Observations on turbulence dynamics and beam-ion driven modes on the TEXTOR tokamak

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At weak (1.3 T) toroidal magnetic field, intense tangential neutral beam injection results in quasi-periodic bursts of MHD activity in the TEXTOR tokamak. In this paper these bursts are characterized using the multi-antenna heterodyne O-mode reflectometer and two arrays of Mirnov coils. The bursts are dominated by a down-chirping $n = 1$ mode whose phenomenology is consistent with the fishbone instability, which is an internal kink driven resonantly by trapped beam ions. When the fishbone reaches its maximum amplitude on TEXTOR a short burst of several modes with $n \geq 3$ is seen. Their frequency in the plasma frame scales with the Alfvén velocity, and is significantly lower than the frequency expected for toroidicity induced Alfvén eigenmodes. This, and other observed phenomenology of the $n \geq 3$ modes, suggests that they are β-induced Alfvén eigenmodes. Observations of such modes together with the fishbone mode are common and well documented in the literature [1]. Bispectral analysis of the reflectometer phase reveals a statistically significant level of interaction between the fishbone and the Alfvénic modes. Most, but not all of the fishbone bursts coincide with ELMs in TEXTOR H-mode plasmas. Similar observations have been reported in the literature on a few occasions [2]. In L-mode, fishbones coincide with spikes of transport resembling the ELMs, whose nature is unknown.

The Mirnov and reflectometer signals show an additional ELM precursor mode with $n = 2$, which is unrelated to the fishbone and Alfvénic modes. Bispectral analysis of the reflectometer phase signals shows that this mode modulates the amplitude of broad band turbulence in the pedestal.

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References

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