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Beta-induced Alfvén-Acoustic Eigenmodes in NSTX and DIII-D Driven by Beam Ions[1]

NIKOLAI GORELENKOV, PPPL, Princeton University

Understanding and predicting energetic ion driven instabilities is essential for planning self-sustained burning plasma experiments where they can strongly affect fusion alpha confinement and plasma performance. We report on a new class of beam driven plasma oscillations called Beta-induced Alfvén-Acoustic Eigenmodes (BAAEs), which results from a coupling, between the Alfvénic and acoustic MHD branches. Because of such coupling a proper theoretical treatment of BAAEs is at the forefront of ideal MHD and kinetic theories and is an ideal application for next-generation gyrokinetic codes in a regime relevant to future burning plasma experiments. The BAAE frequency is located in the Alfvénic acoustic gap below the GAM frequency. In NSTX with high beta (∼20%) BAAEs were observed with frequencies up to 30 kHz, whereas in DIII-D due to lower plasma pressure (beta 2%) the mode frequencies are in the range 10-20 kHz. BAAEs observed so far are localized near the low shear region in plasmas with reversed shear. Their mode structure and frequency from the NOVA code are in good agreement with internal reflectometer and soft X-ray measurements on NSTX. On DIII-D simultaneous radially resolved measurements of density and temperature fluctuations for BAAEs with toroidal mode numbers in the range n=1-15 were made using BES and ECE diagnostics. In NSTX, multiple BAAEs induce strong beam ion losses which correlate with up to 20% drops in neutron signal. BAAEs are useful for diagnosing the internal safety factor profile, as well as the plasma itself. MSE measurements of the minimum q and radial location in NSTX and DIII-D agree with the values inferred from the BAAE theory over a wide range of plasma conditions.

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