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Search for the ITG Mode in DIII-D and Comparison with Theoretical Predictions[1]

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Detailed evaluation of a systematic density scan in Ohmic plasmas accompanied by comprehensive fluctuation measurements shows the appearance of a low frequency turbulence feature with Ion Temperature Gradient (ITG) mode characteristics at the onset of energy confinement saturation, in agreement with features of linear and nonlinear turbulence modeling. Because such theoretical modeling can provide physics-based guidance toward a viable fusion concept, and only sparse or indirect experimental evidence exists for the ITG mode [1], experimental verification of model details is critically needed. High performance plasmas are pgyrm accompanied by decreased microturbulence, interpreted theoretically as ExB suppression of ITG mode turbulence. This uncertainty motivated experiments in DIII-D in which the ITG mode was systematically destabilized through flattening the density profile by increasing the average density in neo-Alcator Ohmic discharges. A strong low frequency turbulence feature was observed in higher-density discharges at and above the onset of confinement saturation, and not observed in low density discharges. This feature was in a range of wavelength ($k_\perp \rho_s \sim$0.2-0.5) and frequency predicted for the ITG mode. Linear stability calculations of the most unstable drift ballooning mode using measured geometry and profiles showed the ITG mode to be much more unstable in the high density discharges and even non-existent in parts of the low density plasmas. Nonlinear gyrokinetic modeling concurs with these results, further showing the ITG mode to be nonlinearly saturated in high density discharges and completely stable in the low density discharges. In discharges below saturation, a broader frequency turbulence feature was observed, the features of which were consistent with a core trapped electron mode. [1] D.L. Brower, et al.

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