

Optimal Control for Open Quantum Systems: Qubits and Quantum Gates

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We present a review of recent developments within our group regarding the formulation and execution of optimal control strategies for the dynamics of quantum systems. We discuss two tasks which are fundamental to quantum control: state-specific and state-independent optimal control. For the former, we provide an analytic inversion scheme for the Lindblad equation, as well as an extension of conventional theory (Pontryagin's principle) to quantum systems which undergo a non-Markovian time-evolution. The main importance for the realization of quantum information processing lies in state-independent optimal control. Here, we address two different approaches: an approach which treats dissipative effects from the environment in lowest-order perturbation theory and a general method based on the time-evolution superoperator concept. Applications to solid-state based physical realizations of single and double qubits illustrate these new methods. Finally, we shall discuss (open questions regarding) the formulation of positivity conserving quantum master equations.