Response of Multi-scale Turbulence and Plasma Transport to Electron Cyclotron Heating in the DIII-D Tokamak*

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Anomalous electron thermal transport is an important and unresolved issue that directly impacts the understanding and prediction of fusion reactor performance. Furthermore, the interaction of low, intermediate, and high-k fluctuations and their impact on transport is a potentially complex system that calls for measurements over a broad wavenumber range. In order to directly address these questions, experiments on the DIII-D tokamak have employed both standard and new turbulence diagnostic sets that cover a large range in wavenumber space, applicable to ion temperature gradient, trapped electron mode, and electron temperature gradient type instabilities. In these experiments, small-scale density turbulence ($k_\perp \rho_i \sim$ 4-10) and electron thermal flux are both observed to increase during electron cyclotron heating (ECH) of a high temperature tokamak plasma ($k_\perp$ is the turbulent wavenumber and ρ_i the ion gyroradius). In contrast, large ($k_\perp \rho_i \geq 1$) and intermediate ($k_\perp \rho_i \sim$ 1-3) scale turbulence $\tilde{n}/n$ levels and ion thermal transport remain effectively constant. This implies that the small-scale turbulence is not a remnant or tail of the ubiquitous, large-scale or intermediate scale turbulence and also indicates a potentially important role in determining anomalous electron thermal transport. Radial scans of small-scale turbulence during ECH indicate decreased fluctuations in the deep core compared with increased levels towards the edge. This trend is consistent with linear gyrokinetic growth rate predictions for electron temperature gradient driven instabilities. The level of small-scale turbulence $\tilde{n}$ is found to positively correlate with local changes to the electron temperature gradient suggesting a potential drive mechanism. Initial comparisons to nonlinear GYRO simulations are underway

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