TURBULENCE AND TRANSPORT DEPENDENCE ON TEMPERATURE RATIO WITH TE/TI ~ 1-1.5, *In EAST H-mode plasmas*

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1. INTRODUCTION

It is essential to investigate how turbulence and transport changes with the temperature ratio variation within the range $T_e/T_i \geqslant 1$ expected for ITER. The nonlinear effects included by the multiple turbulence increase the difficulty to predict transport, while both TEM and ITG will unstable in ITER plasma, verifying the influence of the coexistence of TEM and ITG on transport under the condition that $T_e/T_i \geqslant 1$ is a key issue for transport in future devices like ITER[1].

A result different from previous investigation [2-5] that ITG regression with T_e/T_i increasing was achieved on EAST experiments. The simulation results and experimental results self-consistently presented the evolution of ITG and TEM with T_e/T_i change from 1.0 to 1.5. The transport code provided experimental evidence that the ion thermal transport is strongest when the ITG turbulence and TEM turbulence coexist, compared with the case that ITG dominate or TEM dominate. The combined effects of TEM and ITG is responsible for the enhanced ion heat transport in the experiments. This study broadens our comprehension of the dependence of ion heat transport on turbulence within the range $T_e/T_i \geqslant 1$.

2. MAIN RESULTS

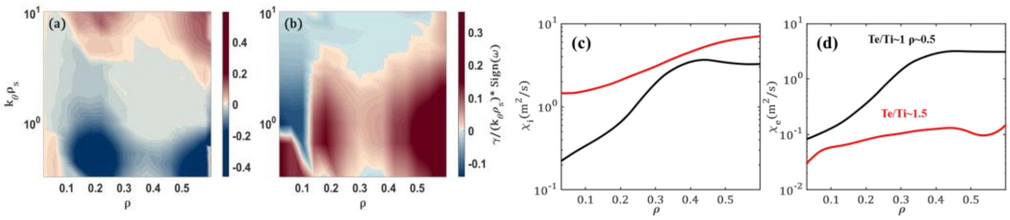

Figure 1. Linear instability analysis of (a) #143033 T_e/T_i ~1.0 at $\rho_{tor} = 0.5$, (b) #143033 T_e/T_i ~1.5 after ECRH in the central region by TGLF. The blue area, with negative real frequency ω, indicating drift wave propagation along the ion diamagnetic drift direction. γ is the growth rate, which is always positive. Radial profiles of the ion (c) and electron (d) heat diffusivity in#143033 in the central region $\rho_{tor} = 0.03$~0.6.

ECRH was used to modulate T_e/T_i in EAST H-mode plasmas, within the range T_e/T_i ~1-1.5 expected for ITER.

Simulation results: The ONETWO results suggest ion thermal diffusivity increase as T_e/T_i increase from 1.0 to 1.5 (Figure 1 (c)), and the dominate turbulence transfer from ITG to TEM as shown in figure 1 (a) and (b). There is mainly ETG mode ($k_\theta\rho_s$~10) and ITG mode ($k_\theta\rho_s$<1) when T_e/T_i ~1 in the central region (Figure 1 (a)), where ITG contributes to ion heat transport. After ECRH applied, TEM ($k_\theta\rho_s$~1) become unstable and coexist with ITG (figure 2(b) and (c)), included stronger ion heat transport and lower Ti (figure 2 (a)). Finally, the ITG become stable and TEM dominant in most of the central region (Figure 1 (b)).

Experimental results: As T_e/T_i increase, the reduction of ITG driven turbulence was confirmed by the density fluctuation measured with the poloidal correlation reflectometer (PCR), the enhanced TEM driven turbulence was confirmed by CO_2 laser collective Thomson scattering diagnostics (CTS), shown in figure 3. The experimental results are consistent with the simulation results. The strongest ion thermal transport occurs at the moment when the T_e/T_i ~1.3, corresponding to the coexistence of TEM turbulence and ITG turbulence.

3. CONCLUSIONS AND PLAN

This work presents the evolution of turbulence and transport with T_e/T_i shift from 1 to 1.5, which is helpful for the understanding of the transport characteristics in future devices. Future plans include conducting simulation studies on the synergistic effects of TEM turbulence and ITG turbulence on transport, and the interaction between the two will be studied.

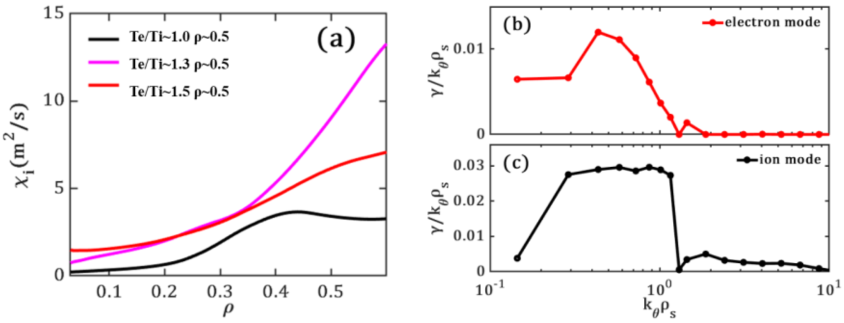

Figure 2.(a) ion heat diffusivity, and normalized linear growth rate spectrum of electron mode (b) and ion mode (c) when $T_e/T_i \sim 1.3$ shows the coexistence of TEM and ITG at $\rho_{tor} = 0.5$.

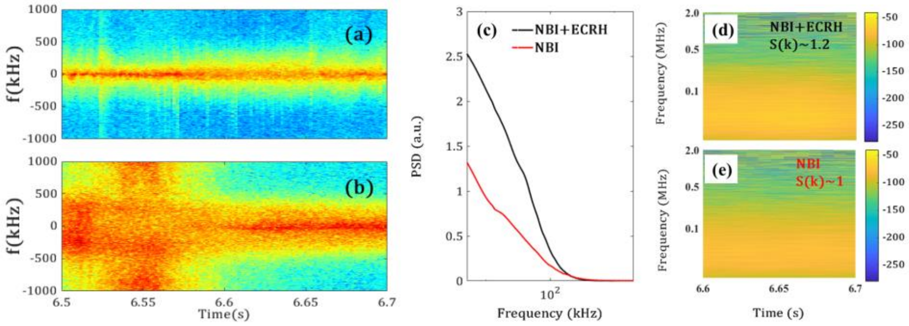

Figure 3. Time evolution of density fluctuation spectrum (a-b) measured by Refl. X-mode @Wp2 91.8GHz with $k_\theta \rho_s < 1$, (c-e) measured by CTS with $1.5 < k_\theta \rho_s < 2.0$. The $T_e/T_i \sim 1.5$ for (a) and (d), $T_e/T_i \sim 1.0$ for (b) and (e).

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