

Multiscale Chirping modes Driven by Thermal Ions in a Plasma with Reactor-relevant Ion Temperature

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A thermal ion driven bursting instability with rapid frequency chirping, assessed to be an Alfvénic ion temperature gradient mode [1], has been observed in plasmas having reactor-relevant temperature in the DIII-D tokamak [2] (see the Fig. 1). The modes are excited over a wide spatial range from macroscopic device size to micro-turbulence size and the perturbation energy propagates across multiple spatial scales. The radial mode structure is able to expand from local to global in ~ 0.1 ms, and it causes magnetic reconnection in the plasma edge, which can lead to a minor disruption event. The $\eta_i (= \partial \ln T_i / \partial \ln n_i)$ exceeds the theory-predicted threshold for the destabilization of Alfvénic continuum due to compressibility of core ions. The most unstable modes belong to the strongly coupled kinetic ballooning mode and β -induced Alfvénic eigenmodes branch [3]. The key features of the observation are successfully reproduced by linear analysis solving the electromagnetic gyrokinetic equations (CGYRO code) [4]. Since the mode is typically observed in high ion temperature >10 keV and high- β plasma regime, the manifestation of the mode in future reactors should be studied with development of mitigation strategies, if needed.

<https://i.ibb.co/9tH68Wt/001.jpg>

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