Plasma Rotation and Radial Electric Field Response to Resonant Magnetic Perturbations in DIII-D*

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Analysis of DIII-D experiments have revealed a complex picture of the evolution of the toroidal rotation v_tor and radial electric field Er when applying edge resonant magnetic perturbations (RMPs) in H-mode plasmas. Measurements indicate that RMPs induce changes to the plasma rotation and Er across the plasma profile, well into the plasma core where islands or stochasticity are not expected. In the pedestal, the change in Er comes primarily from the vxB changes even though the ion diamagnetic contribution to Er is larger. This allows the RMP to change Er faster than the transport timescale for altering the pressure gradient. For n=3 RMPs, the pedestal v_tor goes to zero as fast as the RMP current rises, suggesting increased toroidal viscosity with the RMP, followed by a slow rise in co-plasma current v_tor (pedestal "spin-up") as the pedestal density pumps out. This spin-up could result from a reduction in ELM-induced momentum transport or a resonant jxB torque due to radial current. As v_tor becomes more positive and the pressure pedestal narrows, the electron perpendicular rotation ~0 point moves out toward the top of the pedestal; increasing the RMP current moves this crossing point closer to the top of the pedestal. These changes reduce the mean ExB shearing rate across the outer half of the discharge from several times the linear growth rate for intermediate-scale turbulence to less than the linear growth rate, consistent with increased turbulent transport. Full-f kinetic simulations with self-consistent plasma response and Er using the XGC0 code have qualitatively reproduced the observed profile and Er changes. These results suggest that similar to their role in regulating H-mode plasma transport and stability, plasma rotation and Er play a critical role in the effect of RMPs on plasma performance.

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