

Project Details

ROSES ID: NNH14ZDA001N

Selection Year: 2014

Program Element: Focused Science Topic

Topic: Prediction of the Interplanetary Magnetic Field Vector Bz at 1AU

Project Title:

A comparative study of the timing and the radial and lateral extent of CME-driven shocks associated with metric type II radio bursts relative to the onset time and other properties of SEP events in interplanetary space

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Project Member(s):

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Summary:

We propose to investigate spatial and temporal correlation of metric type II producing coronal shocks with the solar energetic particle (SEP) events in interplanetary (IP) space with a goal to understand longitudinal particle propagation. We will answer to the following scientific questions: Is the wide longitudinal extent of SEP events due to the propagation of a shock ahead of a coronal mass ejection (CME) or due to some other transverse particle transport mechanisms? How do the timing, spectral index, onset-to-peak time and the peak magnitude of the particle flux depend on spacecraft's connection to the CME-driven shock front? This knowledge is crucial for improving the space weather forecast. In addition, our results will provide necessary constraints for numerical simulations and theoretical modeling of particle propagation.

The proposed work directly addresses the LWS/FST objective "Physics-based methods to predict connectivity of SEP sources to points in the inner heliosphere, tested by location, timing, and longitudinal separation of SEPs", with an aim to advance our "basic understanding of the longitudinal extent of SEP events using observations." Our study will contribute to the FST science objectives by providing detailed measurements of the CME and shock propagation in the low solar corona, especially the shock formation time, the delay between type II onset and solar particle release, along with onset-to-peak time, energy spectrum of SEPs, and classification of SEPs based on correlations of shock location relative to the SEP observing spacecraft, the solar particle release time and the delay of the SEP onset relative to the metric type II onset, the SEP path length, the spectral index, and the maximum particle energy. We will create a website so the science community can have easy access to our results. We will present all the obtained results in national scientific meetings and publish them in peer-reviewed scientific journals.

It is essential to combine the radio, EUV and white-light observations together with SEP observations from multiple spacecraft in order to understand the temporal and spatial evolution of the SEP events in their entirety. We will primarily utilize the imaging and particle data from STEREO and SDO, as well as from SOHO, ACE, GOES and Wind missions; and radio observations at the metric wavelengths from multiple radio observatories located around the globe. The radial and lateral extent of CMEs are studied by forward fitting a spherical model on near-simultaneous EUV and white-light images of the CME. The forward modeling is done by using the IDL code RTCLLOUDWIDGET.PRO, which is able to reproduce the image of the 3-D model as seen by the imaging instruments from their respective viewing angles. We determine the solar release time and the path length of the first arriving particles by the velocity dispersion method.

The PI has extensive experience in analyzing the particle, radio and white-light observations of SEP events and CMEs. His scientific background also includes calibration and data analysis of SOHO/ERNE measurements. The CoI has background in instrumentation and analysis of cosmic rays and studies of solar energetic particles. Thus our team has expertise in aspects required for successful completion of the proposed work. Our study will utilize archival data and thus will enhance science return of present science missions. The requested funding provides support for an early-career female researcher.

Publication References:

Summary: no summary

Reference: Gopalswamy, N.; Mäkelä, P.; Akiyama, S.; Yashiro, S.; Xie, H.; Thakur, N.; Kahler, S. W.; (2015), Large Solar Energetic Particle Events Associated with Filament Eruptions Outside of Active Regions, The Astrophysical Journal, Volume 806, Issue 1, article id. 8, 15 pp, doi: 10.1088/0004-637X/806/1/8

Summary: no summary

Reference: Mäkelä, P.; Gopalswamy, N.; Akiyama, S.; Xie, H.; Yashiro, S.; (2015), Estimating the Height of CMEs Associated with a Major SEP Event at the Onset of the Metric Type II Radio Burst during Solar Cycles 23 and 24, The Astrophysical Journal, Volume 806, Issue 1, article id. 13, 11 pp, doi: 10.1088/0004-637X/806/1/13

Summary: no summary

Reference: Gopalswamy, N.; Yashiro, S.; Thakur, N.; Mäkelä, P.; Xie, H.; Akiyama, S.; (2016), The 2012 July 23 Backside Eruption: An Extreme Energetic Particle Event?, The Astrophysical Journal, Volume 833, Issue 2, article id. 216, 20 pp, doi: 10.3847/1538-4357/833/2/216