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Simulation study of the grassy ELM cycles within Edge Plasma Coupling Simulation framework

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The tokamak divertor is subjected to huge heat load, including both the transient heat load due to the edge localized modes (ELMs) and steady-state heat load in between ELMs. Exploring the edge plasma solution compatible with the high-performance plasma is one of the key issues to achieve high-performance steady-state operation of magnetically-confined fusion reactors in the future.
Numerical simulations are indispensable for both understanding the edge plasma physics and predicting the edge plasma behavior. However, the cross-field transport coefficients adopted in the transport codes such as SOLPS-ITER, UEDGE, EDGE2D-EIRENE and SOLEDGE2D-EIRENE are usually given empirically or by fitting experiments. On the other hand, although the turbulent cross-field transport of the edge plasma can be simulated by lots of turbulence codes such as BOUT++ and JOREK, it is hard to achieve a self-consistent simulation of the edge plasma transport due to the large gap between the turbulence and transport time scales. One possible way to realize a self-consistent edge plasma simulation is the coupling simulation by the transport and turbulence codes [1, 2].
In our recent work [3], a simulation framework called EPCS (Edge Plasma Coupling Simulation) is developed for the purpose to implement the self-consistent turbulence-transport coupling simulation of the edge plasma automatically and efficiently. Based on a steady-state coupling simulation workflow, the edge plasma is simulated by iterations of turbulence code BOUT++ [4] and transport code SOLPS-ITER [5], and the converged plasma profiles are consistent with EAST experiments (edge-localized-mode-free stage) at both upstream and divertor target.
Grassy ELM regime is considered as a possible edge plasma solution due to the desirable features including significant reduction of transient divertor heat fluxes and quasi-continuous particle and power exhaust [6]. To investigate the formation mechanisms of the grassy ELMs, a time-dependent coupling simulation workflow is developed and the grassy ELM cycles are simulated within EPCS. The simulated ELM cycles show a counter-clockwise trajectory in the peeling-ballooning diagram with an ELM frequency ~2 kHz, which is consistent with EAST experiment. According to the simulation result, the particle transport is strong at the pedestal foot rather than the region with steep pressure gradient, which can be explained by the influence on the profile of radial electric field shear due to the scrape-off layer plasma.

Reference

[1] T. D. Rognlien, et al., Contrib. Plasma Phys. 44 (2004) 188–193.
[2] D. R. Zhang et al., Nucl. Fusion 60 (2020) 106015.
[3] T. Y. Liu et al., Plasma Phys. Control. Fusion 67 (2025) 055004.
[4] X. Q. Xu et al., Phys. Plasmas 7 (2000) 1951–1958.
[5] S. Wiesen et al., J. Nucl. Mater. 463 (2015) 480–484.
[6] G. S. Xu et al., Phys. Rev. Lett. 122 (2019) 255001.

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