Subject area: B4

FAST PARTICLE CONFINEMENT AND COLLECTIVE EFFECTS IN NSTX

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ST design presents new regimes for fast particle confinement, which include large FLR, orbit width, low aspect ratio, high betas etc.. Obtained experimental data show rich new physics including different types of new instabilities, such as global Alfvén eigenmodes and fishbones.

First we report recent results of experimental and theoretical studies of fast ion confinement in NSTX. Within the accuracy of the measurements first prompt losses agree with the numerically predicted losses. Fast ion loss dependencies on the main plasma parameters, such as plasma current and magnetic field are studied and show good correlation with numerically predicted dependencies.

Second we analyze the beam ion driven instabilities. TAEs are often driven by the super-Alfvénic beam ions with the characteristic toroidal mode numbers $n = 1 - 5$. NOVA analysis of the mode frequencies is in agreement with the data. First hybrid simulations of beam-driven TAE modes in NSTX have been done using the recently developed massively parallel M3D code. The results show unstable TAEs with its frequencies consistent with the experimental observations.

Radially and poloidaly localized Compressional and Global Shear Alfvén Eigenmodes (CAE and GAE, respectively) in low aspect ratio plasma are also reported. New theory is applied to identify recently observed instabilities in MHz frequency range in NSTX. The frequency of observed AEs is correlated with the characteristic Alfvén velocity of the plasma. These AEs are destabilized by free energy in the energetic ion velocity space gradient via Doppler shifted cyclotron resonances with beam ions. Nonlinear simulations of GAE/CAEs has been done with the hybrid kinetic MHD code HYM. Mode structure and the frequency agree with analytical theory and with measured frequencies.

New resonance for fishbone excitation has been proposed to explain low frequency chirping modes observed in NSTX. It allows the bounce frequency resonance of beam ions with the ideal MHD mode.