Numerical simulations of astronaut charging at lunar terminator

Ziyu Huang,[1] Joseph Wang[1]

[1] *Department of Astronautical Engineering, University of Southern California, Los Angeles, CA 90089*
ziyuhuan@usc.edu

Abstract. Lacking a global magnetic field and an atmosphere, the lunar surface is directly exposed to space plasma and solar radiation and is electrically charged by the impingement of electrons and ions and the emission of photoelectrons. Observations have found that the potential of the sunlit surface is typically a few tens of volts positive with respect to ambient due to photoelectron emission, whereas that of the surface in the shadow can be hundreds to thousands of volts negative because of the hot electron flux from the ambient plasma. Charging was not considered a serious risk during the Apollo mission because astronauts always stayed under sunlit but future mission will explore the lunar terminator and far-side. This raise concerns on possible charging risks for astronaut on lunar surface.

This paper presents a simulation study of astronaut charging at the lunar terminator for various lunar surface operation scenarios, surface topologies, and space weather conditions. The ambient plasma is modeled by kappa distributions which more realistically represent the actual plasma condition than the commonly used Maxwellian distributions. Plasma and charging simulations are carried using the recently developed USC-IFEPIC (immersed-finite-element particle-in-cell) code which calculates astronaut charging, lunar surface charging, and plasma flow field self-consistently. The simulation results are used to estimate charging/arcing risks for astronauts at lunar terminator.