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Linear and Nonlinear Hybrid Simulations of Beam-driven TAEs and Fishbone Instability in NSTX

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Energetic particle modes and Alfvénic modes driven by super-Alfvénic beam ions are 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 or losses. In this paper we report on recent new self-consistent simulations of Toroidicity-induced Alfvén Eigenmodes (TAEs) as well as fishbone instabilities in NSTX plasmas using the kinetic/MHD hybrid code M3D-K. The simulation results of TAEs show mode radial structure consistent with the reflectometer measurements of electron density fluctuations. Nonlinear simulation of TAEs shows mode saturation and frequency chirping. The results of fishbone simulation show nonlinear saturation with strong frequency chirping, beam ion profile flattening as well as a nonlinearly-driven m=2/n=1 magnetic island.