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Avalanche Transport of Energetic-ions in Magnetic Confinement Plasmas: Nonlinear Multiple Wave-number Simulation

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This Large burst activity, identified as TAE avalanche, occurs frequently in neutral-beam heated plasmas in NSTX. Based on the typical experimental observation of TAE avalanche on NSTX, a self-consistent nonlinear multiple wave-number simulation associated with TAE avalanches is performed using the experimental parameters and profiles before the occurrence of TAE avalanche as the M3D-K input. The wave-wave nonlinear coupling among different modes and the resonant interaction between different modes and energetic-ions during TAE avalanches are identified. The resonance overlap during the TAE avalanche is clearly observed in the simulation. It is found that the effective wave-wave coupling and a sufficiently strong drive are two important ingredients for the onset of TAE avalanches. TAE avalanche is considered to be a strongly nonlinear process. And it is always accompanied by the simultaneous rapid frequency-chirping and large amplitude bursting of multiple modes and significant energetic-ion loss. The experimental phenomenon is observed on NSTX and is qualitatively reproduced by the simulation results in this work.These findings reported by this talk indicate that the onset of avalanche is triggered by nonlinearity of the system, and are also conducive to understanding the underlying mechanism of avalanche transport of energetic particles in the future burning plasmas, such as ITER.

References

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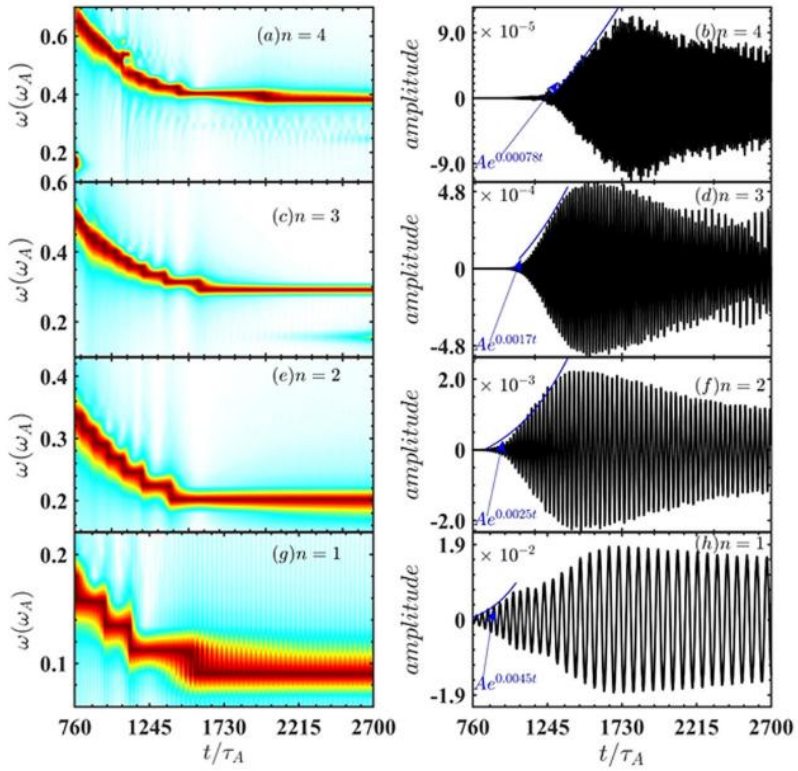

Figure 1. Simulation results of TAE avalanche: In the multiple wave-number simulation including toroidal mode number n=1-4 with energetic-ion effects, the evolution of frequency spectrum and mode amplitude.