Fully kinetic simulation of electromagnetic ion-temperature-gradient instabilities in tokamaks[a]

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Abstract

An electromagnetic model with fully kinetic ions and drift-kinetic electrons for simulation of ion-temperature-gradient (ITG) instabilities is being developed in the toroidal electromagnetic turbulence code GEM. This work is motivated by the observation that gyrokinetic ions are not well justified in tokamak edges with steep density profile due to problematic ordering assumptions. The fully kinetic ion model, which retains the ion gyromotion, avoid these problematic orderings and thus has a wider applicability. The viability of the fully kinetic ion model in simulation of ITG instabilities in tokamaks has recently been demonstrated by Sturdevant et al. [Physics of Plasmas 24, 081207 (2017)]. The present work improves that work by taking into account magnetic perturbations and using the more accurate drift-kinetic model for electrons. Our model uses an implicit electromagnetic field solver to suppress high-frequency compressional Alfven waves and waves associated with the gyro-motion of ions. The ion orbits are advanced by using the well-known Boris scheme and the ion current is computed by using an implicit δf method. Numerical results of electromagnetic ITG instabilities obtained from this model will be presented and benchmarked against the gyrokinetic results in the regime where gyrokinetics are valid.

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