Global Nonlinear Gyro-kinetic Simulations in Tokamaks

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Recent global particle-in-cell (PIC) simulations of electron temperature gradient (ETG) turbulence yielded a much lower level of anomalous transport as compared to local flux tube continuum codes [Z.Lin, PoP **12**, 056124 (2005)]. Two possible mechanisms have been proposed to justify this discrepancy: new physics effects associated with toroidal mode coupling [Lin] and the influence of the non-physical statistical noise due to the particle discretisation [W.N. Nevins, PoP **12**, 122305 (2005)]. The latter paper shows that in PIC simulations a large level of noise can reduce the ETG turbulence induced transport.

During the last years, a large effort has been made in Europe to achieve low noise global PIC simulations. In particular, the global gyro-kinetic electrostatic code ORB5 uses several techniques of noise reduction, including optimised particle loading, control variates method and Fourier filtering. The code has diagnostics to measure directly the influence of the noise, and in addition also uses basic physical conservation properties (energy and particle number) as indicators of the quality of the numerical simulations. Therefore, the code ORB5 is a perfect tool for addressing the problem of the influence of the statistical noise in global GK simulations and to resolve the apparent contradiction between PIC and continuum simulations. This paper will present global PIC simulations of ITG and ETG simulations as well as the discussion on noise and conservation properties.