Correlation ECE Measurements in DIII-D

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Long wavelength, turbulent electron temperature fluctuations have been measured in the core plasma of the DIII-D tokamak using a correlation electron cyclotron emission (CECE) radiometer diagnostic. In L-mode plasmas with neutral beam heating (dominant ion temperature gradient (ITG) turbulence) the relative fluctuation level of long wavelength temperature fluctuations, $\tilde{T}_e/T_e$ measured with CECE increases with radius, 0.3% < $\tilde{T}_e/T_e$ < 1.5% over normalized radial range 0.5 < ρ < 0.8. The electron temperature fluctuations are similar in amplitude and spectrum to density fluctuations measured with a beam emission spectroscopy (BES) diagnostic. Power balance analysis of beam-heated (~2.5 MW, co-injected) L-mode plasmas shows that electron thermal and ion thermal transport increases during additional heating using electron cyclotron heating (ECH) (~2.5 MW). Interestingly, it is also observed that $\tilde{T}_e/T_e$ increases significantly during ECH but the level of long wavelength density fluctuations, $\tilde{n}/n$, measured simultaneously with a BES diagnostic, does not change. Linear and nonlinear modeling using gyrokinetic simulations shows that during ECH, Trapped electron mode (TEM) turbulence is expected to increase at long wavelengths in the wave-number range relevant for the CECE and BES diagnostics. After transitions from low-confinement (L-mode) to high-confinement (H-mode), the level of temperature fluctuations, $\tilde{T}_e/T_e$ ~ 1%, decreases to below the sensitivity limit of the diagnostic, $\tilde{T}_e/T_e$ < 0.3%. The reduction in fluctuation level accompanies the improvement of confinement in H-mode. These results indicate that long wavelength electron temperature fluctuations: (1) are similar in amplitude and spectrum to density fluctuations, (2) can be associated with both ITG and TEM turbulence, and (3) changes in the $\tilde{T}_e/T_e$ fluctuation levels correlate strongly with changes in electron thermal transport. This talk will review experimental results as well as quantitative comparisons of these measurements with nonlinear gyrokinetic turbulence simulations using the GYRO code.

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Review Talk