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TH/P4-28: Self-consistent Kinetic Simulation of RMP-driven Transport: Collisionality and Rotation Effects on RMP Penetration and Transport

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Control of the edge localized modes (ELMs) is one of the most critical issues for a more successful operation of ITER and the future tokamak fusion reactors. This paper reports ITER relevant simulation results from the XGC0 drift-kinetic code, with respect to the collisionality, plasma density, and rotation dependence of the RMP penetration and the RMP-driven transport in diverted DIII-D geometry with neutral recycling. The simulation results are consistent with the experimental results, and contribute to the physics understanding needed for more confident extrapoloation of the present RMP experiments to ITER. It is found that plasma-responded stochasticity becomes weaker as the collisionality gets higher and RMP-driven transport (i.e., density pump-out) is much weaker in the high collisionality case compared with that in the low collisionality one, which is consistent with the recent experimental results on DIII-D and ASDEX-U tokamaks. As for rotation effect, low rotation is found not to affect the stochasticity much in the edge region, while high rotation significantly suppresses the RMPs in the core. The clear difference in RMP behavior between the low and high collisionality regimes can be understood by examining the perturbed current Fourier amplitude profiles within the range of resonant poloidal mode numbers (m=8-15,n=3). It can be seen that primary shielding currents are strongly concentrated around the steep pedestal region just inside the separatrix, which naturally produces very strong suppression of RMPs there, in low collisionality case. However, in high collisionality case, primary shielding currents are very weak and accumulating toward inner radii leading to the shielding of RMPs further into the plasma. Our kinetic simulation method is also applied to the modeling of RMP ELM control experiments on KSTAR tokamak and the results will be presented together.

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