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Reduction of TEM/ETG-scale Density Fluctuations in the Core and Edge of H-mode DIII-D Plasmas[1]

L. SCHMITZ, UCLA

Improved confinement during H-mode has been linked to $E \times B$ shear suppression of large-scale ($k_\theta \rho_s \leq 0.3$) turbulence within an edge transport barrier. While larger scale eddies are preferentially suppressed by increased shear flow in this paradigm, the effects on smaller scale (TEM/ETG-scale) turbulence are less certain. Recent results from DIII-D provide the first experimental evidence that intermediate-scale turbulence ($1 < k_\theta \rho_s \leq 3$) together with larger-scale electron temperature fluctuations [1] are also reduced promptly at the L-H transition. These reductions are not confined to the edge region. Intermediate-scale density fluctuations obtained via Doppler backscattering, are significantly reduced (30%-50%) over a range of normalized radii ($0.5 \leq r/a \leq 0.85$) within a few ms of the L-H transition. A larger reduction ($\geq$75%) is observed at the top of the pedestal ($r/a \sim 0.9$) within 0.2 ms. In addition, low-k electron temperature fluctuations ($k_\theta \rho_s \leq 0.3$, from correlation ECE) are strongly reduced (>75%) at the L-H mode transition and during QH-mode ($r/a \sim 0.7$). Gyrokinetic simulation results [2] predict that $\tilde{T}_e$ fluctuations contribute significantly to L-mode electron heat transport, hence, the observed reduction is likely an important factor in the observed improved H-mode electron heat confinement ($\chi_e^{QH}/\chi_3^L < 0.25$). Doppler backscattering is also utilized to probe time-dependent shear flows (i.e. zonal flows). The results clearly indicate that zonal flow levels are anti-correlated with the amplitude of intermediate-scale density turbulence in L-mode, suggesting that zonal flows play an important role in turbulence/transport regulation.

[1] L. Schmitz et al., Phys. Rev. Lett. **100**, 035002 (2008).
[2] A.E. White et al., Phys. Plasmas **15**, 056116 (2008).

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