Simultaneous Measurement of Electron Temperature and Density Fluctuations in the Core of DIII-D Plasmas*

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Multi-field fluctuation measurements provide opportunities for rigorous comparison between experiment and nonlinear gyrokinetic turbulence simulations. A unique set of diagnostics on DIII-D allows for simultaneous study of local, long-wavelength ($0 < k_\theta \rho_s < 0.5$) electron temperature and density fluctuations in the core plasma ($0.4 < \rho < 0.8$). Previous experiments in L-mode indicate that normalized electron temperature fluctuation levels ($40 < f < 400$ kHz) increase with radius from ~0.4% at $\rho = 0.5$ to ~2% at $\rho = 0.8$, similar to simultaneously measured density fluctuations. Electron cyclotron heating (ECH) is used to increase T_e, which increases electron temperature fluctuation levels and electron heat transport in the experiments. In contrast, long wavelength density fluctuation levels change very little. The different responses are consistent with increased TEM drive relative to ITG-mode drive. A new capability at DIII-D is the measurement of phase angle between electron temperature and density fluctuations using coupled correlation electron cyclotron emission radiometer and reflectometer diagnostics. Linear and nonlinear GYRO runs have been used to design validation experiments that focus on measurements of the phase angle. GYRO shows that if T_e and ∇T_e increase 50% in a beam-heated L-mode plasma ($\rho = 0.5$), then the phase angle between electron temperature and density fluctuations decreases 30%-50% and electron temperature fluctuation levels increase a factor of two more than density fluctuations. Comparisons between these predictions and experimental results will be presented.

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