Project Details

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Selection Year: 2020
Program Element: Focused Science Topic

Topic: The Origin and Consequences of Suprathermal Particles that Seed Solar Energetic Particles

Project Title:
Suprathermal Property Scaling and Acceleration Processes from the Near-Sun Environment to 1AU

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Summary:
The overarching goal of this investigation is to develop a physics-based understanding of the acceleration and sources of the suprathermal (ST) ion population in the inner heliosphere. The ST population is thought to be the primary source of seed particles that feed large solar energetic particles (SEPs), the main driver of space weather. We will achieve this by addressing the following scientific questions:

1. How do acceleration and transport processes sculpt the radial variations of suprathermal particle properties (spectra, composition, etc.) from ~0.1-1.0 AU?
2. What suprathermal particle acceleration mechanisms predominate in the quiet solar wind, energetic storm particles (ESPs), corotating interaction regions (CIRs), and SEP events at 1 AU?
3. How do shock parameters and event properties, such as size, peak flux, and integrated spectrum affect suprathermal acceleration in ESP, SEPs, and CIRs at 1 AU?

We will use the publicly available Parker Solar Probe and Solar Orbiter observations to examine the near-Sun ST environment. STEREO, ACE, and Wind data will be analyzed to understand the ST and energetic particle environment near 1 AU. These missions will provide a wide range of particle measurements enabling the examination of the radial evolution, transport effects, and longitudinal effects from the near-Sun to 1 AU. The observed ST properties will then be used in the iPATH model to understand how the initial seed particle parameters affect the accelerated particle properties at 1 AU.

These three science questions approach the Focused Science Team (FST) stated goal of understanding the origin of ST particles as seed particles in new and meaningful ways. First, characterizing the ST population near the Sun, and determining how it scales out to 1 AU gives new insights into how the seed population mixes and evolves. Seed particles are key ingredients to large SEP events, associated with strong interplanetary shocks. Injection into the shock is a continuous process from the Sun to 1 AU; proper modeling of large SEP events requires knowing the radial variation of the seed population. One outcome of the proposed study is the radial scaling of seed population, which will be incorporated to the iPATH model to examine how different seed populations (and their radial variation) can affect the accelerated particle spectrum. Second, studying a wide variety of solar transient events, focusing on the A/Q distribution of the seed population and that of the accelerated population, will provide a better understanding of the underlying acceleration mechanisms. Third, we will investigate how the shock properties (e.g., geometry, strength, and size in both radial and longitudinal components) contribute to the wide range of SEP properties observed at 1 AU. In achieving this goal, we will use the iPATH model. Input parameters of iPATH include plasma parameters, plus the seed particle distribution, which has NOT been tested much in the past. This proposal will investigate the mechanisms responsible for accelerating these particles to high energies and work to understand particle transport, mixing, and other effects that result in the observed variability in the properties of SEP events at 1 AU.

This proposal will contribute to the FST by providing an understanding of the linkage between the ST population near the Sun to the mechanisms that contribute to their acceleration to energetic particle events observed in solar transient events near Earth. This proposal utilizes both data analysis and modeling to further contextualize the observations and help understand the significance of various parameters to the transport and mixing of ST particles from near Sun to 1 AU. The project also responds to the first Strategic Science Area (SSA-0) determined by the LWS TR&T steering committee and to 2 key science goals of the 2012 Heliophysics Decadal survey (1&4).

Publication References:

no references