45th EPS Conference on Plasma Physics

Explaining Cold-Pulse Dynamics in Tokamak Plasmas using Local Turbulent Transport Models

P. Rodriguez-Fernandez[1], A.E. White[1], N.T. Howard[1], B.A. Grierson[2], G.M. Staebler[3], J.E. Rice[1], X. Yuan[2], N.M. Cao[1], A.J. Creely[1], M.J. Greenwald[1], A.E. Hubbard[1], J.W. Hughes[1], J.H. Irby[1], F. Sciortino[1]

[1]*MIT Plasma Science and Fusion Center, Cambridge, USA*
[2]*Princeton Plasma Physics Laboratory, Princeton, USA*
[3]*General Atomics, San Diego, USA*

It has been observed for more than twenty years that rapid edge cooling of fusion plasmas triggers core electron temperature increases on timescales faster than a diffusion time, and that the effect disappears as plasma density is increased. These temperature inversions have been interpreted as strong evidence of nonlocal transport, and have therefore challenged the local transport paradigm encapsulated in predictive electromagnetic drift-wave turbulent transport models. In this work, the TRANSP power balance code coupled with the quasilinear transport model TGLF-SAT1 [1], with a new saturation rule motivated by cross-scale coupling physics and that captures the nonlinear upshift of the critical gradient, are shown to fully describe the cold-pulse phenomenology [2]. The TGLF-SAT1 model is able to quantitatively capture the prompt onset of the core electron temperature inversion, with a magnitude that is qualitatively consistent with experimental trends, as well as the disappearance at high-density. These new results provide further confidence that local transport models can be used to reliably predict plasma behavior in future tokamaks, such as ITER.

[1] G.M. Staebler et al., 2017 Nucl. Fusion 57 066046
[2] P. Rodriguez-Fernandez et al., Phys. Rev. Lett. 120, 075001 (2018)

This work was supported by U.S. Department of Energy Award No. DE-FC02-99ER5451, using Alcator C-Mod, a DOE Office of Science User Facility. P.R.F. was also supported by U.S. Department of Energy Award No. DE-SC0014264 and a La Caixa Fellowship.