Profile Relaxation Effects in Ion Temperature Gradient Drift Turbulence Simulations

W. W. Lee

Princeton Plasma Physics Laboratory, Princeton University, Princeton, NJ 08543

The common wisdom in magnetic fusion community is that ion temperature gradient (ITG) drift modes are very sensitive to small changes, i.e., very stiff to local temperature and density gradients. Therefore, it has been widely suspected that global gyrokinetic simulations using the δf Particle-in Cell (PIC) scheme [1] suffer from profile relaxation in the nonlinear stages of the simulation, unless an energy source is added in the simulation. Some believed that this relaxation was responsible for the low levels of ion thermal diffusivity observed in these simulations. To explore this question, we have used the global gyrokinetic code, GTC [2, 3] to test the sensitivity of the profile modification caused by self-consistent energy diffusion. By monitoring the actual profile relaxation during the course of the simulation, it is found that this type of relaxation for the δf simulation [4] has negligible effects on the steady state transport for the ions. Instead, the results seem to indicate that turbulence properties in the steady state are mostly determined by the linear (initial) profiles rather than the nonlinearly modified ones. Furthermore, in the nonlinear state, the free energy source in these simulations seemed to become inaccessible to the particles due to the existence of turbulence. In all these simulations, we have included both the nonlinearly-generated zonal flows and the parallel velocity-sapce nonlinearity which were shown to be the essential ingredients for global steady state turbulent transport [5]. In order to verify these δf simulation results, we have also initiated the simulations using the full-F version of the new GTS code in more realistic geometry [6]. Such an approach not only affords us the capability of using the sources and sinks in the simulation, but also may shed some light on the real origin of turbulent steady state transport observed in the simulation. Detail results will be reported.

The work is supported by DoE contract DE-AC02-76-CHO3037, the SciDAC GPS Project (FY05-07) and the OASCR MMRE MultiScale Gyrokinetics Project (FY06-08).

[1] S. E. Parker, and W. W. Lee, Phys. Fluids B **5**, 77 (1993).

[2] Z. Lin, T. S. Hahm, W. W. Lee, W. M. Tang and R. White, *Science*, **281**, 1835 (1998).

[3] S. Ethier, W. M. Tang, and Z. Lin, J. Phys.: Conf. Series **16**, 1 (2005).

[4] R. Ganesh, W. W. Lee, S. Ethier, W. X. Wang and J. Manickam, Sherwood (2008).

[5] W. W. Lee, S. Ethier, R. Kolesnikov, W. X. Wang and W. M. Tang, PPPL Report No. 4275, submitted to IOP Journal of Computational Science and Discovery (2008).

[6] W. X. Wang et al., Phys. Plasmas **13**, 092505 (2006).