The Relevance of the Parallel Nonlinearity in Gyrokinetic Simulations of Tokamak Plasmas

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Abstract

The influence of the parallel nonlinearity on transport in gyrokinetic simulations is assessed for values of ρ_* which are typical of current experiments. Here, $\rho_* = \rho_s/a$ is the ratio of gyroradius, ρ_s, to plasma minor radius, a. The conclusion, derived from simulations with both GYRO [J. Candy and R.E. Waltz, J. Comput. Phys. **186**, 585 (2003)] and GEM [Y. Chen and S.E. Parker J. Comput. Phys. **189**, 463 (2003)] is that no measureable effect of the parallel nonlinearity is apparent for $\rho_* < 0.012$. This result is consistent with scaling arguments which suggest that the parallel nonlinearity should be $\mathcal{O}(\rho_*)$ smaller than the $\mathbf{E}\times\mathbf{B}$ nonlinearity. Indeed, for the plasma parameters under consideration, the magnitude of the parallel nonlinearity obeys the scaling law $|\mathrm{RHS}_{\mathrm{PNL}}| \sim 8\rho_* |\mathrm{RHS}|$, where RHS is the total right-hand side of the gyrokinetic equation, and $\mathrm{RHS}_{\mathrm{PNL}}$ is the contribution from the parallel nonlinearity.

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