TT 14: Many-Body Quantum Dynamics 2 (joint session DY/TT)

Time: Tuesday 11:30–13:00 Location: H20

TT 14.1 Tue 11:30 H20

Disorder-free localization transition in a two-dimensional lattice gauge theory — •Nilotpal Chakraborty[1], Markus Heyl[1,2], Petr Karpov[1], and Roderich Moessner[1] — [1]Max Planck Institute for physics of complex systems, Dresden — [2]University of Augsburg, Augsburg

While the nature of the quantum localization transition (QLT) is still debated for conventional many-body localization, here we provide the first comprehensive characterization of the QLT in two dimensions (2D) for a disorder-free case. Disorder-free localization can appear in homogeneous 2D LGTs such as the U(1) quantum link model (QLM) due to an underlying classical percolation transition fragmenting the system into disconnected real-space clusters. Building on the percolation model, we characterize the QLT in the U(1) QLM through a detailed study of the ergodicity properties of finite-size real- space clusters via level-spacing statistics and localization in configuration space. We argue for the presence of two regimes - one in which large finite-size clusters effectively behave non-ergodically, a result naturally accounted for as an interference phenomenon in configuration space and the other in which all large clusters behave ergodically. As one central result, in the latter regime we claim that the QLT is equivalent to the classical percolation transition and is hence continuous. Utilizing this equivalence we determine the universality class and critical behaviour of the QLT from a finite-size scaling analysis of the percolation problem.

TT 14.2 Tue 11:45 H20

Quantifying local memory in disordered systems across the ETH-MBL transition — •Sebastian Wenderoth and Michael Thoss — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Freiburg

Thermalization decribes the process of a system reaching thermal equilibrium with its environment. The asymptotic state solely depends on a few macroscopic parameters of the environment. Hence, the information about the initial state is lost during the process. Many-body localized systems fail to thermalize due to the absence of transport, and thus, some information about the initial state is retained in local observables at all times.

Based on the time-evolution of a subsystem, we present a concept which can be used to quantify the influence of the initial state on local observables. Using this approach, we investigate local memory in the XXZ Heisenberg spin chain with random local disorder, a paradigmatic model exhibiting a transition from thermalizing to localized dynamics. We discuss the loss of local information and identify different delocalization mechanisms.

TT 14.3 Tue 12:00 H20

Dynamically Induced Exceptional Phases in Quenched Interacting Semimetals — •Carl Lehmann[1], Jan Carl Budich[1], and Michael Schüler[2] — [1]TU Dresden, Dresden, Germany — [2]Paul Scherrer Institute, Villigen, Switzerland

We report on the dynamical formation of exceptional degeneracies in basic correlation functions of nonintegrable one- and two-dimensional systems quenched to the vicinity of a critical point. Remarkably, fine-tuned semimetallic points in the phase diagram of the considered systems are thereby promoted to topologically robust non-Hermitian (NH) nodal phases emerging in the coherent time evolution of a dynamically equilibrating system. Using nonequilibrium Greens function methods within the conserving second Born approximation, we predict observable signatures of these NH nodal phases both in equilibrated spectral functions and in the nonequilibrium dynamics of single-particle density matrix functions.

TT 14.4 Tue 12:15 H20

Nontrivial damping of quantum many-body dynamics — •Tjark Heitmann[1], Jonas Richter[2], Jochen Gemmer[1], and Robin Steinigeweg[1] — [1]Department of Physics, University of Osnabrück, Germany — [2]Department of Physics and Astronomy, University College London, UK

Understanding how the dynamics of a given quantum system with many degrees of freedom is altered by the presence of a generic perturbation is a notoriously difficult question. Recent works predict that, in the overwhelming majority of cases, the unperturbed dynamics is just damped by a simple function, e.g., exponentially. While these predictions rely on random-matrix arguments and typicality, they can only be verified for a specific physical situation by comparing to the actual solution or measurement. Crucially, it also remains unclear how frequent and under which conditions counterexamples to the typical behavior occur. Here, we discuss this question from the perspective of projection-operator techniques, where exponential damping of a density matrix occurs in the interaction picture but not necessarily in the Schrödinger picture. We show that a nontrivial damping in the Schrödinger picture can emerge if the dynamics in the unperturbed system possesses rich features, for instance due to the presence of strong interactions. This suggestion has consequences for the time dependence of correlation functions. We substantiate our theoretical arguments by large-scale numerical simulations of charge transport in the extended Fermi-Hubbard model with nearest-neighbor interactions as perturbations to the integrable reference system.

TT 14.5 Tue 12:30 H20

Effect of electron-electron interaction on the spectral statistics in circular sector graphene billiards — •Xianzhang Chen[1,2] and Liang Huang[1] — [1]Lanzhou Center for Theoretical Physics, and Key Laboratory for Magnetism and Magnetic Materials of MOE, Lanzhou University, Lanzhou, Gansu 730000, China — [2]Université de Strasbourg, CNRS, Institut de Physique et Chimie des Matériaux de Strasbourg, UMR 7504, F-67000 Strasbourg, France

The spectral statistics is a fundamental issue in quantum chaos and has been used widely as a measure to probe the complexity of the underlying quantum systems. In this work, we adopt the one-orbital mean-field Hubbard model to investigate the effect of many-body interactions on the spectral statistics of circular sector graphene billiards. It is found that the spectral statistics are insensitive to the Hubbard interaction U for most of the energy ranges, except for energies around the Dirac point. We choose two representative systems, whose spectral statistics follow Poisson and Gaussian orthogonal ensemble (GOE) when $U = 0$, respectively. As U increases, for both cases, the spectral statistics moves toward GOE. However, after passing a critical value U_c, the spectral statistics turns back toward Poisson as U is increased further, due to the emerging gap and henceforth distinct behaviors of the quasiparticles. In addition, the energies above and below the Dirac point may exhibit different spectral statistics. These results uncover the intriguing connection between Hubbard interaction and the spectral statistics in graphene sector billiards. A physical picture is provided to understand these effects.

TT 14.6 Tue 12:45 H20

Anisotropy-mediated localization — •Ivan Khaymovich — Nordic Institute for Theoretical Physics, Stockholm, Sweden

Recently, the standard picture of Anderson localization transition in d-dimensional long-range (e.g. dipolar) systems has been argued due to several reported counterintuitive examples of (at least power-law) localization beyond the convergence of the perturbation theory. In addition, wave-function spatial decay rates obey a "mysterious" duality [1] mapping different powers 'a' of power-law bending symmetrically around the critical point a=d.

In my talk, I address this intriguing question, present a general approach applicable to all such models, and uncover the role of correlations and the origin of the above duality [2]. The phenomenon of the correlation-induced localization [2] is just the very peak of the iceberg in this field. Therefore I will focus on the effects of anisotropy [3] in dipolar system and show the reentrant localization governed by the anisotropy parameter given by the tilt of an electric field. Note that the range of systems is also not limited by the dipolar systems, but includes also the Weyl semimetals, ultracold atoms, Rydberg excitations in the optical traps and many others.

Literature: [1] X. Deng, V. E. Kravtsov, G. V. Shlyapnikov and L. Santos, Phys. Rev. Lett. 120, 110602 (2018). [2] P. Nosov, I. M. Khaymovich, V. E. Kravtsov, Correlation-induced localization Phys. Rev. B 99, 104203 (2019) [arXiv:1810.01492] [3] X. Deng, A. L. Burin, I. M. Khaymovich, Anisotropy-driven localization transition in quantum dipoles [arXiv:2002.00013]