TH-C

Global Gyrokinetic Simulation of Electron Temperature Gradient Turbulence and Transport in NSTX Plasmas

S. Ethier

Princeton Plasma Physics Laboratory, P. O. Box 451, Princeton, New Jersey 08543

ethier@pppl.gov

Global, nonlinear gyrokinetic simulations of electron temperature gradient (ETG) driven turbulence were carried out with the GTS code using actual experimental parameters of NSTX discharges. Our simulations reveal remarkable new features with regard to nonlinear spectral dynamics in 2D perpendicular wavenumber space. Specifically, there exists direct, strong energy coupling between high-k ETG modes and electron geodesic acoustic modes (e-GAMs with high frequency and poloidal mode number m = 1). At the same time, zonal flows are generated and continuously grow with a fine radial scale. This direct energy coupling may represent a new insight into the underlying mechanism for nonlinear ETG saturation. It also implies that the collisional damping of zonal flows and e-GAMs may have considerable impact on the formation of the steady state spectrum and saturation level. Further, the ETG fluctuation spectra are characterized by strong anisotropy with $k_r \ll k_\theta$. The $k_\perp$ spectrum of density fluctuations is in general agreement with the experimental measurement using coherent scattering of electromagnetic waves. Sensitivity studies of simulated ETG-driven electron thermal transport with respect to the local profiles of electron temperature, safety factor and effective charge number have been carried out, given that plasma profiles and parameters are subject to significant experimental errors. Within experimental uncertainties in plasma profiles, we conclude that ETG turbulence may drive experimentally relevant transport for electron heat in NSTX. ETG turbulence spreading and its effects are also identified in our global simulations. Finally, a newly developed synthetic diagnostic, which reproduces the experimental conditions of high-k scattering, is shown to yield frequency spectra for simulated fluctuations, which are in reasonable agreement with experimental observations.