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Nonlinear Simulation of Beam-driven Multiple TAEs in NSTX
GUOYONG FU, FENG WANG, Princeton University — Energetic particle modes and Alfvénic modes driven by super-Alfvénic beam ions were routinely observed in neutral beam heated plasmas on the National Spherical Torus Experiment (NSTX). These modes can significantly impact beam-ion transport, thus causing beam-ion redistribution and losses. NSTX experimental results show that multiple low-amplitude beam-driven TAEs with weak frequency chirping can transit to mode avalanche with much larger amplitudes and stronger frequency chirping. In order to explore mechanisms of the TAE avalanche, M3D-K nonlinear simulations of multiple beam-driven TAEs and the n=1 fishbone have been carried out. The results show strong interaction between TAEs and fishbone that either enhances or reduces saturation level of individual modes. The simulated saturation levels are found to be very sensitive to the minimum value of safety factor $q_{\mathbf{min}}$. when $q_{\mathbf{min}}$ drops below a critical value ∼1.19, the saturated mode amplitudes increase sharply to large values with stronger chirping. This result is similar to the observed TAE avalanche in the later phase of NSTX discharges as $q_{\mathbf{min}}$ drops in time.

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