TT 29: Nonequilibrium Quantum Many-Body Systems 2 (joint session TT/DY)

Time: Tuesday 14:00–16:00 Location: HSZ 204

TT 29.1 Tue 14:00 HSZ 204

Robust and ultrafast state preparation by ramping artificial gauge potentials — •Botao Wang, Xiaoyu Dong, F. Nur Ünal, and André Eckardt — Max-Planck-Institut für Physik komplexer Systeme Nöthnitzer Str. 38, D-01387 Dresden, Germany

The implementation of static artificial magnetic fields in ultracold atomic systems has been established as a powerful tool, e.g. for simulating quantum-Hall physics with charge-neutral atoms. Taking an interacting bosonic flux ladder as a minimal model, we investigate protocols for adiabatic state preparation based on ramping up the vector potential (in the form of Peierls phases), which is engineered to give rise to the desired magnetic flux. We find that the time required for adiabatic state preparation dramatically depends on the spatial pattern of Peierls phases used to create the flux. This is explained by the fact that, while different patterns (i.e. vector potentials) just correspond to different gauges for static fluxes, they induce different electric fields during the ramp. Remarkably, we find that for an optimal choice, it allows for preparing the ground state almost instantaneously. This provides a novel concept for shortcuts to adiabaticity and may open up a new way for robust state preparation.

TT 29.2 Tue 14:15 HSZ 204

Non-equilibrium steady state solutions of time-periodic driven Luttinger liquids — •Serena Fazzini[1], Piotr Chudinski[2], Chirstoph Dauer[1], Imke Schneider[1], and Sebastian Eggert[1] — [1]Physik und OPTIMAS, Technische Universität Kaiserslautern — [2]School of Mathematics and Physics, Queens Univ. Belfast

The recent development of Floquet engineering has made periodic driving a versatile tool for achieving new phases not accessible in static equilibrium systems. We now study the exact Floquet steady states of the periodically driven Tomonaga-Luttinger liquid without resorting to any high frequency approximations. We show that the time-dependent Schrödinger equation can be solved analytically for a large class of driven interacting 1D systems, which give the resulting non-equilibrium steady states. Remarkably, we observe regions of instabilities as a function of total momentum where the solution is not of Floquet form, which implies a loss of time translational invariance and therefore heating of excitations. For small driving amplitudes the instabilities are close to the naively expected resonance condition $n\omega = 2vq$, but for stronger driving the heating regions separate a rich structure of bands of steady state solutions. Physical consequences are discussed.

TT 29.3 Tue 14:30 HSZ 204

Periodically Driven Manybody System: a Density Matrix Renormalization Group Study — •Imke Schneider[1], Shaon Sahoo[2], and Sebastian Eggert[1] — [1]Department of Physics and Research Center Optimas, Technical University of Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Physics, Indian Institute of Technology Tirupati, Tirupati 517506, India

Driving a quantum system periodically in time can profoundly alter its long-time dynamics and trigger exotic quantum states of matter. We propose a new DMRG method which directly deals with the Fourier components of the eigenstates of a periodically driven system using Floquet theory. With this new method we can go beyond effective Hamiltonians and take into account higher Floquet modes. Numerical results are presented for the isotropic Heisenberg antiferromagnetic spin-1/2 chain under both local (edge) and global driving for energies, spin-spin correlation and temporal fluctuations. As the frequency is lowered, the spin system enters into a Floquet regime with coherent excitations of a large number of Floquet modes, which shows characteristic quantum correlations that cannot be described by any effective static model.

TT 29.4 Tue 14:45 HSZ 204

Suppression of the horizon effect in pairing correlation functions of t-J chains after a quantum quench — Ansgar Kühn, Lorenzo Cevolani, and •Salvatore R. Manmana — Institut für Theoretische Physik, U. Göttingen

We investigate the time evolution of density, spin, and pairing correlation functions in one-dimensional t-J models following a quantum quench using the time-dependent density matrix renormalization group. While density and spin correlation functions show the typical light-cone behavior over a wide range of parameters, in pairing correlation functions it is strongly suppressed. This is supported by time-dependent BCS theory, where the light cone in the pairing correlation functions is found to be at least two orders of magnitude weaker than in the density correlator. These findings indicate that in global quantum quenches not all observables are affected equally by the excitations induced by the quench.

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[1] Phys. Rev. A **98**, 013616 (2018).

TT 29.5 Tue 15:00 HSZ 204

Iterative path integral summations for nonequilibrium quantum transport — •Stephan Weiss, Simon Mundinar, and Jürgen König — Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg

We have developed a numerically exact scheme, the **I**terative **S**ummation of **P**ath-**I**ntegrals (ISPI), to calculate observable of interest in quantum transport setups out of equilibrium [1,2]. Our main focus aims at small interacting quantum dot systems which are coupled to ferromagnetic [2] as well as superconducting leads in a nonequilibrium environment. We take into account small to intermediate Coulomb interactions, finite lead polarizations as well as finite superconducting gap parameters and finite temperature for the respective setups. Our method treats spin-dependent resonant-tunnelling processes in a natural manner. Examples of the tunnelling current are presented for different setups.

[1] S. Weiss, R. Hützen, D. Becker, J. Eckel, R. Egger, and M. Thorwart, Phys. Stat. Sol. B 250, 2298 (2013).
[2] S. Mundinar, Ph. Stegmann, J. König, and S. Weiss, Phys. Rev. B 99, 195457 (2019).

TT 29.6 Tue 15:15 HSZ 204

Mobility of the Fermi polaron for strong couplings — •Stefan Wittlinger[1], Lode Pollet[1], and Andrey Mishchenko[2] — [1]LMU Munich, Munich, Germany — [2]RIKEN, Wako, Japan

We present an algorithmic scheme to calculate the mobility of the Fermi polaron, an impurity immersed into a Fermi bath, for strong couplings. In general, Monte Carlo simulations of the Fermi polaron problem suffer from the fermionic sign problem. For our scheme, we find a wide parameter range with a tractable sign problem. The perturbative expansion of the interaction is sampled using the diagrammatic determinantal quantum Monte Carlo algorithm. The sampling is done in imaginary time, which requires analytical continuation. Most theoretical treatments of the Fermi polaron problem only consider s-wave interactions or rely on the heavy particle approximation. Our scheme allows for the study of more realistic potentials by also considering higher order scattering terms. It also allows for the study of the problem without the heavy particle approximation. I will present results for a repulsive potential well for a wide range of masses and varying interaction ranges. Possible connections to the Anderson orthogonality catastrophe of the infinite mass case will also be discussed.

TT 29.7 Tue 15:30 HSZ 204

Chiral kinetic theory avoiding anomalies — •Klaus Morawetz — Münster University of Applied Sciences, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics - UFRN, Campus Universitário Lagoa nova, 59078-970 Natal, Brazil

The anomalous term $\sim \vec{E}\vec{B}$ in the balance of the chiral density can be rewritten as quantum current in the classical balance of density. This term is derived from the quantum kinetic equations for systems with SU(2) structure within a completely conserving approach and it is suggested that the term is of kinetic origin instead of anomaly. Regularization-free density and pseudospin currents are calculated in Graphene and Weyl-systems realized as the infinite-mass limit of electrons with quadratic dispersion and a proper spin-orbit coupling. The intraband and interband conductivities are discussed. The optical conductivity agrees well with the experimental values using screened impurity scattering and an effective Zeeman field. The universal value of Hall conductivity is shown to be modified due to the Zeeman field. [Eur. Phys. J. B 92 (2019) 176, Phys. Lett. A 383 (2019) 1362, Phys. Rev. B 94 (2016) 165415, Phys. Rev. B 92 (2015) 245425 errata:

Phys. Rev. B93 (2016) 239904(E), Phys. Rev. B 92 (2015) 245426

TT 29.8 Tue 15:45 HSZ 204

Optical excitation of magnons in an easy-plane antiferromagnet: Application to Sr_2IrO_4 — •Urban F. P. Seifert[1,2] and Leon Balents[2,3] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Kavli Institute for Theoretical Physics, University of California, Santa Barbara, CA 93106, USA — [3]Canadian Institute for Advanced Research, Toronto, Ontario, Canada M5G 1M1

Recent experiments show that ultrafast radiation at energies below the optical gap can create coherent magnetic excitations in Mott insulating antiferromagnets. In this talk, we introduce a quantum theory for the interaction of a (classical) light field with the magnetic degrees of freedom in the paradigmatic two-dimensional antiferromagnet Sr_2IrO_4. The reduced space group symmetry of the crystal allows for several channels for spin-operator bilinears to couple to the electric field. Integrating out high-energy degrees of freedom in a Keldysh framework, we derive induced effective fields which enter the equations of motion of the low-energy mode of in-plane rotations which couple to the out-of-plane magnetization. Considering a pump-probe protocol, these induced fields excite magnetization oscillations which can subsequently probed, e.g. using Kerr rotation. We discuss how the induced fields depend on polarization and frequency of the driving light, and our study applies to both resonant and non-resonant regimes. Crucially, the induced fields depend on the two-magnon density of states, thus allowing for further insight into properties of the magnetic excitation spectrum.