Momentum transport from current-driven reconnection

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It is observed in both astrophysical and laboratory settings that the toroidal angular momentum can be rapidly transported in the radial direction. In the toroidal configuration of the reversed field pinch (RFP), rapid momentum transport occurs during a reconnection event and transport is faster than can be explained by collisional viscosity. We calculate momentum transport from current-driven reconnection in an RFP with sheared flow, considering both the effect of a single tearing mode and multiple tearing modes. We present the analytic solutions for the Maxwell and Reynolds stresses from quasilinear theory and from computational solution of the exact equations in the linear regime. The stresses are also calculated for the full nonlinear evolution of a single tearing mode. Computations are performed using the resistive MHD code, DEBS, with an ad-hoc term added to the momentum equation to represent a source of plasma flow in the nonlinear state. We find that a single tearing mode transports momentum, via Maxwell and Reynolds stresses, more rapidly than classical viscous forces. We also compute the complete case of multiple, nonlinearly coupled tearing modes. Multiple mode computations show that the torques are strengthened and transport is enhanced by nonlinear coupling of multiple modes. The flow flattening arises from the total Lorentz force from tearing fluctuations and transport is faster than with viscosity only. Theoretical results are compared with measurements of momentum transport and Lorentz forces in the MST reversed field pinch experiment.

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