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Effect of resonant magnetic perturbations on turbulence-flow dynamics at the L-H transition on DIII-D[1]

MATT KRIETE, University of Wisconsin-Madison

Applied n=3 resonant magnetic perturbations (RMPs) reduce the Reynolds stress drive for mean shear flow in the edge of L-mode plasmas, likely contributing to the RMP-induced increase in L-H power threshold. This L-H power threshold increase is a concern for ITER since RMPs must be applied before the L-H transition to ensure ELM suppression. To understand the cause of this effect, density and turbulence velocity fluctuations spanning ρ=0.85–1.05 are measured by the beam emission spectroscopy (BES) and Doppler backscattering (DBS) diagnostics in ITER-shaped, low-rotation, lower single null (favorable ∇B direction) DIII-D plasmas. Density fluctuation amplitudes measured by BES in the L-mode edge region, ρ=0.93–1.00, are amplified by 20% by RMPs. In contrast, non-resonant magnetic perturbations, which raise the L-H power threshold only slightly, reduce density fluctuation amplitudes by 10%. RMPs reduce the L-mode E_r well depth, correspondingly reducing velocity shear, and raise the turbulence decorrelation rate. Thus, suppression of turbulence by shear flow, parametrized as $\omega_{Shear}/\omega_{Decorr}$, is significantly diminished by RMPs. In addition, radial and poloidal velocity fluctuation amplitudes, estimated by velocimetry analysis of 2D BES data, are reduced by RMPs, leading to a reduction of inferred Reynolds stress $\langle \widetilde{v}_r \widetilde{v}_\theta \rangle$. A simple poloidal flow calculation including terms for Reynolds stress drive and neoclassical damping shows that the resulting reduction of Reynolds stress drive for mean flow, $-\partial_r \langle \widetilde{v}_r \widetilde{v}_\theta \rangle$, accounts for a significant fraction of the L-mode E_r well depth reduction with RMPs.

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