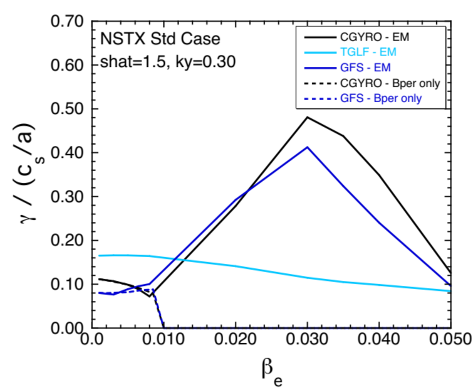
Improved Fidelity to Gyrokinetic Linear Stability with the GFS Gyro-Fluid System For NSTX-U Plasmas

G. M. Staebler[1], J. E. Kinsey[2], E. Belli[3], and J. Candy[3]

[1]Oak Ridge National Laboratory, Oak Ridge, TN, 37831, USA
[2]CompX, P.O. Box 2672, Del Mar, California 92014, USA
[3]General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA
Email: staeblergm@ornl.gov

The linear gyrokinetic stability of drift-waves and kinetic ballooning modes in the spherical torus NSTX-U has been shown to depart significantly from conventional aspect ratio tokamaks due to the effects of parallel magnetic fluctuations. The TGLF linear gyro-fluid system of equations performs well at conventional aspect ratio but lacks sufficient perpendicular energy resolution to resolve the parallel magnetic field fluctuations. The new Gyro-Fluid System (GFS) (G. M. Staebler et al., https://doi.org/10.1063/5.0159054) linear stability gyro-fluid code has a flexible velocity space resolution in both parallel velocity and perpendicular energy so it is able to resolve the fully electromagnetic fluctuations. A database of CGYRO gyrokinetic linear stability calculations was built out of parameter scans around an NSTX-U standard case. The result of verifying the TGLF and GFS linear eigenvalues against this CGYRO database is presented here. It is found that, the higher resolution of the GFS code, provides significant improvement in accuracy of the linear eignvalues of both drift-waves and kinetic ballooning modes (KBM). The narrowing of the access to second stability for KBM by the parallel magnetic fluctuations is strong for the low aspect ratio NSTX-U standard case. This effect is illustrated in the figure below. (J. E. Kinsey et al., submitted to Phys. Plasmas)



With only perpendicular magnetic fluctuations (Bper only) both CGYRO and GFS stabilize the KBM that is unstable with fully electromagnetic fluctuations. The narrowing of the second stability access at weak magnetic shear can be important for KBM induced transport in the central core or pedestal regions of NSTX-U.

Acknowledgements: This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences, Theory Program, using the NSTX-U Fusion Facility, a DOE Office of Science user facility, under Award DE-AC05-00OR22725. We thank the NSTX-U experimental team for providing the data analyses as well as S. Kaye, W. Guttenfelder, and G. Avdeeva for their discussions and assistance.