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Abstract

Random Systems

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Dynamics of Qubits in Random Matrix Environment

Joint with with E. Bratus

We consider models of dissipative and decoherent evolution of two qubits embedded in a disordered environment. Unlike the well known spin-boson model, which describes the translation invariant and macroscopic environment, we model both the environment and its interaction with qubits by random matrices of large size, which are widely used to describe multi-connected disordered media of mesoscopic and even nanoscopic size. An important property of our model is that it incorporates the so called non-Markovian dynamics, which allows for the backflow of energy and information from the environment to qubits and has been actively studied recently in various settings.

We obtain asymptotically exact in the size of environment expressions for the reduced density matrix of qubits valid for all typical realizations of the environment. The expressions, however, are rather complex and we employ the Bogolyubov-van Hove regime (long evolution time and weak qubit-environment interaction) to carry out their detailed analysis both analytical and numerical.

We find several interesting regimes of the entanglement evolution of two qubits, including vanishing their entanglement at a finite moment and, especially, the subsequent entanglement revival. These cases of entanglement dynamics are known in quantum information theory as the entanglement sudden death and entanglement sudden birth and are pertinent to the non-Markovian evolution. They have been found before in special versions of the macroscopic and translation invariant spin-boson model. Our results, obtained for non-macroscopic and disordered environment, demonstrate the robustness and universality of the above and other essential properties of entanglement evolution. Being combined with other processes of quantum information technology (e.g. entanglement distillation), they can lead to a considerably slower

decay of entanglement up to its asymptotic persistence.