The electromagnetic gyrokinetic simulations of ITG and TEM instability in finite-β tokamak plasmas

Guodong Zhang[1,2], Jinxiang You[2], Zihao Wang[2], Lu Wang[1] and Shaojie Wang[2,a)]

[1]*International Joint Research Laboratory of Magnetic Confinement Fusion and Plasma Physics, State Key Laboratory of Advanced Electromagnetic Technology, Huazhong University of Science and Technology*

[2]*Department of Engineering and Applied Physics, University of Science and Technology of China, Hefei, 230023, China*

Electronic mail: wangsj@ustc.edu.cn

1. Introduction

The gyrokinetic codes have become powerful tools to investigate the turbulent transport in tokamak plasmas. After decades of development, the corresponding codes now have the ability to simulate the electromagnetic turbulence. In recent years, the semi-Lagrangian gyrokinetic Numerical Lie Transform (NLT) code has made a series of progress in electrostatic case [1]. In this work, the electromagnetic version is developed and used to perform linear simulations in finite-β case, where β is defined as the ratio of the tokamak plasma kinetic pressure to the magnetic pressure. The linear 2D eigenmode structures of electromagnetic ion temperature gradient (ITG) mode and trapped electron mode (TEM) simulated by NLT are reported in this work. By comparing the mode structures of ITG mode and TEM simulated by NLT and Gyrikinetic Electromagnetic Numerical Experiment (GENE) [2], it indicates that the electromagnetic version of NLT for finite-β simulations is basically accurate and reliable. Further benchmark with scanning toroidal mode number n and β as well as the transitions from ITG mode to TEM and from ITG mode to kinetic ballooning mode (KBM) are still under progress, and will be reported in future.

2. Electromagnetic gyrokinetic equations in NLT

In this section, we briefly introduce the basic model equations including gyrokinetic Vlasov equation and field equation in NLT for electromagnetic gyrokinetic simulations.

The perturbed distribution function δF_σ in gyro-center coordinates $\boldsymbol{Z}$ is computed