Project Details

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Topic: Shock acceleration of solar energetic particles by interplanetary CMEs

Project Title:
Understanding Energetic Particle Responses to Local Interplanetary Shocks through Observations and Theory

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Summary:
We propose to study the energetic particle increases associated with the passages of interplanetary shocks. Although such events, called energetic storm particle (ESP) events, have been studied since the 1960s and theories of particle acceleration by traveling shocks are well developed, previous surveys have repeatedly shown that the many of predicted relationships between the shock parameters and the ESP characteristics are not apparent in the spacecraft data. Exploring these discrepancies, identifying new relationships, and determining relationships that do hold (based on theoretical models) is crucial in the quest to fully understand shock acceleration as it is manifested in the interplanetary medium and to predict the particle response to shocks moving outward from the Sun towards Earth. The solar energetic particle (SEP) events created by shocks driven by coronal mass ejections (CMEs) are a concern for space operations and we are far from being able to predict them. Fortunately, most SEP events are limited in intensity by the streaming limit imposed by the magnetic turbulence generated by the energetic protons. However, in the vicinity of a shock, this limit is typically exceeded by the ESP event, resulting in intensity increases that can be orders of magnitude in size and a significant space weather threat. Additionally, ESP events are our only opportunity to examine the particles accelerated by CME-driven shocks in situ where both the shock and particle parameters can be measured and correlated. More sensitive particle measurements are being made than ever before and by combining the data from the ULEIS and SIS instruments on ACE the energy spectra of heavy ions can be determined over more than 3 orders of magnitude in energy. Spectra of protons and helium are also available from the EPAM instrument and at higher energies from ULEIS and SIS and, when appropriate, GOES. Recently, analysis of interplanetary shocks observed by ACE and Wind has been expanded to routinely fit the plasma and magnetic field data with a variety of methods resulting in a more accurate determination of shock parameters. We propose to combine these improvements in particle measurements and shock analysis with theoretical expertise in shock acceleration to understand the physical reasons for the lack of correlations previously reported for shock parameters and ESP characteristics and to enable progress in constructing a predictive capability.

Publication References:

no references