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Fluid theory of magnetized plasma dynamics at low collisionality[1]

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A general fluid moment formalism for magnetized plasmas in a broadly defined low-collisionality regime [1] is presented. This analysis includes collisional terms based on full Fokker-Plank operators for far-from-Maxwellian distribution functions. It is also valid for any magnetic geometry and for fully electromagnetic nonlinear dynamics with arbitrarily large fluctuation amplitudes. Upon asymptotic expansion in the small ratio between the ion Larmor radius and the shortest macroscopic length scale in the absence of small scale turbulence, two-fluid finite-Larmor-radius systems applicable to macroscopic dynamical evolution on either sonic or diamagnetic drift time scales are obtained. In particular, first significant order FLR equations for the stress tensors and the heat fluxes are given, including a discussion of the collisional terms that need be retained and of the closure terms that need be determined kinetically. With a subsidiary small-parallel-gradient ordering for large-aspect-ratio toroidal plasmas in a strong but weakly inhomogeneous magnetic field, a new reduced two-fluid system is derived, taking into account all the diamagnetic effects associated with arbitrary density and anisotropic temperature gradients.

[1] J.J. Ramos, Phys. Plasmas 14, 052506 (2007).

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