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Study of Multi-Scale Turbulence in the Core of Electron-Heating-Dominant H-mode Plasmas on EAST

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Electron thermal transport is particularly important due to the dominance of electron heating by the fusion-born alpha particles in future magnetic confined burning plasmas [1-6]. H-mode is a high confinement regime which can fulfil the requirement of Q>1 plasma fusion scenarios in ITER and BEST. As important candidates to drive electron thermal transport, the study of TEM and ETG electron-mode turbulence as well as their transport features is necessary and important, especially in electron-heating-dominant H-mode plasmas. In this talk, core region multi-scale density fluctuation from low-k to high-k have been investigated in an electron-heating-dominant ELM-free H mode plasmas ($H_{98,y2}$~1) under the auxiliary heating of ECRH and NBI on EAST. Low-k density fluctuation with k< 5 cm^-1 ($k\rho_i \leq 2$) and high-k density fluctuation with k=10 ($k\rho_i \leq 4$), 20 cm^-1 ($k\rho_i \leq 8$) in the plasma core were measured by the EAST reflectometer diagnostic and CO2 laser collective scattering diagnostic, respectively. Transient suppression of density fluctuation has been found across the L-H transition phase. After that, obvious increase of density fluctuation power in all these wavenumbers (see Figure 1) is observed for more than 500 ms following with the plasma ELM-free phase. Gyrokinetic simulations have been carried out to analyze the dominant micro-instabilities in the turbulence measurement region for the ELM-free phase using the GS2 code. Both TEM and ETG modes are identified to be unstable for $\rho < 0.5$, which is consistent with the obvious power of low-k and high-k density fluctuation observed in experiment. Moreover, the critical temperature gradient $(R/L_{Te})_c$ for the onset of the ETG modes also has been calculated using the GS2 codes. The direct comparison of $(R/L_{Te})_c$ with experimental (R/L_{Te}) supports the observation of obvious high-k turbulence in experiment. Power balance analysis also has been performed by using the TRANSP code. Nonlinear simulations of TEM turbulence are ongoing with the gyrokinetic simulation code GTS.

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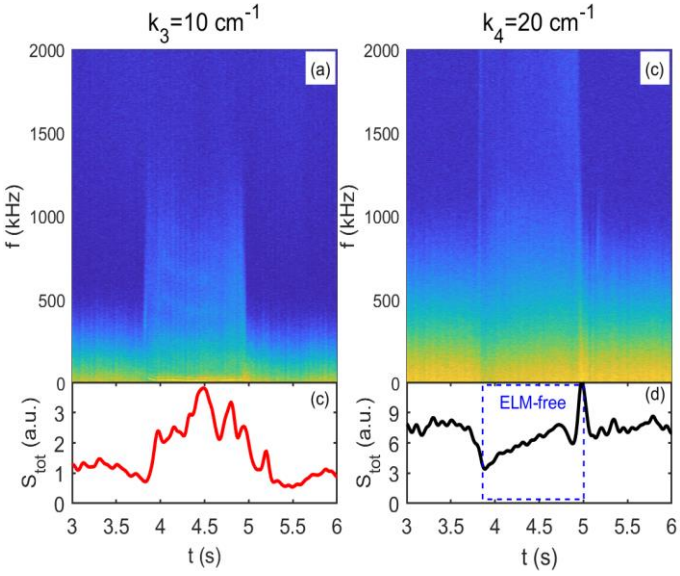

Figure 1. Frequency spectrum of (a) k=10 cm^{-1} and (b) k=20 cm^{-1} density fluctuation measured by CO2 laser collective scattering diagnostic. Turbulence power S_{tot} (i.e., frequency integrated spectral power) of (a) k=10 cm^{-1} and (b) k=20 cm^{-1} density fluctuation.