Progress in simulating turbulent electron thermal transport in NSTX TH-C

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Nonlinear simulations have progressed for multiple NSTX discharge scenarios to (i) validate with experimental turbulence and transport data, (ii) help differentiate unique instability mechanisms, and (iii) improve confidence in predictive modeling for future low aspect ratio fusion devices. First nonlinear gyrokinetic simulations of microtearing turbulence in a high-beta NSTX H-mode discharge predict experimental levels of transport that are dominated by magnetic flutter and increase with collisionality ($\chi_{e,sim}\sim\nu_e^{1.1}$). This dependence is roughly consistent with the normalized energy confinement times ($\Omega_i\tau_E\sim\nu_*^{-0.95}$) from dedicated collisionality (ν_*) scaling experiments, providing evidence for the importance of microtearing modes in high-beta NSTX plasmas. In lower beta H-mode plasmas from a second ν_* scaling experiment, microtearing modes are predicted to be stable. Instead, nonlinear simulations predict that ETG turbulence provides a significant fraction of the experimental transport, although the predicted transport is insensitive to variation in collisionality, apparently in contradiction to the experimental confinement scaling in these discharges ($\Omega_i\tau_E\sim\nu_*^{-0.8}$). ETG transport has also been predicted to be important in RF heated L-mode plasmas that exhibit electron internal transport barriers (e-ITBs) with strong negative magnetic shear ($s<-0.5$). Non-local simulations verify that outside the e-ITB the predicted ETG flux reaches experimental levels, but turbulence cannot propagate inward past the barrier. This suppression results from a nonlinear stabilizing effect related to the negative magnetic shear that occurs in the absence of strong E×B shear. The accumulation of small differences in many parameters (gradients, magnetic equilibrium, Z_{eff}) influences the microstability properties, and likely the confinement scalings of these discharges, to varying degree. For example, additional linear and nonlinear simulations predict that microtearing growth rates and transport increase with beta, s/q (for positive shear, s>0), and possibly even Z_{eff}. On the other hand, ETG turbulence is often weakly dependent or stabilized with beta, and tends to be stabilized by increasing s/q (for s>0) and Z_{eff}. Furthermore, both ETG and microtearing can be stabilized with sufficiently strong density gradient, while microtearing alone can be strongly suppressed with experimental levels of flow shear. In an effort to move towards predictive capability, first tests of the TGLF model for NSTX discharges have begun. While the reduced model can predict both ETG and tearing parity instabilities, detailed validation studies with gyrokinetic simulations are still in progress. This work is supported by US DOE contracts DE-AC02-09CH11466, DE-FG03-95ER54309, DE-AC52-07NA27344 and DE-AC05-00OR22725.