The University of Texas at San Antonio

UTSA Physics and Astronomy

Qualifying Exam

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Abstract

Date: Wednesday , April 16th, 2025

Time: 9:oo am CT

Advisor: Dr. Maher Dayeh

"Juxtaposing the Properties of Ground Level Enhancements (GLE) and Extreme Non-GLE Solar Energetic Particle (SEP) Events with their Solar Sources"

The origin, acceleration, and transport of solar energetic particles (SEPs) in the inner heliosphere are fundamental processes in space plasma physics that remain poorly understood. SEPs are primarily produced by two mechanisms: (1) magnetic reconnection during solar flares, and (2) interplanetary shocks driven by coronal mass ejections (CMEs), which produce gradual SEPs through shock acceleration. SEPs from some gradual events penetrate Earth's atmosphere and produce secondary particles detectable on the ground, generating Ground Level Enhancements (GLEs). The underlying cause of GLE production remains an open question.

The overarching goal of this proposal is to understand the processes that generate extreme SEPs and how they relate to GLEs. To achieve this, we conduct a comprehensive multivariate analysis using energetic particle, plasma, and imaging data from several missions, including ACE, WIND, SDO, STEREO, SOHO, GOES, and, when applicable, PSP and SO. Our approach includes analyzing the timing of particle release at the Sun, examining the properties of parent active regions (ARs), flares, and CMEs, studying the variability of elemental composition, and performing spectral analysis on a broad set of extreme SEP events listed in GOES-NOAA's solar proton event (SPE) catalog. These observations will help evaluate the role of solar sources in shaping SEP characteristics, and identify the conditions required for a SEP event to become a GLE.

Finally, a comparative analysis of GLE and non-GLE events will provide insight into the factors that govern their variability and their connection to solar sources. Findings will help constrain SEP acceleration models and improve space weather prediction capabilities.