Semi-Lagrangian drift-kinetic simulations in toroidal geometry

Yaman Güçlü[1]

[1]*Numerical Methods in Plasma Physics*
Max-Planck-Institut für Plasmaphysik
Boltzmannstr. 2, 85747 Garching, Germany

We consider the gyrokinetic Vlasov equation for ions in the drift-kinetic limit, coupled to a quasi-neutrality equation with adiabatic electrons. For this purpose we have developed a semi-Lagrangian code in Selalib that uses field-aligned interpolation to reduce the number of poloidal planes and hence the memory footprint. Simulations in cylindrical geometry (screw-pinch) were presented last year at Numkin 2016, and we now discuss the extension of our code to a toroidal geometry (Tokamak). As a consequence of the curvature of the magnetic field, the characteristics of the Vlasov equation do not lie on flux-surfaces, even in the absence of an electric field. This causes complications in setting up initial conditions that satisfy a kinetic equilibrium, applying non-constant boundary conditions in phase-space, and treating the O-point. When dealing with these technical difficulties, we realized that the spline facilities in Selalib were not adequate to our needs. Therefore, we have recently developed an arbitrary-order tensor-product spline library that can use so-called "Greville" boundary conditions for interpolation: this enables us to describe fields on rectangular and polar grids, without the need for additional derivative information at the boundaries. Preliminary results on standard test-cases are presented.