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Experimental observation of three-wave interactions between GAM and KTAEs in EAST tokamak

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Energetic particle (EP) related physics are expected to play significant roles in magnetically confinement plasmas [1,2]. EPs may drive collective instabilities, such as shear Alfvén wave (SAW) instabilities, and induce EP anomalous transport. Thus, for quantitative understanding of plasma confinement and fusion performance in future reactors, in-depth understanding of SAW instabilities dynamics including saturation using first-principle-based theory and simulation, as well as experimental verification in present day tokamaks, is needed.

In recent EAST low-density Ohmic discharges, multiple Alfvénic modes (AMs) and geodesic acoustic mode (GAM) have been observed simultaneously. It is found that, these AMs, with the frequency ranging 150~250 kHz, are located below the toroidicity induced SAW continuum gap, and are identified as weakly damped lower kinetic toroidal Alfvén eigenmodes (KTAEs) [3] excited by energetic electrons, and their frequency difference is the same as the observed GAM frequency. Furthermore, these KTAEs and GAM are located in the same radial position, suggesting strong nonlinear three wave interactions, as addressed in Ref. [4]. This nonlinear coupling, may lead to SAW instability nonlinear saturation, as well as EP energy channeling through KTAEs into the GAM, and eventually, bulk plasma heating through GAM collisionless damping.

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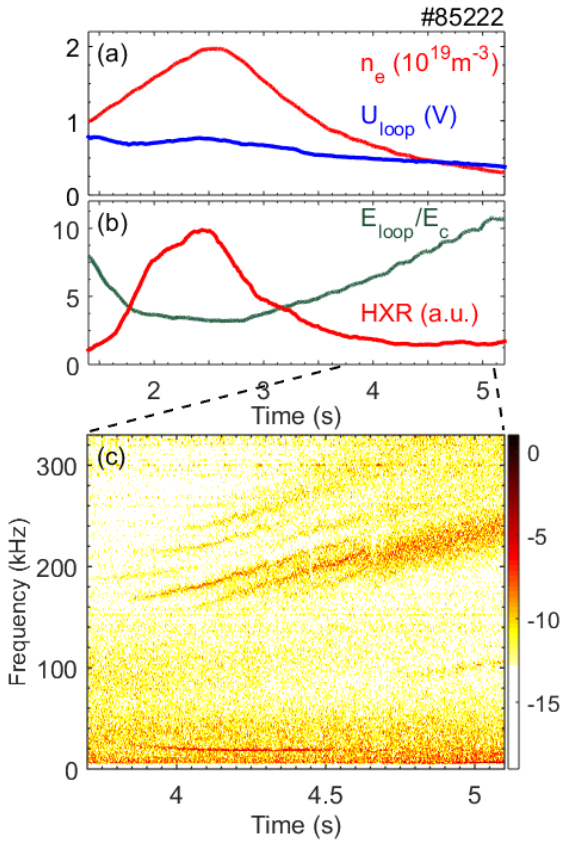

Fig. 1. (a)(b): Evolution of the main plasma parameters over time. (c): Experimental observation of three-wave interactions between GAM and KTAEs.

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