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

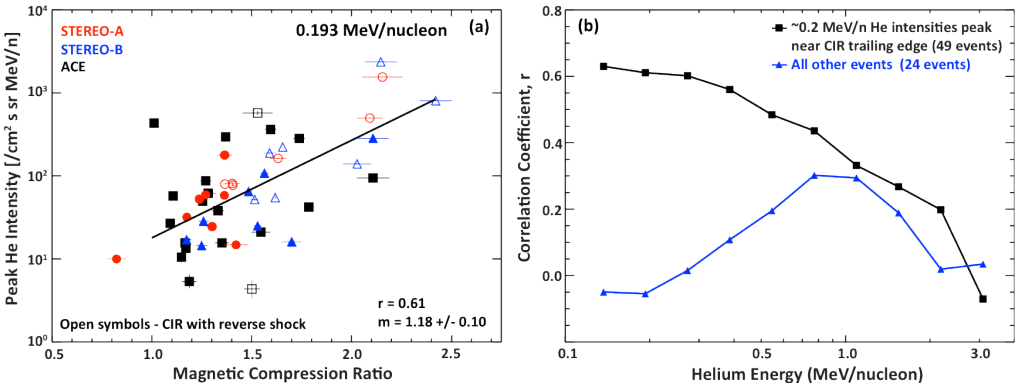

Fig 1: (a) ~0.2 MeV/n He peak intensity (J_{He}) vs magnetic compression ratio (M) in CIRs where the He time intensity profiles peak within ~7 hours of the trailing edge. Black curve: linear fit; m = slope; r = correlation coefficient. (b) Correlation between peak J_{He} and M vs. He energy. Black curve: CIRs where ~0.2 MeV/n He intensity peaks near trailing edge. Blue curve: all other events.

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.

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