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Multiscale Phenomena in Gyrokinetic Turbulence Simulations

W.W. LEE, R. KOLESNIKOV, S. ETHIER, Princeton Plasma Physics Laboratory, R. GANESH, Institute of Plasma Research, India — Through a simple iterative procedure for obtaining the higher order $\mathbf{E} \times \mathbf{B}$ drift and $d\mathbf{E}/dt$ (polarization) drift associated with a single particle motion, we will show that the commonly used gyrokinetic Vlasov-Poisson equations are valid in the long wavelength limit of $k_{\perp}\rho_i \sim o(\epsilon)$ and $k_{\perp}L \sim o(1)$, where ρ_i is the ion gyroradius, L is the scale length of the background inhomogeneity and ϵ is a smallness parameter. This conclusion differs from some recent investigations that questioned the validity of these equations in the long wavelength limit. Moreover, using the gyrokinetic turbulence code (GTC) based on these original gyrokinetic equations in global toroidal geometry, we will show that the velocity space nonlinearity associated with parallel acceleration not only gives rise to the formation of global zonal flows with $k_{\perp}L \sim o(1)$, but also enhances the fluctuations of the long wavelength low m global geodesic acoustic modes (GAM). The amplitude of these modes and the resulting ion thermal flux in the nonlinearly saturated state remain unchanged even if the global relaxation of the background profiles is taken into account in the δf simulation. The effect on the zonal flows from the terms of $o(k_{\perp}^2\rho_i^2)$ and $k_{\perp}L \sim o(1)$ due to the difference between the guiding center and the gyrocenter densities in the presence of spatial inhomogeneities for the background Maxwellian will also be discussed.

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