Geometric stabilization of the electrostatic ion-temperature-gradient driven instability

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The effects of a non-axisymmetric (3D) equilibrium magnetic field on the linear ion temperature-gradient (ITG) driven mode are investigated. We study the strongly driven, toroidal branch of the instability in a global (on the magnetic surface) setting. Non-axisymmetry is included explicitly via the dependence of the magnetic drift on the field line label, i.e. across the magnetic field, but within the magnetic flux surface. We consider the limit where this variation occurs on a scale much larger than that of the ITG mode, and also the case where these scales are similar. Close to axisymmetry [1], we find that an averaging effect of the magnetic drift on the flux surface causes global (on the surface) stabilization, as compared to the most unstable local mode. In the absence of scale separation, we find destabilization is also possible, but only if a particular resonance occurs between the magnetic drift and the mode, and finite Larmor radius effects are neglected. We discuss the relative importance of surface global effects and known radially global effects. Far from axisymmetry, a non-perturbative analysis is introduced. Surface-global effects are described by using a matrix formalism that couples local eigenvalue problems via a lattice equation. It is found that finite Larmor radius effects can suppress the global (on the surface) instability and shift its poloidal location from the position of the greatest local instability, in accordance with numerical global (on the surface) simulations [2]. Spectra of the unstable global eigenfunction whose width grows for increasingly non-axisymmetric systems are predicted and observed numerically. The application of the lattice matrix formalism to other instabilities that require flux-tube coupling is also discussed.

References

[1] Zocco A., Plunk G. G., Xanthopoulos P. and Helander P. 2016 Phys. Plasmas 23
[2] Xanthopoulos P., Plunk G. G., Zocco A. and Helander P. 2016 Phys. Rev. X 6(2) 021033