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Numerical simulation of particle acceleration in CME shocks

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Coronal Mass Ejection (CME) driven shocks are considered to be one of the potential sites to accelerate charged particles. In-situ measurements of CMEs have shown enhancement of particle flux with energies much larger than that of thermal solar wind particles. Nevertheless, understanding such particle energization computationally has been challenging due to the presence of two widely separated scales, where one needs to explore the particles' microphysics along with the macrophysics of the background fluid. In this work, we have examined the probable acceleration mechanisms of such energetic particles using the MHD-PIC approach which is designed to effectively handle the above mentioned scale separation. Our investigation includes simulations of CME-shocks with different Alfvenic Machs along with the variation of the upstream magnetic field's orientation. Particle energy spectrum with a power law slope,f(E)~$E^{-3/2}$, indicates the role of Diffusive Shock Acceleration in parallel shocks. On the other hand, the role of Shock Drift Acceleration is evident for particle energization in quasi-perpendicular shocks. High Mach shocks are found to be better particle accelerators than shocks with low Mach, thereby indicating the role of the shock's strength in the energization process. This work also highlights the presence of different instabilities induced by the escaping high energy particles from the shock front. A combined study of in-situ measurements with such numerical simulations can enrich our understanding of the particle acceleration process in CME-shocks.

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