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Simulation of microtearing turbulence in NTSX and scaling with collisionality

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Thermal energy confinement times in NSTX dimensionless parameter scans increase with decreasing collisionality, $B_T\tau_E \sim \nu_*^{-0.95}$ [1]. While ion thermal transport is neoclassical, the source of anomalous electron thermal transport in these discharges remains unclear, leading to considerable uncertainty when extrapolating to future ST devices at much lower collisionality. Linear gyrokinetic simulations find microtearing modes to be unstable in high collisionality discharges. First non-linear gyrokinetic simulations of microtearing turbulence in NSTX have recently been reported [2], showing from first principles they can yield experimental levels of transport. Magnetic flutter is responsible for almost all the transport (∼98%), perturbed field line trajectories are globally stochastic, and a test particle stochastic transport model [3] agrees to within 25% of the simulated transport. Most significantly, microtearing transport is predicted to increase with electron collisionality, consistent with the observed NSTX confinement scaling. While this suggests microtearing modes may be the source of electron thermal transport, the predictions are also very sensitive to electron temperature gradient, indicating the scaling of the instability threshold is important. In addition, microtearing turbulence is susceptible to suppression via sheared E×B flows, as experimental values of E×B shear (comparable to the linear growth rates) dramatically reduce the transport below experimental values. This work is supported by US DOE contract DE-AC02-09CH11466.

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[3] W.M. Nevins et al., Phys. Rev. Lett. **106**, 065003 (2011); E. Wang et al., Phys. Plasmas **18**, 056111 (2011).