Gyrokinetic simulations of plasma microturbulence in a quasi-steady state regime

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ITER performance is strongly affected by the level of turbulent transport. The heat flux and particle transport from core to edge are responsible for the degradation of the plasma confinement. The actual models for turbulent transport in ITER are based on scaling law extrapolated from experimental data, rather than a proven and justified transport model. Numerical simulations based on the gyrokinetic equations are fundamental tools in the quest for finding such a model. They provide us with a deeper insight on turbulent transport mechanisms and they will eventually allow us to simulate discharges in ITER.

In previous works, we have shown how gyrokinetic simulations can enlighten open questions such as the improving confinement with increasing plasma current. In this case, the simulations indicate a mechanism based on the paradigm of turbulence self regulation by zonal ExB flows as explanation for the scaling of ion heat flux with the total plasma current. A limiting factor in this analysis was the absence of heat sources in the model. The problem was thus equivalent to a shut down of the plasma heating power, with a decaying turbulence left. Recent improvements in noise control and the introduction of heat sources in the model make it possible to run simulations of quasi-steady state turbulence. These simulations, compared to the previously available ones with decaying turbulence, allow us for a more rigorous statistic analysis of turbulent transport. We present a comparison of strategies for driving turbulence implemented in the semi-Lagrangian code GYSELA and the gyrokinetic Lagrangian code ORB5 and their application to the study of problem such as the scaling of turbulent transport with the total plasma current. The particular interest resides in the fact that both codes solve the same set of equations, therefore a direct test and comparison of two substantially different numerical schemes is possible. The benchmark presented, besides representing a necessary step in the validation of the codes, allow us to identify the weakness of each approach and they constitute a guide for further improvements.