TT 82: Correlated Electrons: Nonequilibrium Quantum Many-Body Systems 2

Time: Thursday 16:30–18:30 Location: H22

TT 82.1 Thu 16:30 H22

Dynamical Cooper pairing in non-equilibrium electron-phonon systems — •Michael Knap[1,2], Mehrtash Babadi[3], Gil Refael[3], Ivar Martin[4], and Eugene Demler[2] — [1]Technical University of Munich — [2]Harvard University — [3]Caltech — [4]Argonne National Laboratory

Ultrafast laser pulses have been used to manipulate complex quantum materials and to induce dynamical phase transitions. One of the most striking examples is the transient enhancement of superconductivity in several classes of materials upon irradiating them with high intensity pulses of terahertz light. Motivated by these experiments we analyze the Cooper pairing instabilities in non-equilibrium electron-phonon systems. We demonstrate that the light induced non-equilibrium state of phonons results in a simultaneous increase of the superconducting coupling constant and the electron scattering. We analyze the competition between these effects and show that in a broad range of parameters the dynamic enhancement of Cooper pair formation dominates over the increase in the scattering rate. This opens the possibility of transient light induced superconductivity at temperatures that are considerably higher than the equilibrium transition temperatures. Our results pave new pathways for engineering high-temperature light-induced superconducting states.

TT 82.2 Thu 16:45 H22

Non-Equilibrium Dynamical Cluster Approximation of the Falicov-Kimball Model — •Andreas Herrmann and Philipp Werner — University of Fribourg, Switzerland

We simulate the time-evolution of the Falikov-Kimball model after an interaction quench using a non-equilibrium generalization of the dynamical cluster approximation (DCA). By considering clusters of up to eight sites, we study how non-local correlations affect the relaxation dynamics of local and non-local observables.

TT 82.3 Thu 17:00 H22

Fluctuations of the entanglement entropy in strongly disordered systems — •Johannes Oberreuter and Michael Knap — Walter-Schottky-Institut, Technische Universität München, Garching, Deutschland

The fact that disorder localizes the dynamics in one- and two-dimensional systems is a classic result by Anderson. Recently, the question has arisen, if this effect also pertains to quantum many body systems with interactions, which is known as many body localization (MBL). It has been suggested, that the fluctuations of the entanglement entropy could provide a signature of MBL. We examine this quantity in the framework of the strong randomness (real space) renormalization group. We compare numerical simulations and analytical findings in the infinite randomness fixed point.

TT 82.4 Thu 17:15 H22

Scaling and Universality at Dynamical Quantum Phase Transitions — •Markus Heyl — Technische Universität München

Dynamical quantum phase transitions have recently emerged as a nonequilibrium analogue to conventional phase transitions with physical quantities becoming nonanalytic at critical times. However, a major challenge is to connect to fundamental concepts such as scaling and universality that are intimately related to renormalization group theory and the associated fixed points. In this talk I will show that for dynamical quantum phase transitions in Ising models exact renormalization group transformations in complex parameter space can be formulated. As a result of this construction, the dynamical quantum phase transitions are critical points associated with unstable fixed points of equilibrium Ising models implying scaling and universality. Moreover, signatures of these transitions in the dynamical buildup of spin correlations will be presented with an associated temporal power-law scaling determined solely by the fixed point universality class.

TT 82.5 Thu 17:30 H22

Non-equilibrium inhomogeneous DMFT for correlated Heterostructures: Auxiliary Master Approach — •Irakli Titvinidze, Antonius Dorda, Wolfgang von der Linden, and Enrico Arrigoni — Institute of Theoretical and Computational Physics, Graz University of Technology, 8010 Graz, Austria

The recent impressive experimental progress in tailoring different microscopically controlled quantum objects has prompted increasing interest in correlated systems out of equilibrium. Of particular importance are correlated heterostructures, quantum wires and quantum dots with atomic resolution. In this work we present results for the steady state spectral function and current-voltage characteristics for a system consisting of several monoatomic layers of correlated orbitals, attached to two metallic leads. The non-equilibrium situation is driven by a bias-voltage applied to the leads. To investigate the system we generalize a recently introduced dynamical mean-field theory (DMFT) based theoretical scheme [1] for the multilayer case. Specifically, the approach addresses the DMFT impurity problem within an auxiliary system consisting of a correlated impurity, a small number of uncorrelated bath sites and two Markovian environments described by a generalized Master equation [1,2,3].

[1] E. Arrigoni et al., PRL **110**, 086403 (2013)
[2] A. Dorda et al., PRB **89**, 165105 (2014)
[3] I. Titvinidze et al., arxiv:1508.02953

TT 82.6 Thu 17:45 H22

Quasi-soliton scattering in quantum spin chains — •Davide Fioretto[1], Rogier Vlijm[2], Martin Ganahl[3], Michael Brockmann[4], Masud Haque[4], Hans-Gerd Evertz[5], and Jean-Sébastien Caux[2] — [1]Institut für Theoretische Physik, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institute for Theoretical Physics, University of Amsterdam, Science Park 904, 1090 GL Amsterdam, The Netherlands — [3]Perimeter Institute for Theoretical Physics, 31 Caroline Street North, ON N2L 2Y5, Canada — [4]Max-Planck-Institut für Physik Komplexer Systeme, Nöthnitzer Strasse 38, 01187 Dresden, Germany — [5]Institut für Theoretische Physik, Technische Universität Graz, Petersgasse 16, 8010 Graz, Austria

The quantum scattering of magnon bound states in the anisotropic Heisenberg spin chain is shown to display features similar to the scattering of solitons in classical exactly solvable models. Localized colliding Gaussian wave packets of bound magnons are constructed from string solutions of the Bethe equations and subsequently evolved in time, relying on an algebraic Bethe ansatz based framework for the computation of local expectation values in real space-time. The local magnetization profile shows the trajectories of colliding wave packets of bound magnons, which obtain a spatial displacement upon scattering. Analytic predictions on the displacements for various values of anisotropy and string lengths are derived from scattering theory and Bethe ansatz phase shifts, matching time evolution fits on the displacements.

TT 82.7 Thu 18:00 H22

Electron-phonon scattering in one-dimensional systems — •Christoph Brockt[1], Eric Jeckelmann[1], Florian Dorfner[2], Lev Vidmar[2], and Fabian Heidrich-Meisner[2] — [1]Leibniz Universität Hannover, Germany — [2]Ludwig-Maximilians-Universität München, Germany

We present a study of the scattering of an electronic wave packet by local phonon modes on an one-dimensional lattice. The problem is adressed both numerically and analytically. We find features like transient self-trapping, reflection and dissipation, where the latter two exhibit resonance effects. The parameter range includes the adiabatic, antiadiabatic, weak- and strong coupling regimes. For the numerical part we use a newly developed method for simulating the time evolution of systems with large local Hilbert spaces [1]. It combines the time-evolving block-decimation algorithm [2] with a dynamical optimization of the local boson basis. We use the optimal boson modes [3] to speed up our simulations as well as for gaining insight into the physics of the system.

Support from the DFG through the Research Unit FOR 1807 is gratefully acknowledged.

[1] C. Brockt et al., arXiv:1508.00694v1 (2015)
[2] G. Vidal, PRL **93**, 040502 (2004)
[3] C. Zhang, E. Jeckelmann, and S. R. White, PRL **80**, 2661 (1998)

TT 82.8 Thu 18:15 H22

Filling fraction quantum quenches and the arctic circle — •Jean-Marie Stephan[1], Jacopo Viti[1], Jerome Dubail[2], Nicolas Allegra[2], and Masud Haque[1] — [1]Max Planck Institut für Physik

Komplexer Systeme, Noethnitzer Str. 38 D01187 Dresden, Germany — [2]CNRS & IJL-UMR 7198, Universite de Lorraine, BP 70239, F-54506 Vandoeuvre-les-Nancy Cedex, France

I consider a simple non-equilibrium problem, where a critical one-dimensional system is prepared in a state with two different densities on the left and on the right, and let evolve with a Hamiltonian that conserves the number of particles. For free systems a lot can, and has been understood by making use of a semiclassical picture, in which particles carrying a momentum k propagate ballistically with velocity v(k). Generalization to interacting systems is very much an open problem. I will discuss attempts at understanding such dynamics using field theory. A possible strategy is to study the behavior in imaginary time, the real time dynamics being recovered by performing the Wick rotation. I will show that all degrees of freedom outside a certain region may freeze in imaginary time, contrary to naive expectations. This behavior is analogous to the celebrated "arctic circle" phenomenon found in the study of two-dimensional classical dimer or vertex models. Such imaginary time pictures can be used to make predictions about the behavior of correlation functions, entanglement entropies, or return probabilities after the quench.