DPP12-2012-001121

Abstract for an Invited Paper
for the DPP12 Meeting of
the American Physical Society

Interplay between coexisting MHD instabilities mediated by energetic ions in NSTX H-mode plasmas[1]

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In next-step fusion devices different types of MHD instabilities are likely to coexist and possibly interact. This work addresses an interesting interplay between low frequency (5-20 kHz) and ion cyclotron frequency (1-2 MHz) modes, commonly observed in the early phase of beam heated NSTX H-modes (P_{NB}=4-6MW). The first have been characterized as peripheral kinks, with low toroidal number n=1-3. The second are clusters of Compressional Alfvén Eigenmodes (CAE), with larger n=9-15, propagating in direction of the beams. Despite the temporal and spatial scale separation, the destabilization of CAEs strongly correlates with the presence of low frequency kinks. The kink onset is accompanied by a collapse of the core fast ion density, measured by the Fast-Ion D-Alpha diagnostic (FIDA), while data from neutron and fast-ion loss detectors indicate modest increase of fast ion losses. This suggests that the kink activity may cause fast ion redistribution in phase space, which may in turn affect CAE stability. Based on an ideal MHD description of the peripheral kink structure, validated against experimental data, full-orbit simulations with the SPIRAL code have been used to assess its effect on the fast ion distribution function. Results confirm that in presence of the kink the beam ions are redistributed from core to periphery, with peak density reduced by 20% and total losses increasing by less than 5%, in agreement with observations from fast ion diagnostics. SPIRAL simulations also show that an enhanced pitch angle scattering associated with the kink tends to populate velocity space regions of more parallel pitch ($0.5<V_{||}/V<1$), where direct resonances of observed CAE modes are expected, providing an additional drive for the destabilization of the CAE. The results underline the role of the fast ion distribution as coupling element between different MHD instabilities.

[1]This work is supported by U.S. DOE Grants DEFG02- 06ER54867 and DE-AC02-09CH11466.