Nonlinear global gyrokinetic stellarator simulations of GENE-3D with kinetic electrons

Felix Wilms[1], Alejandro Bañón Navarro[1], Gabriele Merlo[2],
Leonhard Leppin[1], Tobias Görler[1], Tilman Dannert[3], Florian Hindenlang[1], Frank Jenko[1]

[1] *Max Planck Institute for Plasma Physics, 85748 Garching, Germany*

[2] *Oden Institute for Computational Engineering and Sciences, Austin,Texas 78712, USA*

[3] *Max Planck Computing and Data Facility, 85748 Garching, Germany*

Due to the advances in code development and algorithmic performance optimisation, it is possible nowadays to perform global, gyrokinetic simulations in 3-D stellarator geometry. Such studies are of extreme importance, as only they can take into account effects like radially global $E \times B$ shear or global profile shapes, which play a key role in understanding plasma confinement [1]. While studies like [2–5] paved the way for understanding global ITG turbulence in stellarators, all results presented up to this point were provided by using an adiabatic electron model. However, kinetic electron effects can play a major role in order to understand plasma performance in Wendelstein 7-X (W7-X) [6].

For this reason, GENE-3D [7] was recently upgraded to an electromagnetic stellarator turbulence code. In this contribution, we present a first application by comparing global, nonlinear simulations of ITG turbulence in Wendelstein 7-X using adiabatic and kinetic electrons, as well as simulations at finite plasma-β. After that, we present preliminary results of comparisons between simulations with different model complexity that build towards a validation of gyrokinetic theory against an ECRH discharge of W7-X.

References

[1] J. Lore et al., Physics of Plasmas **17**, 5 (2010)

[2] A. Bañón Navarro et al., Plasma Physics and Controlled Fusion **62**, 10 (2020)

[3] M. D. J. Cole et el., Physics of Plasmas **62**, 4 (2020)

[4] E. Sánchez et al., Journal of Plasma Physics **86**, 5 (2020)

[5] H. Y. Wang et al., Physics of Plasmas **27**, 8 (2020)

[6] A. v. Stechow et al., arXiv:2010.02160, 2020

[7] M. Maurer et al., Journal of Computational Physics **420**, (2020)