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Turbulence Simulation of Ion Temperature Gradient and Trapped Electron Mode Using Extended Bounce-Kinetic Model

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Bounce-kinetic model based on the modern nonlinear bounce-kinetic theory[1] has been used for gKPSP gyrokinetic simulations before[2,3]. However, only deeply trapped particles were considered in those ITG (ion temperature gradient) and TEM (trapped electron mode) turbulence simulations. This work reports on an extension including a more accurate description of barely trapped particles, and its applications. The extension is done by integrating asymptotic expansion of bounce frequency ω_b to obtain unperturbed Hamiltonian. Expressions for the Hamiltonian are derived in deeply trapped and barely trapped limits as h_{deeply} and h_{barely}, which are used in the following equation of motion:

$$\frac{\partial H_0}{\partial \psi} \simeq \left[1-\left(\frac{J_b}{J_{b*}}\right)^2\right]\frac{\partial h_{deeply}}{\partial \psi}+\left(\frac{J_b}{J_{b*}}\right)^2\frac{\partial h_{barely}}{\partial \psi} \quad (1)$$

Here, J_b is the bounce action of bounce gyrocenter, J_{b*} is the bounce action at trapped/passing boundary, H_0 is the exact unperturbed Hamiltonian, and ψ is the flux function. Using this extended bounce-kinetic model, we observed an improvement of collisionless TEM behavior at low magnetic shear from the existing model.

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