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Kinetic Understanding of RMP Penetration and Pedestal Transport in Diverted Tokamak Geometry[1]

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A new understanding of self-organized RMP penetration effects on the pedestal plasma response has emerged from the XGC0 particle code with the inclusion of Monte Carlo neutrals and heat/torque sources. XGC0 provides a self-consistent evolution of RMP fields, E_r, plasma profiles, and toroidal current perturbation, which are essential in the RMP self-organization. Results are validated against DIII-D pedestal experiments, including n, T, E_r, U_i, and $U_{e\perp}$ profiles. The coil-induced magnetic islands and stochasticity are substantially reduced in the outer part ("skin-depth layer") of the pre-RMP pedestal. However, islands and stochasticity survive at the inner part of the pre-RMP pedestal and into the core. As a result, RMPs enhance electron heat transport Q_e in the inner part of the pre-RMP pedestal and into the core, but preserve the Q_e barrier at the outer pre-RMP pedestal, as seen in DIII-D. Particle transport is enhanced in both regions, albeit less in the skin-depth layer. Q_e enhancement in the stochastic region is not as catastrophic as that predicted by Rechester-Rosenbluth, since the trapped electrons have limited contribution to parallel heat conduction. Experiments in DIII-D show the existence of a finite ELM suppression q-window. XGC0 finds that the stochasticity suppression by plasma response is noticeably weaker inside the window. Q_e is thus sensitive to the q- window, but density pump-out is not, well matching experiment. This suggests that the "vacuum Chirikov>1 in the whole edge" is only a necessary condition for the plasma to be in the ELM suppression window.

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