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Gyrokinetic Models for Edge Plasmas[1]

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We address two key sets of issues in the development of gyrokinetic equations for magnetic fusion edge simulation codes. Starting with existing second-order gyrokinetic equations [1], we develop a “minimal” electromagnetic gyrokinetic model for edge simulations. Large-amplitude perturbations, believed to be present in the edge, result in time evolution of the gyrokinetic Poisson equation operator, and a need to retain second-order terms in the gyrocenter Hamiltonian to satisfy system energy conservation. These aspects have never been implemented in gyrokinetic simulations. We present methods for implementing the second-order terms in the equations of motion, as well as a practical direct finite-element discretization of the evolving gyrokinetic Poisson-equation operator. While tempting, the use of long-wavelength or Pade’ approximations for this operator would result in violation of energy conservation. An appropriate model for Coulomb collisions comes from an extension of work on bilinear gyrokinetic collision operators [2,3] to include the first-order terms in the transformation from the gyrocenter- to physical-space distribution function prior to insertion in the Landau-Fokker-Planck operator. We also describe a gyrokinetic theory in an extended ordering in which the small parameter is the ratio of the ExB shearing rate to the gyrofrequency. This theory allows for long wavelength ExB flows of order the thermal velocity instead of the more restrictive standard orderings which require that either the electrostatic potential [1] or the ExB flow velocity [4] be small compared with the thermal levels.

[1] A.J. Brizard, Rev. Mod. Phys. **79**, 4217 (2007)
[2] A.J. Brizard, Phys. Plasmas **11**, 4429 (2004)
[3] Z. Xiong et al., J. Comput. Phys. 227, 7192 (2008)
[4] A.M. Dimits et al., Phys Fluids B**4**, 274 (1992).

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