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Long time simulations of microturbulence[1]

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Physics and numerical issues associated with the long time simulations of microturbulence are addressed in the present paper. Firstly, the applications of the Fluctuation-Dissipation Theorem for the noise properties in a nonlinearly saturated system and their subsequent verifications using gyrokinetic particle simulation are discussed. The important finding here is that discrete particle noise, when using insufficient number of particles, will always enhance the transport. Secondly, the use of the global toroidal gyrokinetic particle simulation code (GTC) [1] for investigating the long time behavior of microturbulence is presented. The central issues are: 1) what are the nonlinear physics that are responsible for the steady state turbulence and 2) their numerical convergence and noise properties. The physics focus here is on the ion temperature gradient (ITG) drift turbulence. The effects of the often-neglected velocity space nonlinearity [1] on the production of zonal flow, energy conservation, the evolution of the steady state turbulence and, consequently, the resulting thermal transport are studied. The convergence studies using very large number of particles per cell (from 10 to 1000) have also shown that numerical noise play very insignificant role in the observed steady state thermal transport. This work is supported by the DoE SciDAC GPS Center.

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[2] W. W. Lee, Bull. Am. Phys. Soc. Bull. Am. Phys. Soc. <49>, No. 8, 135 (2004).

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