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Momentum transport during reconnection events in the MST reversed field pinch

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During reconnection events in the MST reversed field pinch momentum parallel to the magnetic field is observed to be suddenly transported from the core to the edge. This occurs simultaneous with a surge in multiple resistive tearing instabilities. From measurements of the plasma flow and the forces arising from tearing instability (Maxwell and Reynolds stresses) we have established that tearing instabilities induce strong momentum transport. Comparison with nonlinear MHD computation of tearing fluctuations supports this conclusion, although it also indicates that effects beyond single-fluid MHD are likely to be important. The radial profile of the parallel velocity is reconstructed from a combination of diagnostics: Rutherford scattering of injected neutral atoms (for majority ions), charge exchange recombination spectroscopy (for minority ions), and Mach probes (for edge majority ion flow). Maxwell stress has been measured previously in the core by laser Faraday rotation, and both stresses are measured in the edge with probes. A surprising observation is that both the Maxwell and Reynolds stresses are each ten times larger than needed to account for the observed momentum transport (i.e., larger than the inertial and viscous terms in the momentum balance equation). However, they are oppositely directed such that their difference is approximately equal to the rate of change of plasma momentum. The large magnitude of the individual stresses is not predicted by MHD theory; the Maxwell stress also produces a Hall dynamo effect, implying that a two-fluid theory might be necessary for a complete description of momentum transport. To test further the relation between momentum transport and tearing fluctuations, momentum transport was measured perturbatively, by altering plasma rotation with inserted biased electrodes. Biasing is applied in plasmas with large tearing activity and improved confinement plasmas in which tearing activity is reduced by inductive current profile control. We find that momentum transport in improved confinement (of energy and particles) plasmas is also reduced about five-fold. Work supported by U.S. DOE and NSF.