CONCERNING THE CHARGING OF AN EXPLORATION CRAFT ON AND NEAR A SMALL ASTEROID.

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Introduction: An object immersed in an airless plasma environment will experience a natural process of surface charging in order to acheieve current balance, or zero net electric current to the object. It has been shown in recent computer simulations that the small-body plasma environment is very complex [1], considering effects of photoemission, topography, and formation of a plasma wake. For this work we consider an exploration craft (or astronaut) immersed within a plasma environment near an asteroid, which exhibits widely varying solar wind and photoelectric particle fluxes and continuously evolving illumination conditions.

Objective: We aim to to determine how an exploration craft or astronaut suit accumulates charge while located in the "nightside" asteroid wake where the particle fluxes are reduced, and in the dayside near-surface photoelectron sheath, by combining an object charging model [2] with kinetic simulations of a near-asteroid plasma environment [1]. We consider an astronaut floating near the asteroid while not in contact with the surface, as well as an astronaut moving along the surface using their hands/gloves to crawl along.

Results: The modeling results suggest that remediation of triboelectric charge via accumulation of plasma currents is an important factor to consider when designing future NEA mission infrastructure, especially if repeated and frequent contact with the surface is planned.

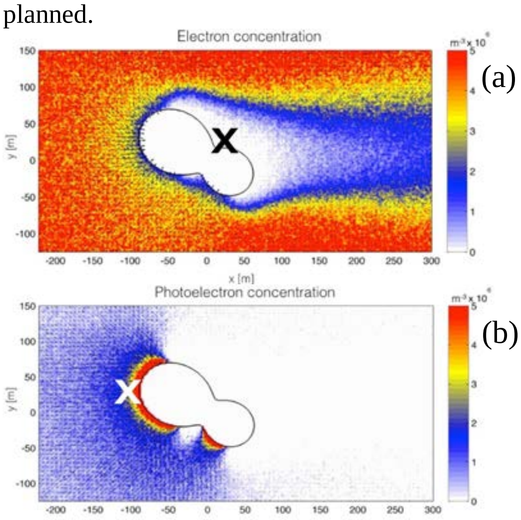

Figure 1: a) Selected "night side" location on asteroid, with electron concentration. b) "Dayside" location immersed in dense photoelectron sheath [3].

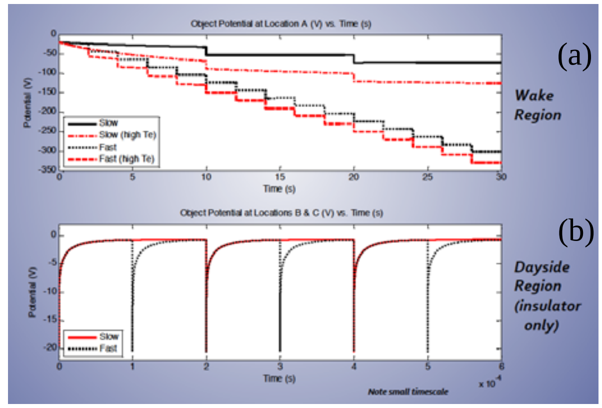

Figure 2: a) "Run-away" object charging in the night-side, b) "instantaneously" remediated tribocharging in the dayside photoelectron-rich sheath.

In shadowed regions such as the location shown in Fig. 1a, the plasma currents are so low (and the effective charge-remediation timescale so long, e.g. minutes to hours) that repeated contact with the surface tribocharges the glove in an uncontrollable fashion, as shown for two representative electron temperatures in Fig. 2a. The resulting buildup of significant negative charge would eventually initiate some other "current of last resort" [4] such as transport of positively-charged dust, field-emission from the glove, or significant alteration of environmental ion currents within the wake. In contrast, the few-meters-thick dayside photoelectron sheath in which the astronaut of Fig. 1b is immersed in is so rich in electrons (and hence so electrically conductive) that accumulated tribocharge dissipates almost instantaneously (e.g. in less than a ms) as shown in Fig. 2b.

As our model astronaut orbits the NEA they would experience plasma currents and associated charge remediation times spanning many orders of magnitude, and the fusion between our numerical models provides a detailed understanding of the charging hazards possibly associated with contact-based NEA exploration.

References: [1] M.I. Zimmerman et al. Icarus, submitted; [2] T.L. Jackson et al., JSR 2011; [3] T.L. Jackson et al., AGU, 2013; [4] W.M. Farrell et al., JGR 2010.