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Dynamics of correlations of many colliding particles

Thursday, 26 September 2024 12:30 (20 minutes)

The talk provides an overview of some advances in the mathematical understanding of the nature of the dynamics of the correlations of many colliding particles. The fundamental equations of modern mathematical physics are studied, in particular the hierarchies of the evolution equations of many hard spheres and their asymptotic behavior described by kinetic nonlinear equations.

First, an approach to describing correlations in a system of colliding particles interacting as hard spheres is discussed, based on a hierarchy of equations for the evolution of a sequence of correlation functions that are cumulants of distribution functions, called the Lioville hierarchy. It is proven that the constructed dynamics of correlations underlie the description of the dynamics of both a finite and an infinite number of hard spheres obeying the BBGKY hierarchies for reduced (marginal) distribution functions or reduced correlation functions.

The structure of expansions representing non-perturbative solutions of the Cauchy problem for these hierarchies of evolution equations is formulated. It has been established that the concept of cumulants of the groups of operators of the Lioville equations underlies non-perturbative expansions of solutions to the hierarchies of fundamental equations describing the evolution of observables and of the state of many hard spheres, as well as forms the basis of the kinetic description of their collective behavior.

In the talk, we also consider a new approach to the problem of a rigorous description of kinetic evolution by means of reduced (marginal) observables governed by the dual BBGKY hierarchy. One of the advantages of the developed approach to the derivation of kinetic equations from the underlying dynamics of many particles is that it provides an opportunity to construct kinetic equations with initial correlations, in particular correlations characterizing the condensed states of a system, and to describe the processes of the propagation of initial correlations within suitable scaling limits.

References

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