Vlasov simulations on an adaptive phase-space grid

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The numerical resolution of the Vlasov equation is usually performed by particle methods (PIC) which consist in approximating the plasma by a finite number of particles. The trajectories of these particles are computed from the characteristic curves given by the Vlasov equation, whereas self-consistent fields are computed on a mesh of the physical space. This method allows to obtain satisfying results with a relatively small number of particles. However, it is well known that, in some cases, the numerical noise inherent to the particle method becomes too important to have an accurate description of the distribution function in phase space. To remedy to this problem, methods discretizing the Vlasov equation on a mesh of phase space have been proposed.

The major drawback of Vlasov methods using a uniform and fixed mesh is that their numerical cost is high, which makes them rather inefficient when the dimension of phase-space grows. For this reason we are investigating a method using an adaptive mesh. The adaptive method is overlayed to a classical semi-Lagrangian method which is based on the conservation of the distribution function along particle trajectories. The phase-space grid is updated using a multiresolution technique.

In this presentation we shall describe the adaptive method and propose some applications to beam physics and plasma physics.