The Role of Resonant Magnetic Field Penetration in Edge Localized Mode Suppression in the DIII-D Tokamak

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Measurements and modeling of DIII-D low collisionality ($\nu^*_e \approx 0.1\text{-}0.3$) plasmas reveal pedestal-top locked modes as the probable trigger for Edge-Localized-Mode (ELM) suppression by n=2 and n=3 Resonant Magnetic Perturbations (RMPs) in a range of plasma conditions including neutral beam torque 3 – 6 Nm, plasma average triangularity δ=0.6-0.3 and edge safety factor q_{95}=3.1-4.1. At the onset of ELM suppression in all these conditions, a rapid (< 1 ms) increase is observed in the high-field-side magnetic response concomitant with an increase in the co-Ip ExB rotation at the top of the pedestal. The nonlinear two-fluid MHD code TM1 [1] is used to simulate the onset of edge locked modes driven by RMPs for experimentally relevant profiles and transport parameters. The simulations reproduce the observed magnitude and time scale for changes in the pedestal ExB rotation and magnetic response of the plasma, strongly supporting the conjecture that ELM suppression is triggered by edge locked mode onset. Further evidence for magnetic island generation at the onset of ELM suppression comes from experiments designed to the hover near the threshold of ELM suppression. Near threshold conditions we observe cyclic magnetic pulsations with a slow toroidal rotation of the plasma magnetic response to the RMP [2], consistent with recent theoretical predictions of the limit cycle behavior of partially penetrated resonant fields [3]. The ELMs are suppressed cyclically in phase with the magnetic pulsations, consistent with the role of finite size magnetic islands in ELM suppression.

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