Ion and electron dynamics in nonlinear PIC simulations

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Gyrokinetic codes are powerful tools for studying microinstabilities, which are commonly held responsible for anomalous transport. Different codes relying on different techniques are used to solve the Vlasov-Poisson system in the gyrokinetic limit, such as Eulerian, semi-Lagrangian or PIC codes. The latter method has the the main disadvantage to introduce statistical noise in the simulations, which can reduce the turbulent transport, as shown in [1].

This talk will describe the latest improvements in the gyrokinetic, global, collisionless code ORB5 [2]. Recently, many efforts have been done to achieve energy conservation, such as the implementation of a diagonal Fourier filter. In this context, the benefic influence of this filter on the energy conservation, which is one of the most important indicator of the quality of the simulation, will be demonstrated. This filter has the property of eliminating unphysical, high parallel Fourier components from the density spectrum. As a result, the time step of the simulation can be strongly increased, while at the same time the number of markers required for a given accuracy is reduced.

Moreover, benchmarks with the CYCLONE base case will be presented for ITG simulations. Additional aspects will be discussed, such as the role of the perturbation initialisation and the influence of geometrical effects.

Finally, the influence of noise on ETG simulations will be discussed through a new noise diagnostics: results show that the discrete particle noise scales with the number of particles per mode kept in the Poisson equation and not with the number of particle per grid cell. Therefore, the use of the diagonal filter reduces by order if magnitudes the number of computational particles required for realistic low noise ETG simulations.

References

[1] W. N. Nevins *et al.*. Phys. of Plasmas **12**, 122305 (2005).

[2] T. M. Tran *et al.*. Theory of Fusion Plasmas, Int. Workshop, 45. Editrice Compositori, Societá italiana di Fisica, Bologna, 1999.