Gyrokinetic Simulation Studies of Plasma Transport in NSTX Experiments

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Global gyrokinetic simulations have been carried out to investigate both turbulent and neoclassical transport properties for experiments in axisysmmetric devices. This study contributes several interesting footnotes to the observation that the ion transport is at neoclassical levels in the National Spherical Torus Experiment (NSTX). Nonlinear turbulence simulations using the shaped-GTC code [W.X. Wang, et al., Phys. Plasmas **13**, 092505 (2006)] show that ion temperature gradient (ITG) driven turbulence has significant fluctuation amplitude, but drives insignificant ion energy transport in NSTX. Ongoing investigations with GTC are focusing on high-k fluctuations associated with trapped-electron modes, and trapped electron effects on ITG turbulence in NSTX discharges. The GTC-Neo code [W.X. Wang, et al., Phys. Plasmas **13**, 082501 (2006)] is a particle-in-cell initial-value code for calculating neoclassical particle, momentum, and energy fluxes in tokamaks, as well as the radial electric field and other quantities. The calculation includes finite-orbit-width (banana width) effects, which make the fluxes intrinsically nonlocal, especially in the radial region closer to the magnetic axis. GTC-Neo simulation is applied to examine ion distribution functions and anisotropic properties of NSTX plasmas. Recent work has made the GEM (Gyrokinetic ElectroMagnetic) particle-in-cell simulation code [Y. Chen and S.E. Parker, J. Comput. Phys. **220**, 839 (2007)] usable with realistic experimentally-derived input data for tokamaks, obtained from TRANSP and NCLASS. The GEM code is now a radially-global code which includes trapped electrons, an impurity species and a hot beam species in addition to electrons and ions, electron collisions, A-parallel, equilibrium ExB velocities, and zonal flows. Work in currently under way on a particle-weight resetting scheme, and to add equilibrium parallel ion flows to the calculation. Preliminary results from the GEM code will be presented for NSTX cases.

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