PHYSICS&ASTRONOMY
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Dissertation Defense

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Advisor: **Jerry Goldstein**

Abstract

Energetics of Near-Earth Particles: Energy Correction in Observation and Measurement

Interpreting near-Earth observations of ring current and solar-originating particles requires an energy correction to uncouple the locally modified measurements from the actual source distribution. This thesis considers energy corrections for two cases: (1) precipitating ring current ions in the Earth's exosphere; (2) suprathermal particles interacting with the surface of solid-state type detectors. Our first case experiences energy loss before detection while our second case experiences energy loss within the detector. We modeled the energy loss from both occurrences to link the detected energies back to the incident energy of the original particles of interest. Modeling, data analysis, and experimental measurements were used in developing the two energy corrections. For the first case, ring current ions that precipitate near the Earth to altitudes below 2,500 km begin to experience energy loss from multiple charge changing interactions with the neutral oxygen exosphere. Low-Altitude Emissions (LAEs) are the particles that escape from low-altitudes as energetic neutrals and observed by a spacecraft at high-altitudes. We found that whether the particle has enough energy to escape back to high altitudes depends on the migration of the particle at low altitudes. Our model provides an energy correction estimate to infer the global precipitating ring current population. The novel approach of our model is the inclusion of a more realistic dipole field and extension of the upper atmosphere than previously published low-altitude models. We validated our energy correction against in-situ sounding rocket measurements, a full Monte-Carlo simulation, and an analytical approximation. For the second case, suprathermal electrons with energy below 30 keV lose all their energy on the surface of a penetrating-type Solid-State Detector (SSD). Suprathermal electrons (~1s keV to ~100s keV) are the seed population to Solar Energetic Particle (SEP) events. We found that varying the Aluminum (Al) layer on top of Avalanche PhotoDiodes (APDs) is compact enough to extend the lower energy detection of SSDs down to a few keV for electrons with little additional resources. The new application of our method is the inclusion of multiple APDs with varied Al thicknesses to separate between species and infer the original energy spectrum. The particle energy loss from our simulated Al layers agrees within one standard deviation of lab measurements for both electrons (5-30 keV) and protons (50-300 keV). Our method and current Al thicknesses show that electron separation is possible up to 60 keV for electron-rich mixed species.

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