# TT 31: Dynamics in Many-Body Systems: Interference, Equilibration and Localization II (joint session DY/TT)

Time: Monday 15:30–17:45 Location: EB 107

TT 31.1 Mon 15:30 EB 107

**Finite-size effects in canonical and grand-canonical quantum Monte Carlo simulations for fermions** — Zhenjiu Wang, Fakher F. Assaad, and •Francesco Parisen Toldin — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Germany

We introduce a quantum Monte Carlo method at finite temperature for interacting fermionic models in the canonical ensemble, where the conservation of the particle number is enforced. Although general thermodynamic arguments ensure the equivalence of the canonical and the grand-canonical ensembles in the thermodynamic limit, their approach to the infinite-volume limit is distinctively different. Observables computed in the canonical ensemble generically display a finite-size correction proportional to the inverse volume, whereas in the grand-canonical ensemble the approach is exponential in the ratio of the linear size over the correlation length. We verify these predictions by quantum Monte Carlo simulations of the Hubbard model in one and two dimensions in the grand-canonical and the canonical ensemble. We prove an exact formula for the finite-size part of the free energy density, energy density and other observables in the canonical ensemble and relate this correction to a susceptibility computed in the corresponding grand-canonical ensemble. This result is confirmed by an exact computation of the one-dimensional classical Ising model in the canonical ensemble, which for classical models corresponds to the so-called fixed-magnetization ensemble. Our method is useful for simulating finite systems which are not coupled to a particle bath, such as in nuclear or cold atom physics.

TT 31.2 Mon 15:45 EB 107

**Coupling of hydrodynamic fluctuations to diffusive modes in a one-dimensional current-carrying wire** — •Philipp Weiss, Marcel Gievers, and Achim Rosch — Institute for Theoretical Physics, University of Cologne, Germany

Closed systems with conservation laws approach thermal equilibrium only algebraically slowly after a sudden perturbation. The reason is that the built-up of equilibrium fluctuations is tied to the diffusive transport of the conserved quantities which results in hydrodynamic long-time tails. A similar behavior is expected for a current-carrying wire, coupled to leads which serve as source and sink of electrons. Here, fluctuation corrections near the connections decay slowly in space along the wire. Though tailored to transport problems, the Boltzmann equation predicts exponentially fast relaxation indicating that the Boltzmann description omits crucial processes. This can be cured *ad hoc* by adding collision noise which gives rise to a stochastic Boltzmann-Langevin equation. However, the full equation is hard to solve and approximation schemes are needed when investigating a specific system.

We propose a "noisy relaxation time approximation" which satisfies the conservation laws and provides a properly correlated noise term. We examine this novel tool using the example of the one-dimensional current-carrying wire: Can we observe the expected long-distance tails? How does our approximation compare to the real dynamics? And to which extent can we control it?

TT 31.3 Mon 16:00 EB 107

**Photo-carrier relaxation of correlated band insulators** — •Nagamalleswara Rao Dasari[1] and Martin Eckstein[2] — [1]Friedrich-Alexander Universitat Erlangen-Nurnberg, Erlangen, Germany. — [2]Friedrich-Alexander Universitat Erlangen-Nurnberg, Erlangen, Germany.

Ionic band insulators are characterized by charge gap, which is given by staggered Ionic potential ($\Delta$). Electronic correlations (U) in these insulators screens the charge gap and makes it smaller than the spin gap. Such correlated band insulators are realized by using simplest model Hamiltonian, i.e., Ionic Hubbard model. In this work, we have studied Ionic Hubbard model in the weak coupling limit by using non-equilibrium dynamical mean-field theory and iterated perturbation theory as an impurity solver. We find that photo-excited correlated band insulators thermalize rapidly when local coulomb interaction is greater than or equal to staggered Ionic potential ($U>=\Delta$). However, in the opposite case where $U<\Delta$, photo-excited system relaxes to a non-thermal steady state, and we did not see the thermalization of this state in our simulation time.

TT 31.4 Mon 16:15 EB 107

**Resonant thermalization of periodically driven strongly correlated electrons** — •Francesco Peronaci, Marco Schiró, and Olivier Parcollet — Institut de Physique Théorique (IPhT), Gif-sur-Yvette, France

We study the dynamics of the Fermi-Hubbard model driven by a time-periodic modulation of the interaction within nonequilibrium Dynamical Mean-Field Theory. For moderate interaction, we find clear evidence of thermalization to a genuine infinite-temperature state with no residual oscillations. Quite differently, in the strongly correlated regime, we find a quasi-stationary extremely long-lived state with oscillations synchronized with the drive (Floquet prethermalization). Remarkably, the nature of this state dramatically changes upon tuning the drive frequency. In particular, we show the existence of a critical frequency at which the system rapidly thermalizes despite the large interaction. We characterize this resonant thermalization and provide an analytical understanding in terms of a break down of the periodic Schrieffer-Wolff transformation.

TT 31.5 Mon 16:30 EB 107

**Dynamical Typicality for initial states with a preset measurement statistics of several commuting observables** — •Ben Niklas Balz and Peter Reimann — Fakultät für Physik, Universität Bielefeld, Germany

We consider all pure or mixed states of a quantum many-body system which exhibit the same, arbitrary but fixed measurement outcome statistics for several commuting observables. Taking those states as initial conditions, which are then propagated by the pertinent Schrödinger or von Neumann equation up to some later time point, and invoking a few additional, fairly weak and realistic assumptions, we show that most of them still entail very similar expectation values for any given observable. This finding thus corroborates the widespread observation that few macroscopic features are sufficient to ensure the reproducibility of experimental measurements despite many unknown and uncontrollable microscopic details of the system.

TT 31.6 Mon 16:45 EB 107

**Formation of Few-Electron-Complexes** — •Hubert Klar — Univ. Freiburg

Systems of 2,3 or 4 electrons in the field of a nucleus are shown to posses unstable equilibrium configurations. The many-body potential energy surface has in such configurations saddle points. AS model we study a saddle point with only one fragmentation direction, and show that the diffraction of an electron wave from the corresponding potential ridge manifests itself as a novel fictitious force being temporarily attractive between electrons. Moreover that force deforms the static potential surface and predicts an energy gap. Our theory extends and translates Wannier classical ionization theory into quantum mechanics. In contrast to Cooper pairs our electronic binding mechanisme stems entirely from correlation rather than fom lattice vibrations.

TT 31.7 Mon 17:00 EB 107

**Dynamic Analysis of a Scissors Structure** — •Yuta Hama[1], Ichiro Ario[1], Kotaro Adachi[1], and Yuki Chikahiro[2] — [1]Hiroshima University, Higashi-hiroshima, Japan — [2]Shinsyu University, Nagano, Japan

The paper presents a new type of deployable and/or folding bridge, which can be quickly constructed in case of damages after a natural disaster. The concept of the bridge is based on the application of scissor-type mechanism, which provides its rapid deployment. The presented research reviews fundamental numerical and experimental results for the full-sized scissors structure. Experimental testing included strain and acceleration measurements in free and forced loading conditions. From these results, it was possible to estimate basic dynamic characteristics of the bridge. Besides, in order to provide a basis for development of new construction methods under gravity. This dynamic research allows for a better and safer design of the movable and foldable full-scale scissors type of bridge.

TT 31.8 Mon 17:15 EB 107

**Dynamics in the ergodic phase of the many-body localization transition for a periodically driven system** — •Talía L. M. Lezama[1], Soumya Bera[2], and Jens H. Bardarson[3] — [1]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany — [2]Department of Physics, Indian Institute of Technology Bombay, Mumbai 400076, India — [3]Department of Physics, KTH Royal Institute of Technology, Stockholm, SE-106 91 Sweden

Closed disordered interacting quantum systems can experience a many-body localization phase transition when tuning the disorder strength around its critical value. Recent studies have shown that the ergodic phase is not a common metallic phase but that it rather exhibits non-trivial mechanisms (mainly Griffiths effects) foregoing the many-body localized phase. Those mechanisms have been described in terms of dynamical quantities such as autocorrelation functions, return probability, entanglement entropy and imbalance, to mention some. Here, we study the dynamics of a Floquet model of many-body localization, focussing on the dynamical regimes on the ergodic side of the transition.

TT 31.9 Mon 17:30 EB 107

**Characterizing time-irreversibility in disordered fermionic systems by the effect of local perturbations** — •Giuseppe De Tomasi[1], Frank Pollmann[2], Markus Heyl[1], Shreya Vardhan[3], and Eric Heller[4] — [1]MPIPKS, Dresden, Germany — [2]TMU, Munich, Germany — [3]MIT, Cambridge, USA — [4]Harvard, Cambridge, USA

We study the effects of local perturbations on the dynamics of disordered fermionic systems in order to characterize time-irreversibility. We focus on three different systems, the non-interacting Anderson and Aubry-André-Harper (AAH-) models, and the interacting spinless disordered t-V chain. First, we consider the effect on the full many-body wave-functions by measuring the Loschmidt echo (LE). We show that in the extended/ergodic phase the LE decays exponentially fast with time, while in the localized phase the decay is algebraic. We demonstrate that the exponent of the decay of the LE in the localized phase diverges proportionally to the single-particle localization length as we approach the metal-insulator transition in the AAH model. Second, we probe different phases of disordered systems by studying the time expectation value of local observables evolved with two Hamiltonians that differ by a spatially local perturbation. Remarkably, we find that many-body localized systems could lose memory of the initial state in the long-time limit, in contrast to the non-interacting localized phase where some memory is always preserved.