DY 19: Quantum dynamics, decoherence and quantum information

Time: Wednesday 17:00–18:00 Location: ZEU 118

DY 19.1 Wed 17:00 ZEU 118

Thermodynamics of quantum systems: work and heat in finite systems — •Heiko Schröder and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Germany

Through the advent and the implementation of quantum information technology over the past decade there is a growing interest in the thermodynamics of quantum systems and their parts. In order to tackle this challenge, it is necessary to identify what thermodynamic role (heat or work source) each part plays in a given system and thus how the exchanged energy may be split into heat and work. We present a definition of finite quantum mechanical work sources and illustrate the concept by means of the behavior of a system consisting only of a single spin coupled to a harmonic oscillator. In addition, we give a generalized definition of heat and work based on the previous results and the concept of a local effective measurement basis (LEMBAS [1]).

[1] H. Weimer et al., Europhys. Lett. 83 (2008), 30008

DY 19.2 Wed 17:15 ZEU 118

Quantum dynamics in dispersive optomechanics — •Georg Heinrich and Florian Marquardt — LMU, Department für Physik, Arnold-Sommerfeld Center, CeNS, Theresienstr. 37, 80333 München

Macroscopic mechanical objects can be coupled to electromagnetic fields through radiation pressure. These optomechanical setups are supposed to reveal quantum effects and allow to explore the interaction of light and matter in a new regime at the boundary between quantum and classical physics. The realization of a macroscopic object, cooled to its quantum mechanical ground state, seems to be within experimental reach. Nevertheless, the detection of its energy eigenstates poses fundamental challenges. One of the most promising setups in the field is a dispersively coupled system where a dielectric membrane is placed in the middle between two high-finesse mirrors. Apart from the experimental advantage of separating mechanical and optical units, in principle, this approach allows Fock state detection and QND measurements. Here, we investigate cavity-photon dynamics of such a system in the regime where the timescale for photon exchange, between the two cavity halves, becomes comparable to the mechanical oscillation period. We discuss arising mechanical sidebands in the cavity spectrum that produce hybridized states which are superpositions of optical excitations in both sides of the cavity, with states that include phonons in the membrane. This will have implications on Fock state detection and might as well be relevant for other systems such as mechanical objects coupled to superconducting cavities.

DY 19.3 Wed 17:30 ZEU 118

Statistical model for the effects of dephasing on transport properties of large samples — •Matías Zilly[1], Orsolya Ujsághy[1,2], and Dietrich E. Wolf[1] — [1]Department of Physics, University of Duisburg-Essen and CeNIDE, 47048 Duisburg, Germany — [2]Department of Theoretical Physics and Condensed Matter Research Group of the Hungarian Academy of Sciences, Budapest University of Technology and Economics, Budafoki út 8., H-1521 Budapest, Hungary

We present a statistical model for the effects of dephasing on the transport properties of large devices. The physical picture is different from earlier models which assume that dephasing happens continuously throughout the sample, whereas we model the dephasing in a statistical sense, assuming a distribution of completely phase-randomizing regions between which the transport is coherent and described by the nonequilibrium Green's function method. Thus the sample is effectively divided into smaller parts making the numerical treatment more efficient. As a first application the conductances of ordered and disordered linear tight-binding chains are calculated and compared to the results of other phenomenological models in the literature.

DY 19.4 Wed 17:45 ZEU 118

Exact quantum quench dynamics of the fermionic pairing model — •Alexandre Faribault[1], Pasquale Calabrese[2], and Jean-Sébastien Caux[3] — [1]Physics Department, ASC and CeNS, Ludwig-Maximilians-Universität, Theresienstr. 37, 80333 München, Germany — [2]Dipartimento di Fisica dell'Università di Pisa and INFN, 56127 Pisa, Italy — [3]Institute for Theoretical Physics, Universiteit van Amsterdam, 1018 XE Amsterdam, The Netherlands

Understanding the non-equilibrium dynamics of extended quantum systems after the trigger of a sudden, global perturbation (quench) represents a daunting challenge, especially in the presence of interactions. The main difficulties stem from both the vanishing time scale of the quench event, which can create arbitrarily high energy modes, and its non-local nature, which precludes the utility of local excitation bases.

We here show that nonperturbative methods based on integrability can prove sufficiently powerful to completely characterize quantum quench problems: we illustrate this using a simple model of fermions with pairing interactions (Richardson's model).

The effects of quenches on the dynamics of important observables are discussed. Many of the features we find are expected to be universal to all kinds of quench situations in atomic physics and condensed matter.