CONTROLLING DECOHERENCE

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The influence of noise on the tunnelling dynamics of a solid state based two level system (a Qubit) is investigated. By use of external control forces and noise of the non-demolition type (phase damping) and of the dissipative type we exhibit several possibilities to manipulate the coherence and decoherence properties of a driven two-level system. The control forces are either linearly polarized or circularly polarized periodic fields, which are subjected to environmental noise. The coherence properties are elucidated for the case of coherent destruction of tunnelling by linear polarized fields [1] and circularly polarized fields [2]. In the latter case, the delocalization rate turns out to be universal [3]. For the situation of a two-level atom interacting with a leaky cavity we demonstrate that a suitably tuned external cw-field-control is capable to slow down considerably the decoherence properties of the atom quantum dynamics. This effect is demonstrated for different initial preparations, a ground state and a localized initial condition, respectively [4, 5]. Finally, we consider the process of decoherence of two coupled two-level systems, namely the process of decoherence of a two-Qubit XOR operation with both, bit-flip errors and phase errors. Various gate quantifiers (fidelity, purity, entanglement capability) are monitored during a quantum XOR operation as a function of temperature, friction strength and coupling strength [6].

References:

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For a comprehensive review on driven quantum tunnelling and quantum control with cw-fields see also in:
M. Grifoni and P. Hänggi, ***Driven Quantum Tunneling***, Physics Reports, **304**: 229 (1998).