SWEEP A QUBIT TO ENTANGLE STATES AND TO GAUGE ITS ENVIRONMENT

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Here, we shall demonstrate that the sweep of a Qubit which is coupled to external quantum degrees of freedom (such as quantum oscillator degrees of freedom) is extremely beneficial for entanglement creation and the gauging of quantum dissipation. Recently, we succeeded in the derivation of the *excact zero-temperature transition probability for the dissipative Landau-Zener problem* [1]. The standard, i.e. the non-dissipative Landau-Zener problem, is an exactly solvable textbook example in time-dependent quantum mechanics, having found its way into many applications in physics and chemistry. Our exact result [1] constitutes an prominent generalization: It describes how the coupling of the Qubit to its environment impacts the transition probability. The measurement of this transition probability allows then for a precise gauging of the quantum-dissipation at work. Moreover, we find that the final quantum state exhibits a peculiar entanglement between the Qubit and the coupled quantum oscillator degrees [2]. It is possible to selectively perform a multi-partite entanglement among different oscillator degrees of freedom [3], -- including an entanglement with a whole bath [1, 4]. A large class of realistic types of coupling is considered. Surprisingly, the final transition probability is not affected at all by environments that only cause pure dephasing. In general, we find that Landau-Zener sweeps provide a robust tool for characterizing the environment of a tunable Qubit. Promising applications include superconducting Qubits, especially in circuit-QED [2,3,4,5].

This presentation is based on the following publications:

[1] M. Wubs, K. Saito, S. Kohler, P. Hänggi, and Y. Kayanuma
Gauging a quantum heat bath with dissipative Landau-Zener transitions
Phys. Rev. Lett **97**, 200404 (2006).

[2] K. Saito, M. Wubs, S. Kohler, P. Hänggi, and Y. Kayanuma
Quantum state preparation in circuit QED via Landau-Zener tunneling
Europhys. Lett. **76**, 2228 (2006).

[3] M. Wubs, S. Kohler, and P. Hänggi
Entanglement creation in circuit QED via Landau-Zener sweeps
Physica E **40**, 187197 (2007),

[4] K. Saito, M. Wubs, S. Kohler, Y. Kayanuma, and P. Hänggi
Dissipative Landau-Zener transitions of a qubit: Bath-specific and universal behavior
Phys. Rev. B **75**, 214308 (2007).

[5] D. Zueco, G. M. Reuther, P. Hänggi, and S. Kohler
Entanglement and disentanglement in circuit QED architectures
Physica E **42**, 363–368 (2010);
D. Zueco, P. Hänggi, and S. Kohler
Landau-Zener tunnelling in dissipative circuit QED
New J. Phys. **10**, 115012 (2008).