Temporal Evolution of Energetic Particles and Magnetic Field Waves Near CME-driven shocks

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Coronal Mass Ejection- or CME-driven interplanetary (IP) shocks are responsible for causing the so-called energetic storm particle (ESP) events observed at Earth. However, despite recent observational and theoretical advances, many important questions regarding such CME- associated particle events remain unanswered. This is because ESP events occur due to a confuence of numerous poorly understood physical effects all of whose contributions can vary with time and location. These effects include: the origin, structure, and obliquity of the shocks, the nature of wave-particle interactions and the type of turbulence that is present near the shocks, the distribution and composition of the seed populations, and the type of injection and accel- eration processes involved. In this paper, we combine observations of ↑ $\sim$0.1-0.5 MeV/nucleon
O and Fe ions with that of the magnetic field near four CME-driven IP shocks observed at the Advanced Composition Explorer spacecraft to differentiate between shocks where the seed population is most likely dominated by thermal solar wind ions and those events where it is dominated by pre-existing suprathermal ions. In particular, we use the temporal evolution of (1) O and Fe intensities, (2) power-law spectral indices of O, (3) the Fe/O and C/O ratios, and (4) the magnetic field power spectrum to identify unique signatures that provide strong clues regarding the origin of the seed population. Such observational signatures may also be useful in modeling the properties of the so-called large gradual solar energetic particle (SEP) events that are primarily accelerated by CME shocks near the Sun.