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Electron gyro-scale fluctuations in NSTX plasmas[1]

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The mechanisms responsible for anomalous electron thermal transport are not well understood, but recent gyrokinetic simulations suggest electron temperature gradient (ETG) turbulence on the electron gyro-scale ($k_\perp \rho_e < 1$) may be culpable. The National Spherical Torus Experiment (NSTX) is well-suited to investigate the connection between ETG turbulence and electron thermal transport because the ETG mode is linearly unstable across large regions of NSTX plasmas and electron thermal transport is anomalous in all NSTX confinement regimes. In contrast, ion thermal transport is generally neoclassical in NSTX H-mode plasmas. To investigate the connection between ETG turbulence and electron thermal transport, a collective scattering system has been installed to measure electron gyro-scale density fluctuations with spatial and k-space localization. The system measures up to five distinct fluctuation wave-vectors with $k_\perp \rho_e < 0.6$ and $k_\perp < 20$ cm^{-1}, and measured wave-vectors are primarily radial. Measurements show rich turbulent dynamics on the electron gyro-scale in central and outer regions of NSTX plasmas. Both L-mode and H-mode discharges show enhanced fluctuations when the electron temperature gradient exceeds the ETG critical gradient, thus supporting the conjecture that ETG turbulence exists in NSTX plasmas. In H-mode discharges, fluctuations decrease at higher toroidal field values and when the equilibrium E$\times$B flow shear rate is comparable to GS2 linear growth rates. For a limited set of core measurements in H-mode plasmas, transport analysis with TRANSP shows electron thermal transport in the central region of the plasma decreases when fluctuations increase, thus suggesting the observed fluctuations have limited impact upon transport in this region in the discharges studied.

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