Elimination of small magnetic wells in gyrokinetic stability calculations for a quasi-symmetric configuration

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The existence of local ripple wells in stellarators complicates the calculation of microinstability properties [1]. This is particularly true for quasi-symmetric configurations (e.g., HSX, NCSX, QPS), which have much more complex Boozer spectra than other types of stellarators and which consequently have many small local ripple wells [1, 2]. Resolving these configurational details is a heavy computational burden: high spatial resolution is required to capture the small scale of the wells, and high velocity-space resolution is required to include the narrow trapped regions.

Physical intuition suggests that in a distribution of ripple wells of diminishing extent and depth, only the larger wells play an important role in determining the microinstability properties. This should particularly be true for quasi-axisymmetric configurations such as NCSX, because they are designed to have one very large magnetic well per poloidal circuit and the 'bad curvature' region is well aligned with it. Nevertheless, a method of simplifying the configuration and the criteria for identifying 'small' ripple wells requires justification through convergence tests. A 'brute force' smoothing of |B| vs distance along the field line that ignores all 'small' wiggles can be easily implemented, but this would not be consistent with other elements of the configuration description. An alternative that is more self-consistent, would be to remove some Boozer components (small Bmn, or small n*Bmn, ...) and then calculate all drifts and geometric quantities from the reduced Boozer spectrum, but this reduced Boozer spectrum will not represent a true MHD equilibrium. We will determine whether these faults can be tolerated in the context of linear stability calculations.

We will examine several strategies for simplifying the NCSX configuration description, and evaluate how these simplifications affect the growth rates and frequencies of 'pure' ITG microinstabilities (i.e., adiabatic electrons). The characteristics of a successful simplification scheme may depend on the collisionality and the relative importance of ITG and TEM drive, so we will eventually examine TEM and ITG/TEM-hybrid modes and include scans in collisionality.

[1] G. Rewoldt, L.-P. Ku, W. M. Tang, Phys. Plasmas **12** (2005) 102512.
[2] G. Rewoldt, L.-P. Ku, W. M. Tang, W. A. Cooper, Phys. Plasmas **6** (1999) 4705.