TT 20: Dynamics in many-body systems: Equilibration and localization II (joint session DY/TT)

Time: Monday 15:30–18:00 Location: H19

TT 20.1 Mon 15:30 H19

Environment induced pre-thermalization in the Hubbard dimer — •Nikodem Szpak[1], Eric Kleinherbers[1], Friedemann Queisser[2], Jürgen König[1], and Ralf Schützhold[2,3] — [1]Fakultät für Physik, Universität Duisburg-Essen — [2]Helmholtz-Zentrum Dresden-Rossendorf — [3]Institut für Theoretische Physik, Technische Universität Dresden

We study a strongly interacting two-site Fermi-Hubbard model representing two coupled quantum dots and couple them to Markovian baths. We compare the real-time diagrammatic technique derived within the Keldysh formalism with a simplified model in the form of a Lindblad master equation for the reduced density matrix based on the Born-Markov approximation. Solving it exactly, we observe equilibration at different time-scales corresponding to thermalization and pre-thermalization processes.

TT 20.2 Mon 15:45 H19

Prethermalization and typical response of weakly perturbed quantum many-body systems — •Lennart Dabelow and Peter Reimann — Fakultät für Physik, Universität Bielefeld, 33615 Bielefeld

We explore the temporal relaxation of quantum many-body systems under the influence of weak-to-moderate perturbations. Situations we have in mind include, for instance, a sudden quench from one Hamiltonian to a related but different second Hamiltonian. Another example are integrable systems subject to a small integrability-breaking perturbation, commonly leading to prethermalization. Using a typicality approach, we show that the perturbed dynamics resembles the unperturbed time evolution modulated by an exponential decay towards the (possibly modified) long-time limit. We support our theory by comparison with both experimental and numerical data.

TT 20.3 Mon 16:00 H19

How to teach equilibration to the Boltzmann equation: a noisy relaxation time approximation — •Philipp Weiss and Achim Rosch — Institute for Theoretical Physics, University of Cologne, Germany

Equilibration of closed systems is controlled by diffusive transport of conserved quantities. After a quench these systems approach thermal equilibrium only slowly, hydrodynamic long-time tails emerge. As an analog in space one expects long-distance tails to appear when the system is perturbed only locally. A natural example for this situation is a current-carrying wire coupled to leads. We expect the connections to induce long-distance tails which show up as correction in the voltage drop.

The Boltzmann equation is widely used for tackling transport problems. However, it predicts exponential relaxation as it does not capture fluctuations of the hydrodynamic modes. Close to equilibrium a fluctuation-dissipation relation restores the missing piece of information, giving rise to a stochastic Boltzmann-Langevin equation.

Here, we present a simplified version, a "noisy relaxation time approximation", which we derive from a conserving relaxation time approximation supplemented with a suitably correlated noise term. We use our new tool to track the equilibration of a one-dimensional wire after a quench. Our prime goal is to detect long-time tails and long-distance tails indicating the diffusive built-up of the equilibrium correlations.

TT 20.4 Mon 16:15 H19

Boltzmann relaxation dynamics in strongly interacting quantum lattice systems — •Friedemann Queisser[2,3] and Ralf Schützhold[1,2,3] — [1]Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, Duisburg 47057, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [3]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

To the best of our knowledge, we present the first derivation of the Boltzmann equations for strongly interacting spinless fermions on a lattice in higher dimensions. Our derivation is based on a hierarchy of correlations [1]. For a large repulsive nearest neighbor interaction, the ground state at half filling is given by a charge density wave state. In this limit, we find that the collisions between particles and holes dominate over particle-particle and hole-hole scattering. Furthermore we shall discuss the validity of the η-theorem and the dependence of the thermalization dynamics on the type of excitation (particles or holes).

[1] P. Navez and R. Schützhold, Phys. Rev. A **82**, 063603 (2010)

TT 20.5 Mon 16:30 H19

Effect of anisotropic diffusion on spinodal decomposition — •Abhinav Sharma[1], Hidde Vuijk[1], and Joseph Brader[2] — [1]Leibniz Institute for polymer research, Dresden, Germany — [2]University of Fribourg, Fribourg, Switzerland

We study the phase transition dynamics of a fluid system in which the particles diffuse anisotropically in space. The motivation to study such a situation is provided by systems of interacting magnetic colloidal particles subject to the Lorentz force. The Smoluchowski equation for the many-particle probability distribution then acquires an anisotropic diffusion tensor. Using the method of dynamical density functional theory we predict that the intermediate-stage decomposition dynamics can be slowed down significantly by anisotropy; the coupling between different Fourier-modes is strongly reduced. Numerical calculations are performed for a model (Yukawa) fluid that exhibits gas-liquid phase separation.

15 min break

TT 20.6 Mon 17:00 H19

Cooperative efficiency boost for quantum heat engines — David Gelbwaser-Klimovsky[1], Wassilij Kopylov[2], and •Gernot Schaller[2] — [1]Department of Chemistry and Chemical Biology, Harvard University, Cambridge, USA — [2]Institut für Theoretische Physik, Technische Universität Berlin, D-10623 Berlin, Germany

The power and efficiency of many-body single-stroke heat engines can be boosted by performing cooperative non-adiabatic operations in contrast to the commonly used adiabatic implementations. The key property relies on the fact that non-adiabaticity allows for cooperative effects, that can use the thermodynamic resources only present in the collective non-passive state of a many-body system. In particular, we discuss an analytic formula for the efficiency of a quantum Otto cycle, which increases with the number of copies used and reaches a many-body bound, which we discuss analytically.

[1] D. Gelbwaser-Klimovsky, W.Kopylov, and G. Schaller, *Cooperative efficiency boost for quantum heat engines*, arXiv:1809.02564.

TT 20.7 Mon 17:15 H19

Light-induced Hall current in Graphene: beyond the high-frequency limit — •Marlon Nuske[1] and Ludwig Mathey[1,2,3] — [1]Zentrum für optische Quantentechnologien, Universität Hamburg, 22761 Hamburg, Germany — [2]Institut für Laserphysik, Universität Hamburg, 22761 Hamburg, Germany — [3]The Hamburg Centre for Ultrafast Imaging, 22761 Hamburg, Germany

In the high-frequency limit driving graphene with circularly-polarized light leads to a quantized Hall effect. In experiment, however, this idealized theoretical limit is often not achievable. We therefore investigate the effects of a finite-frequency circularly-polarized pulse on the Hall conductivity of graphene. For such a setup it is crucial to include decay processes in the theoretical model. We analyze the additional resonant contributions to the Hall current that arise from finite frequency driving. We explore different regimes, where either the resonant or the effective high-frequency contributions dominate the Hall current.

TT 20.8 Mon 17:30 H19

Environment induced pre-thermalization in the Mott-Hubbard model — •Friedemann Queisser[2,3], Ralf Schützhold[1,2,3], Nikodem Szpak[1], and Patrick Navez[2] — [1]Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, Duisburg 47057, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [3]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

Using a hierarchy of correlations, we discuss the strongly interacting Fermi-Hubbard model in the Mott insulating regime coupled to a Markovian environment [1,2]. The environment is chosen such that the particle number is constantly monitored at each lattice site. As expected, the environment induces a decay rate of γ the quasi-particles frequencies and tends to diminish the correlations between lattice sites. Surprisingly, the environment does also steer the state of the system on intermediate time scales $\mathcal{O}(1/\gamma)$ to a pre-thermalized state very similar to a quantum quench. The full thermalization and the approach to an infinite temperature state occurs via local on-site heating and takes much longer.

[1] P. Navez and R. Schützhold, Phys. Rev. A **82**, 063603
[2] F. Queisser and R. Schützhold, arXiv:1808.09906

TT 20.9 Mon 17:45 H19

Laser driven ultrafast crystallization of phase-change material Ge1Sb2Te4 — •Jingyi Zhu[1], Shuai Wei[2], Julian Merten[2], Christoph Persch[2], Lin Yang[1], Matthias Wuttig[2], and Paul H. M. van Loosdrecht[1] — [1]Physics institute 2, University of Cologne, 50937, Germany — [2]I. Institute of Physics (IA), RWTH Aachen University, Aachen, 52074, Germany

Rapid and reversible switching between amorphous and crystalline phases of the phase-change materials are either used or very promising in a wide range of applications in the electronic, optoelectronic, and photonic memory devices. Here we use time-resolved spontaneous Raman spectra to monitor the ultrafast process of melting, bond softening and crystallization in the phase changing material Ge1Sb2Te4 upon laser excitation. We demonstrate ultrafast crystallization on a ps timescale by monitoring the transient formation of a well-defined phonon mode signaling the crystalline state emerging from a broad vibrational continuum typical for the amorphous state.