Validation Study Using KSTAR Plasmas

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Since future fusion plasmas will be very different from fusion plasmas in the present experiments, the first principle transport model should be developed to predict the confinement performance of future fusion device in the design process. It is known that turbulent transport is one of main cross-field transport mechanisms in magnetic fusion plasmas and gyrokinetic model has been considered as a main tool can be used to describe the turbulent transport phenomena. The gyrokinetic validation study also has been conducted extensively to understand turbulent transport and finally to achieve first principle transport model [1].

KSTAR [2] is a good testbed for the gyrokinetic validation study since KSTAR has the great suite of fluctuation diagnostics, which is required for rigorous validation study. In this presentation, we will show the gyrokinetic validation study results using a beam heated ELMing H-mode plasma in KSTAR, for the first time.

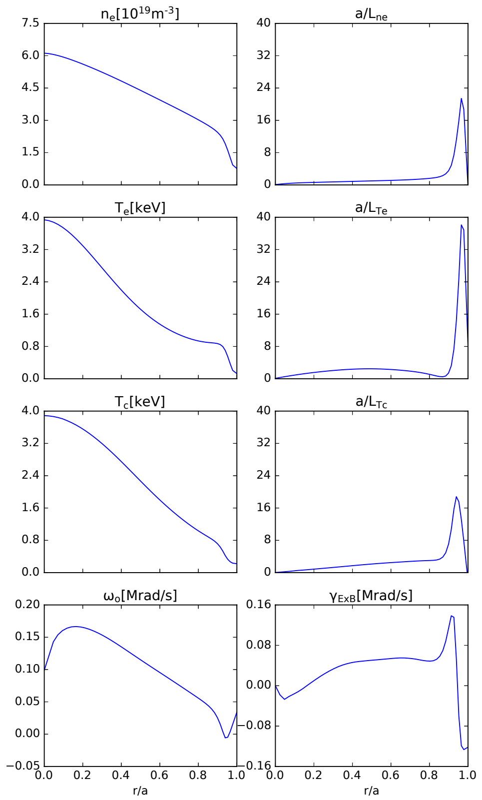

Fig. 1 Profile analysis results of KSTAR H-mode discharge (shot 25690, time=5720ms). Right three figures show inverse gradient scale length of quantity normalized by minor radius, a (a/Lx). ω_o **and** $\gamma_{E\times B}$ **denote rotation frequency and ExB shearing rate, respectively. Their definition can be found in [3]**

In this validation study, the CGYRO code [4] is used for gyrokinetic analysis. Simulated heat flux levels calculated from CGYRO code will be compared with experimental heat flux levels estimated from power balance analysis using TRANSP [5]. We first selected one H-mode discharge appropriate for gyrokinetic validation study, which has very weak MHD activities to avoid additional transport driven by MHD modes. Then, profile analysis and power balance analysis coupled with kinetic equilibrium analysis were performed. Figure 1 shows the results of profile analysis. At this point, we have assumed the flat Z_{eff} profile with Z_{eff}=2.0 for carbon density profile. Total plasma energy estimated from TRANSP run with Z_{eff}=2.0 matches well with the total plasma energy level from equilibrium analysis, suggesting that average Z_{eff} in this discharge is close to 2. However, impurity and main ion density gradients can affect gyrokinetic analysis results significantly. We will explore this possibility using visible bremsstrahlung measurements in the future. Figure 2 shows the linear analysis results at r/a=0.5. In this analysis, we can see that the real frequency of most unstable modes is in the ion diamagnetic direction, which is negative here.

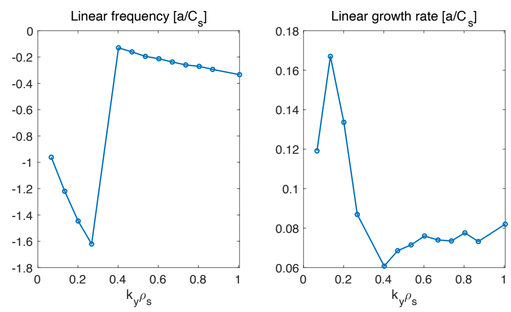

Fig. 2 Linear analysis results at r/a=0.5

In this presentation, we will show linear and nonlinear gyrokinetic analysis results in this KSTAR H-mode discharge and compare the simulated heat transport level with experiment. We will also discuss fast ion effects in this discharge using gyrokinetic analysis.

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