The Effect of Electron Cyclotron Heating on Density Fluctuations at Ion and Electron Scales in ITER Baseline Scenario Discharges on DIII-D

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Experiments on DIII-D simulating the ITER Baseline Scenario show that torque-free pure electron heating affects density fluctuations at electron scales on a sub-confinement time frame, whereas fluctuations at ion scales change only after profiles have evolved to a new stationary state. The plasma state is perturbed by switching off Electron Cyclotron Heating (ECH) with beam heating maintaining constant β_N, while the time evolution of density fluctuations is measured by the Phase Contrast Diagnostic (PCI). Within 20 ms after turning off ECH, the intensity of fluctuations is observed to increase at scales smaller than the ion gyroradius ($2\ cm^{-1} < k_R < 10\ cm^{-1}$); in contrast, larger scale fluctuations are seen to decrease in intensity on a longer time scale, after other equilibrium quantities have evolved. Non-linear gyro-kinetic simulations at electron gyroradius scales suggest that the PCI-measured increase in high-k fluctuations is due to electron modes enhanced by prompt changes to the electron temperature profile. Such modes generate an increased heat flux and an inward particle pinch. Modeling at ion scales indicates that the low-k response is consistent with the dominant ITG modes being weakened by the increased flow shear in the new stationary state. These results have important implications for turbulent transport in ITER which will be characterized by dominant electron heating as a result of alpha particles slowing down primarily on electrons.

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