Noisy Phase Gates in Geometric Computation

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Geometric phase provides inherent fault tolerance, which makes it a useful resource for quantum computation. In a realistic implementation of a quantum computer, the effect of noise due to interaction with the environment cannot be ignored. In a recent work, we studied geometric phase of an open two-level quantum system interacting with its environment, treated generally as a squeezed, thermal bath under various types of system-bath interactions, both non-dissipative and dissipative. The bath was considered in a standard way as composed of a large number of non-interacting harmonic oscillators. For the case of a dissipative interaction, the system-bath interaction was considered in the weak Born-Markov approximation, a regime appropriate for the study of geometric phases in the context of environmental decoherence. These results extend the features of geometric phase in open quantum systems reported in the literature to include effects due to squeezing, and detail the connection between these open-system effects to quantum noise processes familiar from quantum information theory. Here these results are used to characterize the performance of phase gates in the context of geometric quantum computation.