Generalized quantum kinetic equation for interacting particles with quantum statistics

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Nowadays the considerable progress in the rigorous derivation of quantum kinetic equations in suitable scaling limits is observed. We develop a new formalism for the description of the quantum kinetic evolution based on usage of a non-perturbative solution of the quantum BBGKY hierarchy.

We establish that in case of initial data, which is completely determined by a one-particle density operator, all possible states of infinitely many bosons or fermions at arbitrary moment of time can be described without any approximations by means of a one-particle density operator together with explicitly defined marginal functionals of this one-particle density operator. For this purpose we develop the method of the kinetic cluster expansions of cumulants of scattering operators, which define the evolution operators of every term of expansions of the marginal functionals of the state over the products of a one-particle density operator, and derive the generalized quantum kinetic equation. Thus, for initial states of many-particle systems obeying Fermi-Dirac or Bose-Einstein statistics, which are given in terms of a one-particle marginal density trace-class operator, the equivalence of the Cauchy problem of the quantum BBGKY hierarchy and the Cauchy problem of the generalized quantum kinetic equation is proved.

The specific quantum kinetic equations can be derived from constructed generalized quantum kinetic equation in the appropriate scaling limits or as a result of certain approximations. For example, in the mean-field scaling limit we derive the quantum Vlasov kinetic equation for bosons or fermions. In particular case of pure states it reduces to the nonlinear Schrödinger equation.

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[2] Gerasimenko V.I., Tsvir Zh.A., Math. Bulletin Shevchenko Sci. Soc., 2010, **7**.