BSTING: fluid turbulence simulations in stellarators

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Wendelstein 7-X has been optimized for neoclassical transport and recent experimental observations [1] indicate that turbulence can contribute to significant radial transport, especially at the edge. Novel edge and scrape-off-layer (SOL) physics have been observed in the first experimental campaign. Edge filaments [2] and high frequency heat flux variations [3] are among many new observations which merit numerical investigation. While there are several edge fluid turbulence frameworks for tokamak geometries, the complicated nature of a stellarator edge and scrape-off-layer has as yet inhibited the development of a fluid turbulence framework for stellarator geometries. One of these simulation frameworks written for tokamak geometries, BOUT++ [4], is also able to simulate phenomena such as ELMs, magnetic reconnection, plasma transport and neutral interaction. The BSTING project [5] has extended BOUT++ to stellarator geometries, thereby providing the first nonlinear fluid simulation framework for non-axisymmetric geometries.

Here we outline recent developments in the BSTING project, including a newly implemented curvilinear grid system suitable for stellarator edge magnetic topology, and present simulations of plasma filaments in stellarator geometries [5].

Stellarator-relevant simulations of filaments in simplified geometries are also presented, including verification of simulated filaments in W7-X-like scenarios which yield remarkable agreement to experimental observations [6]. We also present simulations of filaments in regions of highly-varying connection length [7] and nonuniform curvature [8], both features of the W7-X SOL. Finally, a discussion the relevance and application of these methods to Wendelstein 7-X edge turbulence scenarios is provided.

References

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