2D Properties of Core Turbulence on DIII-D and Comparison to Gyrokinetic Simulations

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Abstract. Quantitative 2D characteristics of localized density fluctuations are presented over the range $0.3 < r/a < 0.9$ in L-mode plasmas on DIII-D [J.L. Luxon, Nucl. Fusion **42**, 6114 (2002)]. Broadband density fluctuations increase in amplitude from $\tilde{n}/n < 0.5\%$ in the deep core to $\tilde{n}/n \sim 2.5\%$ near the outer region. The observed Doppler-shift due to the $\mathbf{E}\times\mathbf{B}$ velocity matches well with the measured turbulence group and phase velocities (in toroidally rotating neutral beam heated plasmas). Turbulence decorrelation rates are found to be ~200 kHz at the edge and to decrease toward the core ($0.45 < r/a < 0.9$) where they approach the $\mathbf{E}\times\mathbf{B}$ shearing rate (~50 kHz). Radial and poloidal correlation lengths are found to scale with the ion gyroradius and exhibit an asymmetric poloidally elongated eddy structure. The ensemble-averaged turbulent eddy structure changes its tilt with respect the radial-poloidal coordinates in the core, consistent with an $\mathbf{E}\times\mathbf{B}$ shear mechanism. The 2D spatial correlation and wavenumber spectra [$S(k_r, k_\theta)$] are presented and compared to nonlinear flux-tube GYRO simulations at two radii, $r/a = 0.5$ and $r/a = 0.75$, showing reasonable overall agreement, but the GYRO spectrum exhibits a peak at finite k_r for $r/a = 0.75$ that is not observed experimentally; $\mathbf{E}\times\mathbf{B}$ shear may cause this discrepancy.

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