Alfvén Eigenmode stability with beams in ITER-like plasma

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ABSTRACT

The toroidicity-induced Alfvén Eigenmodes (TAE) in a proposed ITER burning plasma experiment, driven unstable by two groups of energetic particles, α-particle fusion products and tangentially injected beam ions are studied. Both species are super-Alfvénic but have different pitch angle distributions and the drive for the same pressure gradients is typically stronger from co-injected beam ions as compared to the isotropically distributed α-particles. The study emphasizes the role of the anisotropy in the beam ion distribution function on TAE growth rate via the additional velocity space drive. At the injection energy $E_{b0} = 1MeV$ TAEs are predicted to be stabilized in the nominal ITER discharges if the injection angle is perpendicular to the magnetic axis. TAEs are marginally unstable if the injection aims at the plasma center where the ion Landau damping is strong, whereas with the off-axis NBI the instability is stronger with the growth rate above 1% of TAE mode frequency.

The effect of TAEs on fast ion beta profiles is evaluated on the bases of a quasi-linear diffusion model which makes use of expressions for the local growth and damping rates and calculates the relaxed alpha particle profiles by imposing power balance between the alpha particle fusion power production of the background plasma with the power transferred from alpha particles to electrons due to drag. These results illustrate the parameter window that is available for plasma burn when TAE modes are excited.