Project Title: Energetic electron anisotropy and thermal plasma conditions in the solar wind

Project Reference Code: Zhao-UAH

Name of Project Leader: Lingling Zhao

Host Facility: University of Alabama in Huntsville

Internship Location: Cramer Research Hall

Host Facility Location: 301 Sparkman Drive NW, Huntsville, AL 35805

Project Description (roughly 300 words):
Energetic electrons in the solar wind often show anisotropic pitch-angle distributions, meaning that their motion is not equally distributed in all directions relative to the local magnetic field. The evolution of this anisotropy provides information about particle transport, magnetic connectivity, and pitch-angle scattering. At the same time, the surrounding thermal plasma may also be anisotropic, with different temperatures perpendicular and parallel to the magnetic field. Such thermal temperature anisotropies can provide free energy for plasma instabilities and wave activity, which may in turn affect the propagation and scattering of energetic electrons. In this project, the student will investigate whether the pitch-angle anisotropy of energetic-electron events is related to the local thermal plasma environment. Selected energetic-electron events will be identified using spacecraft observations, and their intensity profiles and pitch-angle distributions will be examined. A quantitative measure of energetic-electron anisotropy will be calculated and compared with thermal electron temperature anisotropy, plasma beta, and magnetic field fluctuations. The student will use Python to process, analyze, and visualize spacecraft measurements for multiple events. Statistical comparisons will be used to determine whether strong or weak energetic-electron anisotropy tends to occur under particular thermal plasma conditions. The project will also examine whether changes in energetic-electron anisotropy are associated with enhanced wave activity that could contribute to pitch-angle scattering. The main goal is to better understand whether energetic-electron anisotropy is influenced mainly by the local plasma environment or by larger-scale transport and magnetic connectivity.

Disciplines: physics, math, computer science

Importance:
This project will provide hands-on experience in space plasma data analysis, including multi-spacecraft observations, event selection, particle anisotropy, and statistical methods. The student will gain a better understanding of energetic electron events and their connection to the solar wind plasma environment. The results will contribute to broader efforts to understand energetic particle transport, turbulence, wave-particle interactions, and space radiation.

Requirements:

- Preferred Major
  - STEM students.
- Class work
  - Average level in physics.

- Programming knowledge
  - Python.
- Software knowledge
  - Numpy, scipy, pyspedas.
- Other

Biography (roughly 100-150 words):
Dr. Lingling Zhao received her Ph.D. in Space Physics in 2013. She is an Associate Professor of the Department of Space Science (SPA) at The University of Alabama in Huntsville (UAH). She has accumulated rich experience in modeling and observational analysis of the transport of galactic cosmic rays, anomalous cosmic rays, and interstellar pickup ions. Dr. Lingling Zhao is currently working on the solar wind turbulence and energetic particles observed by Parker Solar Probe and Solar Orbiter.

Is U.S. citizenship required to participate in this project? No

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