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Magnetic Dissipation in Force-Free Magnetic Fields — 3D PIC Simulation of a Sheet-Pinch Configuration

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Many astrophysical plasma environments are low β and nearly force-free, with the magnetic free energy stored in the twists of the field lines. Observations have strongly suggested that magnetic energy has been continuously released to heat and accelerate plasmas. We will present 2D and 3D Particle-in-Cell (PIC) simulation results of magnetic reconnection in a force-free plasma, which is modeled by a sheet pinch configuration. This configuration is unstable to the collisionless tearing instability. We will present the nonlinear evolution of this system. In 3D, there exist multiple resonant layers that are unstable to the collisionless tearing. Layer-layer interaction plays a dominant role in determining the overall magnetic dissipation process. We also show that the system evolves from an initially homogeneous state to a state populated with highly anisotropic structures, such as current and vorticity filaments. We will discuss the role of these intermittent regions in the overall magnetic energy dissipation process.