Current understanding of pedestal and ELM stability

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In high confinement (H-mode) tokamak plasmas, a transport barrier near the plasma edge creates very steep temperature and density gradients. The global plasma confinement is largely determined by the edge pedestal pressure due to so-called stiff profiles. Periodic plasma instabilities called Edge Localised Modes (ELMs) that can erode plasma facing components are driven by the strong pressure gradients and localised current density at the edge of the plasma. Therefore, it is important to understand pedestal behaviour in order to: predict the occurrence of ELMs and devise methods to suppress them or mitigate their effects; and to predict the height of the pedestal and so determine global plasma performance.

The largest or Type I ELMs are found to be triggered by ideal MHD instabilities. At the end of the ELM cycle the plasma becomes unstable to edge-localised peeling-ballooning modes (PBMs). Various methods are used to control ELMs and ideal MHD stability analysis explains how the stability, and, consequently the plasma behaviour, changes. This talk will include recent developments in understanding ELM behaviour when resonant magnetic perturbations (RMPs) are applied to mitigate the ELM effects.

The stability to PBMs sets the ultimate limit for the pedestal, but does not uniquely determine the pedestal height because a wider pedestal allows a higher pedestal without causing PBM instability. In order to determine the pedestal width, the mechanisms mediating inter-ELM pedestal evolution must be considered. In the EPED model [1], kinetic ballooning modes (KBMs) are assumed to limit the pedestal gradient during the ELM cycle until PBMs are triggered; the fully developed pedestal width and height is determined by the intersection of these two stability criteria. The pedestal structure in various machines will be explored and compared to modelling.

[1] Snyder P.B., et al. Phys. Plasmas 16 (2009) 056118.

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