DY 3: Poster Sesssion I: Quantum Chaos and Many-Body Quantum Dynamics

Time: Tuesday 17:30–19:30 Location: P

DY 3.1 Tue 17:30 P

Drift-induced Delocalization Transition in Resonance Channels — •Jan Robert Schmidt, Arnd Bäcker, and Roland Ketzmerick — TU Dresden, Institut für Theoretische Physik, Dresden

In higher-dimensional Hamiltonian systems resonance channels play a prominent role. Transport is typically slow due to Arnold diffusion, leading quantum mechanically to dynamical localization. Resonance channels widen as they approach the chaotic sea. We show that this induces (i) classically a drift and (ii) quantum mechanically leads to delocalization if the drift is strong enough. We propose a scaling of the delocalization transition by a single transition parameter. These phenomena are confirmed in a 4D symplectic map with a large resonance channel.

DY 3.2 Tue 17:30 P

Dynamics of NV centers interacting with background spins — •Lukas Voss and Jürgen Stockburger — Institute for Complex Quantum Systems, Ulm University

The nitrogen vacancy (NV) center in diamond is considered to be one of the most promising physical systems for application in emerging quantum technologies such as quantum sensing and quantum computing [1]. The corresponding protocols are highly sensitive to the interactions of NV centers with either ^{13}C background spins or other NV centers.

The number of spins typically involved is too large for direct methods of propagation (curse of dimensionality). As a remedy, we modify a stochastic jump method for coherent quantum dynamics introduced by Breuer [2], which greatly reduces the dimension of the state space of the propagation (sum vs. product spaces).

We demonstrate this technique for an NV center and several nuclear background spins and find attractive performance characteristics. Further investigations are aimed at clustering a large number of background spins. Treating intra-cluster interactions by unitary propagation while applying the jump approach to inter-cluster interactions will further improve simulation performance.

[1] MW Doherty et al., *Physics Reports* **528**, 1 (2013)
[2] H-P Breuer *Physical Review A* **69**, 122 (2004)

DY 3.3 Tue 17:30 P

Quantum signatures of partial barriers in 4D symplectic maps — •Jonas Stöber, Arnd Bäcker, and Roland Ketzmerick — TU Dresden, Institut für Theoretische Physik

Partial transport barriers in the chaotic sea of Hamiltonian systems restrict classical chaotic transport, as they only allow for a small flux between phase-space regions. Quantum mechanically for 2D symplectic maps one has a universal quantum localizing transition. The scaling parameter is the ratio of flux to the Planck cell of size h, such that quantum transport is suppressed if h is much greater than the flux, while mimicking classical transport if h is much smaller.

In a higher-dimensional 4D map one naively expects that the relevant scaling parameter is the same, but now with a Planck cell of size h squared. We show that due to dynamical localization along resonance channels the localization length modifies the scaling parameter. This is demonstrated for coupled kicked rotors for a partial barrier that generalizes a cantorus to higher dimensions.

DY 3.4 Tue 17:30 P

Enhanced state transfer by complex instability in coupled kicked tops — •Maximilian Kieler and Arnd Bäcker — Technische Universität Dresden, Institut für Theoretische Physik and Center for Dynamics, 01062 Dresden, Germany

By considering coupled kicked tops we provide a mechanism for a fast transfer between two specific states representing bits. This crucially relies on that fact that the semiclassical limit corresponds to a higher-dimensional system which allows for more types of stability of fixed points than the two-dimensional case. Tuning the parameters, the coupled kicked tops have fixed points with complex instability. Quantum mechanically this allows for a rapid transfer between coherent states located at these points, which is much faster than the coexisting dynamical tunneling.

DY 3.5 Tue 17:30 P

Fermionic duality beyond weak coupling: General simplifications of open-system dynamics — •Valentin Bruch[1], Konstantin Nestmann[1], Jens Schulenborg[2], and Maarten Wegewijs[1,3] — [1]Institute for Theory of Statistical Physics, RWTH Aachen, 52056 Aachen, Germany and JARA-FIT, 52056 Aachen — [2]Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen — [3]Peter Grünberg Institut, Forschungszentrum Jülich, 52425 Jülich, Germany

A large class of fermionic open systems obeys a powerful dissipative analogue of the "symmetry" of hermitian conjugation in closed quantum systems. This *fermionic duality relation* applies to quantum-impurity transport models with strong interactions and hybridization exhibiting many-body and memory effects. Here we extend this relation from the time-nonlocal memory-kernel approach (Nakajima-Zwanzig) to prominent quantum-information inspired approaches in their exact formulation [arXiv:2104.11202]. These include the Kraus-operator decomposition of the dynamical map as well as the time-convolutionless quantum master equation with a time-local generator and generalized Lindblad jump-operators. Whereas in some of these formulations this yields a strong restriction on the involved quantities, in others it can be exploited to partially by-pass nontrivial time-evolution calculations. Fermionic duality also offers new insights into the divisibility and causal structure of the dynamics and applied to nonperturbative semigroup approximations [Phys. Rev. X 11, 021041 (2021)] it provides a new way to construct initial-slip corrections.

DY 3.6 Tue 17:30 P

Quantum dynamics and thermodynamics in nanosystems with strong electronic-vibrational coupling under external driving — •Jakob Bätge[1], Wenjie Dou[2], Amikam Levy[3], and Michael Thoss[1] — [1]Institute of Physics, University of Freiburg, Freiburg, Germany — [2]School of Science, Westlake University, Hangzhou, China — [3]Department of Chemistry, Bar-Ilan University, Ramat-Gan, Israel

The development and optimization of quantum devices increase the interest in dynamics and thermodynamics of systems on the scale of single atoms and molecules. In this contribution, we investigate the nonequilibrium quantum dynamics of a time-dependent driven nanosystem with interacting electronic and vibrational degrees of freedom utilizing the numerically exact hierarchical equations of motion approach for multiple fermionic and bosonic environments [1]. We analyze the role of vibrations in the electronic friction induced by electronic-vibrational coupling and identify the adiabatic and nonadiabatic contributions to thermodynamic quantities[2].

[1] J. Bätge *et al.*, Phys. Rev. B **103**, 235413 (2021)
[2] W. Dou *et al.*, Phys. Rev. B **101**, 184304 (2020)

DY 3.7 Tue 17:30 P

Floquet prethermalization and Rabi oscillations in optically excited Hubbard clusters — •Junichi Okamoto[1,2] and Francesco Peronaci[3] — [1]Institute of Physics, University of Freiburg, Germany — [2]EUCOR Centre for Quantum Science and Quantum Computing, University of Freiburg, Germany — [3]Max Planck Institute for the Physics of Complex Systems, Germany

Floquet engineering is a growing field of study to realize exotic many-body quantum states beyond the conventional material science in equilibrium. The Floquet picture in terms of effective Hamiltonians is valid in the limit of high-frequency drive, where the heating rate is suppressed. In contrast, when the drive frequency is comparable to the energies of the system, the effect of heating is non-negligible, and the analysis becomes intricate. However, even in this case, the existence of quasi-steady states, so-called Floquet prethermal states (FPSs), has been demonstrated, which expands the boundary of Floquet engineering to a realistic drive range. In this work, we have investigated the optically excited Hubbard clusters by exact diagonalization. We show that FPSs emerge not only off resonance but also for resonant excitation, provided a small field amplitude. Notably, FPSs at resonance occur with Rabi oscillations. At stronger fields, thermalization to infinite temperature is observed. We elucidate the origin of the FPSs using time-dependent perturbation theory and the two-site Hubbard model. A finite-size analysis substantiates the main findings.

DY 3.8 Tue 17:30 P

Transmission through three-terminal microwave graphs with orthogonal, unitary and symplectic symmetry — Felipe de Jesús Castañeda-Ramírez[1], Angel M. Martínez-Argüello[2], •Tobias Hofmann[3], Aimaiti Rehemanjiang[3], Moisés Martínez-Mares[1], José A. Méndez-Bermúdez[4], Ulrich Kuhl[5], and Hans-Jürgen Stöckmann[3] — [1]Departamento de Física, Universidad Autónoma Metropolitana-Iztapalapa, Apartado Postal 55-534, 09340 Ciudad de México, Mexico — [2]Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México, Apartado Postal 48-3, 62210 Cuernavaca, Mor., Mexico — [3]Fachbereich Physik der Philipps-Universität Marburg, D-35032 Marburg, Germany — [4]Instituto de Física, Benemérita Universidad Autónoma de Puebla, Apartado Postal J-48, 72570 Puebla, Pue., Mexico — [5]Université Côte d'Azur, CNRS, Institut de Physique de Nice (INPHYNI), 06108 Nice, France

Transmission measurements through three-port microwave graphs are performed, in analogy to three-terminal voltage drop devices, with orthogonal, unitary, and symplectic symmetry. The terminal used as a probe is symmetrically located between two different chaotic subgraphs of the same mean density of states. Each subgraph is connected to one port, the input and the output, respectively. We find a good agreement with theoretical predictions, provided the effects of dissipation and imperfect coupling to the ports is considered. This extends previous studies using an asymmetric probe position [1].

[1] A. M. Martínez-Argüello et.al, Phys. Rev. B **98** (7) (2018) 075311.

DY 3.9 Tue 17:30 P

Heat transport through a superconducting artificial atom — •Meng Xu, Juergen Stockburge, and Joachim Ankerhold — ICQ and IQST, Ulm University, Germany

Theoretical studies of photonic heat transport and rectification in superconducting platforms play an important role not only in understanding current experimental findings but also in designing and potentially improving future architectures to control heat, for example in circuit Quantum Electrodynamics (cQED). Moreover, fundamental questions regarding signatures of quantum mechanics in thermodynamic properties of devices at nanoscales have not been answered yet and require advanced simulation techniques beyond conventional perturbative treatments

Quantum heat transfer through a generic superconducting set-up consisting of a tunable transmon qubit placed between resonators that are terminated by thermal reservoirs is explored. Applying the numerical exact hierarchical equation of motion (HEOM) approach, steady-state properties are revealed, and experimentally relevant parameter sets are identified. Benchmark results are compared with predictions based on approximate treatments to demonstrate their failure in broad ranges of parameter space. These findings may allow improving future designs for heat control in superconducting devices.

DY 3.10 Tue 17:30 P

Interaction-driven dynamical quantum phase transitions in a strongly correlated bosonic system — •Sebastian Stumper[1], Michael Thoss[1,2], and Junichi Okamoto[1,2] — [1]Institute of Physics, University of Freiburg — [2]EUCOR Centre for Quantum Science and Quantum Computing, University of Freiburg

We investigate the dynamical quantum phase transitions (DQPTs) in the one-dimensional extended Bose-Hubbard model after a sudden quench of the nearest-neighbor interaction strength. We show that interaction-driven DQPTs can appear after quenches between two topologically trivial insulating phases based on extensive matrix-product-states simulations. The threshold value of the quench parameter for the DQPTs does not coincide with the equilibrium phase boundaries, which is contrary to the DQPTs between topologically distinct phases. Furthermore, we define a new set of string and parity order parameters to characterize the dynamics and find a close connection between DQPTs and these order parameters for both types of quenches. Finally, the timescales of DQPTs are also studied, revealing different kinds of power laws for the topological and interaction-driven cases.

DY 3.11 Tue 17:30 P

A particle conserving framework to transport in AC-driven quantum dots contacted to superconducting leads — •Julian Siegl[1], Jordi Pico-Cortes[1,2], and Milena Grifoni[1] — [1]Universität Regensburg — [2]Universidad Autónoma de Madrid

Transport through an interacting quantum dot coupled to superconducting leads and subject to DC and AC-bias is studied within a particle conserving framework. In this formulation, charge conservation during tunneling of an electron out of the dot includes processes where a quasiparticle is destroyed in the superconductor and simultaneously a Cooper pair is created. This possibility gives rise to non vanishing coherences of the density matrix involving Cooper pairs and states with zero or double occupancy in the quantum dot. In the sequential tunneling regime (second order in the tunneling), the *anomalous* contribution to the current due to the coherences is negligible and quasiparticle transport dominates. Here, the combination of AC and DC bias gives rise to stability diagrams whose features cannot be explained within the simple Tien-Gordon theory. At higher orders the coherences are responsible for the supercurrent in the junction.