Three-dimensional simulations of edge plasma transport with LHW-induced magnetic perturbations on EAST

S. Xu[1,2], M. Rack[1], Y. Liang[1,2], J. Huang[1], M. Jia[1,2], Y. Feng[3], J. Cosfeld[1], H. Zhang[2], S. Liu[2], Y. Gao[1], K. Gan[2], W. Feng[2], L. Wang[2], W. Zholobenko[1], D. Reiter[1]

[1] *Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung-Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany*

[2] *Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031, People's Republic of China*

[3] *Max-Planck-Institute für Plasmaphysik, 17491 Greifswald / 85748 Garching, Germany*

Recent experiments from the Experimental Advanced Superconducting Tokamak (EAST) show that lower hybrid waves (LHWs) can profoundly change the magnetic topology by inducing helical current filaments flowing along magnetic field lines in the scrape-off layer [1, 2]. The spectrum of LHW-induced perturbation fields automatically adjusts to the edge-safety-factor, because the helicity of current filaments closely fits the pitch of the edge field line. It has been proved in the experiments that such flexible magnetic perturbations have powerful abilities in controlling heat load on divertor targets, controlling impurities, as well as mitigating Edge-Localized Modes (ELMs). However, the underlying physical mechanisms are still unclear. To better understand the physics behind, here it is investigated how these magnetic perturbations caused by LHWs affect the edge plasma transport utilizing the 3D Monte Carlo code EMC3-EIRENE. The 3D magnetic topology structure is reflected in the plasma properties, due to much stronger parallel field transport compared with cross field diffusion. Good quantitative agreements between simulations and experiments demonstrate that the EMC3-EIRENE code now is capable of taking into account the LHW-induced magnetic perturbation fields with both physical and geometrical effects being considered. The larger current of filaments caused by the increased LHWs input power can further deepen the penetration depth of the additional transport channel by extending the stochastic edge layer, and influence the ratio of heat (or particle) flux between split striated and original strike line on divertor targets. The 3D simulation results also indicate that the additional plasma transport channel induced by LHWs can significantly cause the redistribution of heat load between inner and outer divertor targets, which could not be found by the field line tracing method in previous works [3, 4].

References

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