Linear and Nonlinear Verification of Gyrokinetic Microstability Codes

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Verification of nonlinear microstability codes is a necessary step before comparisons or predictions of turbulent transport in toroidal devices can be justified. By verification we mean demonstrating that a code correctly solves the mathematical model upon which it is based. Some degree of verification can be accomplished indirectly from analytical instability threshold conditions, nonlinear saturation estimates, etc. for relatively simple plasmas. However, verification for experimentally relevant plasma conditions and physics is beyond the realm of analytical treatment and must rely on code-to-code comparisons, i.e., benchmarking. Here we present comparisons, both linear and nonlinear, between the gyrokinetic codes GYRO and GS2. We do so at two radii, r/a = 0.5 and 0.7 (a is the minor radius), for the same discharge as in earlier work.* The comparisons include electromagnetic fluctuations, passing and trapped electrons, plasma shaping, one impurity, and finite Debye-length effects at the highest k_θ. However, **E**×**B** flow shear is neglected and $\rho^* \equiv \rho_s/a$ is assumed vanishingly small (ρ_s is the sound-speed ion gyroradius). Results neglecting and including e-i collisions (Lorentz model) are presented. Except for the collisional nonlinear results at r/a = 0.7, we find good agreement between the codes for the linear frequencies and nonlinear fluxes at both radii and for both collision models. Therefore, we have formulated four linear and three nonlinear benchmarks with significantly different plasma parameters that other codes can seek to meet.

*C. Holland, A. E. White, G. R. McKee, M. W. Shafer, J. Candy, R. E. Waltz, L. Schmitz, and G. R. Tynan, Phys. Plasmas **16**, 052301 (2009)