4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Direct Gyrokinetic Quasilinear Modeling of Microtearing Transport

T. Xie, M. J. Pueschel, D. R. Hatch
Institute for Fusion Studies, University of Texas at Austin
e-mail (speaker): Tao.Xie@austin.utexas.edu

Gyrokinetic turbulence simulations are commonly used to investigate fundamental physics and predict transport in fusion devices. However, their computational intensity results in the need for fast but reliable reduced models for important applications such as profile evolution, real-time control, or optimization. Quasilinear mixing-length models have been deployed successfully for many turbulence regimes, but never for microtearing (MT) turbulence. This electromagnetic instability can drive turbulence under many conditions, such as in the tokamak core, spherical tokamaks, reversed-field pinches, or the H-mode pedestal; in the latter, it has been clearly identified in magnetic fluctuation data and affects the evolution of the electron temperature profile.

It is shown here for the first time that a quasilinear model based on linear gyrokinetic simulations is able to reproduce nonlinear trends of MT transport. To this end, the quasilinear approach $\chi = \sum_k C_k w_k \frac{\gamma_k}{\langle k_\perp^2 \rangle}$ is used here to describe MT-based magnetic flutter heat diffusivity, heuristically replacing the electrostatic potential φ with the sum of φ^2 and the vector potential $A_\parallel^2$ in both the quasilinear weight $w_k = \frac{Q_k}{(\varphi_k + A_{\parallel,k})}$ and in the flux surface average $\langle \cdots \rangle$ with weight $\varphi^2 + A_\parallel^2$. The quasilinear estimates are then compared with nonlinear heat fluxes based on the parameter case in Ref.[1] while varying the electron temperature gradient, collisionality, and plasma beta, showing good predictive performance of the model.

Reference

[1] H. Doerk *et al.*, Phys. Rev. Lett. **106**, 155003 (2011).