

P1.1025 Nonlinear Dynamics of Toroidal Alfvén Eigenmode in HL-2A H-mode Plasmas

Monday, 8 July 2019 14:00 (2 hours)

See the full abstract here:

<http://ocs.ciemat.es/EPS2019ABS/pdf/P1.1025.pdf>

The nonlinear dynamics of shear Alfvénic wave fluctuations have become a major concern in magnetically confined fusion, since they can be driven unstable by energetic particles (EPs). There are two routes for the Alfvénic fluctuation nonlinear dynamic evolution, with one corresponding to wave-particle phase space nonlinear dynamics dominated by resonant particles, while the other, dubbed as nonlinear wave-wave interactions, describing nonlinear spectrum evolution due to the nonlinear couplings among modes. The former route can be described by the bump-on-tail paradigm or fishbone paradigm. The latter route may take place via Compton scattering of the bulk ions and magnetohydrodynamic (MHD) nonlinearities effects as well as zonal structure generation. Those theoretical predictions had been shown to be relevant in realistic fusion plasmas. On experiments, many nonlinear dynamics phenomena of shear Alfvénic wave fluctuations occur and are identified in laboratory and space plasmas.

In the present paper, the nonlinear dynamics of toroidal Alfvén eigenmodes (TAEs), including nonlinear wave-particle and wave-wave interactions, have been observed in the HL-2A NBI H-mode plasmas. It is found that there are strong nonlinear mode couplings between TAEs with $n=3$ and low frequency MHD mode (kink or fishbone) with $n=1$. The pitch-fork phenomena of TAEs can grow explosively and become an explosive instability. The explosive events have two kind fine structures, i.e., multi-modes and pitch-fork. The two kind structures can coexist, but the strong nonlinear mode coupling induces that the pitch-fork weakens or vanishes and the modes blow-up in finite-time, and this indicates that the nonlinear mode coupling may redistribute energetic-ions, destroy hole-clump pairs in the phase-space, and induce three-wave mixing nonlinearly. As a consequence, the TAE nonlinear dynamics can trigger the onset of ELMs and pedestal collapse within several hundred Alfvén times. Following the continuous appearances of rich nonlinear dynamics phenomena, more attentions should be paid to understand the underlying mechanisms, as experimental verification of numerical simulations and analytical theory, that are developed for the predictive ability for future burning plasma scenarios.

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Session Classification: Poster P1

Track Classification: MCF