Seminar

Institute for Plasma Research

Title : Effect of on-axis ECRH on ELM dynamics and pedestal behavior in DIII-D

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Date : 25th September 2019 (Wednesday)

Time : 3.30 PM.

Venue : Seminar Hall, IPR

Abstract:

Pedestal evolution and associated instabilities in-between ELMs, in different operating scenarios, is a key area of tokamak research as pedestal pressure is a deciding factor for core plasma performance. Among other effects, ELMs are known to limit energy confinement. Working hypothesis of ELM onset is based on the peeling-ballooning (PB) model. However, there are several experimental observations in JET, TCV, AUG, where ELMs are not triggered even though the pedestal gradients have reached the critical PB gradients and continue in a long metastable state prior to an eventual onset of ELM. Onset mechanisms in such ELMs cannot be deciphered comprehensively as of today. Further, it is well known that frequency of type 1 ELMs increases with the power crossing the edge plasma. ELM characteristics do not depend on the power deposition location or the heating mix unless the heating is done directly in the pedestal region as in that case the evolution of edge profiles is modified. This is also supported by the PB model. This work intends to decipher the pedestal evolution in the inter-ELM period towards an ELM event and the change in ELM frequency by changing the heating mix. In DIII-D, ECRH is applied (at $\rho = 0.2$) in increments in NBI shots to study the effects of Te/Ti > 1 and density pump-out on the pedestal. For NBI, there are rapid ELMS (f_{ELM} ~ 46 Hz) of varied amplitude. On the other hand, for ECRH, the ELM frequency is well-defined, lower (f_{ELM} ~ 27 Hz) than in the NBI shots, and each type-I ELM is followed by one or two very small Dα spikes. For the pure NBI shot, pedestal gradients reach saturation much faster compared to the ECRH shots. In ECRH shots, the gradients recover through an intriguing path that can be discerned into five distinctive phases. Mirnov coils show 3 distinct modes at 13~116 kHz in ECRH shots only. Phase-locked analysis shows Amplitude of these modes do not grow for the first 12 ms of the inter-ELM period and then grow to saturation from 12~25 ms. Note that ∇n_e, ∇T_e and ∇p_e reaches their peak value at ~12 ms and then suffers a small drop coinciding with the small Dα spikes following the large type I ELMs. Interplay of a coherent mode and high frequency broadband fluctuations are seen in Doppler Back Scattering (DBS) data. Onset and seizure of these modes are strongly correlated with the profile recovery phases in the inter-ELM period. These results clearly indicate that, ∇pe needs to reach a certain threshold to destabilize these modes and survival of these modes depends on specific narrow bounded values of ∇pe. On the hindsight, recovery of gradients and triggering of ELMs are largely dependent on these modes as they alter the transport at the pedestal.

Acknowledgement: This work is supported by US DOE under DE-SC0019302 and DE-FC02- 04ER54698