Coupling of Neutral-beam-driven Compressional Alfvén Eigenmodes to Kinetic Alfvén Waves in NSTX and Energy Channelling

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Objectives

- Perform numerical study of beam-ion driven global (GAEs) and compressional (CAEs) Alfven eigenmodes in NSTX
- Investigate relationship between GAE/CAE modes and observed flattening of the electron temperature profiles
- Challenges of this study:
  - Requires full-orbit kinetic description of fast ions, including cyclotron resonances.

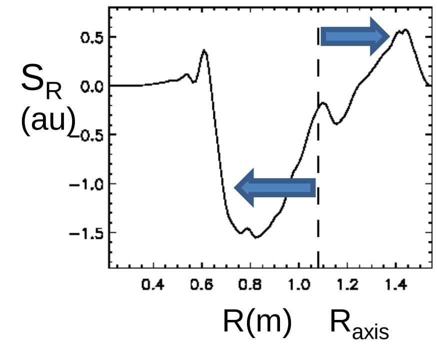
Accomplishments

- First self-consistent simulations of neutral-beam-driven CAEs have been performed using the HYM code.
- It is shown that an essential feature of all CAE modes in NSTX is their coupling to kinetic Alfven waves (KAW) that occurs on the high-field side at the Alfven resonance location (Fig.2).
- The NBI power transferred to one CAE has been estimated as up to P=0.4MW, based on measured displacement amplitudes and HYM calculated mode structure.
- Energy flux is shown to be directed away from the magnetic axis (CAE) toward the resonance location (KAW).
- It is found that strong CAE/KAW coupling follows from dispersion relation, therefore, this mechanism applies to any device with unstable CAEs.

Impact

- Energy channelling mechanism can provide an explanation to the observed reduced heating of the plasma core in the NSTX.

Fig.1 Radial component of quasilinear Poynting vector **S**=<**E**x**B**>. Energy flux is directed away from magnetic axis, ie from CAE to KAW.



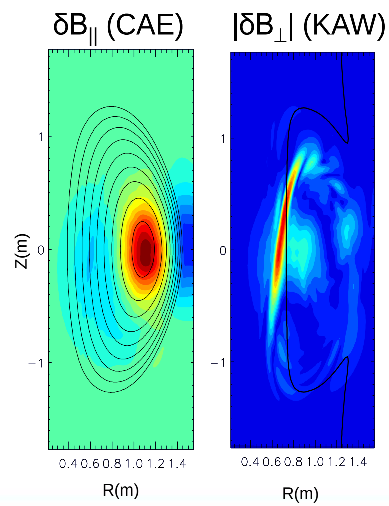


Fig.2 Contour plots of magnetic field perturbation for n=4 co-rotating CAE show resonant coupling to KAW. Solid line corresponds to the resonant condition $\omega_A(Z,R)=\omega$.