数学与系统科学研究院

计算数学所学术报告

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<u>报告题目</u>**：**

A dynamical low-rank algorithm for the Vlasov-Poisson equation

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上午 **10:00-11:00**

<u>报告地点</u>：　数学院南楼七层

702 教室

Abstract:

Many problems encountered in plasma physics require a description by kinetic equations, which are posed in an up to six-dimensional phase space. A direct discretization of this phase space, often called the Eulerian approach, has many advantages but is extremely expensive from a computational point of view. In the present paper we propose a dynamical low-rank approximation to the Vlasov-Poisson equation, with time integration by a particular splitting method. This approximation is derived by constraining the dynamics to a manifold of low-rank functions via a tangent space projection and by splitting this projection into the subprojections from which it is built. This reduces a time step for the six- (or four-) dimensional Vlasov-Poisson equation to solving two systems of three- (or two-) dimensional advection equations over the time step, once in the position variables and once in the velocity variables, where the size of each system of advection equations is equal to the chosen rank. By a hierarchical dynamical low-rank approximation, a time step for the Vlasov-Poisson equation can be further reduced to a set of six (or four) systems of one-dimensional advection equations, where the size of each system of advection equations is still equal to the rank. The resulting systems of advection equations can then be solved by standard techniques such as semi-Lagrangian or spectral methods. Numerical simulations in two and four dimensions for linear Landau damping, for a two-stream instability and for a plasma echo problem highlight the favorable behavior of this numerical method and show that the proposed algorithm is able to drastically reduce the required computational effort.

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