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Extension of Gyro-Landau Fluid Equations to Higher Order[1]

ILON JOSEPH, ANDRIS DIMITS, Lawrence Livermore National Lab — Gyro-Landau fluid theory can be used to accurately model turbulent fluctuations over the wide range of collisionality present in tokamak edge plasmas. Here, the theory is extended to more accurately treat the effects of finite perturbation amplitude and finite collisionality. At 2^{nd} order in amplitude, the gyro-averaged Hamiltonian is modified by quadratic correlations in the gyro-phase dependent part of the effective potential. The quadratic terms can be expressed through a bilinear 4D spatial integral operator that approximately splits into the product of $\Gamma_0^{1/2}$ operators. In order for the system to conserve energy, the Poisson equation must retain quadratic terms in density and potential and has a similar approximation. Landau closures based on fitting linear dispersion relations [1] for the core plasma typically neglect finite collisionality and nonlinearity in the closure itself. A generalization of the technique developed in [2] to treat the Chapman-Enskog fluid expansion yields a nonlinear extension of the linear closures.

[1] G. W. Hammett and F. W. Perkins, Phys. Rev. Lett. **64**, 3019 (1990).
[2] Z. Y. Chang and J. D. Callen, Phys. Fluids B **4**, 1167 (1992).

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