

D i s s e r t a t i o n D e f e n s e

S a m u e l H a r t

Date: : **Monday, September 30, 2024**

Time: **10:00 am/CT**

Advisor: **Dr. Maher Al Dayeh**

**UNDERSTANDING THE ORIGINS AND ACCELERATION MECHANISMS
OF ³HE-RICH SOLAR ENERGETIC PARTICLE EVENTS**

The unique composition of ³He-rich SEP events provides significant insight into the origination, acceleration, and transport process(es) at play within reconnecting magnetic field lines. In this work, we identify all ³He-rich time periods observed by ACE/ULEIS and STEREO/SIT over the last two full solar cycles, and we use these time periods as a basis for multiple studies. In the first statistical survey, we calculate the ³He/⁴He and Fe/O abundance ratios of each ³He-rich time period in two energy ranges: 0.32 – 0.45 MeV/nuc and 0.64 – 1.28 MeV/nuc and provide the statistical quantities of their distributions, and we discuss the results in addition to releasing a live catalog of the identified time periods. In the second statistical survey, we select a subset of clear, isolated ³He-rich SEP events from the catalog and analyze their spectral properties. We place each event into one of two categories: events with fast-and-wide coronal mass ejections (CMEs), and events without. We find that the energy spectra of ³He-rich SEP events without CMEs are typically harder and more rounded at lower energies, while the spectra of events with CMEs exhibit power laws. For events without CMEs, we find that the average low-energy spectral indices of heavy ions are lowest for Mg & Si suggesting the presence of a second harmonic wave-particle resonance with a source plasma temperature ranging from 1.0 – 1.3 MK (i.e., typical coronal temperatures). Our final major study is an in-depth case study on the near-scatter-free recurrent ³He-rich injections that occurred on July 15 – 17, 2023 followed by a large gradual SEP event originating from the same solar active region. We (1) identify the solar sources and discuss how the recurrent injections are possible, (2) show that the subsequent gradual SEP event does not have an impulsive seed population, (3) analyze the radial evolution of ³He-rich SEPs by comparing observations at Parker Solar Probe (0.6 AU) and ACE (1 AU). The presentation concludes with discussion on for future research projects on ³He-rich SEP events.

Samuel is in his sixth year of graduate school in the University of Texas at San Antonio - Southwest Research Institute joint space physics graduate program. Prior to his research in Heliophysics, Samuel studied the Earth's magnetosphere using data from the Interstellar Boundary Explorer spacecraft. Samuel boasts an h-index of 2, an i10-index of 0, and a total citation count of 14. His work has been featured in both *The Astrophysical Journal* and the *Journal of Geophysical Research: Space Physics*.