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Probing Plasma Turbulence by Modulating the Electron Temperature Gradient[1]

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Validating transport models is an essential step toward accurate predictive capability of plasma transport in tokamak plasmas. Experiments with a single key parameter varied and the turbulence response measured provide excellent data sets for model validation studies. One such experiment on DIII-D will be discussed where the electron temperature gradient was systematically varied and the turbulence response documented and compared with predictions from the gyrokinetic turbulence code GYRO. The temperature gradient scale length a/L_{Te} was varied at the plasma mid-radius by repetitively switching from ECH deposition just inside to just outside the mid-radius which modulated a/L_{Te} at essentially fixed T_e. Electron density fluctuations at wavenumbers $k_\theta = 5$–6 cm^{-1}, typically associated with TEM turbulence, were measured with a Doppler backscattering system (DBS) and were well correlated spatially and temporally with the variation produced in a/L_{Te}. The turbulence amplitude modulation was spatially localized, peaked between the two ECH deposition regions, and was consistent with expectations based on a/L_{Te} being a drive term for TEM turbulence. The DBS lab frame frequency was observed to increase when a/L_{Te} decreased. However, this is likely a result of variations in poloidal $E \times B$ motion rather than changes in the turbulence frequency. A direct comparison of GYRO predictions using a synthetic diagnostic module developed for DBS shows agreement within experimental uncertainties with measured turbulence amplitude variation but disagreement in spectral shape and considerable disagreement between predicted heat fluxes and power balance analysis. This is an area of ongoing investigation. Additional experiments at larger plasma radii were carried out where modulation of temperature fluctuations were also seen and will be discussed.

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