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Comprehensive Gyrokinetic Simulations of Turbulent Transport in DIII-D with the GYRO Code[1]

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The Eulerian gyrokinetic code GYRO[2] now operates with all its planned features: ITG physics with trapped and passing electrons, finite-beta fluctuations, collisions, shaped plasma geometry, as well as equilibrium $\mathbf{E} \times \mathbf{B}$ and profile variation. While in principle a full-radius, full-torus code, GYRO can simulate any radial subdomain ($r_a < r < r_b$), with variable toroidal mode spacing ($n = 0;\ \Delta n;\ 2\Delta n;\ \ldots$), using quasi-periodic flux-tube or multilayer nonperiodic radial boundary conditions. In the nonperiodic case, radial profile variation is allowed, and an adaptive source is required to maintain the equilibrium driving gradients. An important result is that we can systematically recover gyroBohm-scaled transport in the small-ρ_* limit ($\rho_* = \rho_i/a$) with both quasi-periodic and non-periodic boundary conditions.[3] In this limit, we also reproduce in detail the nonlinear, flux-tube Cyclone benchmarks.[4] GYRO has most recently been used to simulate actual DIII-D plasmas, and reproduces the near-Bohm scaling seen in dimensionally matched L-mode discharges. In these simulations, the effect of equilibrium $\mathbf{E} \times \mathbf{B}$ rotational shear is very large, and the levels of energy transport — which are close to the experimental values — are substantially lower than that found from local flux-tube simulations.

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[2]J. Candy and R.E. Waltz, *An Eulerian Gyrokinetic-Maxwell Solver*, to appear in J. Comput. Phys.
[3]R.E. Waltz, J. Candy and M.N. Rosenbluth, Phys. Plasmas **9** (2002) 1938.
[4]A.M. Dimits, *et al.*, Phys. Plasmas **7** (2000) 969.