PIC Simulations

Jacob Trier Frederiksen
Niels Bohr Institute

The semi-Lagrangian particle-in-cell code concept has gained enormous popularity within computational plasma modeling. The combined Lagrangian detailed kinetics of plasma phase spaces, and Eulerian modeling of electromagnetic fields have proven a cost-effective – yet relatively precise – way to describe fast dynamics in all reaches of plasma physics.

In the first part of the module, we aim to introduce/review some basic concepts of explicit particle-in-cell plasma modeling, comprising

- Vlasov plasma conceptual framework
- basic equations of Maxwell-Boltzmann plasmas
- representation and discretization of the Maxwell-Boltzmann plasma
- finite size particles, interpolation schemes and accuracy
- consequences of the finite size particle approach
- numerical 'modification' of the plasma physics

The second part of the module will be devoted to reviewing a modern versatile, highly modularized and parallelized PIC code tool – the PhotonPlasma code – which has been used in Copenhagen for studies. After a brief introduction, I will turn to a '*per case*' overview of the facilities currently being used (or tested), which are unique to the PP code framework. We shall devote some focus describe in detail two components of the PhotonPlasma code which are unique in implementation, namely computational modules concerned with

- synthesis of radiation and radiation diagnostics of computational plasmas
- collisionality and collision term implementation strategies

During the last part of my lectures, the students will be given a well contained and limited specific exercise task to be solved in small-group (i.e. ten groups of 6) dicussion. We shall select at random three groups' discussion results to be very briefly presented in plenum in a 3-minute speedtalk, thus, concluding the lecture module.