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Experimental study of high-k turbulence during an energy confinement degradation phase in EAST ohmic plasmas

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Anomalous electron thermal transport is one of the crucial issues for the ultimate realization of fusion power using toroidal magnetic confinement devices. Previously published papers in theories, simulations and experiments show that high-k turbulence may play an important role in driving plasmas anomalous electron thermal transport. In this talk, we present a detailed experimental study of the behavior of high-k turbulence and its relationship with plasma energy confinement in EAST ohmic L-mode plasmas with $I_p = 0.4$ MA [1]. High-k turbulence with $k_\perp = 10, 18, 26\ cm^{-1}$ ($k_\perp \rho_s \leq 5.2$) from density fluctuation at $r/a \sim 0.5$ and high-k turbulence with $k_\perp = 8, 20\ cm^{-1}$ [$k_\perp \rho_s \leq 1.86$, see Fig. 1(a) and (b)] from density fluctuation at $r/a \sim 0.7 - 0.97$ were measured by tangential and poloidal collective scattering diagnostics, respectively. High-k turbulence power and energy confinement time τ_E are found to be temporally correlated to line-averaged electron density n_e in the plasma current flat-top phase [see Fig. 1(a) -(d)]. Statistical results of high-k turbulence power versus τ_E [see Fig. 1(e)] more clearly show that high-k turbulence is correlated to the degradation of plasma energy confinement in high line-averaged n_e condition, but high-k turbulence seems less important to the linear range τ_E in the lower-n_e condition as well as the transition between linear range τ_E and the energy confinement degradation the higher-n_e condition. Moreover, profiles of electron temperature T_e and n_e as well as their normalized gradients in a part of high-k density fluctuation measurement region have been used to qualitatively explain the enhancement of turbulence power in the energy confinement degradation phase. Linear gyro-kinetic simulations by the GS2 code also have been carried out to explain the high-k turbulence enhancement in the high-n_e condition.

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References

[1] P. J. Sun et al 2020 Nucl. Fusion **60** 046016

Figure 1

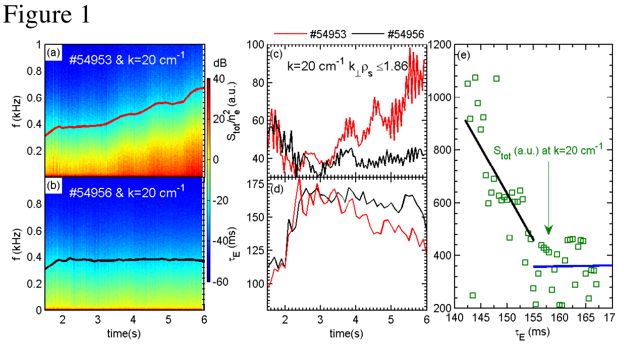

Fig. 1. Spectrograms of density fluctuation from (a) $k_\perp = 20\ cm^{-1}$ for #54953 and (b) $k_\perp = 20\ cm^{-1}$ for #54956. Note that the red solid line in (a) and the black line in (b) denote the line-averaged electron density (normalized by 4) for #54953 and #54956, respectively. The time evolution of the normalized $k_\perp = 20\ cm^{-1}$ density fluctuation power in (c) and energy confinement time τ_E in (d) for #54953 and #54956, respectively. (e) statistical results of τ_E versus $k_\perp = 20\ cm^{-1}$ density fluctuation power. Note that the solid black line and the solid blue line in (e) denote the linear fit statistical results for $\tau_E < 155$ ms and $\tau_E > 155$ ms, respectively.