IMP 8 GME Energetic Particle Observations over Three Solar Cycles

Ian G. Richardson¹, Hilary V. Cane², and

Tycho von Rosenvinge
Astroparticle Physics Laboratory,
NASA/Goddard Space Flight Center

Robert E. McGuire
Heliospheric Physics Laboratory
NASA/Goddard Space Flight Center

¹Also CRESST and Department of Astronomy, University of Maryland, College Park;
²Also School of Mathematics and Physics, University of Tasmania
IMP 8

- Launched October 26, 1973;
- ~35 R_e orbit, ~12 day period (~7 days in solar wind);
- Mission officially terminated in October, 2001; tracking continued until contact with the spacecraft was lost in late 2006;
- GME (Goddard Medium Energy) Experiment;
- Measurements of ~1 – 400 MeV/n protons and heavy ions; 3 - 18 MeV electrons; Intensities and anisotropies;
- 3 separate instruments (VLET, LED, MED);
Overview of Sunspot Number and IMP 8 GME
0.88 – 230 MeV Proton Observations, 1973 - 2005

- Sunspot Number
- 0.88 - 1.15 MeV Protons
- 24-29 MeV Protons
- 121-230 MeV Protons
- Anti-Coincidence Guard Count Rate

CIR-Accelerated (Bad Data Points)
Solar Energetic Particles
Cosmic Rays

A>0 A<0 A>0 A<0
Shock of September 24, 1998

Broad particle peak around shock + clean flow reversal ($E_0$=9°; $\theta_{Bn}=78°$)
Example of Shock Spike

Pancake Distribution => Shock Drift Acceleration; $\theta_{Bn}=80^\circ$
0.88-1.15 MeV Proton Intensity vs Local Shock Speed
0.88-1.15 MeV Proton Intensity vs Shock Compression
Examples of CIR-Associated 0.88 – 1.15 MeV Proton Enhancements and Cosmic Ray Modulations, January – April, 2005
4 - 22 MeV Proton Flow Azimuth Distribution, February 5 – April 30, 2005

Sunward Flow

Sunward proton flow from CIR reverse shocks

Plasma Temperature
Solar Wind Speed
Density
Magnetic Field Intensity
Flow Angle

Histogram
Richardson, Cane and Wibberenz (1999) noted that recurrent (~27 day) galactic cosmic ray modulations are larger in A>0 epochs. The pattern continues in the current epoch (A<0). (Bad data points also present in 2005-2006.)
Summary

• The IMP 8 GME has provided a wealth of observations of energetic particles, including SEP, CIR events, and galactic cosmic rays, extending over three solar cycles (October, 1973 - late 2006).