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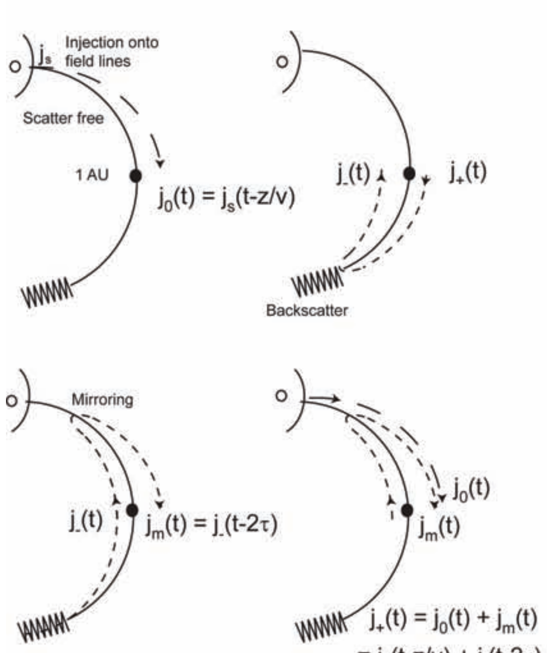
Solar Injection Histories of Near-Relativistic Solar Electrons



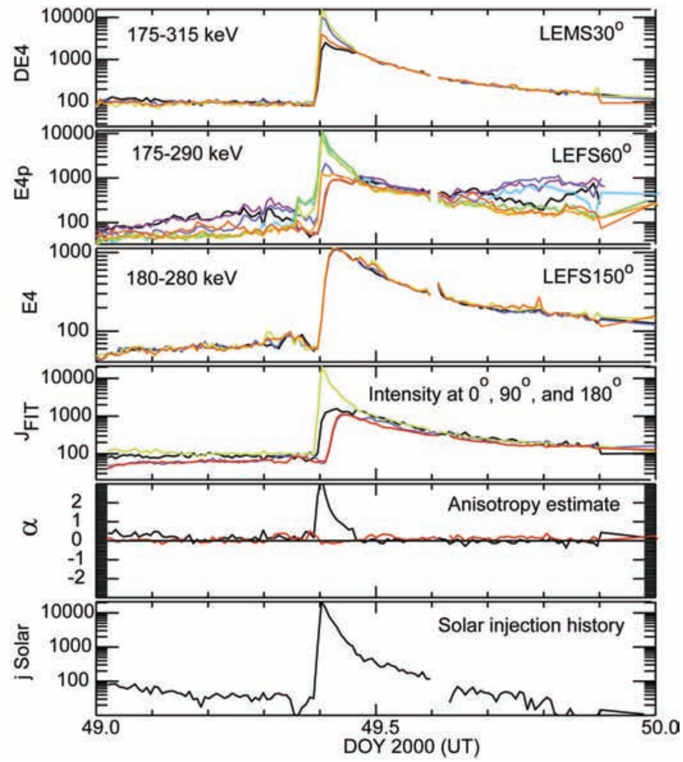


Fig. 1 (left): *Solar energetic particles observed near 1 AU (solid dot) contain both an injected and a mirrored component. The mirrored component has backscattered beyond 1 AU, mirrored inside 1 AU, and returned to 1 AU. The equation/algorithm (lower right) describes this process.* **Fig. 2 (right)** *shows an application of our algorithm to extract the actual solar injection history from a near-relativistic (175-300keV) electron event.*

The near-light speed and nearly scatter-free propagation out to 1 AU of 175-300 keV electrons preserves the essential details of their injection onto the interplanetary magnetic field. We have developed a quantitative method that uses the pitch-angle anisotropies to extract the electron injection history for near-relativistic beam-like solar electron events well past the rise-to-maximum phase. As sketched in Fig. 1, this is accomplished by subtracting from the outgoing electrons at 1AU (j_+) those that have already back-scattered from beyond 1AU, re-crossed 1AU (j_-) and finally returned to 1 AU (j_m). The difference between the outgoing intensity (j_-) and that of this mirrored component, delayed by its mirroring time 2τ inside 1AU, $j_m(t) = j_-(t-2\tau)$, gives the intensity $j_0(t) = j_s(t-z/v)$ of the “first-crossing” electrons that are still arriving directly from the Sun (j_s) after traveling a distance (z) along the field line at velocity (v). The implementation of the time-shifted algorithm (Fig. 2) starts from the spin-sectored intensities (different colors) in the three EPAM heads (top 3 panels). These sectored data are fit with exponential functions of pitch-angle $j_{FIT} = j_{norm}\exp(\alpha\mu)$ independently for both the outward ($\mu>0$) and inward ($\mu<0$) hemispheres. The best fit to the data (j_{FIT}) is shown in the fourth panel for three pitch angles (0°,90°,180°). Referring to the algorithm given in Fig. 1, we express the outgoing intensity $j_+=j_{FIT}(0^o)$ and the ingoing intensity $j_-=j_{FIT}(180^o)$ along the field line in terms of the “first-crossing” intensity (j_0) and the mirroring intensity (j_m). The simplicity of this algorithm yields the solar injection history (well past the intensity maximum) directly without recourse to models for acceleration/release or propagation. We are finding that it is not unusual for the injection history to last >1/2 day (bottom panel), implying that the acceleration/release process for near-relativistic electrons is extended much longer than the flash phase of solar flares.

This item was contributed by Dennis K Haggerty and Edmond C Roelof (JHUAPL). Questions and comments to Dennis.Haggerty@jhuapl.edu; Edmond.Roelof@jhuapl.edu. For an archive of earlier ACE News items see http://www.srl.caltech.edu/ACE/ACENews_Archives.html.