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Linear Stability and Nonlinear Dynamics of Fishbone in NSTX[1]

FENG WANG, Dalian University of Technology, GUOYONG FU, J.A. BRESLAU, Princeton Plasma Physcs Laboratory, JINYUAN LIU, Dalian University of Technology, DEYONG LIU, University of California — Plasms in spherical tokamaks such as NSTX, with a safety factor above unity and weakly reversed magnetic shear may be unstable to an ideal, non-resonant internal kink mode. This mode, termed the LLM in MAST, can saturate and persist. This indicates strong interaction of energetic beam ions with LLM. In this work, we perform linear and nonlinear simulations to investigate energetic particle effects on the non-resonant kink mode and excitation of fishbone for NSTX-like parameters and profiles. The global kinetic-MHD hybrid code M3D-K is used. Numerical results show that beam ions have a strong stabilizing effect on the kink mode at low values of q_{min} and beam beta. However, at higher beam ion pressure, a fishbone-like mode is excited. The results show that the fishbone is preferentially excited at higher q_{min} values, consistent with the observed appearance of fishbone before "long-lived mode" in NSTX and MAST experiments. Nonlinear simulations show that the fishbone saturates nonlinearly with strong downward frequency chirping, and beam distribution flattened. An m/n=2/1 magnetic island is induced nonlinearly, which could provide a trigger for the 2/1 NTM sometime observed after fishbone instability in NSTX.

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