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Equilibrium Constraint Choices for Anisotropic Ballooning Mode Stability Scans

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The effects of pressure anisotropy on the stability regimes of Edge Localised Modes (ELMs) in tokamak plasmas are being studied through stability scans of particular-n ballooning modes. Isotropic marginal stability scans of JET scenarios do not always correctly predict the marginal stability boundaries of ELMs[1], where high beam power and high gas fuelling are associated with ELMs triggering before reaching the Peeling-Ballooning boundary. Neutral beam injection can produce significant pressure anisotropy, which motivates studies of the potential effects of anisotropy on stability. The anisotropic tools HELENA+ATF[2] and MISHKA-A[3] have been used to produce a series of equilibria and calculate the growth rates of ballooning modes.

Anisotropic magnetohydrodynamic equilibria are remapped iteratively according to a set of constraints on the physical profiles of the plasma. Several remapping choices were investigated, with the choice to relate isotropic and anisotropic pressures as $p_i = < p^* > = \frac{p_\parallel + 2p_\perp}{3}$. Studies of equilibrium remapping were undertaken to meaningfully quantify the relationship between the pressure anisotropy of a plasma with the growth rates of specific instabilities.

The investigation was performed on a theoretical tokamak scenario for an H-mode plasma, based on a previous study of an n=30 ballooning mode[4]. Multiple options for constraining current density and pressure were investigated. A constraint could be applied to the current density such that the total and surface averaged thermal energies were constrained, but with significant shifts in the safety factor profile. Alternatively, when the safety factor flux function was constrained along with surface-averaged thermal energy, the total thermal energy would change. Both constrains consistently showed that increasing perpendicular pressure destabilises ballooning modes, however a noticeably larger effect is produced when conserving the safety factor.

References

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