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Transport Equations In Tokamak Plasmas[1] J.D. CALLEN, C.C. HEGNA, A.J. COLE, Univ. of Wisconsin, Madison, WI 53706-1609 — Transport equations for tokamak plasmas are usually obtained by taking flux-surface averages of the collisional Braginskii equations. However, tokamak plasmas are usually not in collisional regimes. Also, ad hoc terms are added for: neoclassical effects on the parallel Ohm's law (trapped particle effects on resistivity, bootstrap current); fluctuation-induced transport; heating, current-drive & flow sources and sinks; small non-axisymmetries; etc. Here we develop self-consistent second order in gyroradius fluid-moment-based transport equations, including poloidal and toroidal flow equations, in nearly axisymmetric tokamak plasmas. The derivation begins from fluid moments of the plasma kinetic equation transformed to poloidal magnetic flux coordinates, uses neoclassical-based parallel viscosity closures, and includes all the added effects noted above, many of which produce non-ambipolar radial particle fluxes. An evolution equation for toroidal plasma rotation results from setting the net radial current produced by the sum of these non-ambipolar fluxes to zero. The net radial particle flux is then the sum of the usual intrinsically ambipolar fluxes (classical, neoclassical, etc.) plus the non-ambipolar fluxes evaluated at the ambipolarity-enforcing toroidal plasma rotation (radial electric field). The resultant transport equations will be presented and contrasted with the usual ones.

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