DY 12: Quantum Dynamics, Decoherence, and Quantum Information II

Time: Tuesday 10:15–13:15 Location: ZEU 255

DY 12.1 Tue 10:15 ZEU 255

Hamiltonian of mean force for a damped quantum oscillator — •Stefanie Hilt, Benedikt Thomas, and Eric Lutz — Department of Physics, University of Augsburg, 86135 Augsburg, Germany

We consider a quantum harmonic oscillator linearly coupled to a reservoir of harmonic oscillators. For a finite coupling strength the stationary distribution of the damped oscillator is not of the Gibbs form, in contrast to standard thermodynamics. We quantify this deviation by evaluating the quantum Hamiltonian of mean force exactly and discuss its connection with the initial coupling process between system and reservoir.

DY 12.2 Tue 10:30 ZEU 255

Energy-time uncertainty for driven quantum systems — Sebastian Deffner and •Eric Lutz — Department of Physics, University of Augsburg, D-86135 Augsburg

We derive a generalization of the energy-time uncertainty relation for driven quantum systems based on the Bures geometric distance in Hilbert space and the concept of quantum speed limit. This relation is valid for arbitrary driving protocol and arbitrary distance between initial and final state.

DY 12.3 Tue 10:45 ZEU 255

Asymmetric Bethe-Salpeter equation for pairing and condensation — •Klaus Morawetz — University of Applied Science Münster, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics (IIP), Universidade Federal do Rio grande do Norte - UFRN, Brazil

The Martin-Schwinger hierarchy of correlations are reexamined and the three-particle correlations are investigated under various partial summations. Besides the known approximations of screened, ladder and maximally crossed diagrams the pair-pair correlations are considered. It is shown that the recently proposed asymmetric Bethe-Salpeter equation to avoid unphysical repeated collisions is derived as a result of the hierarchical dependencies of correlations. Exceeding the parquet approximation we show that an asymmetry appears in the selfconsistent propagators. This form is superior over the symmetric selfconsistent one since it provides the Nambu-Gorkov equations and gap equation for fermions and the Beliaev equations for bosons while from the symmetric form no gap equation results. The selfenergy diagrams which account for the subtraction of unphysical repeated collisions are derived from the pair-pair correlation in the three-particle Greenfunction. It is suggested to distinguish between two types of selfconsistency, the channel-dressed propagators and the completely dressed propagators, with the help of which the asymmetric expansion completes the Ward identity and is Φ-derivable.
arXiv:1006.4695

DY 12.4 Tue 11:00 ZEU 255

Modular Entanglement — •Giulia Gualdi[1,2], Salvatore Marco Giampaolo[2], and Fabrizio Illuminati[2] — [1]Universiät Kassel Fachbereich 10 - Mathematik und Naturwissenschaften Institut für Physik Heinrich-Plett-Str. 40 D-34132 Kassel — [2]Dipartimento di Matematica e Informatica, Università degli Studi di Salerno, Via Ponte don Melillo, I-84084 Fisciano (SA), Italy; CNR-SPIN, and INFN Sezione di Napoli, Gruppo collegato di Salerno, I-84084 Fisciano (SA), Italy

We introduce and discuss the concept of modular entanglement. This is the entanglement that is established between the end points of modular systems composed by sets of interacting moduli of arbitrarily fixed size. We show that end-to-end modular entanglement scales in the thermodynamic limit and rapidly saturates with the number of constituent moduli. We clarify the mechanisms underlying the onset of entanglement between distant and non-interacting quantum systems and its optimization for applications to quantum repeaters and entanglement distribution and sharing.

DY 12.5 Tue 11:15 ZEU 255

Dynamics of quantum phase transitions using ensembles of classical trajectories — •Alexander Itin[1,2] and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Space Research Institute, Profsoyuznaya str. 84/32, Moscow 117997, Russia

Recently, Truncated Wigner Approximation was applied to study dynamics of quantum phase transitions (QPT) in infinitely-coordinated models such as the Dicke and Lipkin-Meshkov-Glick models [1,2,3]. The initial quantum state is represented by an ensemble of classical trajectories, with quantum observables being obtained by averaging over the classical ensemble. As an external parameter is changed, the quantum system experiences a passage through a QPT, while trajectories from the classical ensemble undergo a passage through a bifurcation. Non-adiabaticity of the ensemble of classical trajectories can be described by mapping to Painleve equations, as shown recently in [2,3]. After overviewing recent results in this field, we present the application of the method to the dynamics of splitting and merging of multiple Bose-Einstein condensates [4,5].

[1] A. Altland et al., Phys.Rev,A 79, 042703 (2009).
[2] A.P. Itin and P. Törmä, Phys. Rev. A 79, 055602 (2009).
[3] A.P. Itin and P. Törmä, arXiv:0901.4778.
[4] J. Dziarmaga et al., Phys. Rev. Lett. 101, 115701 (2008)
[5] R. Schützhold et al., Phys. Rev. Lett. 97, 200601 (2006)

DY 12.6 Tue 11:30 ZEU 255

Quantum dynamics of the time-dependent elliptical billiard — •Florian Lenz[1], Fotis K. Diakonos[2], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — [2]Department of Physics, University of Athens, GR-15771 Athens, Greece

We analyze the quantum dynamics of the time-dependent elliptical billiard. Since there are no standard methods available to tackle this problem, a numerical procedure for the time-propagation of an arbitrary initial state is developed. To circumvent the time-dependent Dirichlet boundary conditions, a series of transformations is applied, yielding a Hamiltonian with static boundary conditions but in turn time-dependent masses and additional time-dependent potential terms. By means of an expansion ansatz, this eventually yields a large system of coupled ordinary differential equations, which can be solved by standard techniques. While for low driving frequencies the evolution of the energy is purely adiabatic, with increasing frequency more and more higher excited states with the same symmetry properties as the initial state get populated. The time-evolution of the population coefficients of the instantaneous eigenstates exhibit characteristic periods, which are much larger than the period of the external driving. These periods depend sensitively on the driving frequency and display a resonance like structure. We employ a Rabi-like coupled, driven few level model to trace the origin of the large periods of the population coefficients and find excellent agreement with the full numerical simulations.

15 min. break.

DY 12.7 Tue 12:00 ZEU 255

Probing quantum coherence in arrays of superconducting qubits — •Alexandra Liguori, Angel Rivas, Susana Huelga, and Martin Plenio — Institut f\"ur Theoretische Physik, Universit\"at Ulm, D-89069 Ulm, Germany

In the mid-80's the so-called phenomenon of dynamic localization was shown for a charged particle moving under the influence of a sinusoidally-varying time-dependent electric field, and more recently similar resonances in the conduction were found to be present also in ion channels. In this work we study the conditions under which this dynamic localization can be found in arrays of superconducting qubits. This phenomenon can serve as a signature of quantum coherence in such systems and moreover could be checked experimentally by various groups constructing arrays of superconducting flux qubits.

DY 12.8 Tue 12:15 ZEU 255

Dissipative quantum mechanics: Taming the sign problem — •Jürgen T. Stockburger — Universität Ulm, Institut für Theoretische Physik, 89069 Ulm

Influence functionals are a straightforward non-perturbative approach to open quantum systems in the path integral formalism. Numerical work based on this approach suffers from the dynamical sign problem, a severe degradation of sampling statistics for long time intervals.

However, influence functionals can be formally re-interpreted as generating functionals of c-number-valued quantum noise. This immediately leads to an equivalent non-Markovian stochastic dynamics in terms of pure or mixed quantum states, allowing numerical simulation in the Schrödinger picture. Since the noise forces are complex-valued, a new (typically milder) sign problem arises from the non-unitary propagation of stochastic samples. For friction kernels with finite effective support, this simulation method is modified such that stochastic variances remain bounded in the long-time limit, thus curing the sign problem. Hybrid stochastic approaches which preserve hermiticity of individual samples are also discussed.

DY 12.9 Tue 12:30 ZEU 255

Generating particle-like scattering states in wave transport — •Stefan Rotter, Philipp Ambichl, and Florian Libisch — Institute for Theoretical Physics, TU Vienna, Austria

We introduce a class of scattering states which display trajectory-like wave function patterns in coherent transport through complex scatterers. These deterministic scattering states feature the dual property of being eigenstates to the Wigner-Smith time-delay matrix and to the transmission matrix with classical transmission eigenvalues close to 0 or 1. An operational protocol for generating these states based on the scattering matrix is put forward and successfully tested numerically for regular, chaotic and disordered scattering systems. These results pave the way for the experimental realization of particle-like wave fronts in transport through complex media with possible applications like secure and low-power communication.

Preprint available at: arXiv:1008.3132

Topical Talk DY 12.10 Tue 12:45 ZEU 255

Non-equilibrium quantum relaxation, thermalization and boundary effects — •Heiko Rieger[1] and Ferenc Iglói[2] — [1]Theoretical Physics, Saarland University, D-66041 Saarbrücken, Germany — [2]Research Institute for Solid State Physics and Optics, H-1525 Budapest, Hungary

The quantum dynamical evolution of an interacting many-body system prepared in a specific state that is not an eigenstate of the Hamiltonian is an interesting and theoretically challenging problem. Experimentally achieved for instance by fast quenches of external parameters fundamental questions concern the nature of the stationary (i.e. time-translational invariant) state of this non-equilibrium quantum relaxation including the issue of thermalization and potential descriptions by Gibbs ensembles. In this talk we focus on two issues that we address within the context of an integrable model, the transverse Ising chain. The first concerns the characterization of the non-stationary quantum relaxation following a quench: How is thermalization achieved during the time-evolution? How do correlations develop in time towards the stationary state, is there a time dependent correlation length, etc.? The second addresses quantum relaxation and potential thermalization in the presence of boundaries. Obviously an interesting question is whether the time and length scales characterizing the stationary relaxation in the bulk is altered in the vicinity of the boundary, and whether thermalization is achieved there and if yes, how?