AlfvénEigenmode Stability and Fast Ion Loss in DIII-D and ITER Reversed Magnetic Shear Plasmas

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Abstract. Neutral beam injection into reversed magnetic shear DIII-D plasmas produces a variety of Alfvénic activity including toroidicity-induced Alfvén eigenmodes (TAEs) and reversed shear Alfvén eigenmodes (RSAEs). With measured equilibrium profiles as inputs, the ideal MHD code NOVA is used to calculate eigenmodes of these plasmas. The postprocessor code NOVA-K is then used to perturbatively calculate the actual stability of the modes, including finite orbit width and finite Larmor radius effects, and reasonable agreement with the spectrum of observed modes is found. Using experimentally measured mode amplitudes, fast ion orbit following simulations have been carried out in the presence of the NOVA calculated eigenmodes and are found to reproduce the dominant energy, pitch, and temporal evolution of the losses measured using a large bandwidth scintillator diagnostic. The same analysis techniques applied to a DT 8 MA ITER steady-state plasma scenario with reversed magnetic shear and both beam ion and alpha populations show Alfvén eigenmode instability. Both RSAEs and TAEs are found to be unstable with maximum growth rates occurring for toroidal mode number $n = 6$ and the majority of the drive coming from fast ions injected by the 1 MeV negative ion beams. AE instability due to beam ion drive is confirmed by the non-perturbative code TAEFL. Initial fast ion orbit following simulations using the unstable modes with a range of amplitudes ($\delta B/B = 10^{-5} - 10^{-3}$) have been carried out and show negligible fast ion loss. The lack of fast ion loss is a result of loss boundaries being limited to large radii and significantly removed from the actual modes themselves.

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