Degradation and protection of entanglement between solid state qubits

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A crucial challenge for future quantum technologies is to protect fragile entanglement against environment-induced decoherence. Various Dynamical Decoupling (DD) sequences emerged recently as high-order decoherence suppression schemes for single qubit systems. How quantum correlations in multi qubit systems can be effectively preserved via DD is still a open issue. The problem is particularly severe in solid state implementations of quantum bits, which are typically affected by broadband noise [1].

We study entanglement degradation of two non-interacting qubits subject to independent baths with broadband spectra typical of solid state nano-devices [2]. We obtain the analytic form of the concurrence in the presence of adiabatic noise for classes of entangled initial states presently achievable in experiments. We find that adiabatic (low frequency) noise affects entanglement reduction analogously to pure dephasing noise. Due to quantum (high frequency) noise, entanglement is totally lost in a state-dependent finite time.

As a first step towards the long-term goal of preservation of quantum correlations between solid state qubits, we investigate the possibility to preserve bipartite entanglement between two superconducting qubits subject to quantum bistable fluctuators, extending control tools developed for solid state single qubit gates in Ref. [3]. In the absence of interaction between the qubits, we investigate how the phenomena of entanglement revival for non-Markovian noise and the entanglement sudden death for Markovian noise are influenced by the DD. Protection of entanglement via the quantum Zeno effect is found under special conditions.

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