Nonlinear Gyrokinetic Simulations of Electron Internal Transport Barriers in the National Spherical Torus Experiment*

J. Luc Peterson,[1] G. W. Hammett,[1] D. R. Mikkelsen,[1] H. Y. Yuh,[2] R. Bell,[1] J. Candy,[3] E. Mazzucato,[1] S. M. Kaye,[1] B. LeBlanc,[1] D. R. Smith,[4] and R. E. Waltz[3]

[1]*Princeton Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08543, USA*
[2]*Nova Photonics Inc., Princeton, New Jersey 08540, USA*
[3]*General Atomics, San Diego, California 92186-2608, USA*
[4]*Department of Engineering Physics, University of Wisconsin-Madison, Madison, Wisconsin 53706, USA*

Observations in the National Spherical Torus Experiment (NSTX)[1] have found electron temperature gradients that greatly exceed the linear onset for electron temperature gradient-driven (ETG) turbulence. These discharges, deemed electron internal transport barriers (e-ITBs), coincide with a reversal in the shear of the magnetic field and with a reduction in electron-scale density fluctuations. To investigate this phenomenon further, we numerically model electron turbulence in NSTX reversed-shear plasmas using the gyrokinetic turbulence code GYRO[2]. Our simulations confirm that reversing the magnetic shear can allow the plasma to reach maximum electron temperature gradients well beyond the critical gradient for the linear onset of instability. Additionally, at large temperature gradients with reversed shear, we find that linearly sub-dominant off-midplane radial streamers can emerge, which alter the structure and transport levels of the saturated state. The strong nonlinear upshift in the critical gradient for transport could not only help explain the observation of e-ITBs in NSTX, but could also have implications for using reversed shear to control turbulent heat transport and enhance electron confinement in future fusion devices.

[1] M. Ono et al., Nucl. Fusion **40**, 557 (2000).
[2] J. Candy and R. E. Waltz, J. Comput. Phys. **186**, 545 (2003).

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