TT 50: Many-Body Localization

Time: Wednesday 18:00–19:00 Location: HSZ 204

TT 50.1 Wed 18:00 HSZ 204

Many-body localization from a one-particle perspective in the disordered 1D Bose-Hubbard model — •Miroslav Hopjan and Fabian Heidrich-Meisner — Institute for Theoretical Physics, University of Göttingen, Germany

We numerically investigate 1D Bose-Hubbard chains with onsite disorder by means of exact diagonalization. Consistent with previous studies, we observe signatures of transition from the ergodic to the many-body localized (MBL) regime when increasing the disorder strength or energy density. Apart form the entanglement entropy as a conventional but indirect measure for the ergodic-MBL transition we utilise the one-particle density matrix (OPDM) to characterize the system [1]. We show that the natural orbitals (the eigenstates of OPDM) are extended in the ergodic phase and real-space localized when one enters into the MBL phase. Furthermore, the distributions of occupancies of the natural orbitals as well as the diagonal part of OPDM (i.e., the site occupancies) can be used as measures of Fock-space localization in the respective basis [2]. Moreover, the full distribution of the densities of the physical particles provides a one-particle measure for the detection of the ergodic-MBL transition which could be directly accessed in experiments with ultra-cold gases.

[1] S. Bera, H. Schomerus, F. Heidrich-Meisner and J.H. Bardarson, PRL 115, 046603 (2015).
[2] M. Hopjan and F. Heidrich-Meisner, in preparation.

TT 50.2 Wed 18:15 HSZ 204

Dynamics of spin chains in the presence of long-range interactions — •Sebastian Wenderoth[1], Seelam Rajagopala[1], Nathan Ng[2], Michael Kolodrubetz[3], Eran Rabani[2], and Michael Thoss[1] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany — [2]Department of Physics and Chemistry, University of California, Berkeley, California, United States — [3]Department of Physics, The University of Texas at Dallas, Richardson, Texas, United States

In many-body localized (MBL) systems local observables do not equilibrate under unitary quantum dynamics and, therefore, these systems cannot be described within the framework of quantum statistical mechanics. Usually, the MBL phase is studied in locally interacting systems with static disorder e.g. a disordered Ising chain with nearest neighbour interactions. [1] Here, we study a disordered Ising chain in which all spins couple to a central d-level system (qudit), which induces spin flip interactions. Employing the multilayer multiconfiguration time-dependent Hartree approach [2,3], we are able to simulate the dynamics of large spin chains in a numerically exact way. Using this approach, we examine dynamical signatures of the localized and thermalizing phases at much larger system sizes than those achievable with exact diagonalization, consistent with having converged to the thermodynamic limit.

[1] A. Pal *et al.*, Phys. Rev. B **82**, 174411 (2010).
[2] O. Vendrell *et al.*, J. Chem. Phys. **134**, 044135 (2011).
[3] H. Wang *et al.*, J. Chem. Phys. **119**, 1289 (2003).

TT 50.3 Wed 18:30 HSZ 204

Entanglement dynamics of a one-dimensional many-body-localized system coupled to a bath — •Elisabeth Wybo, Michael Knap, and Frank Pollmann — Department of Physics, Technische Universität München, James-Franck-Strasse 1, D-85748 Garching, Germany

In isolated, interacting and strongly disordered quantum systems thermalization may break down, leading to a novel many-body localized phase. However, this special phase will be destroyed if the system is not well isolated from the environment. We investigate how many-body localization is destroyed in systems that are weakly coupled to a Markovian environment. In particular, we study entanglement probes like the negativity in quench setups, and determine their typical scaling. To this aim we use both tensor-network and exact-Krylov techniques.

TT 50.4 Wed 18:45 HSZ 204

Dynamical quantum phase transitions and many-body localization in spin chains with quasiperiodic fields — •Leonardo Benini[1], Piero Naldesi[2], Rudolf Roemer[1,3], and Tommaso Roscilde[4] — [1]University of Warwick, Coventry, U.K. — [2]Université Grenoble-Alpes, LPMMC and CNRS, Grenoble, France — [3]Université de Cergy-Pontoise, Institut d'Études Avancées, and LPT, Cergy-Pontoise, France — [4]Université de Lyon, Ens de Lyon, Université Claude Bernard and CNRS, Lyon, France

We study dynamical properties of many-body localized systems through the lens of dynamical quantum phase transitions (DQPTs) theory. We explore the quench dynamics of a one-dimensional Heisenberg model with quasi-periodic on-site magnetic fields, investigating the emergence of singularities in the return rate of the Loschmidt echo both in the strong MBL regime and close to criticality. Quenching from an initially ordered Néel state, we show the appearance of a sequence of DQPTs deep in the MBL phase, periodically distributed along the real-time axis. We then establish a connection between the non-analytic behavior of the dynamical free energy and the oscillations of the spin imbalance. A second quench protocol, which investigates the non-equilibrium dynamics of the system initialized in its ground-state, provides additional insights on the emergence of DQPTs associated with the MBL phase. We develop an experimentally viable criterion to discern between the ergodic and the MBL phase exploiting non-analyticities of the Loschmidt free energy in the short-time dynamics.