Stellarator turbulence simulation in Europe: a tour of its latest achievements

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Two types of devices represent the most promising concepts as magnetic confinement fusion reactors: tokamaks, such as ITER, and stellarators, with Wendelstein 7-X (W7-X) [1] being the largest example operated to date. Both devices rely on generating a strong magnetic field with toroidal geometry for the confinement of the energy and particles of a hydrogen plasma. Collisions between the different species constituting the plasma, along with the inhomogeneity of the confining magnetic field, give rise to the so-called *neoclassical* heat and particle losses. At reactor-relevant conditions, these losses are much larger in generic stellarators than in tokamaks due to the inherent 3D structure of the former. However, optimization towards reduced neoclassical losses have become routine in stellarator design, mainly after its application to the design of W7-X, which has been demonstrated in experiments [2]. As a consequence, microturbulence, driven by Larmor scale fluctuations of the electromagnetic fields, has gained substantial relevance as its associated losses typically exceed the neoclassical levels in neoclassically optimized stellarators [3].

The system of equations obeyed by microturbulence in strongly magnetized plasmas, also known as gyrokinetic equations, can only be solved through numerical simulation for experimentally relevant cases. In addition, the high computational cost of handling 3D geometries has hindered the development of gyrokinetic codes for stellarators in the past and made the understanding of their turbulence to lag behind that for tokamaks. However, the factors above-mentioned and the greater numerical capacity have recently converged, leading to a rapid development and exploitation of stellarator gyrokinetic codes. Much of this effort is addressed in the context of the project *TSVV#13: Stellarator Turbulence Simulation* of the EUROfusion-Theory and Advanced Simulation Coordination (E-TASC) programme. [4] In the present contribution the main achievements in stellarator turbulence simulation will be reviewed, with particular emphasis on those delivered by the TSVV#13 project.

References

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