Kinetic simulations for the plasma edge in the collisional regime

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The inhomogeneous Vlasov equation, a non-linear differential equation, is used in plasma physics to simulate the time-dependent distribution of particles in real and velocity space. There the particle interactions are modeled with collisions.

The presented plasmas contain multiple species and various collision operators.

Consequently there are also quantities, e.g. the electric field, that must be determined self-consistently.

Solvers for the ensuing systems of Vlasov and additional closure equations, e.g. Poisson's equation, are computationally expensive. For this reason running simulations of physically interesting problems requires immense resources.

Hence, it is of hight priority for the plasma fusion community to develop new fast solvers.

We reduce the computational effort by splitting the computation of the electric field, i.e. the closures, and also the species-specific Vlasov equations. For the resulting equation a range of optimized numerical methods can be used (such as semi-Lagrangian schemes, preconditioned Krylov methods, ...).

Most of these algorithms can be formulated in the framework of stencil computations. This means that we are able to achieve an efficient implementation, while still providing a high level interface to the user of the software.

In this talk we consider numerical simulations of edge plasmas. These simulations are time-dependent and conducted in one space and two velocity dimensions.

In particular, we will consider quantities like particle density or energy flux and how they are modified by different collision models. These quantities are relevant when designing the divertor targets in fusion devices.