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Nonlinear reorganization of pedestal modes leading to the ELM onset

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Understanding the edge localized modes (ELMs) that occur in the pedestal of H mode plasma is a long-standing issue for the fusion community. For instance, recent experiments have shown that while the pedestal is pinned over a long period of time, an ELM can still be suddenly triggered [1,2,3]. The cause of these events, that arise after a long period during which the pedestal is pinned, do not fit the standard peeling-ballooning model and they deserve some further attentions. As we report in this work, nonlinear interactions between modes can change the stability condition of a pedestal, such that a stable pedestal for a long time (50ms) can suddenly become unstable and trigger an ELM [4].

Our study focuses on the nonlinear three wave interaction between three dominant quasi-coherent modes localized in the pedestal. The result of this interaction is that one of these modes with the lowest amplitude during the first half of the inter-EM period is amplified through three wave interactions. This amplification brings turbulence at an outer radial position in the pedestal foot near the separatrix. In addition, this displacement of turbulent energy is due to the fact that the third mode is radially shifted towards the last close surface compared to the two other modes, see subplot (b) of the figure on the right.

The nonlinear coupling of pedestal modes, associated with radial distortions pushing out of the pedestal, thus appear as a possible mechanism for the triggering of low frequency ELMs.

New progress on the basic understanding of the influence of the nonlinear coupling of pedestal modes on the ELM onset will be discussed.

References

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Figure: Evolution of radial mode envelope, under the effect of three waves interaction.