A Landau fluid model for electromagnetic plasma microturbulence

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Abstract

A fluid model is developed for the description of microturbulence and transport in magnetized, long mean-free-path plasmas. The model incorporates both electrostatic and magnetic fluctuations, as well as finite Larmor radius and kinetic effects. Multi-species Landau fluid equations are derived from moments of the electromagnetic gyrokinetic equation, using fluid closures which model kinetic effects. A reduced description of electron dynamics, appropriate for the study of microturbulence on characteristic ion drift and Alfvén scales, is derived via an expansion in the electron to ion mass ratio. The reduced electron equations incorporate curvature, ∇B, and linear and nonlinear $E \times B$ drift effects, needed to model the electron contribution to the drive and damping of ion gyroradius scale instabilities in tokamaks. The Landau fluid model is linearly benchmarked against gyrokinetic codes, and found to reproduce the toroidal finite beta ion temperature gradient and kinetic ballooning instabilities.

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