Quantum control of non-Gaussian noise in hybrid quantum networks

Antonio D'Arrigo, Giuseppe Falci, and Elisabetta Paladino

DFA University of Catania & CNR-IMM UOS Catania (Università), Via Santa Sofia 64, Catania, Italy

The design of quantum control of non-Gaussian noise became a key requirement in the newly perspective of hybrid distributed architectures made of natural/artificial atoms and photons. In this presentation I will review our recent works on entanglement protection of non-Gaussian and 1/f noise via dynamical decoupling during both universal two-qubit gates and distribution through noisy communication channels.

First I will present the integration of dynamical decoupling into a universal two-qubit gate in the presence of 1/f noise [1] acting locally on each of the qubits forming the entangling gate. Both the case of pure dephasing and of depolarizing [2] noise will be addressed investigating the gate efficiency under periodic, Carr-Purcell, and Uhrig dynamical decoupling sequences. For local pure dephasing, dynamical control allows for quantum sensing of 1/f noise. We find an analytic expression of entanglement fidelity in terms of noise filter functions allowing to single out the sequence-specific capability to bypass cumulants of the underlying non Gaussian processes [3].

Finally, I will report two all-optical experiments demonstrating that purely local control also allows for on-demand entanglement restoration during distribution through noisy communication channels in the presence of non-Markovian dynamics [4]. The restored entanglement being a manifestation of "hidden" quantum correlations resumed by the local control [5].

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