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High-energy Particle Acceleration at Coronal Shocks: the Effect of Large-scale Streamer-like Magnetic Field Structures

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Large gradual solar energetic particle (SEP) events are of particular importance because of their hazardous threats to astronauts and equipment in space. Although there are compelling observational evidence supporting the scenario of particle acceleration at strong shocks driven by coronal mass ejections, it is not clear how those high-energy particles are accelerated and what the determining factors are in producing extremely large events. Recent observations have shown that in extreme large SEP events the CME-shocks develop and accelerate particles at heights very close to the Sun (<3 solar radii). Motivated by this, we present an SEP acceleration study including the process that a strong shock propagates through a streamer-like magnetic field in the low corona region. Particle acceleration is modeled by numerically solving the Parker transport equation with both spatial diffusion along and across the magnetic field. We show that particles can be sufficiently accelerated to up to a few hundred MeV within a few solar radii. In the streamer-like field case, particles are more efficiently accelerated compared to the case with a simple radial magnetic field. This suggests that the coronal magnetic field configuration is an important factor for producing large SEP events. We also discuss the distribution of particles as they propagate in the shock region with changing magnetic field geometry at the shock front, which may offer predictions of energetic particles that Solar Probe Plus can test.

Primary authors: Dr GUO, Fan (Los Alamos National Laboratory); KONG, Xiangliang (Shandong University); GIACALONE, Joe (University of Arizona); LI, Hui (Los Alamos National Laboratory)

Presenter: Dr GUO, Fan (Los Alamos National Laboratory)

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