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On processes of creation and propagation of correlations in quantum many-particle systems

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We consider the problem of the rigorous description of the evolution of states of large particle quantum systems by means of marginal correlation operators. The physical interpretation of marginal correlation operators is that the macroscopic characteristics of fluctuations of mean values of observables are determined by them on the microscopic level. In particular, considered problem is related to the problem of an entanglement of quantum states.

As a result of the definition of the marginal correlation operators within the framework of dynamics of correlations governed by the von Neumann hierarchy we establish that a sequence of such operators is governed by the nonlinear quantum BBGKY (Bogolyubov-Born-Green-Kirkwood-Yvon) hierarchy and a nonperturbative solution of the Cauchy problem to this hierarchy of nonlinear evolution equations is represented in the form of series expansions over the number of particles of subsystems which generating operators are the corresponding-order cumulants of the groups of nonlinear operators of the von Neumann hierarchy for a sequence of correlation operators.

Moreover, the concept of quantum kinetic equations in case of initial states specified in terms of a one-particle density operator and correlation operators, for instance, the initial correlation operators, characterizing the condensed states or their influence on ultrafast relaxation processes in plasmas, was considered. In particular, we established that a mean field behavior of processes of the creation of correlations and the propagation of initial correlations in large particle quantum systems are governed by the Vlasov-type quantum kinetic equation with initial correlations. In case of pure states derived kinetic equation can be reduced to the Gross—Pitaevskii kinetic equation or to the nonlinear Schrödinger equation.

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