Recent Findings on Electron Acceleration in Turbulent Reconnection

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Abstract

Magnetospheric Multiscale mission observations in the Earth's magnetotail have identified regions of strong turbulence associated with magnetic reconnection and particle acceleration. In these regions, ion and electron distributions display significant non-thermal tails indicating acceleration up to _˜100 times their initial thermal energies. We investigate electron energization in these turbulent regions using 3D test-particle simulations based on the measured electric and magnetic fields. We explore stochastic energization, Fermi reflection, betatron acceleration, and Speiser-like orbits. (1) We find that electron energization results primarily from electrostatic electric fields with frequencies above the ion cyclotron frequency. (2) Stochastic processes and turbulence-boosted Speiser-like orbits dominate energization and acceleration. (3) Fermi reflection contributes to low-energy electron energization. (4) Perpendicular electric fields deliver the majority (about 2/3) of the energization, but parallel electric fields make a significant contribution. (5) Interestingly, the electron distributions in the turbulence region and in exiting electrons display higher parallel energization; strong pitch angle scattering is seen. (6) Trapping in the low magnetic field surrounding the current sheet enhances acceleration by increasing dwell time in turbulence. These results reveal a complex energization process in which turbulence near a reconnecting current sheet plays a dual role; it directly energizes electrons and enhances Speiser drifts, which appears to produce the highest-energy electrons.

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