Gyrokinetic microinstability calculations in Wendelstein 7-X and other quasi-isodynamic stellarators

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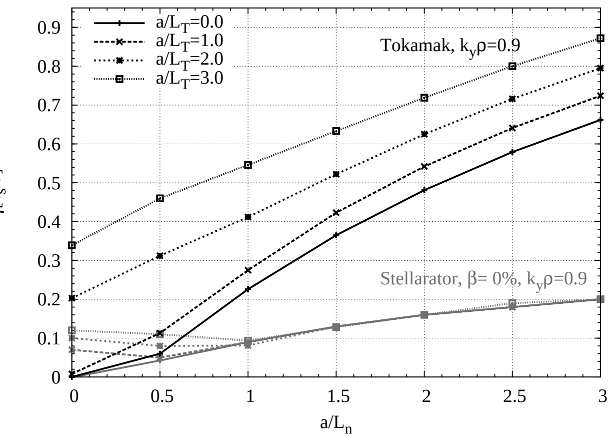
In this talk, simulation results of density- and temperature-gradient-driven microinstabilities in stellarators are presented. The focus lies on quasi-isodynamic stellarators. In these configurations all contours of constant magnetic field strength B are poloidally closed, the second adiabatic invariant J is constant on flux surfaces and peaks in the centre, and thus the diamagnetic drift frequency ω_{*a} and the bounce-averaged magnetic precession frequency $\overline{\omega_{da}}$ are in opposite directions, $\omega_{*a} \cdot \overline{\omega_{da}} < 0$. It was recently shown [1] that, thanks to this property of average "good curvature" for trapped particles, the trapped-particle instability as well as the ordinary electron-density-gradient-driven trapped-electron mode are stable in the electrostatic and collisionless approximation if the temperature gradients are not too high. This prediction follows from the finding that particles that bounce faster than the mode in question draw energy from it near marginal stability if ω_{*a} and $\overline{\omega_{da}}$ are not resonant anywhere on the flux surface. The question arises how this result translates to actual stellarators which are never perfectly quasi-isodynamic. We thus perform comparitive gyrokinetic simulations for Wendelstein 7-X, another almost perfectly quasi-isodynamic configuration [2] and a shaped tokamak (DIII-D). Comparing the two stellarators with DIII-D, we find significantly reduced growth rates in the former. The electrons are destabilising in the tokamak in contrast to the stellarators, where the electrons in most cases extract energy from ITG and TEM modes. This stabilising property is observed in Wendelstein 7-X even though the stability criterion $\omega_{*a} \cdot \overline{\omega_{da}} < 0$ is not met everywhere.



Growth rates for trapped-electron mode simulations for various gradients in DIII-D and a quasi-isodynamic stellarator

References

[1] J.H.E. Proll, P. Helander, J.W. Connor and G.G. Plunk, Phys. Rev. Lett. **108** 245002 (2012)

[2] A.A. Subbotin, M.I. Mikhailov, V.D. Shafranov, M.Yu. Isaev, J. Nührenberg, C. Nührenberg, R. Zille, V.V. Nemov, S.V. Kasilov, V.M. Kalyuzhnyj and W.A. Cooper, Nucl. Fusion **46** 921 (2006)