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Parallel closures for transport applications[1]

J.-Y. JI, Utah State University

We present recent advances in solving the steady-state closure problem with applications to parallel transport in magnetically confined plasmas. First, we present a treatment of the linearized Coulomb collision operator for ionized plasmas. Moment expansion of a distribution function reduces the collision operator to products of moments and speed dependent terms that include the full particle and field responses. This approach preserves the conservation properties of the collision operator for each moment and provides for quantitative, collisional transport coefficients. Next, we discuss converting ordered kinetic equations into a small set of coupled ordinary differential equations for higher-order moments. By preserving the collisionless response of free-streaming particles and the nonlinear temperature and density dependence in thermodynamic drives, we study parallel transport in the nearly collisionless core of magnetically confined plasmas and in edge plasmas where density and temperature vary significantly along magnetic field lines. Finally, we discuss the solution of the coupled higher- order moment equations in the NIMROD code and apply this solution in studies of parallel electron heat transport in the SSPX experiment[2] and large tokamaks.

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[2]E. B. Hooper, *et al.*, Nucl. Fusion **39**, 863 (1999).