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Suppression of Alfvénic modes through modification of the fast ion distribution[1]

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Experiments on NSTX-U have shown for the first time that small amounts of high pitch-angle, low ρ_L beam ions can strongly suppress the counter-propagating Global Alfvén Eigenmodes (GAE) [1]. GAE have been implicated in the redistribution of fast ions and modification of the electron power balance in previous experiments on NSTX. The ability to predict the stability of Alfvén modes, and development of methods to control them, is important for fusion reactors like ITER, which like NSTX, will be heated with a large population of non-thermal, super-Alfvénic ions (unlike the normal operation of conventional tokamaks). The suppression of the GAE by adding a small population of high-pitch resonant fast ions is qualitatively consistent with an analytic model of the Doppler-shifted ion-cyclotron resonance drive responsible for GAE instability [2]. The model predicts that fast ions with $k_\perp\rho_L<1.9$ are stabilizing, which is in good agreement with the experimental observations. A quantitative analysis was done using the HYM stability code [3] of one of the nearly 100 identified examples of GAE suppression. The simulations find remarkable agreement with the observed mode numbers and frequencies of the unstable GAE prior to suppression. Adding the population of high pitch-angle, low ρ_L beam ions to the HYM fast ion distribution function predicts complete suppression of the GAE. TRANSP/NUBEAM calculations for the example analyzed with HYM suggest that the additional beam source increases the population of resonant fast ions with $k_\perp\rho_L<1.9$ by roughly a factor of four.

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