Non-linear dynamics of toroidicity-induced Alfvén eigenmodes in NSTX

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The dynamics resulting from the non-linear coupling of multiple toroidicity-induced Alfvén eigenmodes (TAEs) is believed to be one of the main loss mechanisms for fast ions in ITER. This phenomenon is commonly observed in neutral beam-heated plasmas on the National Spherical Torus Experiment (NSTX), where bursts of TAE activity can cause substantial (≤30%) losses over ~1ms. Fast ion losses scale with the activity in the TAE band. In addition, modes with frequencies both below and above the TAE gap appear in the Fourier spectrum of magnetic fluctuations during large amplitude bursts. The frequency and amplitude evolution of these modes is consistent with a simple model based on quadratic interactions between the unstable TAEs. This non-linear coupling leads to effective growth rates >10%, thus enabling an explosive behavior of TAE modes and enhanced fast ion losses.

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