TT 96: Correlated Electrons: Nonequilibrium Quantum Many-Body Systems II

Time: Thursday 15:00–17:00 Location: HSZ 304

TT 96.1 Thu 15:00 HSZ 304

Transient dynamics of open quantum systems — OLEKSIY KASHUBA[1] and •HERBERT SCHOELLER[2] — [1]Institut fuer Theoretische Physik, TU Dresden — [2]Institut fuer Theorie der Statistischen Physik, RWTH Aachen

We present a renormalization group (RG) method which allows for an analytical study of the transient dynamics of open quantum systems on all time scales [1]. Whereas oscillation frequencies and decay rates of exponential time evolution follow from the fixed point positions, the long-time behavior of pre-exponential functions is related to the scaling behavior around the fixed points. We show that certain terms of the RG flow are only cut off by inverse time, which leads to a difference between infrared and ultraviolet scaling. An evaluation for the ohmic spin boson model at weak damping reveals significant deviations from previous predictions in the long-time regime. We propose that weak coupling problems for stationary quantities can in principle turn into strong coupling ones for the determination of the long-time behavior.

[1] O. Kashuba and H. Schoeller, Phys. Rev. B87, 201402(R) (2013)

TT 96.2 Thu 15:15 HSZ 304

Stationary properties of generic 2-level systems in nonequilibrium — •STEFAN GOETTEL, FRANK REININGHAUS, and HERBERT SCHOELLER — Institut für Theorie der Statistischen Physik, RWTH Aachen

We consider a generic quantum dot in nonequilibrium in the Coulomb blockade regime at fixed charge and zero temperature. In the weak coupling regime, we present a generic weak-coupling expansion of the stationary density matrix and the conductance based on a recent formulation of real-time renormalization group (RTRG) by using the Laplace variable as flow parameter, in analogy to the expansion presented in Ref.[3] where a Masubara-frequency cutoff has been used. We apply this expansion to a 2-level system and find generically that the effective Liouvillian contains terms linear or quadratic in the renormalized couplings which can not be described by perturbation theory with renormalized couplings from poor man scaling methods. At large bias voltage, we find that at vanishing and large magnetic fields renormalized perturbation theory works well whereas at intermediate magnetic fields of the same order as the typical renormalization, significant differences occur which can only be described from the full RTRG method. Furthermore, we present evidence that the same generic behaviour is expected for 3- and 4-level systems.

[1] M. Pletyukhov, H. Schoeller, Phys. Rev. Lett. 108, 260601 (2012)
[2] O. Kashuba and H. Schoeller, Phys. Rev. B87, 201402(R) (2013)
[3] H. Schoeller and F. Reininghaus, Phys. Rev. B80, 045117 (2009)

TT 96.3 Thu 15:30 HSZ 304

Quantum quenches and and statistics of projective quantum measurements — •JONATHAN LUX and ACHIM ROSCH — Institut für Theoretische Physik, Universität zu Köln

Recently, it became possible to determine the position of ultracold atoms in a 2d optical lattice with single-site resolution[1]. This was used to perform time dependent projective quantum measurements in a many particle system.

Motivated by this development, we study a quench in the 2d XXZ Heisenberg model, where the initial state is a 1d chain of, for example, up-spins in a bath of down-spins. Here the zoology of quasiparticles and their reaction schemes are very rich. After a weak quench, the density of excitations induced by the quench is very low. This allows for a semiclassical approach: the creation and the scattering of the quasiparticles are quantum mechanical, while they propagate classically[2]. Using this method, we study the non-equilibrium statistics of projective quantum measurements, and find that many projective observables show algebraic long-time tails.

[1] T. Fukuhara, et al., Nature Phys. **9**, 235 (2013).
[2] S. Sachdev, and K. Damle, PRL **78**, 943 (1997).

TT 96.4 Thu 15:45 HSZ 304

Out of equilibrium quantum criticality and real-time dynamics — •PEDRO RIBEIRO[1,2,3], FARZANEH ZAMANI[1,2], and STEFAN KIRCHNER[1,2] — [1]CFIF-IST, Universidade de Lisboa, Lisboa, Portugal. — [2]MPI-PKS, Dresden, Germany — [3]MPI-CPfS, Dresden, Germany,

A systematic understanding of the physical properties of correlated systems away from thermal equilibrium is currently actively pursued in a broad variety of contexts. This interest in the theoretical description of far-from-equilibrium dynamics is fueled by recent experimental achievements to probe non-thermal states in a controlled fashion. In this talk we report on recent progress in the understanding of real time evolution of certain impurity models near local critical quantum points away from thermal equilibrium. The reported results are based on a generalisation of the dynamic large-N approach to the Keldysh contour that can be used to efficiently obtain the full real-time dynamics. Particular attention is given to the approach to previously found steady-state solutions when the system is quenched near criticality.

TT 96.5 Thu 16:00 HSZ 304

Auxiliary master equation approach to nonequilibrium correlated impurities — •ANTONIUS DORDA, MARTIN NUSS, ENRICO ARRIGONI, and WOLFGANG VON DER LINDEN — Technische Universität Graz, Graz, Österreich

A theoretical scheme for the study of correlated quantum impurity problems out of equilibrium is presented, which is particularly suited to address steate steady properties within Dynamical Mean Field Theory. The approach, recently introduced in [1], is based upon a mapping of the original impurity problem to an auxiliary open quantum system consisting of the interacting impurity coupled to bath orbitals as well as to a Markovian environment. The dynamics of the auxiliary system are governed by a Lindblad master equation whose parameters are used to optimize the mapping. The accuracy of the method can be readily estimated and systematically improved by increasing the number of auxiliary bath orbitals. To solve for the Green's functions of the auxiliary impurity problem, a non-hermitian Lanczos diagonalization is used [2]. Results for the steady state current-voltage characteristics of the single impurity Anderson model are presented and compared against data from time evolving block decimation. Furthermore, the bias dependence of the single particle spectral function and the splitting of the Kondo resonance are discussed.

[1] E. Arrigoni et al., Phys. Rev. Lett. 110, 086403 (2013)
[2] A. Dorda et al., in preparation

TT 96.6 Thu 16:15 HSZ 304

Universal post-quench dynamics at quantum critical points — •PIA GAGEL[1], PETER P. ORTH[1], and JÖRG SCHMALIAN[1,2] — [1]Institute for Theory of Condensed Matter, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [2]Institute for Solid State Physics, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany

We consider a quench in a system initially located in the vicinity of a quantum critical point and that is suddenly moved to the critical point. In this regime one finds a universal exponent that is not related to the equilibrium exponents and that governs the post-quench short time dynamics. We calculate this exponent for an open quantum system and discuss the implications for the dynamics of the order parameter and response functions. The approach demonstrates that quantum-quenches can be efficient tools to manipulate and study quantum many body systems.

TT 96.7 Thu 16:30 HSZ 304

Many-body localization and entanglement in disordered quantum spin models — •RAJEEV SINGH, JENS BARDARSON, and FRANK POLLMANN — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

The presence of disorder in a non-interacting system can localize all the energy eigenstates, a phenomena dubbed Anderson localization. Many-body localization is a generalization of this phenomena to include *interactions*. The dynamics of disordered interacting quantum systems shows a logarithmic growth (associated with glassy systems) in the entanglement entropy after a global quench [1]. For finite systems, this growth saturates and the saturation value obeys a volume law. A volume law leads to a constant entanglement entropy per site which might be related to thermal entropy and imply partial thermalization of the system. In this work, we study further the dynamics of disordered quantum spin systems and parameter dependence of the long time saturation.

[1] J. H. Bardarson, F. Pollmann and J. E. Moore, Phys. Rev. Lett. 109, 107202 (2012)

TT 96.8 Thu 16:45 HSZ 304

Many body localization in a quantum Ising model: A numerical study — •Jonas Kjäll, Jens Bardarson, and Frank Pollmann — Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany

Closed correlated quantum systems with disorder can experience many-body localization. These systems do not thermalize and the properties of the individual finite energy eigenstates become important. Recently, Huse et. al. concluded that eigenstates with broken symmetry order the quantum system, even at energy densities where the corresponding thermal system is disordered. We perform a detailed exact diagonalization study of a random Ising chain with a short ranged interaction between the excitations. We find signatures of the three predicted localized phases. One is paramagnetic and the two others have a broken Z_2 symmetry with spin-glass order. These last two can further be distinguished by spectral properties.