Particle Acceleration At Shock Waves and Downstream Small-Scale Flux Ropes

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An emerging paradigm for the dissipation of magnetic turbulence in the supersonic solar wind is via localized small-scale reconnection processes, essentially between quasi-2D interacting magnetic islands or flux ropes. Charged particles trapped in merging magnetic islands can be accelerated by the electric field generated by magnetic island merging and the contraction of magnetic islands. We discuss the basic physics of particle acceleration by single magnetic islands and describe how to incorporate these ideas in a distributed “sea of magnetic islands” by developing a transport formalism. We discuss particle acceleration in the supersonic solar wind and extend these ideas to particle acceleration at shock waves. Shock waves generate naturally vortical turbulence and particle acceleration at shocks is likely therefore to be a combination of classical diffusive shock acceleration and acceleration by downstream magnetic islands or flux ropes. These models are appropriate to the acceleration of both electrons and ions. We describe model predictions and supporting observations made at the heliospheric termination shock.