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EX/P3-17: Measurement and Simulation of Electron Thermal Transport in the MST Reversed-Field Pinch

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Comparison of measurements made in the MST Reversed-Field Pinch (RFP) to the results from extensive single-fluid nonlinear resistive MHD simulations provides two key observations. First, thermal diffusion from parallel streaming in a stochastic magnetic field is reduced by particle trapping in the magnetic mirror associated with the toroidal equilibrium. Second, the structure and evolution of long-wavelength temperature fluctuations measured in MST shows remarkable qualitative similarity to fluctuations appearing in a finite-pressure nonlinear MHD simulation. New high-time-resolution measurements of the evolution of the electron temperature profile [Te(r,t)] through a sawtooth event in high-current RFP discharges have been made using the recently enhanced capabilities of the multi-point, multi-pulse Thomson scattering diagnostic on MST. Thermal diffusion is calculated by performing a low resolution fit of the χe profile to the electron temperature data via the energy conservation equation, assuming Fourier's law qe = -ne χe ∇Te. These measurements are then compared directly to simulations using the nonlinear, single-fluid MHD code DEBS, run at parameters matching the RFP discharges in MST. These simulations display MHD activity and sawtooth behavior similar to that seen in MST. In a zero beta simulation, the measured χe is compared to the thermal diffusion due to parallel losses along diffusing magnetic field lines, vpar Dmag, where Dmag is determined from the simulation by tracing magnetic field lines. Agreement within uncertainties is only found if the reduction in thermal diffusion due to electron trapping is taken into account. In a second simulation, the pressure field was evolved self consistently assuming Ohmic heating and anisotropic thermal conduction. Although these pressure-evolved simulation results need further confirmation, the fluctuations in the simulated temperature are very similar in character and time evolution to temperature fluctuations measured in MST.

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