SHOT NOISE SPECTRUM OF CHARGE QUBITS REALIZED IN NANODEVICES

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The way a quantum two-level system (qubit) loses coherence due to the coupling with a noisy environment has been the subject of intense research for many years. This fundamental problem has received a great deal of attention due to recent advances in solid state nanodevices in which quantum two-level systems have been realized using different degrees of freedom (charge, spin, flux) [1]. Interest in current noise [2], in particular in presence of dephasing and dissipation, has risen owing to the possibility of extracting valuable information not available in conventional dc transport experiments.

In this work [3] we develop a formalism that allows to study the charge and current noise spectra of qubits under transport conditions in a dissipative bosonic environment. By combining (non-)Markovian master equations with correlation functions in Laplace-space one can derive noise formulae for both weak and strong coupling to the bosonic bath.
Our results show how by studying noise and current fluctuations in coupled quantum dots or superconducting single electron transistors (Cooper pair boxes) one can reveal the complete dissipative, internal dynamics of the two-level system. In particular, quantum coherence in the two-level system suppresses noise. This coherence-induced reduction of noise is diminished by weak dissipation and/or a large level separation. Furthermore, for weak dissipation, the dephasing and relaxation rates of the two-level system can be extracted from noise. In the strong dissipation regime, the localisation-delocalisation transition of the spin-boson model becomes visible in the shot noise.

References:

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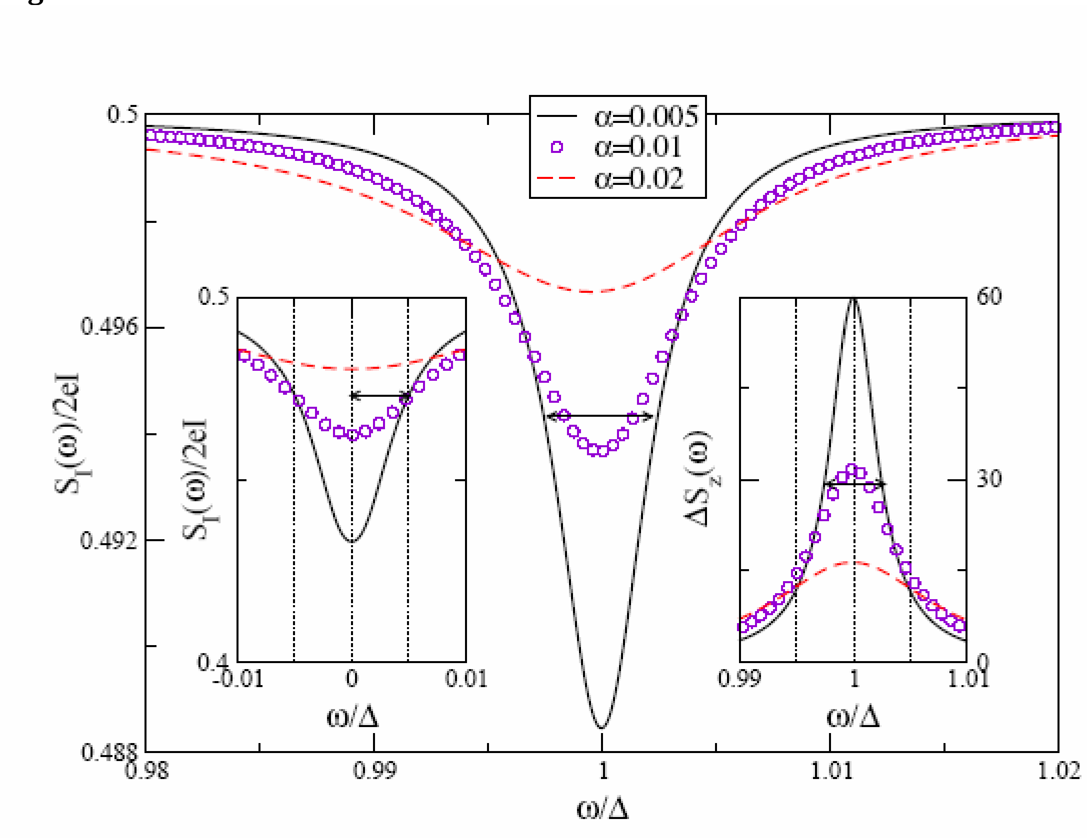
Figures:



Caption: Effect of decoherence on current noise near resonance (ohmic dissipation) for different couplings α to the dissipative bath. $S_I(\omega)$ can be directly related with the internal dissipative dynamics of the qubit. This is shown in the right inset where the pseudospin correlation function $S_z(\omega)$ is plotted.Arrows indicate the calculated relaxation rate. Left inset: low frequencies region near shot noise limit ω=0. The half-width at low frequencies (relaxation) is *twice* that around the frequency of the two-level system Δ (dephasing). Our results demonstrate that noise measurements on charge qubits realized in double quantum dots or superconducting single electron transistors allow to extract the dephasing and relaxation rates of the qubit for weak dissipation.