ABSTRACT

Understanding the physics of the edge pedestal and edge localized modes (ELMs) is of great importance for ITER and the optimization of the tokamak concept. The peeling-ballooning model has quantitatively explained many observations, including ELM onset and pedestal constraints, in the standard H-mode regime. The ELITE code has been developed to efficiently evaluate peeling-ballooning stability for comparison to observation and predictions for future devices. We briefly present recent progress in the peeling-ballooning model, including studies of the apparent power dependence of the pedestal, and studies of the impact of sheared toroidal flow. Nonlinear 3D simulations of ELM dynamics using the BOUT code are also described, leading to an emerging understanding of the physics of the onset and dynamics of ELMs in the standard intermediate to high collisionality regime. Recently, highly promising low collisionality regimes without ELMs have been discovered, including the quiescent H-mode (QH) and resonant magnetic perturbation (RMP) regimes. We present recent observations of the density, shape and rotation dependence of QH discharges, and studies of the peeling-ballooning stability in this regime. We propose a model of the QH-mode in which the observed edge harmonic oscillation (EHO) is a saturated kink/peeling mode which is destabilized by current and rotation, and drives significant transport, allowing a near steady-state edge plasma. The model quantitatively predicts the observed density dependence, and qualitatively predicts observed mode structure, rotation dependence, and outer gap dependence. Low density RMP discharges are found to operate in a similar regime, but with the EHO replaced by an applied magnetic perturbation.