1st Asia-Pacific Conference on Plasma Physics, 18-23, 09.2017, Chengdu, China

Nonlinear gyrokinetic simulation of ITG turbulence based on a numerical Lie-transform perturbation method

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Turbulence transport plays an important role in the magnetic confinement tokamak plasmas. The particle and energy transport due to turbulence is significantly larger than that computed from the neoclassical collisional transport theory in tokamak plasmas. Turbulence transport in tokamak is commonly related to microinstabilities which is driven by temperature and density gradients. The micro-scale turbulence is generally investigated by the nonlinear gyrokinetic theory and simulation. Recently, the global gyrokinetic code NLT [1] in terms of the magnetic coordinates has been developed, which is based on a special numerical Lie-transform perturbation method, called the I-transform perturbation method [2-5]. The character of the I-transform method used in the NLT code is to decouple the perturbation part of the gyrocenter motion from the unperturbed motion, which makes the 4D interpolation in the fixed points become possible. The high-dimensional interpolation in the fixed points has been successfully used in the gyrokinetic code NLT. [6] The NLT code has been verified by the linear geodesic acoustic mode test and the linear ITG cyclone test. [1] The electrostatic gyrokinetic nonlinear turbulence code NLT is developed for numerically studying turbulence transport in tokamak plasmas. For improving the computational efficiency and avoiding the numerical instabilities, field-aligned coordinates and a Fourier filter are adopted in the NLT code. Nonlinear tests of ITG turbulence with adiabatic electrons are performed for verifying the NLT code by comparing with other gyrokinetic codes, such as GENE and ORB5. The time evolution of the ion heat diffusivity and the relation between the ion heat diffusivity and the ion temperature gradient are compared in the nonlinear tests. Good agreements are achieved from the nonlinear benchmarks between the NLT code and other codes. In addition, different phases of mode structures of the perturbed electric potential have been simulated.

References

[1] L. Ye, Y. Xu, X. Xiao, Z. Dai, and S. Wang, J. Comput. Phys. **316**, 180 (2016).
[2] S. Wang, Phys. Plasmas **19**, 062504 (2012).
[3] S. Wang, Phys. Rev. E **87**, 063103 (2013).
[4] S. Wang, Phys. Plasmas **20**, 082312 (2013).
[5] Y. Xu, Z. Dai, and S. Wang, Phys. Plasmas **21**, 042505 (2014).
[6] X. Xiao, L. Ye, Y. Xu, and S. Wang, Commun. Comput. Phys. in press (2017).