Experimental evidences of nonlinear interaction between Alfvén eigenmodes and drift waves in DIII-D tokamak

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Evidence from DIII-D experiments demonstrates that ion temperature gradient (ITG) turbulence can significantly decrease in response to Alfvén eigenmode (AE) activity in neutral-beam-heated discharges. This phenomenon is consistently observed across multiple discharges. Local ITG turbulence is reduced by ~50% in cases with a single toroidal AE (see the Fig. 1) and, in some instances, is completely suppressed in plasmas with multiple AEs sharing identical toroidal mode numbers. The full suppression of ITG persists for several energy confinement times and is accompanied by a transient improvement in plasma confinement, including a ~30% increase in electron and ion temperatures at constant heating power. Simulations using measured plasma parameters, excluding AE activity, show that the linear growth rate of ITG remains nearly unchanged across the suppression phases. Velocimetry measurements from beam emission spectroscopy (BES) reveal a substantial increase in oscillations of ExB flow, while Doppler backscattering diagnostics indicate an enhancement of E×B shear flow, associated with excitation of AEs. In the cases analyzed, fast-ion dilution changes by only a few percent, suggesting a minimal impact on ITG turbulence. The experimental data and simulation suggest that AE-driven zonal flows, consistent with theoretical predictions, may play a key role in mitigation and/or suppression of ITG turbulence. A comprehensive understanding of the interactions between AE activity and turbulence is crucial for improving predictions of alpha particle and thermal transport, which are vital for optimizing reactor performance.

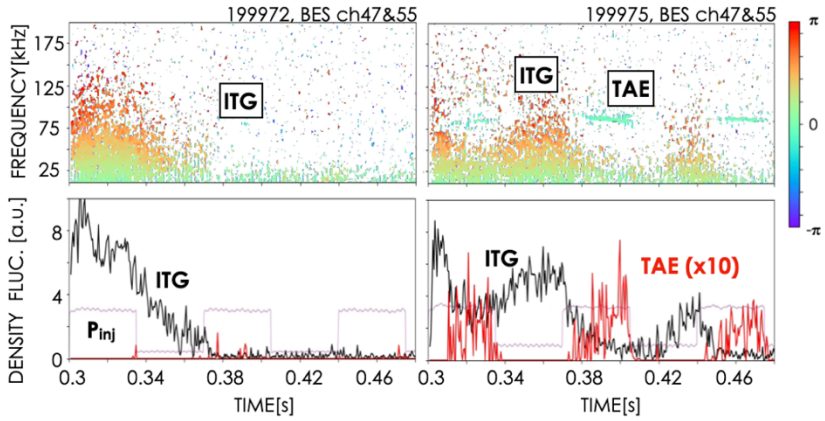

Figure 1 Time evolution of ITG amplitudes without TAEs (left column) and with TAE (right column) at similar heating power.

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