Evidence for Local Acceleration of CIR-Associated Suprathermal Particles at 1 AU

Corotating interaction regions (CIRs) form when a stream of fast solar wind overtakes a parcel of slow wind that was emitted from the Sun at an earlier time. This interaction creates a compression region that corotates with the Sun and can strengthen to form shocks that accelerate particles. CIRs are the primary producer of the tens of keV/n to several MeV/n particles measured at 1 AU during periods of low solar activity. The common interpretation is that these enhancements arise from the sunward propagation of particles accelerated at CIR-driven shocks between ~2 to 5 AU; these particles lose energy and are scattered as they travel inward against the outward flowing solar wind resulting in a turnover in their energy spectrum below ~0.5 MeV/n (e.g., Fisk & Lee, 1980). This interpretation has accounted for a number of CIR particle event features, including the large intensity gradients in the inner heliosphere and the exponentially decaying spectral profiles, the primary exception being the spectral profiles at 1 AU where the predicted turnover at lower energies is generally not seen (see Richardson 2004). This has led many to speculate that the lower energy, or suprathermal, CIR-associated particles at 1 AU are accelerated more locally.

We have investigated this topic by examining 1-hour averaged energetic particle observations from ACE/ULEIS and the SIT instruments on STEREO-A and STEREO-B during 73 CIR-associated suprathermal helium (He) intensity enhancements at 1 AU. A large number of these events had their ~0.2 MeV/n He time intensity profiles peak at or near the trailing edge of the CIR compression region, roughly two thirds of these profiles peaking within ~7 hours of this boundary. We identified a strong correlation between the ~0.2 MeV/n He peak intensities and magnetic compression ratios at the trailing edge within these events (Fig 1a), establishing the trailing edge as a possible site where CIR-associated particles can be accelerated to suprathermal energies near 1 AU. Events where the ~0.2 MeV/n He intensities peaked beyond the ~7 hour threshold showed a weaker correlation between these parameters. Our results also show an energy dependence for this relation, the correlation falling off at > 0.8 MeV/n (Fig 1b). This provides an upper limit for the particle energies that can be reached via local acceleration at 1 AU; the compressions at 1 AU do not appear to be strong enough to accelerate particles to energies above ~1 MeV/n. For additional details, see Ebert et al., ApJ, 749, 73, 2012.

Submitted by Robert W. Ebert, Maher A. Dayeh, and Mihir I. Desai of the Southwest Research Institute, and Glenn M. Mason of the Johns Hopkins University Applied Physics Laboratory. Please direct questions or comments to rebert@swri.edu.