Numerical studies on the gyrokinetic natural boundary value problem for microturbulence in Tokamak

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ABSTRACT:

Drift waves in tokamak belong to the local mode pertaining to a given rational surface, which suggest a natural boundary condition away from the rational surface. The well-known 'outgoing wave boundary condition' for one dimensional (1D) slab model [1] has been first extended to the two dimensional (2D) 'ballooning boundary condition' for a fluid model in axisymmetric tokamak [2], then to the four dimensional (4D) gyro-kinetic model in this paper. The distinction to the existing similar numerical experiments such as the so-called GENE local (global) [3] essentially lies in the boundary conditions, where the periodic (Dirichlet-Neumann) boundary conditions are adopted. In contrast, for the so-called 'ballooning boundary condition' in endeavor of this paper use is made of the natural boundary condition of the system, the solution of the most significant flavor, the so-called weakly asymmetric ballooning theory (WABT), being the asymptotic solution of the 4D eigenmode equation on basis of the 2D ballooning theory, just as the same token of 'outgoing boundary condition' for 1D slab model. The numerical experiments are carried out in a pure collisionless plasma with circular magnetic surface for ion temperature gradient (ITG) mode and trapped electron mode (TEM). The associated Reynolds stress are also calculated and presented graphically as well as the 2D structure of wave functions.

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