Project Details

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Program Element: Focused Science Topic

Topic: Factors that Control the Highly Variable Intensity and Evolution of Solar Particle Events

Project Title:
An analytical investigation of factors controlling the variability of large gradual SEP events

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Summary:
The large gradual SEP ion events that present major challenges for the safety of astronauts and space assets near Earth orbit are thought to originate from acceleration of solar wind ions and remnant energetic ions at coronal/interplanetary shocks driven by coronal mass ejections. The process of shock acceleration, particularly in the limit of effective particle scattering that guarantees near isotropy of the particle distribution functions, is well understood in general terms and has been successful in accounting qualitatively for most of the energetic particle populations observed throughout the heliosphere. It is therefore puzzling that shock acceleration has had difficulties accounting for the large variability observed in the intensities, fluences, composition and general structure of gradual SEP events. Our contention is that the process of diffusive shock acceleration is extremely sensitive (in part due to nonlinear feedbacks) to the parameters governing the shock, the solar wind plasma environment, and the remnant energetic particle environment. The interplay between these various sensitivities leads to a broad distribution of possible energetic particle characteristics. We propose to investigate with analytical techniques the effects on SEP variability of (1) the injection rates of different solar wind ions into the process of diffusive shock acceleration; (2) the excitation of hydromagnetic waves upstream of the shock by the accelerating ions; (3) the role of magnetic field obliquity at the shock in injection, the rate of acceleration, and wave excitation; (4) the special case of nearly perpendicular shocks; (5) the energy spectrum and composition of the remnant energetic "seed" particle population in the vicinity of the shock; (6) the importance of the shock compression ratio; (7) the magnetic connection geometry of the shock front to the observer; and (8) the "streaming limit" caused by the escape of accelerating ions from the turbulent foreshock.

Publication References:

no references