Constraining lunar surface charging using Apollo CPLEE observations

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The Charged Particle Lunar Environment Experiment (CPLEE) was deployed during the Apollo 14 mission to measure electron and ion fluxes incident at the surface of the Moon. This study focuses on utilizing CPLEE observations to investigate the interaction between the Moon and the surrounding space plasma environment; in particular, determining the electric potential between the lunar surface and ambient plasma under different conditions. Previous analyses of CPLEE data reported a lunar surface potential of >200 V positive on the dayside when the Moon was in the plasma sheet region of the Earth's magnetotail; this is about an order of magnitude greater than expected from surface charging models. During our investigation, we re-evaluate the constraints that can be placed on the sign and magnitude of the lunar surface potentials using CPLEE data. By curve-fitting Maxwellian distribution functions to CPLEE energy spectra we can well-constrain the plasma temperature; however, we have not yet found any truncations in the energy spectra indicative of surface charging effects (likely due to CPLEE's high energy threshold of 40 eV). Therefore, variations in ambient plasma concentration and surface potential cannot be uniquely distinguished, thus we obtain a family of possible solutions for these two parameters. We also investigate the reliability of the higher energy channels (> ~3.5 keV), which often appear to follow the shape of the CPLEE single-count background spectrum. This strongly suggests an instrumental effect that might only be apparent during operations on the Moon, since it was not reproduced during instrument calibration in the laboratory. We are working to distinguish the influence of penetrating radiation, such as galactic cosmic rays (GCRs) and solar energetic particles (SEPs), on this possible instrumental effect. This analysis will be used to examine how the lunar surface potential is dependent upon both the Moon's location in its orbit and conditions in the interplanetary medium; especially during traversals of the plasma sheet and tail lobe regions within the Earth's magnetotail, and intervals coinciding with SEPs events. Finally, we investigate utilizing CPLEE's charged particle fluxes as evidence for nonmonotonic potentials (i.e. potentials that do not monotonically increase or decrease to 0). This phenomenon has been discussed both in theoretical and orbiter studies; however, only recently has Apollo lunar surface data been used to corroborate conclusions from previous studies. By re-examining Apollo Lunar Surface Experiments Package (ALSEP) data, we hope to strengthen these results.