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TH/5-1: Gyrokinetic Instabilities in an Evolving Tokamak H-mode Pedestal

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Plasma equilibria reconstructed from the spherical tokamak MAST, have sufficient resolution to capture plasma evolution during the short period between edge-localised-modes (ELMs). Immediately after the ELM steep gradients in pressure, P, and density, n_e, form a pedestal close to the separatrix, and then expand into the core. Local gyrokinetic analysis over the ELM cycle reveals the dominant microinstabilities, and suggests a new physical picture for the formation and arrest of this pedestal: in the pedestal dP/dr and dn_e/dr are limited by kinetic ballooning modes (KBMs), consistent with the hypothesis of the EPED pedestal model; in the core close to the pedestal KBMs are absent, but higher perpendicular wavenumber microtearing modes (MTMs) dominate and limit the electron temperature gradient; the pressure pedestal propagates into the core because increasing dn_e/dr and dP/dr stabilises the MTMs until they are supplanted by KBMs at higher dP/dr; deeper inside the core dP/dr is lower and MTMs become more virulent over the ELM cycle with rising local beta; when the pedestal is almost fully developed, the pressure gradient transition region is close to an instability threshold where MTMs and KBMs become simultaneously unstable with large growth rates over a broad spectral range. Above this threshold the dominant modes change from KBMs at lower wavenumber, to MTMs above a toroidal mode number n ~ 25. (n = 25 is within the observed range for ELM filaments in MAST.) The breaching of this limit may trigger a significant change in edge transport. Recent measurements from the pedestal region between ELMs in DIII-D find high and low frequency bands of turbulence propagating in the electron and ion drift directions respectively, broadly consistent with the properties of the MTMs and KBMs reported here. Further analysis to deepen our understanding of these physical processes is underway and will be reported.

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