A simplified collision operator for gyrokinetic simulations

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Neoclassical theory provides a standard against which gyrokinetic simulations must confront. Of course, transport in plasmas is overwhelmingly dominated by turbulence as compared to collisional transport. Nonetheless, in kinetic theory, confrontation to neoclassical predictions proves crucial for at least two reasons: at long times, (i) the system is forced to relax towards a Maxwellian, which is not a gyrokinetic equilibrium solution and (ii) collisions damp the poloidal flows which are acknowledged to possibly strongly impact the turbulence. Both predicaments are of prime importance for the GYSELA code [1,2] since (i) as a *full–f* code, complex non-Maxwellian distribution functions are allowed to develop and (ii) as a *full torus* (global) code, large scale flows are intrinsically modelled.

To avoid detrimental communications in the massively parallel structure of GYSELA, a simplified Fokker–Planck-like collision operator has been implemented, which acts in the parallel direction only. We will show that this simplified choice allows to exactly recover both the banana and the plateau regimes and can be extended to the Pfirsch–Schlüter regime. Perturbatively around a magnetic island, we calculate from the entropy production rate the diffusion due to trajectory effects in toroidal geometry. Close to the separatrix, the collisions account for a friction force between trapped and passing particles which is mainly transverse to the magnetic island. This transverse direction is almost aligned with the magnetic field lines and justifies our choice to only consider the parallel direction.

The proposed presentation will detail how such a physics is properly accounted for in the reduced collision operator. The impact of collisions on the equilibrium (neoclassical theory) and on the turbulence is investigated. Especially, possible synergistic effects are of special importance for confinement time predictions.

References

[1] V. Grandgirard, *et al. Plasma Phys. Control. Fusion*, 49(12B):B173–B182, 2007.
[2] G. Dif-Pradalier, *et al. submitted to Physics of Plasmas*.