Poloidal Reynolds stress, and its influence on intrinsic rotation/momentum transport

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One of the key issues of anomalous momentum transport is that of poloidal rotation. This is due to both the effects of poloidal rotation on toroidal momentum transport, and because poloidal momentum itself can deviate from neoclassical predictions and can be driven by turbulent processes. First, using a simple collisional drift wave turbulence model with background vorticity gradient, and then using a gyrokinetic formulation, the poloidal Reynolds stress has been derived. The results suggests that the dominant mechanism for the evolution of poloidal rotation is potential vorticity (PV) homogenization. PV homogenization is a process whereby the potential vorticity profile is mixed and homogenized. It is known to be a useful "constrained relaxation" principle in the theory of geostrophic fluid dynamics. In collisional drift wave turbulence (ala 'Hasegawa-Wakatani'), total PV is the difference of fluid vorticity and density, so "PV homogenization" corresponds to both the action of vorticity diffusion (i.e. turbulent viscosity) and a ∇n driven influx of vorticity (i.e. a residual stress driving poloidal flow). Even though this study is part of an attempt to describe the turbulent transport of the momentum vector in the presence of radial electric field shear and geometry effects. Here, the focus will be on the dynamics of the poloidal component, where a careful analytical derivation is compared with results from a linear experiment. The advantage of using a linear experiment to verify the poloidal part of the model is two-fold. First a simple collisional drift wave closure is plausible for a linear experiment and second, the poloidal momentum dynamics is isolated as there is no "toroidal rotation" in a linear device. Such verification is essential for an understanding of the full system with geometry effects, where the poloidal component is known to play an important role, but can not be isolated par the fact that the toroidal momentum dynamics is non-trivial.