Large scale poloidal and toroidal flows interacting with collisionless gyrokinetic turbulence

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Shear flows have a profound influence on turbulence-driven transport in tokamaks. Global scale flow profiles, meso-scale flow structures associated with transport barriers, and turbulence-scale fluctuating flows are all predicted to be important. The introduction of arbitrary initial flow profiles into the code ORB5 allows the convenient study of how these flows both influence transport levels, and self-consistently evolve. As previously demonstrated, turbulence suppression is possible above a certain shearing rate magnitude for homogeneous shear flows, and little evolution of the shearing rate is seen. However, when a flow with a zone boundary, where the shearing rate reverses at mid-radius, is introduced, the shear flow evolves substantially during the simulation. $E \times B$ shear flows with a zone boundary of a positive sign decay to a saturation amplitude, consistent with the well known saturation of turbulently generated zonal flows. Interestingly, there is no such saturation seen for flow profiles with the opposite sign, and complete suppression is possible. This provides interesting insights into the dynamics of zonal flow saturation. In these simulations, toroidal momentum transport can still be modelled as a diffusivity roughly proportional to the thermal diffusivity, which in turn depends on the $E \times B$ flow profile.