Entanglement protection in superconducting qubits by dynamical decoupling

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Superconducting circuits are a promising technology for the realization of quantum information on a solid state platform. The coherence times of the present generation of devices ($\sim \mu$s) are about three orders of magnitudes larger than the first implementations. However, further improvement of the coherence times at least of one order of magnitude would be required to reach the level for practical quantum error correction. In particular, a major question currently unsolved is establishing the best strategy to maintain long-enough a sufficient degree of entanglement.

Solid-state noise sources are often characterized by broad-band and non-monotonic power spectrum. Usually, the spectrum of at least one of the noise sources is 1/f at low-frequencies, at the system's eigen-frequencies instead indirect measurements indicate white or ohmic spectrum. We have investigated and characterized the effects of solid state broad-band noise in various architectures, from single/coupled quantum bits to artificial multilevel atoms, also in the presence of time-dependent external driving fields. A general route to identify optimal operating conditions of reduced sensitivity to 1/f noise sources in complex architectures has been proposed [1] and applied to an entangling two-qubit gate realized by a capacitive coupling of two transmons in a circuit-QED architecture in [2].

Complementary to optimal tuning, dynamical decoupling strategies are a promising tool to suppress the effect of 1/f noise [3]. In this presentation we will illustrate that entanglement between superconducting qubits can be preserved by proper sequences of echo pulses, feasible with current experimental equipments. Our analysis suggests a possible way to simultaneously store entanglement and perform high-fidelity two-qubit gates [4].

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