DY 2: Quantum Dynamics, Decoherence and Quantum Information

Time: Monday 9:30–12:00 Location: HÜL 186

Invited Talk DY 2.1 Mon 9:30 HÜL 186

Welcome to Twin Peaks: momentum-space signatures of Anderson localization — •Cord A. Müller — Fachbereich Physik, Universität Konstanz

Quantum Systems with structural disorder present unusual challenges when is comes to understanding long-time limits of their phase-space dynamics. In particular, Anderson localization is well known to suppress classical diffusion of (matter) waves in real space—but much less is known about its momentum-space signatures.

Recently, a new signature of strong Anderson localization has been discovered for ultracold atoms following a quantum quench: a twin-peak signal in the particles' momentum distribution. This structure combines the familiar back-scattering peak with a coherent forward-scattering peak [1]. The forward peak appears to be a genuine signal for the onset of strong localization, surviving in the presence of weak magnetic fields. Recent non-perturbative calculations in a quasi-1D setting [2] have confirmed that the forward peak can serve as a reliable signature of Anderson localization. This theory describes the peak's temporal genesis as well as its aymptotic features such as width and height, and arguably presents the only instance where the temporal evolution of a strong localization phenomenon can be described analytically at all times.

[1] T. Karpiuk et al., PRL 109, 190601 (2012)
[2] T. Micklitz et al., arXiv:1311.2268

DY 2.2 Mon 10:00 HÜL 186

Adiabatic-Markovian Dynamics at Avoided Crossings — •Peter Nalbach — I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstr. 9, 20355 Hamburg

In order to study Landau-Zener transitions at avoided crossings under the influence of environmental fluctuations we derive effective nonequilibrium Bloch equations. Thereby, we employ an adiabatic-Markovian approximation which results in effectively time-dependent relaxation and dephasing rates and a time-dependent quasi-equilibrium statistical operator to which the system is driven. At weak coupling, where in a static case a Markovian approximation is valid, we observe very good agreement for the full driving speed range between the nonequilibrium Bloch equations predictions and numerical exact data for the Landau-Zener transition and the excitation survival probability [1]. The nonequilibrium Bloch equations, thus, allow for an efficient tool to analyze and model the dynamics in driven double quantum dot [2] and other qubit realizations.

[1] P. Nalbach and M. Thorwart, Phys. Rev. Lett. 103, 220401 (2009) & Chem. Phys. 375, 234 (2010).

[2] P. Nalbach, J. Knörzer and S. Ludwig, Phys. Rev. B 87, 165425 (2013).

DY 2.3 Mon 10:15 HÜL 186

A generalized quantum regression theorem for non-Markovian two-time correlation functions of system operators — •Jinshuang Jin[1,2,3], Michael Marthaler[3,4], and Gerd Schön[3,4] — [1]Karlsruhe Institute of Technology (KIT), Institute of Nanotechnology, Karlsruhe, Germany — [2]Department of Physics, Hangzhou Normal University, Hangzhou, China — [3]Institut für Theoretische Festkörperphysik, Karlsruhe Institute of Technology(KIT), Karlsruhe, Germany — [4]DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology, Karlsruhe, Germany

We present an efficient scheme for the calculation of two-time correlation functions for open quantum systems with memory effect. This scheme is the generalization of the quantum regression theorem with the consideration of non-Markovian effects. We further apply the present method to both Ferminonic and Bosonic systems. The former is to study the charge fluctuation spectrum of the interacting quantum dots in the sequential tunneling regime. The latter is to investigate the non-Markovian effect of the phonon bath on the emission spectrum of a cavity. The characteristic non-Markovian features in the spectra are explored.

DY 2.4 Mon 10:30 HÜL 186

Coherence phase diagram and a quench dynamics of a spin-boson model. — •Oleksiy Kashuba[1], D.M. Kennes[2], M. Pletyukhov[2], V. Meden[2], and H. Schoeller[2] — [1]Institut für Theoretischen Physik, Technische Universität Dresden — [2]Institut für Theorie der Statistischen Physik, RWTH Aachen

We study the non-Markovian dynamics of the small dissipative quantum system coupled to an thermodynamically equilibrated environment. The memory effects probed by the quenching of the coupling strength. We discovered the contra-intuinive tendency of the system to the enhancement of the coherence in response to stronger memory of the incoherent behaviour before the quench. Studying the dynamics of the system at different coupling and temperatures we revealed several distinct "phases" by discriminating between the dynamics on intermediate and long time scales. Surprisingly, elevated temperature can render the system "more coherent" by inducing a transition from the partially coherent to the coherent regime.

15 min break

DY 2.5 Mon 11:00 HÜL 186

Beyond Born-Markov: validity, dependencies and the initial state problem — •Christian Karlewski, Michael Marthaler, and Gerd Schön — Institut für Theoretische Festkörperphysik, KIT, 76128 Karlsruhe

We expand the master equation for an open quantum system in terms of the Born and the Markov approximation. This makes it possible to calculate higher order-terms in the coupling strength to the bath beyond the famous Born-Markov approximation. Additionally, we are able to compare and distinguish between the terms belonging to Born or Markov approximation. The first issue we address with this approach is the initial state problem. Our method allows to quantify initial correlations and thus the error made by neglecting them. Secondly, we investigate the behaviour of a specific system, the spin boson model with an Ohmic noise with Drude-Lorentz cutoff, and we compare our computations with the Born-Markov approximation.

DY 2.6 Mon 11:15 HÜL 186

Dissipative dynamics and energy transfer of a harmonic oscillator coupled to nonthermal baths — •Daniel Pagel[1], Andreas Alvermann[1], Holger Fehske[1], Peter Nalbach[2], and Michael Thorwart[2] — [1]Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald — [2]I. Institut für Theoretische Physik, Universität Hamburg

The dissipative dynamics of a quantum-mechanical system can be studied in a microscopic setting if one includes an explicit coupling to one or more baths of harmonic oscillators. Allowing for general nonequilibrium bath preparations instead of the usually employed thermal ones, we look at the long-time behavior of the dissipative harmonic oscillator coupled to one bath and prove that it equilibrates in the absence of isolated modes. The stationary density matrix in the long-time limit then depends on the initial bath state only. We discuss the requirements for full thermalization of the central oscillator. In the case of multiple baths, where stationary nonequilibrium states of the central oscillator become possible, we show that the fluctuations of the central oscillator follow an exact generalized nonequilibrium fluctuation relation. Finally, we discuss the generalization of the cumulant generating function for the energy transfer through the oscillator to the nonthermal situation.

DY 2.7 Mon 11:30 HÜL 186

Optimal control of non-interacting (quantum) harmonic oscillators and qubits — •Frank Boldt and Karl Heinz Hoffmann — Professur Theoretische Physik, insbesondere Computerphysik, Technische Universität Chemnitz

In this talk the time-optimal and decoherence free control of an ensemble of non-interacting (quantum) harmonic oscillators is given, using an geometrical approach based on the Casimir companion [1]. These time-optimal decoherence free passages are shortcuts to adiabaticity. Therefore fast optimal cooling processes are possible and maximum cooling rates will be given [2]. Further, time-optimal and decoherence free controls of an ensemble of non-interacting qubits will be deduced as a second example [3].

The optimal controls presented are piece-wise continuous functions

(Bang-Bang controls) and thus hard to realize experimentally. As an outline, bounds for continuous controls with finite switching times were calculated to give experimenters hard limits for instance to adjust their experimental realized version of the control by a feedback loop.

[1] F. Boldt et al., PRA 87, 022116 (2013)

[2] P. Salamon et al., Phys. Chem. Chem. Phys., 2009, 11, 1027-1032

[3] F. Boldt et al., EPL 99, 40002 (2012)

DY 2.8 Mon 11:45 HÜL 186

Dynamics of entanglement entropy and entanglement spectrum crossing a quantum phase transition — •Elena Canovi[1], Elisa Ercolessi[2], Piero Naldesi[2], Luca Taddia[2], and Davide Vodola[2,3] — [1]Institut für Theoretische Physik III, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany — [2]Dipartimento di Fisica e Astronomia dell'Università di Bologna and INFN, Sezione di Bologna, Via Irnerio 46, 40127 Bologna, Italy — [3]PCMS (UMR 7504) and ISIS (UMR 7006), Université de Strasbourg and CNRS, Strasbourg, France

We study the time evolution of entanglement entropy and entanglement spectrum in a finite-size system which crosses a quantum phase transition at different speeds. We focus on the Ising model with a time-dependent magnetic field, which is linearly tuned on a time scale τ. The time evolution of the entanglement entropy displays different regimes depending on the value of τ, showing also oscillations which depend on the instantaneous energy spectrum. The entanglement spectrum is characterized by a rich dynamics where multiple crossings take place with a gap-dependent frequency. Moreover, we investigate the Kibble-Zurek scaling of entanglement entropy and Schmidt gap.