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Progress in 5-Dimensional Plasma Turbulence Simulations of Fusion Energy Devices[1]

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There has been interesting progress recently in the development of 5-dimensional gyrokinetic codes for simulating turbulent transport in magnetic fusion [1-3]. The mechanisms driving this turbulence will be illustrated with intuitive physical pictures and visualizations from the simulations. This will also give insight into methods to reduce this turbulence that are being studied in experiments. 5-dimensional plasma turbulence is a very challenging problem, but these codes have been made feasible by the exponential growth in computing power, and, equally importantly, by advanced algorithms. These algorithms include the gyrokinetic equations themselves (a rigorous expansion of the full equations that average over high-frequency gyromotion while retaining nonlinearities), along with computational techniques such as spectral methods, higher-order algorithms, efficient field-aligned coordinates, and implicit techniques. The most comprehensive of these codes now include all of the effects thought important for realistic calculations of the drift-wave turbulence that occurs in the core region of tokamaks: fully gyrokinetic ions and electrons, magnetic and electric fluctuations, etc., and they are being heavily used to study turbulent transport in fusion devices. This talk will conclude with a description of remaining challenges, including multiscale couplings and the complexity of turbulence in the edge region of fusion devices.

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3. Y. Chen, S.E. Parker, B.I. Cohen, A.M. Dimits et al., Nucl. Fus. 43, 1121 (2003)

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