Hierarchies of evolution equations for correlations in open quantum systems

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This talk aims to formulate and explore the fundamental evolution equations that describe the propagation processes of correlations in open quantum systems. Recently, this topic has attracted significant attention because the description of quantum processes for information transfer, built upon the evolution equations for state correlations of open quantum systems, remains an ongoing challenge.

The talk presents a mathematical theory of evolution equations that describe correlations of the state of open quantum systems on a microscopic scale and their interrelations.

The main challenges addressed are:

a) Hierarchies of fundamental evolution equations for the correlations of open quantum systems and the problem of the construction of their non-perturbative solutions.

b) The mathematical origins of the master kinetic equation and of the evolution of correlations as described by its solution.

c) The propagation of initial correlations between a system and its environment is governed by the master equation that accounts for these initial correlations.

This talk will focus on the evolution equations governing open quantum systems that are initially correlated with their environment. In conventional approaches to open quantum systems, the reduced dynamics of a system are described based on the assumption that the system and the environment are initially uncorrelated. It will be reviewed a novel method for describing the collective behavior of open quantum systems based on the evolution of correlations [1],[2]. One advantage of this approach is that it incorporates the initial correlations of particle states in an open system, particularly those that characterize their entangled states.

References:

[1] Gerasimenko, V. I.: Towards the challenge of propagation of initial correlations in open quantum systems. Proc. Inst. Math. NASU, 19 (1) 12–26 (2022).

[2] Gerasimenko, V. I., Gapyak, I. V.: Propagation of correlations in a hard-sphere system. J Stat. Phys., 189 (2) (2022). doi:10.1007/s10955-022-02958-8