Towards Geometric Particle-in-Cell Schemes for Gyrokinetics

Michael Kraus (michael.kraus@ipp.mpg.de)

Max-Planck-Institut für Plasmaphysik
Boltzmannstraße 2, 85748 Garching, Deutschland

In this talk we will describe two lines of research towards geometric particle-in-cell schemes for gyrokinetics.

In the first part, novel integrators for guiding centre dynamics are presented. These methods are designed to respect momentum and energy conservation and exhibit superior long-time stability compared to conventional methods like explicit Runge-Kutta integrators. In addition to good energy behavior, which has already been reported in previous work [1], the advantages with respect to the conservation of toroidal momentum will be highlighted [2]. Previously presented integrators for the guiding centre system [1] are prone to the growth of parasitic modes [3] which eventually drive the simulation unstable. It will be shown how these issues can be resolved, thereby avoiding the appearance of such modes and allowing for extremely long time simulations.

In the second part, we will describe a novel technique for the derivation of particle-in-cell finite-element methods for the Vlasov-Maxwell system based on the discretization of the underlying Hamiltonian structure [4]. The resulting system is solved in a charge preserving way. Spline differential forms [5] ensure conservation of the divergence of the magnetic field and stability of the field solver.

The talk will be concluded with an outline of possible strategies to consolidate these techniques in order to obtain geometric particle-in-cell schemes for gyrokinetics.

References

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