Global Turbulence Simulations of CYCLONE Base Case and MAST Plasmas

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Micro-instabilities are believed to underlie turbulent transport in tokamaks. The main benchmark for different turbulence theories and numerical codes was carried out under the CYCLONE project in the US and the CYCLONE base case equilibrium has been used to benchmark both local and global codes for ion temperature gradient (ITG) driven microturbulence.

The electron response has usually been assumed to be adiabatic in ITG simulations due to computational requirements for simulating the kinetic electron response. Using a global gyrokinetic PIC code ORB5 and including the trapped electron physics we show that the stability threshold in CYCLONE base case is shifted to a lower level of temperature gradient (R/L_T) from the adiabatic electron case. Therefore, the ITG transport in real plasmas should be higher than what most simulations using adiabatic electron response predict. These computations were performed on a Cray XT4 supercomputer (HECToR, Edinburgh) requiring 120 hours on 1024 processors.

We also use the CYCLONE base case to the test two fluid global electromagnetic code CUTIE against previously obtained results from electrostatic codes [1]. The difference to other codes is the inclusion of electromagnetic effects that makes it possible to destabilise MHD modes in the simulation. However, CUTIE reproduces the turbulence saturation at the same value of R/L_T as the electrostatic codes.

Micro-instabilities have been extensively studied using local gyrokinetic flux tube codes. However, global effects can also affect local stability properties. Therefore, we investigate the differences in ITG stability with adiabatic and kinetic electron response using ORB5 and local flux tube eigenvalue code GS2 for a variety of plasma equilibria. We vary the $\rho_* = \rho_i/a$ parameter to show how the global simulation approaches the local simulation as ρ_* decreases. As a spherical tokamak has a higher value of ρ_* than a conventional tokamak, global effects are expected to be important. Results of a comparison of turbulence simulations for MAST L-mode plasma using the ORB5 and GS2 codes will also be presented.

[1] A.M. Dimits et al. Phys. Plasmas **7** (2000) 969.

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