Analysis of the Mars Odyssey MARIE Experiment Data

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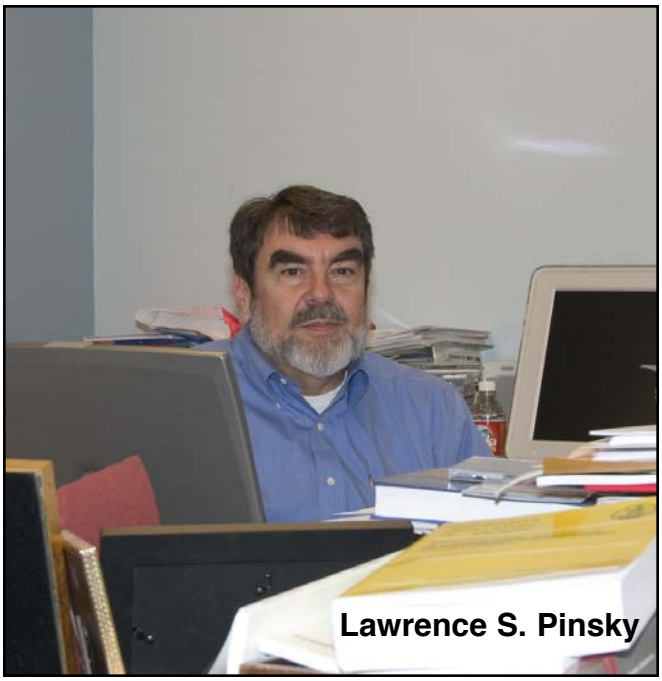
Abstract—Analysis of MARIE data in conjunction with data from ACE shows that the intensity of solar energetic particles depends strongly on how well the observation point is connected magnetically to the site at which the particles are accelerated.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THE INSTRUMENT MARIE ABOARD MARS ODYSSEY IS designed to determine the radiation dose attributed to energetic nuclei in Mars orbit, for the purpose of mission planning for eventual manned missions to Mars. In combination with data from other spacecraft—such as ACE and Ulysses—MARIE data is also suitable for studies of the propagation of these particles, which are largely galactic cosmic rays and particles accelerated due to solar activity, in the inner heliosphere.

Results

A plot of the observed particle fluxes in MARIE's A1 detector over an 18 month period is shown in Fig. 1 (*lower panel*) compared to fluxes measured by the Solar Isotope Spectrometer (SIS) aboard ACE *(upper panel*). Even a cursory examination of this figure shows that sometimes there is a good correlation between solar particle events (SPE's) observed with different instruments, while at other times the conditions at the different locations seem completely independent of one another. This is a result of the way that the SPE particles propagate away from their acceleration sites. Particles are constrained to move along the solar magnetic field lines, which, roughly speaking, follows an Archimedian spiral outward from the Sun.[1] Thus, when Earth and Mars are connected to the same set of magnet-

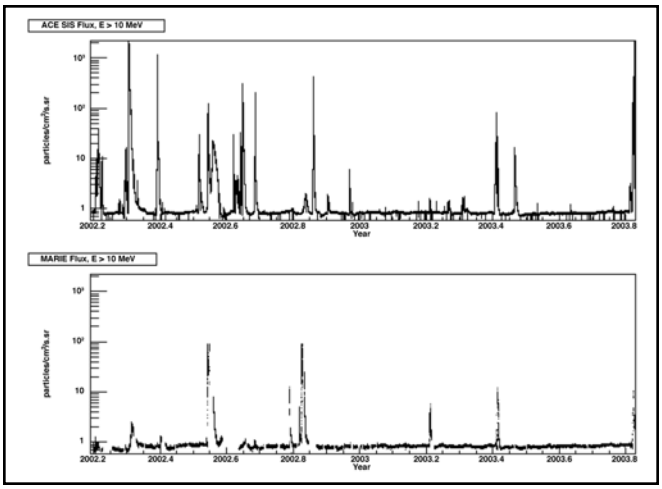

Figure 1. A comparison of the flux of *n* and near Mars (*lower panel*). The times where the flux increases rapidly are due to particles accelerated by solar activity; persistent low level background is a consequence of galactic comic rays.

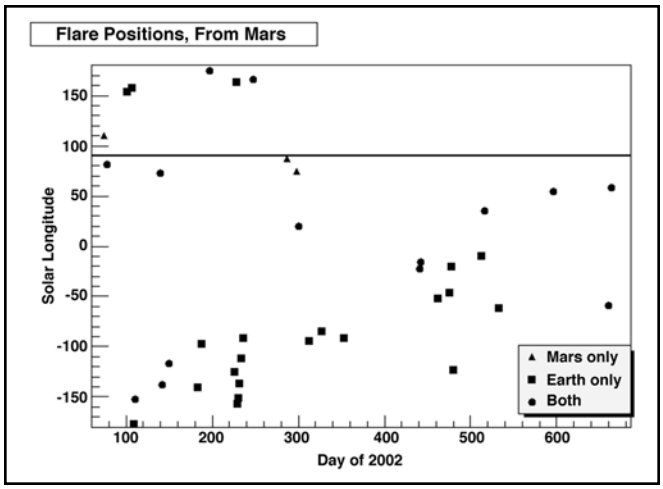

Figure 2. A plot of the solar longitude (as seen from Mars) from which SPE's originated as detected at Mars only (triangles), Earth only (squares), and both locations (circles). The straight line at longitude of +90 degrees indicates the nominal longitude of best magnetic connection for Mars, assuming a solar wind speed of 400 km/s. Note that the events detected at Earth but not at Mars originated from a range of longitudes 180 degrees opposed to the longitude of best connection for Mars (i.e., originated from longitudes centered around –90 degrees.)

ic field lines they see similar particle events, while if the are connected to significantly different sets of field lines the level of SPE particles can vary substantially. In fact, in the most extreme case where the field lines the two planets are connected to are separated by 180 degrees, there is essentially no correlation between the fluxes observed. Figure 2 illustrates this point; the SPE's observed at both Mars and Earth, as well as those that are observed at Mars only are clustered around the solar longitude of best connection for the Mars. On the other hand, those events observed only at Earth tend to originate in the quadrant diametrically opposed to the longitude of best connection for Mars.

The results of these analysis of the MARIE data are useful not only for the study of studying the physics of propagation of SPE particles in the inner heliosphere, but are also for the purpose of mission planning for future un-manned and manned Mars missions.

References

[1]E. N. Parker, "The Passage of Energetic Charged Particles through Interplanetary Space," *Planetary and Space Science* 13 (1965): 9-49.

Publications and Presentations

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