Edge Stability of Stationary ELM-Suppressed Regimes on DIII-D*

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Two edge localized mode (ELM)-free H-mode regimes on DIII-D, the QH-mode and resonant magnetic perturbation (RMP) H-mode, represent possible solutions to the problem of ELMs in next generation tokamaks. A study of the edge stability of these regimes provides insight into their stationary nature and operational requirements. In the quiescent QH-mode, which is obtained at low density when at least 80% of the neutral beam injection is in the direction counter to the plasma current, results suggest that a low toroidal mode number, $n \leq 5$, peeling instability, which would normally produce ELMs, becomes saturated through a combination of toroidal rotational shear drive and rotation damping due to drag by a conducting wall. This saturated mode, the edge harmonic oscillation, also provides the particle transport to maintain the QH-mode in steady state. Under this hypothesis, low density is required to access the low-n peeling unstable regime where modes are driven by rotational shear and there is good coupling to the conducting wall for damping of the rotation as the mode grows. We speculate that counter injection is required to produce high rotational shear to access this regime before the edge current density limit is reached and an ELM is triggered. In RMP H-mode, an $n=3$ coil provides the non-axisymmetric perturbation. Complete ELM suppression is limited to low collisionality at a resonant q value where the RMP generated stochastic field is effective at increasing transport in the edge transport barrier (ETB). The ETB pressure gradient is kept below the stability limit and its value controlled with the RMP coil. New results extend the RMP ELM suppression to higher triangularity, with cross-sectional shape similar to ITER. Similar pedestal pressures are obtained in the higher triangularity ITER similar shapes compared to previous results at low triangularity due to offsetting effects of reduced pressure gradient limit and increased ETB width.

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