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Theoretical study of a transmon-type qubit connected to a semi-infinite transmission line

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The research is dedicated to a detailed theoretical study of dynamic processes that occur during the interaction of a transmon-type qubit connected to a semi-infinite transmission line with two signals: pump and probe. By manipulating the frequencies and amplitudes of the signals it is possible to explore the system behavior. We use the Lindblad equation formalism to make our calculations. From the solution of the Lindblad equation one can get upper charge level occupation probability as a function of pump and probe signals parameters (amplitudes and frequencies) and build these dependencies.
In Ref. [1] the authors mentioned that the experimentally measured reflection coefficient corresponds to upper charge level occupation probability in the theory. In Ref. [2] the theoretical model describing the system was developed and approved experimentally. The current research is an extension of the corresponding article: here we build the dependencies which were not considered before. Particularly we studied the steady state, by plotting the dependence of upper charge level occupation probability on the probe frequency and the pump frequency. For studying dynamics the upper charge level occupation probability was built as a function of (a) time and the probe frequency; (b) time and the probe frequency. The obtained plots provide a deeper insight into the underlying physical processes and could be valuable for guiding future experiments. Additionally, we address the Lindblad equation using Lindblad superoperators in different bases. In our opinion, this comparative analysis holds significant methodological importance.

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