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Global Alfvén eigenmode stability dependence on fast-ion distribution function

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Global Alfvén eigenmodes (GAE) have been extensively studied on NSTX and with analytic and numerical modeling. Multiple GAE with a range of toroidal mode numbers are commonly observed in NSTX plasmas heated with neutral beams. Recently, analytic and numerical modeling has been used to very successfully model the suppression of GAE experimentally observed with the injection of high pitch ($V||/V \approx 1$) resonant fast ions. In this paper we show that the scaling of the GAE frequency and toroidal mode numbers with toroidal field is qualitatively consistent with the analytic theory describing the Doppler-shifted ion cyclotron resonance (DCR) drive for the GAE. The GAE in NSTX and NSTX-U are excited through an ion cyclotron resonance with co-moving beam ions. The GAE propagate in the opposite, or counter, direction at frequencies down-shifted from the ion cyclotron frequency by the motion of the beam ions, that is, in the moving frame of the beam ions, the GAE frequency is up-shifted to the ion-cyclotron frequency. An analytic model of this resonant drive is presented in Ref. 1. An important result from this work is the prediction that resonant fast ions with $k\perp\rho < 1.9$ would be stabilizing ($1.9 < k\perp\rho < 3.9$ would provide drive). In this paper we use a simple dispersion relation for GAE combined with the DCR analytic theory to predict both the range of toroidal mode numbers and frequencies of unstable GAE. We find that this prediction is reasonably consistent with the observed experimental scaling.

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Author: Dr FREDRICKSON, Eric (PPPL)

Co-author: Dr PODESTA, Mario (Princeton Plasma Physics Laboratory)

Presenter: Dr PODESTA, Mario (Princeton Plasma Physics Laboratory)

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