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Predictive Gyrokinetic Transport Simulations and Application of Synthetic Diagnostics[1]

J. CANDY, General Atomics

In this work we make use of the gyrokinetic transport solver TGYRO [1] to predict kinetic plasma profiles consistent with energy and particle fluxes in the DIII-D tokamak. TGYRO uses direct nonlinear and neoclassical fluxes calculated by the GYRO and NEO codes, respectively, to solve for global, self-consistent temperature and density profiles via Newton iteration. Previous work has shown that gyrokinetic simulation results for DIII-D discharge 128913 match experimental data rather well in the plasma core, but with a discrepancy in both fluxes and fluctuation levels emerging closer to the edge ($r/a > 0.8$). The present work will expand on previous results by generating model predictions across the entire plasma core, rather than at isolated test radii. We show that TGYRO predicts temperature and density profiles in good agreement with experimental observations which simultaneously yield near-exact (to within experimental uncertainties) agreement with power balance calculations of the particle and energy fluxes for $r/a \leq 0.8$. Moreover, we use recently developed synthetic diagnostic algorithms [2] to show that TGYRO also predicts density and electron temperature fluctuation levels in close agreement with experimental measurements across the simulated plasma volume.

[1] J. Candy, C. Holland, R.E. Waltz, M.R. Fahey, and E. Belli, "Tokamak profile prediction using direct gyrokinetic and neoclassical simulation," Phys. Plasmas **16**, 060704 (2009).
[2] C. Holland, A.E. White, G.R. McKee, M.W. Shafer, J. Candy, R.E. Waltz, L. Schmitz, and G.R. Tynan, "Implementation and application of two synthetic diagnostics for validating simulations of core tokamak turbulence," Phys. Plasmas **16**, 052301 (2009).

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