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Experimental Study of Multi-scale Interaction between (Intermediate, Small)-scale Microturbulence and MHD modes in EAST Plasmas

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Understanding plasma transport in phases with significant MHD activities (especially during plasma current ramp-up/down and disruption) in tokamak plasmas is crucial for predicting and thus controlling plasma behavior for future fusion devices, e.g. ITER. Since microturbulence plays an important role in driving anomalous plasma transport, the interactions between MHD modes and microturbulence is thought to be important in determining anomalous plasma transport [1]. Recent theoretical results in the literature show that microturbulence can nonlinearly interact with macro-instabilities such as kink/tearing mode through nonlinear cascade process or through temperature and/or density profile modulation from macro-instabilities. Due to the huge temporal and spatial scale separation between microturbulence and MHD modes, it is impossible for the present-day supercomputers to simulate their nonlinear interactions in a self-consistent way. In this talk, we present evidence of multi-scale interactions between (intermediate, small)-scale (kρ_i~2-6) microturbulence and MHD modes in EAST plasmas, including the first experimental identification of nonlinear coupling between microturbulence and an MHD mode during the current ramp-down phase in a set of L-mode plasmas in EAST [2] and the effects of 2/1 classical tearing mode on microturbulence [3] in the core of another set of EAST L mode plasmas using the EAST CO_2 laser collective scattering diagnostic in forward mode and far-forward mode. We demonstrate the nonlinear coupling between microturbulence and MHD mode with bispectral analysis [4] and envelope method [5], showing statistically significant bicoherence and modulated turbulent density fluctuation amplitudes correlated with the MHD mode. We also show that microturbulence spectral power is correlated to the 2/1 tearing mode and modulation effects on microturbulence by the 2/1 tearing mode.

[1] P.J. Sun et al 2018 Nucl. Fusion 58 016003

[2] P.J. Sun et al 2018 Plasma Phys. Control. Fusion 60 025019

[3] Kim Y C and Powers E J 1979 IEEE Trans. Plasma Sci. PS-7 120

[4] Y. Nagashima et al 2005 Phys. Rev. Lett. 95095002

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