

Roles of RMP-induced Changes of Radial Electric Fields in ELM Suppression

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Resonant magnetic perturbations (RMPs) can be used to mitigate or fully suppress the harmful Edge Localized Modes (ELMs). In DIII-D, the ELM suppression is observed to be correlated with the enhanced particle and heat transport near the pedestal top. Initial simulations using Gyrokinetic Toroidal Code (GTC) show that the kink responses to the 3D RMP have little effect on the growth rate of electromagnetic kinetic-ballooning mode and on the turbulent transport and zonal flow damping in electrostatic turbulence [Holod, *et. al.*, *Nuclear Fusion* 57, 016005 (2017)]. On the other hand, fast RMP modulation experiments in DIII-D tokamak show that the turbulent poloidal velocity changes in phase with the modulated RMP current, suggesting that the RMP may modify the local radial electric field E_r .

Here we report from GTC simulations that reduced $E_r \times B$ shearing rate due to the RMP leads to the much stronger driftwave instability in the outer edge and outward turbulence spreading, resulting in a larger turbulent transport on the pedestal top in the DIII-D experiments. Simulation results are consistent with experimental observations of increased turbulence and transport near the pedestal top during RMP-induced ELM suppression. Furthermore, GTC simulations of neoclassical transport show that the electron flutter motion due to the RMP islands introduces a radial particle flux that is not strong enough to directly provide the measured enhancement in the transport, but may contribute to the observed change in the radial electric field. Finally, electrostatic turbulence simulations with adiabatic electrons show no significant increase of the saturated ion heat conductivity in the presence of RMP-induced islands. However, electron response to zonal flow in the presence of magnetic islands and stochastic fields can drastically increase zonal flow dielectric constant for long wavelength fluctuations. Zonal flow generation can then be reduced and the microturbulence can be enhanced greatly.

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