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A Robust Safety Factor Constraint for Anisotropic MHD Stability Studies of Edge Localised Modes

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The anisotropic ideal magnetohydrodynamics codes HELENA+ATF[1] and MISHKA-A[2] are being used to study the linear stability of edge localised modes in tokamak plasmas with a well-constrained safety factor. Edge localised modes provide significant challenges for modern tokamaks, and heating methods produce significant pressure anisotropy with respect to magnetic field lines, motivating detailed study of stability boundaries.

Previous growth rate scans of pressure anisotropy and edge localised mode linear stability[3] have been extended to higher aspect ratio tokamak configurations, showing an inverted trend. Variations in the safety factor after equilibrium remapping are more pronounced in the low aspect ratio cases and increase with anisotropy, with effects on the growth rate comparable to the apparent effect of pressure anisotropy. This suggests that the observed trend-inversion may be a result of safety factor variation.

To remove this influence, we are applying an internal safety factor constraint in which the anisotropic and flowing force balance equation is solved numerically in a form that depends explicitly on the safety factor. This should provide more robust equilibria than the external methods which calculate tokamak equilibria iteratively but do not always converge exactly to the same safety factor. Because magnetohydrodynamic modes are typically sensitive to the safety factor, a robust constraint for an anisotropic ideal magnetohydrodynamic equilibrium code will also be beneficial to more broad tokamak stability studies.

References
[1] Z S Qu *et al* 2014 *Plasma Phys. Control. Fusion* **56** 075007
[2] Z S Qu *et al* 2015 *Plasma Phys. Control. Fusion* **57** 095005
[3] A Johnston *et al* 2018 *Plasma Phys. Control. Fusion* **60** 065006

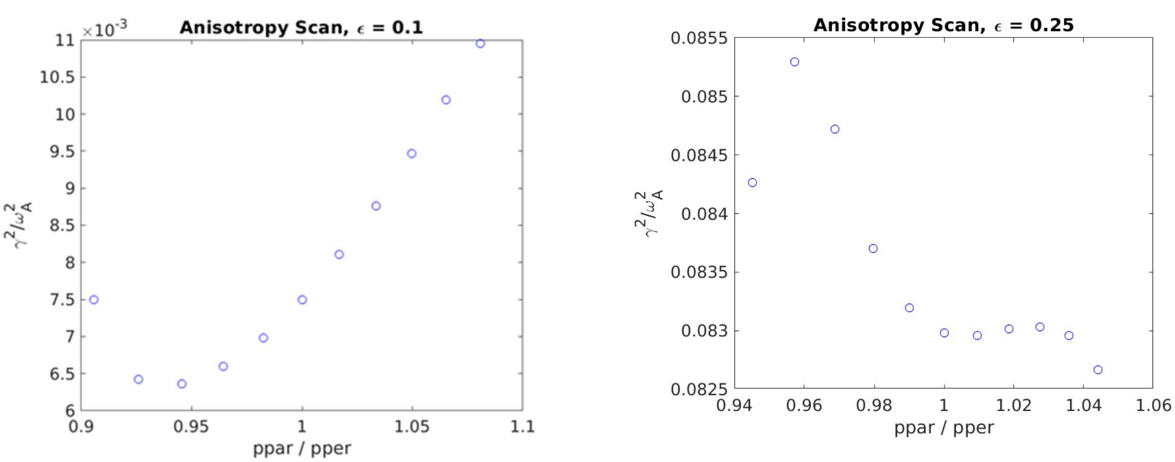

Figure 1: Anisotropic growth-rate scans of an n=30 ballooning mode with (left) high aspect ratio $\epsilon = \frac{a}{R_0} = 0.1$, and (right) low aspect ratio $\epsilon = 0.25$. The low aspect ratio scan matches the direction of the trend found in [3], however has greater variation in the safety factor as anisotropy is varied, which may be the cause of the trend inversion. The growth-rate γ is normalised to the Alfven frequency ω_A, and the ratio of parallel to perpendicular pressure is measured in the centre of the pedestal.