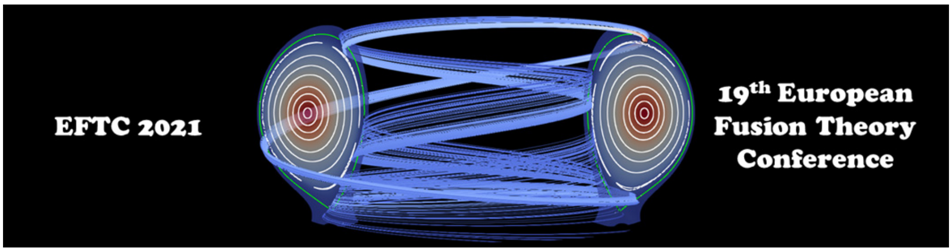

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Instabilities and turbulence in stellarators from the perspective of global codes

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Simulating global plasma instabilities and turbulence in stellarators with gyrokinetic codes is significantly more complicated and computationally expensive than in tokamaks and, partly because of this, the field is significantly less developed in stellarators than in the tokamak counterpart. The main reason is that the three-dimensional geometry of stellarators makes the flux tube model unsuitable for these devices. Consequently, simulating instabilities and turbulence in stellarators requires covering at least a full surface or a (full-surface and) radially global computational domain. The latter is the most complete computational domain and the most expensive in terms of the computational cost of the simulations. In order to reach a predictive capability, simulation codes require their verification through comparisons between different codes and against theoretical models and their validation against experimental measurements. In this contribution, we address the verification of two global gyrokinetic delta-f codes specifically designed for three-dimensional geometries, EUTERPE and GENE-3D. EUTERPE was developed as a linear code and afterward was extended incorporating non-linear saturation mechanisms, different models for kinetic electrons and impurities, and electromagnetic effects. GENE-3D has recently been extended to include electromagnetic effects. For this verification activity, we use two magnetic configurations, the standard configuration of the helical device LHD and a configuration of the optimized stellarator W7-X. We tackle several problems with different levels of complexity, from linear simulations with adiabatic electrons to non-linear or multi-species simulations. In addition, we also study two problems that are of particular relevance for stellarators and for which the global codes are well suited: the spatial localization of instabilities and turbulence and the influence of a long-wavelength radial electric field on them. A thorough comparison of results from both codes is performed, finding a very good agreement between them.

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