Quantitative Tests of ELMs as Intermediate *n* Peeling-Ballooning Modes*

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Two of the major issues crucial for the design of the next generation tokamak burning devices are the predictability of the edge pedestal height and control of the divertor heat load in H-mode configurations. Both of these are strongly impacted by edge localized modes (ELM) and their size (depth). A working model for ELMs is that they are intermediate toroidal mode number, n ~ 5–30, peeling-ballooning modes driven by the large edge pedestal pressure gradient P′ and the associated large edge bootstrap current density J_{BS}. The interplay between P′ and J_{BS} as a discharge evolves can excite peeling-ballooning modes over a wide spectrum of n. The pedestal current density plays a dual role by stabilizing the high n ballooning modes but providing free energy to drive the intermediate n peeling modes. This makes a systematic evaluation of this model particularly challenging.

This paper describes recent quantitative tests of this model using experimental data from the DIII-D, the JT-60U, and the ASDEX-U tokamaks. These tests are made possible by recent improvements to the ELITE MHD stability code [1], which allow an efficient evaluation of the unstable peeling-ballooning modes, as well as by improvements to other diagnostic and analysis techniques. Some of the key testable features of this model are: (1) ELM sizes are related to the radial widths of the unstable modes, (2) the unstable modes generally have a strong ballooning character localized in the outboard bad curvature region, and (3) at high collisionality, ELM size becomes smaller because J_{BS} is reduced.

These predicted features are consistent with many ELM observations in DIII-D, JT-60U, and ASDEX-U discharges. The predicted growth rate attains a significant value just before an ELM occurs and the observed $\Delta T_e/T_e$ from statistical analysis of DIII-D Thomson data is consistent with the calculated radial width of the most unstable peeling-ballooning mode. The absence of ELM-generated particle flux on the inboard side of DIII-D double-null divertor discharges supports the strong ballooning character of these modes. The predictions of small or large radial widths of the unstable modes are consistent with the small and giant ELMs observed in JT-60U. Ongoing studies include a detailed testing of the model against ASDEX-U small type II and giant ELM discharges and a new ASDEX-U small ELM similarity experiment in DIII-D focused on the effects due to edge collisonality.

[1] Snyder, P.B., *et al*, “ELMs and the Pedestal: A Model based on Coupled Peeling-Ballooning Modes,” to appear in Phys. Plasmas, May 2002.

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