Transport Predictions for Density-Gradient-Dominated Regimes

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Tokamak energy confinement is often limited by turbulent transport due to temperature-gradient-driven instabilities; however, a low-recycling plasma boundary may support high edge temperatures, resulting in a flattened temperature profile and eliminating the drive mechanism for ITG and ETG turbulence. In this regime, modes driven by the density gradient may dominate the overall transport. To characterize transport in this regime, the dependence of particle and thermal fluxes as a function of density gradient with zero temperature gradient were examined, using the GYRO[1] code and parameters from the "Cyclone base case". The nonlinear scaling of flux with density gradient indicates a nonlinear upshift in the critical gradient as reported elsewhere[2]. In addition, a heat pinch is observed.

The GYRO code has been used to assess the performance predictions for the Lithium Tokamak Experiment (LTX), a spherical torus designed to investigate the low-recycling lithium wall regime.[3]

Linear simulations indicate that during active gas-puffing, both ITG and TEM modes are unstable. Charge-exchange losses with gas puff neutrals and weak electron-ion coupling suppress the edge T_i resulting in a steep ion temperature gradient and low T_i/T_e which drive the ITG mode.

The relatively small size of LTX ($a/\rho_s \sim$25–40) permits global nonlinear simulations of most of the plasma volume at reasonable computational cost, though it also complicates the simulations by making the role of the wall, sources, and sinks more important. Initial nonlinear simulations using predicted profiles during gas puffing failed to saturate indicating that the transport may be greater than expected. Saturation is achieved after relaxing the density and temperature profiles.

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[3] R. Majeski, *et al.* Nuclear Fusion **49** (2009), 055014.