# Non-Markovian dynamics of Quantum Processors in Solid-State Quantum Environments


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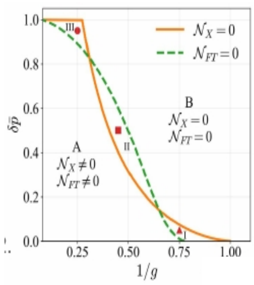
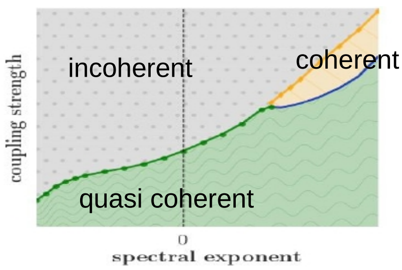
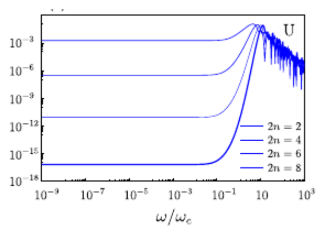
**Abstract**: We investigate quantum models of non-Markovian environments coupled yo a Qubit, describing typical noise sources in the solid-state. We discuss a Lindblad embedding approach to two-level-system environments, coherent-incoherent dynamics with quantum $1/f^{\eta}$noise, and strategies to fight or to detect noise while processing two-qubit gates.


Non-Markovian dynamics of a qubit in a quantum environment is investigated for three paradigmentic case studies [1]. A phenomenological model system of a qubit coupled to a switching quantum impurity is shown to exhibit a cross-over from a Markovian to a non-Markovian regime of dynamics, depending on the parameters. We introduced a measure of non-Narkovianity based on spectroscopic features which for certain regions of parameters proves to be more sensitive than the two standard Breuer-Laine-Piilo and the Luo-Fu-Song measures (Fig. 1).

We then address the spin-boson model to the regime of quantum $1/f^{\eta}$noise characterized by negative exponents of its spectral distribution. Using the numerically exact time-evolving matrix product operator, we find the dynamic regime diagram, including pseudocoherent dynamics controlled by quantum $1/f^{\eta}$ noise (Fig.2).




Finally, we investigate dynamical decoupling while processing an entangling two-qubit gate based on an Ising-xx interaction. We evaluated generalized filter functions that describe decoupling while processing and allow us to derive an approximate analytic expression as a hierarchy of nested integrals of noise cumulants. By exploiting the properties of selected pulse sequences, we show that it is possible to extract the second-order statistics (spectrum and cross-spectrum) and to highlight non-Gaussian features contained in the fourth-order cumulant.

## References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