Gyrokinetic Particle-In-Cell Calculations of Ion Temperature Gradient Driven Turbulence with Parallel Nonlinearity and Strong Flow Corrections*

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Abstract

Nonlinear gyrokinetic calculations have been performed with the three-dimensional, global, toroidal, particle-in-cell, delta-f, UCAN code[1] to study the effects of parallel nonlinearity and strong (externally imposed) flow corrections on ion temperature gradient driven turbulence. These calculations are electrostatic and adiabatic electrons are used. An equilibrium ion temperature gradient only is imposed, along with a generic parabolic q-profile appropriate to a large aspect ratio tokamak. The strong flow corrections derived by T. S. Hahm[2] have been added to the usual orbit and weight equations used in the UCAN code. The parallel nonlinearity[3] has been reactivated as well in the same equations. To examine the effect of strong flow corrections, the calculations have been performed with fluctuations-generated flows or zonal flows arbitrarily set to zero but with externally imposed sheared flows obeying a variety of profiles more or less localized in radius and with various flow magnitudes. The calculations show that the strong flow corrections have a qualitative effect on the saturation level of the fluctuations and on the steady-state heat flux even at the highest flow magnitudes used. The calculations with the re-activated parallel nonlinearity have been performed with no externally imposed flow but with fluctuations-generated or zonal flows allowed to self-consistently evolve. The parallel nonlinearity makes a quantitative difference in the saturation level of the fluctuations and in the saturated flux, as reported by Villard and colleagues[3]. This difference does however appear to diminish as the system size is increased at fixed ion gyroradius. Results of convergence studies with increasing system size and with varying degrees of self-similarity in profiles and parameters will be presented.

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