6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Simulations of scrape-off layer power width for EAST H-mode plasma and ITER 15 MA baseline scenario by 2D electrostatic turbulence code

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A recent published work will be presented in this report [1]. It is well known that the scrape-off layer power width (λ_q) is an important parameter for characterizing the divertor heat loads. Many experimental, theoretical, and numerical studies [2-6] on λ_q have been performed in recent years. In this report, a 2D electrostatic turbulence code, BOUT-HESEL, has been upgraded to simulate H-mode plasmas for the first time. The code is validated against the previous implementation and the experimental λ_q scalings for L-mode plasmas and experiments with a typical EAST H-mode discharge. The simulated λ_q is found to agree quite well with the Eich scaling [2] for the EAST H-mode discharge (see figure 1) and the comparison of the probability distribution function of the parallel particle flux with the measurements by reciprocating probes is also consistent. The code is utilized to simulate the ITER 15 MA baseline scenario [7]. The ITER simulation reveals that the radial particle/heat transports are dominated by blobby transports (see figure 2), and predicts $\lambda_{q,ITER}$ = 9.6 mm, which is much larger than the prediction by the Eich scaling ($\lambda_{q,ITER} \approx 1$ mm). Based on the EAST modified cases, an estimated HESEL H-mode scaling, $\lambda_q = 0.51 R_c^{1.1} B_t^{-0.3} q_{95}^{1.1}$ is proposed. This scaling predicts $\lambda_{q,ITER}$ = 9.3 mm, which agrees surprisingly well with that for the ITER case. A further investigation combined with the basic parameters in the database of the Eich scaling shows that the missing positive scaling dependence on the machine size (R_c) in the Eich scaling appears to be shaded by the negative scaling dependence on the toroidal magnetic field (B_t) for current devices. This is however not the case for ITER, explaining why simulations in recent studies and this paper can reproduce the Eich scaling for current devices, but predict a much larger λ_q for ITER. According to the simulation results, the strong positive scaling dependence of λ_q on R_c is due to a combination of slowing down the parallel heat transports by increasing the parallel connection length and the enhancement of the radial E × B turbulent heat transports when the machine size is increased.

References

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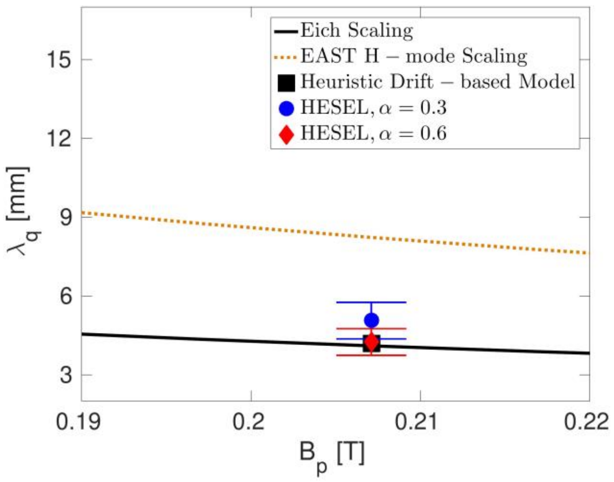

Figure 1 Comparisons of the simulated λ_q with the experimental scalings and the heuristic drift-based model.

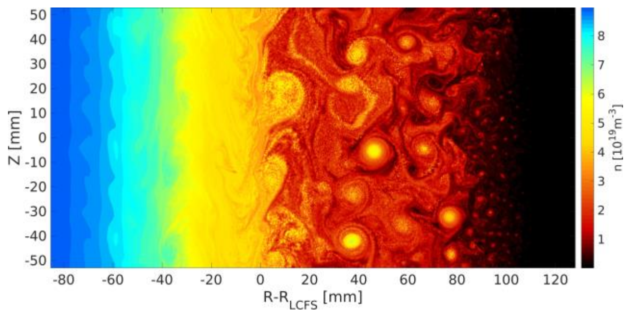

Figure 2 A snapshot of the density in the saturated phase for the simulation of the ITER 15 MA baseline scenario