Intrinsically No-ELM and Small ELM Regimes and Extrapolation to Burning Plasmas

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H-mode is usually considered to be the preferable operating regime for fusion reactors because of the good confinement. However, the large energy bursts due to the edge localized mode (ELM) instability, which are common in H-mode, impose a big challenge to the diverter and plasma-facing components. Control of type-I ELMs is required for high current operation on ITER. While several active ELM-control techniques including resonant magnetic perturbation (RMP) and pellet pacing are planned for ITER, there is also a worldwide effort to explore passively stable regimes that would be highly desirable for future reactors. This talk reviews the current understanding of the leading intrinsically no-ELM and small ELM regimes, including the Quiescent H-mode (QH), wide-pedestal QH, I-mode, enhanced-Dalpha (EDA) H-mode, quasi-continuous exhaust (QCE) and grassy ELM regimes. The key distinction between these regimes are the processes that hold the edge plasma away from the MHD peeling-ballooning mode instability boundary. The pedestal fluctuation measurements and simulations that our understanding of these processes is based upon are presented. This talk also examines recent experimental progress in pushing the operational space of no-ELM and small ELM regimes towards reactor conditions. For the reactor application, a no-ELM or small-ELM regime needs to be integrated with high confinement, low external injected torque, low pedestal top collisionality, high Greenwald fraction and a power exhaust solution. Several of these conditions can be difficult to achieve simultaneously in present-day devices, and open questions regarding extrapolability and some other alternative no-ELM and small ELM approaches such as using plasma shape change and impurity injection are discussed.

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