Edge Localized Mode Control in DIII-D Using Magnetic Perturbation-Induced Pedestal Transport Changes*

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In DIII-D, large Type I ELMs are eliminated without degrading confinement using n=3 edge resonant magnetic perturbations (RMPs) in H-modes with ITER-relevant pedestal collisionalities $\nu_e^* \sim 0.1$ when the edge safety factor is in the resonant window q_{95} = 3.7. Linear peeling-ballooning stability analysis indicates that the Type I ELMs are suppressed by reducing the pedestal pressure gradient ∇p^{TOT} below the peeling-ballooning limit. This reduction is controlled by changing the RMP amplitude, and results from an increase in particle, not electron thermal transport. This result is inconsistent with stochastic layer transport theory. Density fluctuations in the pedestal increase, consistent with enhanced anomalous particle transport reducing ∇p^{TOT}. In contrast, at $\nu_e^* \sim 4$, the Type I ELMs are replaced by small recycling fluctuations, possibly Type II ELMs, which are correlated with increased intermittent "blob" transport. Because the energy loss in each event is less than that from a Type I ELM but the number of these events increases, the divertor impulses are reduced while the overall transport is constant. This process produces values of ∇p^{TOT} which are nearly unchanged in the ELM-suppressed H-mode, suggesting that different mechanisms suppress the ELMs in the two ν_e^* regimes. At low ν_e^*, fluctuation-driven transport increases, reducing ∇p^{TOT} below the stability limit. At high ν_e^*, "Type II ELMs" are destabilized, leading to a limit cycle that holds ∇p^{TOT} just below the Type I ELM stability limit.

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