Particle Transport Modification Due to Resonant Magnetic Perturbations on the DIII-D Tokamak*

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We present the first direct measurements of particle transport changes due to n=3 resonant magnetic perturbations (RMPs) in both H-mode and L-mode DIII-D plasmas, along with associated measurements of turbulence changes and transport modeling. RMP application is at present the most successful technique for suppressing edge localized modes (ELMs), but also has the undesired effect of reducing the operating density by 5%-30%. Understanding and limiting this density reduction is a key issue for achieving high performance on ITER. In this paper, we present the first direct confirmation of an increase in particle diffusivity (D), and reduction in inward pinch velocity (v), with RMP application, in both L- and H-mode plasmas. In H-mode, the changes in D and v, determined using gas puff modulation techniques, are consistent with the observed decrease in density with RMP, and extend into the plasma core. The increase in D and decrease in v are also correlated with an increase in density fluctuation levels, and a decrease in ExB shearing levels. Calculations with the linear TGLF code indicate that the measured profile changes increase the maximum linear growth rate from about 0.1 MHz in ELMing H-mode to about 0.25 MHz in RMP ELM suppressed H-mode, with the peak growth rate occurring at higher $k_\theta \rho_s$ in agreement with the measured fluctuation changes, and a shift from ion to electron propagation. This indicates that the changes in core density are the result of changes in gradients and not a direct result of the applied RMPs. On the contrary, in the pedestal area fluctuations decrease whereas the density gradient scale length increases and the ExB shearing levels increase, indicating that changes in turbulent transport cannot explain the density changes in this area of the plasma.

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