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Evolution of Continuous Variable Entanglement and Discord in Open Quantum Systems

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Abstract

In the framework of the theory of open systems based on completely positive quantum dynamical semigroups, we give a description of the continuous-variable quantum entanglement and quantum discord for a system consisting of two non-interacting modes embedded in a thermal environment. Entanglement and discord are used to quantify the quantum correlations of the system. For all values of the temperature of the thermal reservoir, an initial separable Gaussian state remains separable for all times. The time evolution of logarithmic negativity, which characterizes the degree of entanglement, indicates that in the case of an entangled initial Gaussian state, entanglement suppression (entanglement sudden death) takes place, for non-zero temperatures of the environment. Only for a zero temperature of the thermal bath the initial entangled state remains entangled for finite times. Analysis of the time evolution of the Gaussian quantum discord, which is a measure of all quantum correlations in the bipartite state, including entanglement, shows that quantum discord decays asymptotically in time under the effect of the thermal bath. This is contrast with the sudden death of entanglement. Before the suppression of the entanglement, the qualitative evolution of quantum discord is very similar to that of the entanglement.

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