ABSTRACT

A formal expression for the canonical steady state density profile in a tokamak can be obtained from the Fokker-Planck type diffusion equation derived from the Vlasov equation in the limit of anomalous diffusion due to strong turbulence. Here we derive an explicit expression for this canonical profile for a tokamak with arbitrary cross-section and aspect ratio. The resulting profile is independent of the spatial dependence of the diffusion coefficient, but does depend on the relative diffusion of trapped versus passing particles. Under conditions where only the trapped particles transport due to interactions with the turbulence the profiles are considerably flatter than if both the trapped and passing transport the same. The steepness of the calculated profile depends on the ratio of the diffusion coefficients for passing and trapped particles. The calculated profiles are compared with measured profiles from the tokamak known as DIII–D. Density profiles for a typical International Toroidal Experimental Reactor (ITER) plasma are also derived.