Electrostatic gyrokinetic simulations in Wendelstein 7-X geometry: benchmark between the codes `stella` and `GENE`

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Experimental results in the first campaigns [1, 2] of Wendelstein 7-X (W7-X) have shown that, due to the optimization of the magnetic configuration with respect to neoclassical transport, turbulence is essential to understand and predict the total particle and energy fluxes. This has motivated much work on gyrokinetic modelling in order to interpret the already available experimental results and to prepare the next experimental campaigns. At the same time, new stellarator gyrokinetic codes, which due to the complexity of the equations they solve require the use of High Performance Computing (HPC), have just been or are being developed. Thus, it is desirable to have a sufficiently complete, documented and well-verified set of linear and nonlinear gyrokinetic simulations in W7-X geometry against which new codes or upgrades of existing codes can be tested and benchmarked. This work [3] is an attempt to provide such a set of simulations through a comprehensive benchmark between the recently developed code `stella` [4] and the well-established code `GENE` [5] in W7-X geometry. It consists of linear and nonlinear collisionless electrostatic flux-tube simulations, organized into five different 'tests'. They include stability analyses of linear ion-temperature-gradient modes and density-gradient-driven trapped-electron modes, computation of the collisionless relaxation of zonal potential perturbations and calculation of heat fluxes driven by ion-temperature-gradient turbulence. As different magnetic field lines are not equivalent in stellarator geometry, simulations in two different flux tubes are provided, pointing out the similarities and differences between the stability features in both of them.

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