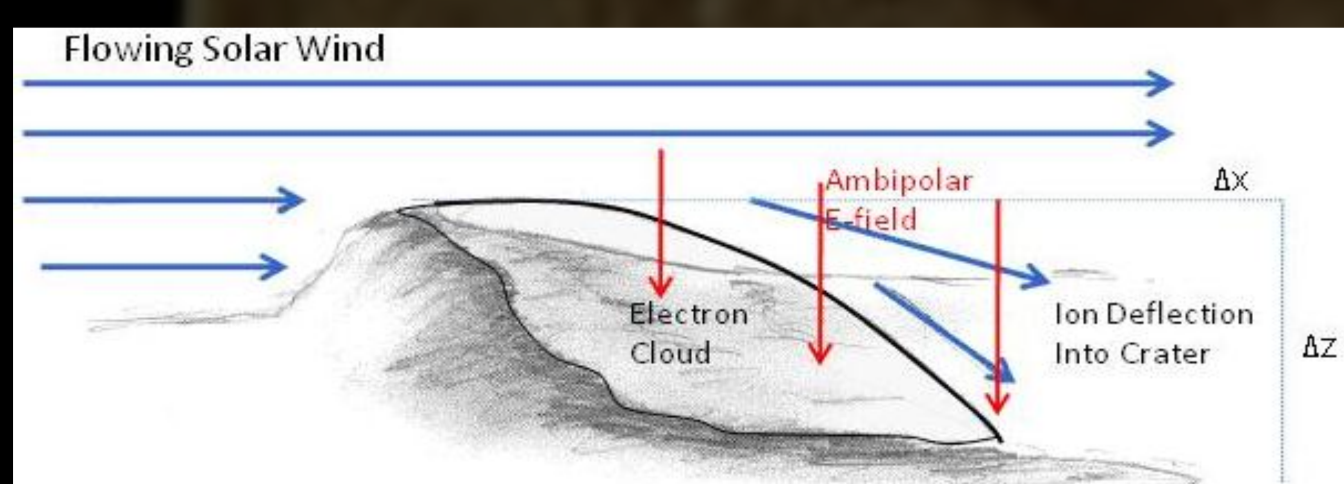

Figure 1: Solar wind flowing over an obstacle (crater), forming a plasma mini-wake.

Wheel Charging

Two types of wheels are considered. The conducting LRV (Lunar Roving Vehicle) wheels of Apollo 15 – 17 and the insulating MET (Modular Equipment Transporter) wheels from Apollo 14. Charge exchange happens with each wheel rotation. This system is modeled as a capacitor, initially connected to a tribo-electric current source.

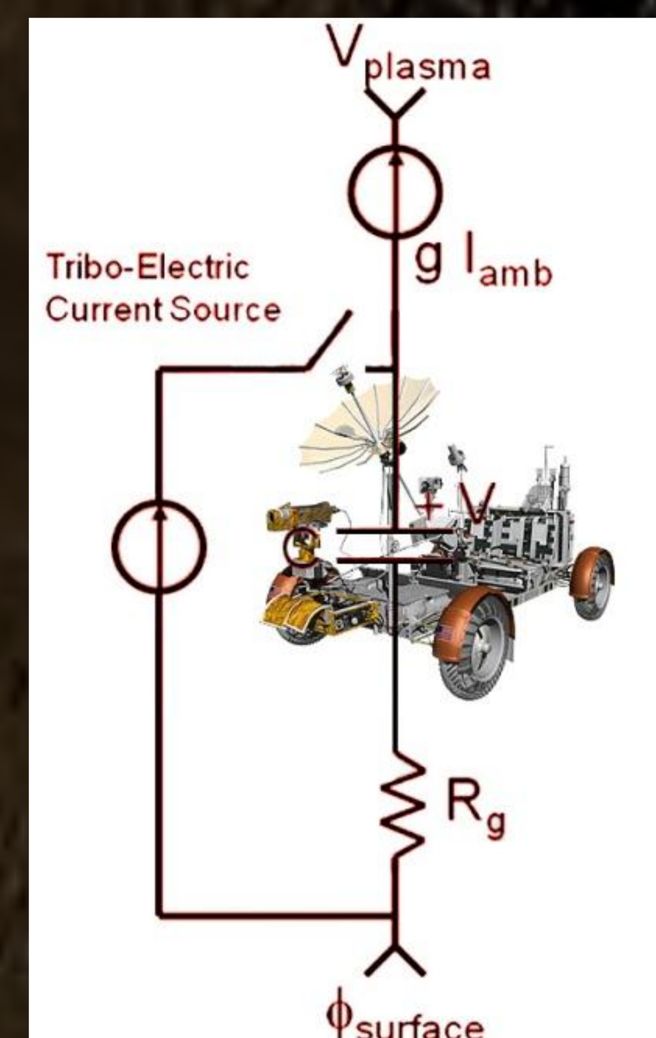

Figure 2: Equivalent circuit model for a rover on the lunar surface

Since tribo-charging is dynamic, the potential of the tribo-charging wheel is found by solving a charging equation (Jackson et al. 2011). Environmental electron and ion currents are taken into account, and the dust tribo-electric charging source incorporates changes in the current due to dust size and the amount that sticks to the wheel. Sticking is treated as a free parameter.

Results

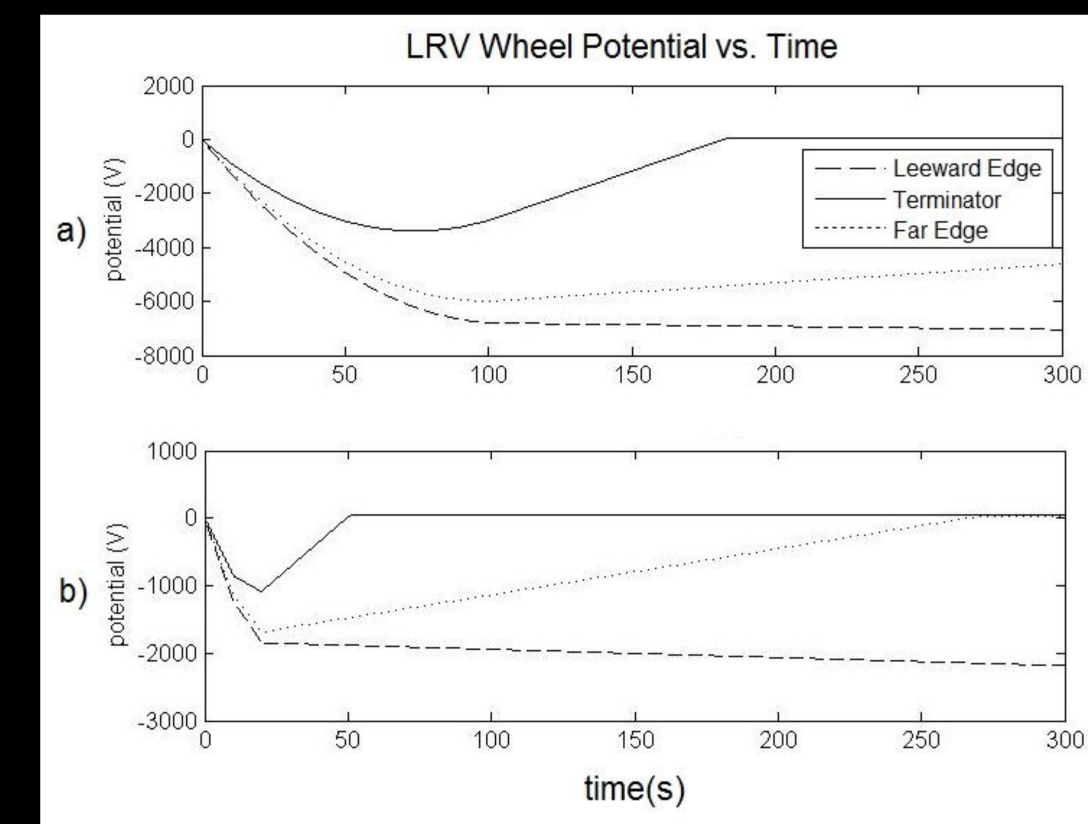

Figure 3: Wheel potential vs. time. a) low sticking, b) high sticking

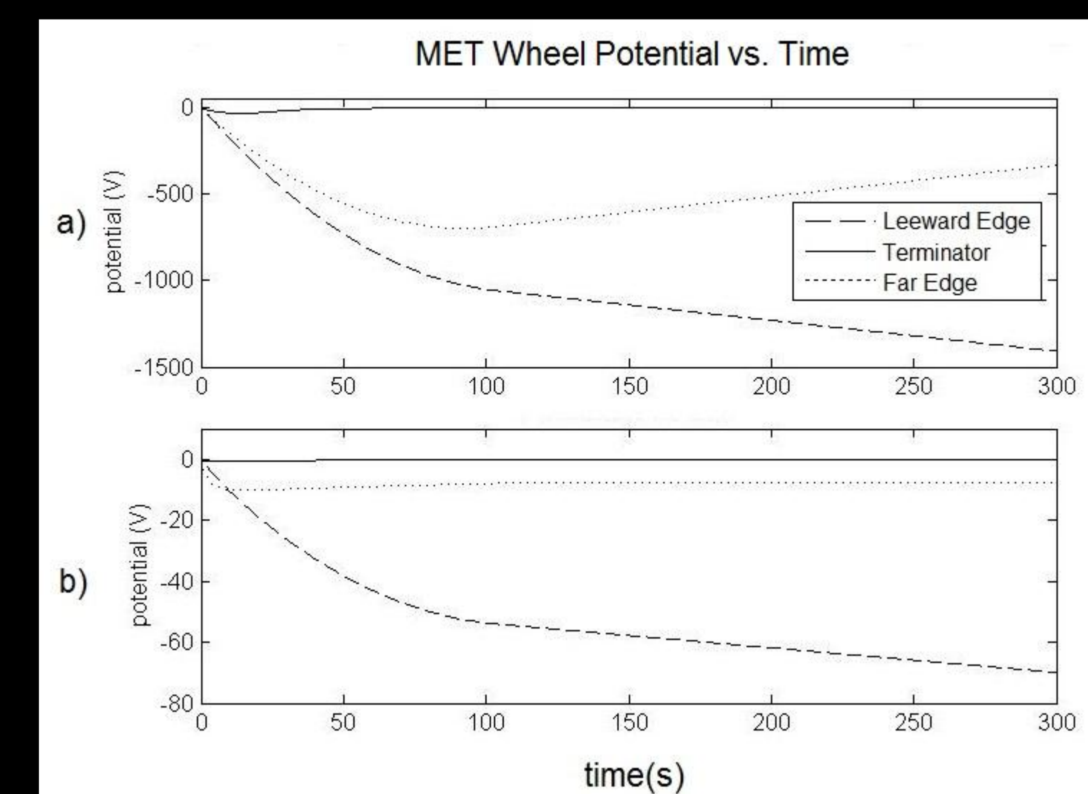

Figure 4: Wheel potential vs. time. a) small regolith grains, b)large regolith grains

Conclusion

Speed – Increasing speed causes an increase in overall potential.

Grain size - Larger grains contribute less to the overall potential than smaller grains.

Wheel parameters – The conducting wheel tribo-charges to a larger potential than the insulating wheel on the semiconductor surface.

Sticking factor – Dust sticking affects tribo-electric properties. The more dust that sticks, the less the wheel charges, due to grain-grain interactions.