Turbulent transport of impurities in multispecies stellarator plasmas

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Numerical simulation of gyrokinetic plasma turbulence and several of its major achievements have been made possible thanks to the large capacity for calculation of modern High Performance Computing (HPC) platforms. The computational cost of solving the gyrokinetic system of equations is particularly high, even for electrostatic turbulence in the flux tube approximation, when several species with disparate masses are accounted for. Moreover, the three-dimensional plasma geometry of stellarators adds extra demands to the gyrokinetic calculations performed for these devices. One must typically consider a larger spatial domain than just a flux tube extended along one poloidal turn, as done in general for axisymmetric tokamak equilibria. Furthermore, it becomes necessary to set finer grids to appropriately resolve, in the phase space, the dynamics of the different populations of trapped particles and accurately capture their role on the driven turbulence.

For the reasons mentioned above, the feasibility of performing multispecies gyrokinetic simulations in stellarator configurations and, in particular, of scanning the space of plasma parameters has been very limited so far. The present contribution contains one of the very few numerical analyses in that line, specifically, to study the turbulent transport of impurities in the Wendelstein 7-X stellarator [1]. The transport of several impurity species at various concentration values is assessed in the presence of different background turbulence. The results are obtained by means of linear and nonlinear simulations carried out with the recently developed δf gyrokinetic code `stella` [2] in its flux tube version. The code uses a mixed implicit-explicit algorithm that greatly reduces, compared to fully explicit schemes, the necessary computational resources. The advantages of this approach and its potential for the research on stellarator gyrokinetic turbulence will also be discussed.

References

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[2] M. Barnes, F. I. Parra and M. Landremann.*stella: An operator-split, implicit-implicit δf-gyrokinetic code for general magnetic field configurations* J. Comp. Phys. **391** 365 (2019).