A simple model for turbulence driven poloidal rotation in the vicinity of a transport barrier

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Increasing evidence, both experimental as well as numerical, has indicated that poloidal rotation profiles may deviate substantially from those anticipated from neoclassical theory [1]. In particular, deviations from neoclassical rates of poloidal rotation are often observed to be most acute in the vicinity of internal transport barriers [2] or near corrugations in the temperature profile [3]. In this work, a quasilinear formulation of turbulence driven poloidal rotation [4] is extended to incorporate finite amplitude corrections as well as self-consistent feedback via $E \times B$ shear onto the ambient microturbulence. It is found that, at stationarity, the turbulence driven component of the poloidal flow is constrained by the imaginary component of the renormalized plasma dielectric function, in accord with expectations from wave energy balance [5]. This extended formulation is subsequently employed to develop a minimal transport model incorporating both neoclassical as well as turbulence driven poloidal rotation. This transport model, which reduces to that considered in Ref. [6] for negligibly small turbulence drive, is utilized to demonstrate that the turbulence driven component of the poloidal flow depends sensitively on the local temperature gradient. Analysis of this model suggests that while the turbulence driven poloidal flow is often modest throughout the bulk of the plasma volume, large turbulence driven poloidal flow shear may develop in the vicinity of a transport barrier.

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