Contribution ID: **19** Type: **not specified**

Study of Solar Energetic Particle Events for Support of Human and Robotic Spaceflight

Monday 19 October 2015 15:30 (45 minutes)

This study aims for a better interpretation of high-energy Solar Energetic Particle (SEP) events using the Alpha Magnetic Spectrometer (AMS-02), and the fleet of NASA solar observatories in space. Future space exploration is dependent on an understanding of the radiation environment through the Solar System. AMS-02 is a particle detector installed on the International Space Station (ISS) that primarily focuses on high-energy physics.

As a heliospheric observatory, AMS-02 measures particle rigidities from 0.5 GV to a few TV and proton energies over 125 MeV. The AMS-02 energy detection range is relatively higher and more precise than any other detector in the NASA satellite fleet. AMS-02 recognition is vital to future missions in space considering that the isolated SEP events are highly energetic and reach the ISS in low Earth orbit. Between May 2011 and February 2014, AMS-02 detected 18 SEP events analyzed in this study.

The fleet of NASA spacecraft provides information about SEP events detected by AMS-02 and corresponding flare event parameters. High intensity solar events from May 2011 to February 2014, purely X- and M-class flares, are compared with AMS-02 SEP events to identify any correlations for the range of solar activity. AMS-02 SEP events invoke significant increases in proton flux, X-ray flux, and FERMI gamma ray bursts identified by various detectors in the highest respective energy range bins.

The 18 AMS-02 SEP events are not well associated with X-ray flux, large-scale coronal propagating front (LCPF) velocities, or coronal mass ejection (CME) energies and velocities. Notably, all AMS-02 SEP events show unique type III radio burst structures. The AMS-02 type III radio bursts comprise of low frequencies (14 MHz-10 kHz) with extended durations. A contour algorithm is used to isolate constant flux frequencies; exhibiting type III radio bursts over 2.5 hours for every AMS-02 event. Non-AMS-02 events typically average type III radio burst durations for 1.5 hours, even showing absences of radio bursts in certain scenarios. X-ray flux, LCPF velocities, and CME energies and velocities are poorly correlated to AMS-02 maximum-recorded energies, and prove unsatisfactory for SEP event predictions. Remarkably, long duration type III radio bursts appear to be sufficient conditions for AMS-02 SEP events in this sample.

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Session Classification: Poster Session