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Experimental and Numerical Study of the Enhancement of Ion-scale Turbulence during Neutral Beam Injection in the Core of an EAST L Mode Plasma

P. J. Sun[1], Y. Ren[2], W. X. Wang[2], X. F. Han[1], H. Q. Liu[1], Y. D. Li[1], H. S. Cai[3], G. S. Li[1], Y. F. Wang[1], B. L. Hao[1], M. F. Wu[1], Z. P. Luo[1], S. X. Wang[1], Y. Q. Chu[1], G. S. Xu[1], J. S. Hu[1], J. L. Chen[1], Y. T. Song[1] and the EAST team
[1]Institute of Plasma Physics, Chinese Academy of Sciences, [2]Princeton Plasma Physics Laboratory, [3]University of Science and Technology of China
e-mail (sunpj@ipp.ac.cn):

Anomalous thermal transport can limit the achievable density and temperature gradients and thus severely degrade energy confinement in the plasma core [1-7]. ITG, TEM and ETG turbulence have been considered to be possible candidates for the explanation of ion/electron thermal transport. Characterizing, understanding and thus controlling turbulence are very important to future fusion reactors, e.g., ITER. In this talk, we report an observation of ion-scale turbulence enhancement in the core of EAST L mode plasmas in responding to the stepping-up of neutral beam injection (NBI) power. Measured by an ordinary mode reflectometer at r/a≈0.25, core ion-scale turbulence at $k_\perp \leq 5$ cm^{-1} (i.e. $k_\perp \rho_s \leq 1.5$, where ρ_s is the ion gyroradius with sound speed using locally measured T_e, and $k_\perp$ is the perpendicular wavenumber) is found to increase in the frequency-integrated spectral power S_{tot} following a stepping-up of NBI power (see **Fig.1**). This positive correlation between turbulence spectral power and heating power and the time sequence of heating power stepping-up and turbulence enhancement strongly suggest the observed ion-scale turbulence is responsible for core plasma transports in these EAST L-mode plasmas, which is supported by the further power balance analysis from the TRANSP code. It is also found that the time scale of turbulence power increasing seems to positively correlate with the magnitude of NBI power stepping-up, e.g., turbulence saturation time being approximately equal to 20, 70 ms with Δ PNBI ≈ 0.5, 0.8 MW, respectively. Linear gyrokinetic stability analysis using the GS2 code shows that the most unstable ion-scale instability is ITG mode, its linear critical ion temperature gradient is close to but a little lower than that at t = 3.7 s, and the linear growth rate of ITG mode calculated with experimental profiles is higher with increased NBI power, indicating the ITG nature of the observed ion-scale turbulence. Nonlinear simulation results from the GTS code sees much higher turbulence and transport with the increase of NBI power in the inner core region around r~0.25, which is consistent with the enhancement of experimentally observed turbulence at high NBI power.

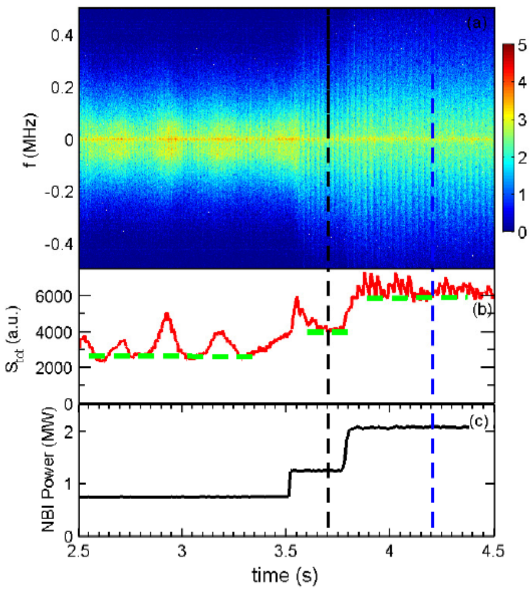

Figure 1. (a) Frequency spectrum of k < 5 cm−1 ion-scale density fluctuation measured by the microwave reflectometer diagnostic; (b) turbulence power Stot (i.e., frequency integrated spectral power) of density fluctuation in (a); (c) time waveform of the injected neutral power.

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