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Simulations on the particle and heat fluxes for the RF heating H-mode on EAST

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In order to understand and control the heat flux issue for the future tokamaks, the particle and heat fluxes of the EAST RF heating H-mode have been simulated by the 6-field 2-fluid model in BOUT++ framework [1]. The simulated particle fluxes induced by the edge coherent turbulence on the outer divertor targets are comparable with the measurements of the width and peak amplitudes by the divertor probes. Based on this simulation, the EAST ELMy H-mode discharges with different plasma current Ip and geometries are applied to study the scaling law of SOL width. The Eich's Scaling is well reproduced by the simulations [2]. However, the simulated SOL width is only half of the EAST measurements, because there is no RF heating scheme in the simulations, which is effective to change the boundary topology and increases the flux expansion [3]. In order to prove the topology change effects of LHW in SOL region, a modeled helical current filament (HCF) in SOL, which has the same amplitude to the experiments, is added as the force-free form into the 6-field 2-fluid module. The RF sheath boundary condition is also considered in the self-consistent calculation of the radial electric field. The radial magnetic field induced by this HCF could be much smaller than the perturbed field, but it is able to force the perturbations with the same toroidal mode number to grow up at the start of the linear phase. This forced mode is effective to compete with the spontaneous fluctuations and change the linear properties, which leads to the obvious suppression of the divertor heat flux and the broadening of SOL width. The preliminary results shows that the HCF is able to increase the SOL width by ~25%, and the peak parallel heat flux towards divertor target is decreased by 32%. The broadening of the particle flux by HCF clearly shows the secondary striate filaments on divertor target, which is similar to the splitting of the strike point found by the divertor probes.

[1] T.Y. Xia & X.Q. Xu, Nucl. Fusion 55 (2015) 113030
[2] T.Y. Xia et al., Nucl. Fusion 57 (2017) 116016
[3] Y.F. Liang et al., PRL 110, (2013) 235002.

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Primary author: Mr XIA, Tianyang (Institute of Plasma Physics, Chinese Academy of Sciences)

Co-authors: Dr GUI, Bin (ASIPP); Mr WU, Y.B. (Donghua University); Mr HUANG, Y.Q. (ASIPP)

Presenter: Mr XIA, Tianyang (Institute of Plasma Physics, Chinese Academy of Sciences)

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