SPICE Online Workshop

May 3rd - 5th 2020, Mainz, Germany

DISSIPATIVE PHASES OF ENTANGLED QUANTUM MATTER

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DISSIPATIVE PHASES OF ENTANGLED QUANTUM MATTER

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Program

Afternoon Session – Monday, May 3rd

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15:00 – 15:30	**Giulia SEMEGHINI, Havard** Exploring new scientific frontiers with programmable atom arrays
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16:30 – 17:00	**Michael FLEISCHHAUER, University Kaiserslautern** Nonlinear transport of Rydberg excitations: From topolopgical lattice hamiltonians to emerging gauge fields
17:00 – 17:30	**Coffee Break**

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18:30 – 19:00	**Ramasubramanian CHITRA, ETH Zürich** Anomalous dissipative transitions
19:00 – 19:30	**Coffee Break**
19:30 – 20:00	**Giuseppe CARLEO, EPFL** Simulations of driven and open quantum systems with neural-network quantum states
20:00 – 20:30	**Aashish CLERK, Chicago** Driven-dissipative quantum systems and hidden time-reversal symmetries
20:30 – 21:00	**Zala LENARČIČ, Jozef Stefan Institute** Critical behavior near the many-body localization transition in driven open systems

Afternoon Session – Tuesday, May 4th

13:00 – 16:30	**Young Scholars Session**
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Evening Session – Tuesday, May 4th

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17:30 – 18:00	**Silvia VIOLA KUMINSKIY, MPI Erlangen** Cavity Magnonics
18:00 – 18:30	**Yaroslav TSERKOVNYAK, UCLA** Topological Transport of Deconfined Hedgehogs in Magnets
18:30 - 19:00	**Coffee Break**
19:00 – 19:30	**Prineha NARANG, Harvard** Ab initio Approaches to Non-Equilibrium Dynamics in Quantum Matter
19:30 – 20:00	**Achim ROSCH, Köln** Archimedean screw and time quasicrystals in driven chiral magnets
20:00 – 20:30	**Coffee Break**
20:30 – 21:30	**Iacopo CARUSOTTO, INO-CNR BEC,** **Steve GIRVIN, Yale University,** **Alexey GORSHKOV, University of Maryland** Roundtable on Dissipation and quantum technologies

Afternoon Session – Wednesday, May 5th

14:00 – 14:30	**Alicia KOLLÁR, University of Maryland** Engineering Qubit-Qubit Interactions in Circuit QED Lattices
14:30 – 15:00	**Martin ECKSTEIN, FAU Erlangen-Nürnberg** Non-equilibrium steady-state description of photo-induced orders in Mott insulators
15:00 – 15:30	**Francesco PIAZZA, MPIPKS** Fermi polaron laser in two-dimensional semiconductors
15:30 – 16:00	**Coffee Break**
16:00 – 16:30	**Giovanna MORIGI, Saarland University** Criticality, Entanglement and topology of self-organized phases in many body cavity quantum electrodynamics
16:30 – 17:00	**Tobias DONNER, ETH Zürich** An emergent atom pump driven by global dissipation in a quantum gas
17:00 – 17:30	**Coffee Break**

Evening Session – Wednesday, May 5th

17:30 – 18:00	**Ulrich POSCHINGER, Mainz** Trapped ions: A versatile experimental platform for few-body quantum physics
18:00 – 18:30	**David WELD, UC Santa Barbara** Experimental realization of the many-body quantum kicked rotor
18:30 – 19:00	**Berislav BUCA, Oxford** Non-stationary quantum many-body dynamics
19:00 – 19:30	**Coffee Break**
19:30 – 20:00	**Ben LEV, Stanford University** An Optical Lattice with Sound
20:00 – 20:30	**Kushal SEETHARAM, MIT** Correlation engineering via non-local dissipation
20:30 – 21:00	**Coffee Break**
21:00 – 22:00	**Jonathan Keeling, University of St. Andrews,** **Walter Strunz, TU Dresden** Roundtable on Adiabatic elimination: Effective density matrix equations of motion

Speaker Abstracts

Monday, May 3rd, 14:00

Measurement induced phase transitions in monitored fermion systems

Sebastian DIEHL
Köln

A wave function exposed to measurements undergoes pure state dynamics, with deterministic unitary and probabilistic measurement induced state updates, defining a quantum trajectory. For many-particle systems, the competition of these different elements of dynamics can give rise to a scenario similar to quantum phase transitions. However, due to the stochastic nature of the wave function this type of phase transition does not manifest itself in common observable averages, obtained from the statistically averaged density matrix, and have instead mainly been observed in the dynamics entanglement.

Here we establish a novel type of entanglement transition between a regime of logarithmic entanglement growth, and a quantum Zeno regime obeying an area law, in continuously monitored fermion dynamics. We analyze the phase transition from different perspectives, via numerical simulations of monitored lattice fermions, and via analytical construction of an effective field theory for monitored Dirac fermions. In particular, we identify the relevant degrees of freedom for describing the phase transition, and show that their dynamics is governed by a non-Hermitian quantum Sine-Gordon model. This yields a physical picture for the phase transition in terms of a depinning from the measurement operator eigenstates induced by unitary dynamics, and places it into the BKT universality class.

Monday, May 3rd, 14:30

Dissipative transitions in Floquet-Lindblad systems

Rosario FAZIO
ICTP

Thanks to the recent impressing experimental progresses, the investigation of non-equilibrium properties of driven-dissipative systems in quantum systems has received an impressive boost. This activity revived the study of dissipative phase transition in synthetic matter. The predicted steady-state phase diagram of these driven dissipative systems becomes incredibly rich, displaying a variety of phenomena. I will discuss the steady-state phase diagram in which the competition between the unitary evolution and the dissipative term manifests in a time-periodic dynamics. The Hamiltonian I will consider is that of a long-range interacting spin system, the non-unitary part is local. I will discuss both symmetry-breaking phase and entanglement phase transitions.

Monday, May 3rd, 15:00

Exploring new scientific frontiers with programmable atom arrays

Giulia SEMEGHINI
Harvard

We will discuss the recent advances involving programmable, coherent manipulation of quantum many-body systems using atom arrays excited into Rydberg states. Specifically, we will describe our recent technical upgrades that now allow the control over 200 atoms in two-dimensional arrays. Recent results involving the realization of exotic phases of matter, study of quantum phase transitions and exploration of their non-equilibrium dynamics will be presented. In particular, we will report on realization and probing of quantum spin liquid states - the exotic states of matter have thus far evaded direct experimental detection. Finally, realization and testing of quantum optimization algorithms using such systems will be discussed.

Monday, May 3rd, 16:00

Nonequilibrium dynamics of quantum gases in time-dependent disorder

Artur WIDERA
TU Kaiserslautern

Ultracold gases have proven powerful model systems to study quantum dynamics in various scenarios. In particular, the ability to tune atomic interactions and to interface these systems with time-dependent potentials opens the door to probe fascinating nonequilibrium dynamics experimentally.

Here, I will discuss our experiments investigating an ultracold Fermi gas along the BEC-BCS crossover in time-dependent disorder.

First, we study the response of a molecular Bose-Einstein condensate when quenched into and out of a disordered optical potential. We unravel the in-situ density and the global phase response and find markedly different time scales. Tracing the quantum relaxation following a quench out of a disordered system, we find that the quantum phase needs a surprisingly long time to relax, pointing at possibly long-lived phase excitations.

Second, we investigate the dissipative dynamics of an interacting gas in disorder with tunable correlation time, where we probe the emerging excitations and dynamics. Comparing the dynamics of thermal and quantum gases, we conclude that the quantum gas is only affected via thermal coupling to the non-condensed part for a broad range of correlation times.

Monday, May 3rd, 16:30

Nonlinear transport of Rydberg excitations: From topolopgical lattice hamiltonians to emerging gauge fields

Michael FLEISCHHAUER
University Kaiserslautern

Recent experiments have demonstrated that spin-orbit coupling can give rise to density-dependent Peierls phases associated with the transport of Rydberg spin excitations in atom arrays [1]. This nonlinear hopping provides a natural way for the implementation of a variety of non-trivial spin systems ranging from topological lattice models to lattice gauge theories, anyon physics and spin liquids. After discussing the microscopic origin of the nonlinear transport and its application for the realization of simple lattice gauge theories and anyon physics, I will consider two specific models in more detail, a one-dimensional zig-zag ladder and a two-dimensional honeycomb lattice model. Here the competition between nearest-neighbor density-density interaction, linear and nonlinear transport and frustration gives rise to a variety of interesting phases and phenomena. In the zig-zag model effective gauge fields emerge leading to liquids or lattices of vortices of excitation currents. In the honeycomb model we find some evidence for chiral spin liquid behavior.

[1] V. Lienhard, P. Scholl, S. Weber, D. Barredo, S. de Leseleuc, R. Bai, N. Lang, M. Fleischhauer, H. P. Büchler, T. Lahaye, and A. Browaeys, Phys. Rev. X 10, 021031 (2020)

Monday, May 3rd, 17:30

Symmetry enriched phases of quantum circuits

Ehud ALTMAN
Berkeley

Quantum circuits consisting of random unitary gates and subject to local measurements have been shown to undergo a phase transition, tuned by the rate of measurement, from a state with volume-law entanglement to an area-law state. I will argue that a much richer phase structure emerges if symmetries are imposed on the circuit. However, the classification is governed by an enlarged effective symmetry, which combines the physical circuit symmetry with dynamical symmetries associated with the ensemble of quantum trajectories. This opens the door to of phases, which would not have been possible in presence of the circuit symmetry alone.

I will give two simple examples to illustrate these ideas: (i) a 1+1 dimensional circuit with Z2 spin symmetry gives rise to a number of phases including volume law states with distinct broken symmetries; (ii) A circuit with Gaussian fermion gates obeying only the Z2 fermion parity, nonetheless exhibits a critical phase separated from area law phases by a measurement induced Kosterlitz-Thouless transition.

Monday, May 3rd, 18:00

Classical metastability in open quantum systems

Katarzyna MACIESZCZAK
Cambridge

Metastability is a phenomenon of a large separation present in the timescales of the dynamics of an open quantum system. This leads to the existence of a time regime in which system states appear to be stationary before their eventual relaxation towards a true stationary state. In this talk, I will characterise classical metastability in an open quantum system, which corresponds to the existence of distinct metastable phases. I will explain how such phases manifest themselves in experiments and how they can be found in numerical situations. I will also discuss how classical metastability allows for breaking of discrete symmetries of the dynamics. While metastability is an intrinsically dynamical phenomenon, it is always present in proximity to static first-order phase transitions. Therefore, the presented results can be used to investigate such transitions, which typically occur in the large size limit, through the inherited metastable behaviour at moderate sizes accessible to numerics.

Monday, May 3rd, 18:30

Anomalous dissipative transitions

Ramasubramanian CHITRA
ETH Zürich

In this talk, we will explore scenarios where a weak coupling to a nonthermal environment profoundly alters the phase diagram of the closed system, giving rise to a special class of dissipation-induced transitions. Here, an infinitesimal dissipation suffices to knock the system out of its ground state and stabilize a higher-energy stationary state, often overwhelming the symmetry breaking tendencies of the system. We demonstrate the ubiquitousness of such dissipative

stabilzation of excited states in Dicke like light-matter coupled models and the paradigmatic parametric Kerr resonator. We show how dissipation leads to rich physics and discuss their consequences for experiments.

Monday, May 3rd, 19:30

Simulations of driven and open quantum systems with neural-network quantum states

Giuseppe CARLEO
EPFL

In this talk I will discuss recent advances in the numerical simulation of driven and open quantum systems using several variational representations of the many-body quantum state based on artificial neural networks [1]. First, I will consider the case of driven, closed quantum systems and take the case of driven spin ½ Heisenberg systems both in one and two dimensions as a benchmark for both the expressive power and the simulation complexity of quantum dynamics with neural quantum states [2].

I will then discuss extensions of neural-network quantum states to study open quantum systems using representations of the density matrix based on Restricted Boltzmann Machines [3]. I will show how this representation can be used to simulate Lindblad dynamics in two-dimensional dissipative spin systems. Finally, I will present a novel variational representation of the density matrix, based on more expressive deep neural networks and with the important property of being automatically positive definite. I will discuss applications of this new representation for finite-temperature quantum simulation [4].

[1] Carleo and Troyer, Science 355, 602 (2017)
[2] Hofmann et al, in preparation (2021)
[2] Hartmann and Carleo, PRL 122, 250502 (2019)
[3] Torlai and Melko, PRL 120, 240503 (2018)
[4] Vicentini and Carleo, in preparation (2021)

Monday, May 3rd, 20:00

Driven-dissipative quantum systems and hidden time-reversal symmetries

Aashish CLERK
Chicago

Quantum systems subject to both driving and dissipation often have complex, non-thermal steady states, and are at the forefront of research in many areas of physics. For classical systems, microscopic time-reversal symmetry leads to open systems satisfying detailed balance; this symmetry makes it extremely easy to find their stationary states. In this talk, I'll discuss a new way to think about detailed balance in fully quantum settings based on the existence of a "hidden" time-reversal symmetry. This symmetry has a direct operational utility: it provides a surprisingly simple way to find exact descriptions of non-trivial steady states. This symmetry is present in a number of experimentally-relevant systems. and has clear observable signatures. I'll try to give a gentle introduction to these ideas, with a particular focus on models of driven, interacting bosonic modes (as can be realized in superconducting circuits and a variety of quantum optical platforms).

Monday, May 3rd, 20:30

Critical behavior near the many-body localization transition in driven open systems

Zala LENARČIČ
Jozef Stefan Institute

Many-body localization (MBL) is typically studied in closed setups because any coupling to a thermal bath breaks the local integrals of motion and causes relaxation to a thermal steady state. However, if one considers coupling to non-thermal baths or if the system is also weakly driven, the local integrals of motion obtain highly non-thermal values. Nearly thermal steady states in the ergodic phase are thus distinctly different from highly non-thermal steady states in the MBL phase.

I will describe how this property can be used to study the MBL phase transition in weakly open driven systems. By tuning the coupling strength to the environment, we can detect key features of the MBL transition: the divergence of dynamical exponent and the lower bound on the critical disorder strength.

In the end, I will show how to detect the lack of thermalization due to MBL or integrability with an unsupervised learning approach based on autoencoders by only considering local observables. The proposed procedure allows to identify the local complexity of states from experimental setups and even extract the responsible Hamiltonian operator.

[1] Z. Lenarcic, E. Altman, and A. Rosch, PRL 121, 267603 (2018)
[2] Z. Lenarcic, O. Alberton, A. Rosch, and E. Altman, PRL 125, 116601 (2020)
[3] M. Schmitt and Z. Lenarcic, arXiv:2102.11328

Tuesday, May 4th, 17:00

Nonperturbative approach to ultrastrong coupling waveguide quantum electrodynamics

Eugene DEMLER
Harvard

Developing reliable theoretical tools for analyzing strongly interacting light-matter systems is one of the primary goals of the emergent field of ultrastrong coupling waveguide QED. When the coupling strength is comparable to or even exceeds the energy of photons and matter excitations, standard theoretical approaches based on perturbative treatment of light-matter interactions or truncation in the number photon states are not applicable. This talk will review a novel approach to analyzing in- and out-of-equilibrium properties of ultrastrong coupling waveguide QED systems based on a non-perturbative unitary transformation that entangles photons and matter excitations. In the new frame of reference factorization between light and matter becomes exact for infinite interaction strength and for all interaction strengths an accurate effective model can be derived. New features of the ultrastrong coupling regime include emergence of a ladder of many-body bound states, drastic mass enhancement, and renormalization of single particle potentials.

Tuesday, May 4th, 17:30

Cavity Magnonics

Silvia VIOLA KUMINSKIY
MPI Erlangen

Cavity Magnonics studies the coherent coupling of light to collective magnetic excitations in solid state systems. In the microwave (MW) regime, a magnetic element is embedded in a MW cavity, whereas in the optical regime the magnetic material can be also used as an optical cavity if patterned appropriately. This not only enhances the magnon-photon coupling (making these systems promising for applications in quantum technologies) but also allows studying coherent light-matter interaction in a novel platform. In my talk I will go over the basics of cavity magnonics and present results on recent theory developments in my group.

Tuesday, May 4th, 18:00

Topological Transport of Deconfined Hedgehogs in Magnets

Yaroslav TSERKOVNYAK
UCLA

We theoretically investigate the dynamics of magnetic hedgehogs, which are three-dimensional topological spin textures that exist in common magnets, focusing on their transport properties and connections to spintronics. We show that fictitious magnetic monopoles carried by hedgehog textures obey a topological conservation law, based on which a hydrodynamic theory is developed. We propose a nonlocal transport measurement in the disordered phase, where the conservation of the hedgehog flow results in a nonlocal signal decaying inversely proportional to the distance. The bulk-edge correspondence between the hedgehog number and skyrmion number, the fictitious electric charges arising from magnetic dynamics, and the analogy between bound states of hedgehogs in ordered phase and the quark confinement in quantum chromodynamics are also discussed. Our study points to a practical potential in utilizing hedgehog flows for long-range neutral signal propagation or manipulation of skyrmion textures in three- dimensional magnetic materials.

Tuesday, May 4th, 19:00

Ab initio Approaches to Non-Equilibrium Dynamics in Quantum Matter

Prineha NARANG
Harvard

In this talk, I will present work from my research group on describing, from first principles, the microscopic dynamics, decoherence and optically-excited collective phenomena in quantum matter at finite temperature to quantitatively link predictions with 3D atomic-scale imaging, quantum spectroscopy, and macroscopic behavior. Capturing these dynamics poses unique theoretical and computational challenges. The simultaneous contribution of processes that occur on many time and length-scales have remained elusive for state-of-the-art calculations and model Hamiltonian approaches alike, necessitating the development of new methods in computational condensed matter and quantum chemistry1–3. I will introduce our work at the intersection of ab initio cavity quantum-electrodynamics and electronic structure methods to treat electrons, photons and phonons on the same quantized footing, accessing new observables in strong light-matter coupling4,5. Building on this, I will present our work on driving quantum systems far out-of-equilibrium to control the coupled electronic and lattice degrees-of-freedom6–8. Finally, I will give an outlook on connecting these recent predictions with ultrafast and FEL experiments underway.

[1] Rivera, N., Flick, J. & Narang, P. Variational Theory of Nonrelativistic Quantum Electrodynamics. Phys. Rev. Lett. 122, 193603 (2019).

[2] Flick, J., Rivera, N. & Narang, P. Strong light-matter coupling in quantum chemistry and quantum photonics. Nanophotonics 7, 1479–1501 (2018).

[3] Flick, J. & Narang, P. Cavity-Correlated Electron-Nuclear Dynamics from First Principles. Physical Review Letters vol. 121 (2018).

[4] Schäfer, C., Flick, J., Ronca, E., Narang, P. & Rubio, A. Shining Light on the Microscopic Resonant Mechanism Responsible for Cavity-Mediated Chemical Reactivity. arXiv [quant-ph] (2021).

[5] Philbin, J. P. et al. Room temperature single-photon superfluorescence from a single epitaxial cuboid nano-heterostructure. arXiv [physics.optics] (2021).

[6] Juraschek, D. M., Meier, Q. N. & Narang, P. Parametric Excitation of an Optically Silent Goldstone-Like Phonon Mode. Physical Review Letters vol. 124 (2020).

[7] Juraschek, D. M., Narang, P. & Spaldin, N. A. Phono-magnetic analogs to opto-magnetic effects. Phys. Rev. Research 2, 043035 (2020).

[8] Juraschek, D. M., Neuman, T., Flick, J. & Narang, P. Cavity control of nonlinear phononics. arXiv [cond-mat.mtrl-sci] (2019).

Tuesday, May 4th, 19:30

Archimedean screw and time quasicrystals in driven chiral magnets

Achim ROSCH
Köln

In chiral magnets a helical magnetic texture forms where the magnetization winds around a propagation vector q. We show theoretically [1] that a magnetic field which is spatially homogeneous but oscillating in time, induces a net rotation of the texture around q. This rotation is reminiscent of the motion of an Archimedean screw and is equivalent to a translation with finite velocity. Technically, it arises due to the coupling of the oscillations to an overdamped Goldstone mode. The Archimedean screw can be used to transport spin and charge and thus the screwing motion is predicted to induce a voltage parallel to q. Using a combination of numerics and Floquet spin wave theory in a dissipative system, we show that the helix becomes unstable upon increasing the oscillating field forming a `time quasicrystal', oscillating in space and time for moderately strong drive.

[1] Nina del Ser, Lukas Heinen, Achim Rosch, arXiv:2012.11548

Wednesday, May 5th, 14:00

Engineering Qubit-Qubit Interactions in Circuit QED Lattices

Alicia KOLLÁR
University of Maryland

The inherent strong coupling between microwave resonators and superconducting qubits available in the circuit QED architecture makes it possible to use the spectrum of multimode photonic environments to engineer qubit-qubit interactions. Previously, one-dimensional cavity arrays and modulated waveguides have been used to induce exponentially-localized interactions [1,2]. Lattices of coplanar waveguide resonators re- alize artificial photonic materials that provide a tailored environment for with versatile control [3]. Qubits in these lattices experience a photon-mediated flip-flop interaction, which takes on different forms depending on the structure of the lattice, giving rise to a direct hardware-level implementation of a graph-like spin model with connections determined by the microwave resonator network. Here we present results towards realizing a larger variety interactions, such as frustrated interactions, in which different terms compete and favor different configurations, allowing a spin model to exhibit memory, and hyperbolic interactions, which lead to rapid growth of connectivity and efficient connections.

[1] N. M. Sundaresan et al., Phys. Rev. X 9, 011021 (2019)
[2] V. S. Ferreira et al., arXiv:2001.03240 (2020). [3] A. J. Kollr et al., Nature 45, 571 (2019)

Wednesday, May 5th, 14:30

Non-equilibrium steady-state description of photo-induced orders in Mott insulators

Martin ECKSTEIN
FAU Erlangen-Nürnberg

Laser excitation in solids can induce long-lived non-equilibrium phases, which can be stabilized by non-thermal electron distributions (photo-doping) or non-thermal fluctuations of different order parameters. Examples include eta-pairing superconductivity in laser-excited Mott insulators, or hidden spin and orbital orders. Despite the fruitful experimental exploration, theoretical studies on microscopic models face the challenge of exponentially separated time scales. We address this difficulty by introducing a steady-state description of photo-doped Mott insulators using an open-system setup, where the photo-doped state is stabilized as a non-equilibrium steady-state by a weak external driving. Taking advantage of the stationarity, efficient numerical tools within steady-state Dynamical Mean-Field Theory become available.

Wednesday, May 5th, 15:00

Fermi polaron laser in two-dimensional semiconductors

Francesco PIAZZA
MPIPKS

We study the relaxation dynamics of driven, two-dimensional semiconductors, where itinerant electrons dress optically pumped excitons to form two Fermi-polaron branches. Repulsive polarons excited around zero momentum quickly decay to the attractive branch at high momentum. Collisions with electrons subsequently lead to a slower relaxation of attractive polarons, which accumulate at the edge of the light-cone around zero momentum where the radiative loss dominates. The bosonic nature of exciton polarons enables stimulated scattering, which results in a lasing transition at higher pump power. The latter is characterized by a superlinear increase of light emission as well as extended spatiotemporal coherence. The many-body dressing of excitons can reduce the emission linewidth below the bare exciton linewidth set by nonradiative loss.

[1] Tomasz Wasak, Falko Pientka, Francesco Piazza, arXiv:2103.14040

Wednesday, May 5th, 16:00

Criticality, Entanglement and topology of self-organized phases in many body cavity quantum electrodynamics

Giovanna MORIGI
Saarland University

We analyse the quantum phases of the extended Bose-Hubbard model with global interactions. This model describes ultracold bosonic atoms confined by a two-dimensional optical lattice and interacting via global forces mediated by cavity photons. The cavity-mediated potential is periodic and, in the configurations we consider, its periodicity is double the lattice spacing. Depending on the frequency detuning between atom and cavity, the cavity-mediated potential is described either by density-density interactions, or by global correlated hopping between lattice sites, or by the sum of the two.

We first consider the regime where global correlated hopping is dominant. We use DMRG to study the quantum phases of a one-dimensional lattice at half filling and show that quantum interference between single-particle tunnelling and global interactions give rise to a self-organized topological insulator. The onset of quantum interference leads to spontaneous breaking of the lattice translational symmetry, the corresponding phase resembles nontrivial states of the celebrated Su-Schriefer-Heeger model. Nevertheless, here it arises from an interference phenomenon that has no known fermionic analog.

We then discuss a two-dimensional lattice in the regime where the global potential gives rise to density-density interactions. The interplay between tunneling, onsite interactions, and the global potential gives rise to a rich ground-state phase diagram, which can exhibit Mott-insulator, superfluid, lattice super solid, and charge-density wave phases. We determine the quantum phase diagram by means of a mean-field ansatz and use a slave boson in order to evaluate the entanglement-entropy, the physical spectrum and corresponding entanglement spectrum in the different phases. We probe the scaling of entanglement entropy in the different phases, and discuss in particular on the transition from superfluid to supersolid, which is controlled by the strength of the global interactions.

Wednesday, May 5th, 16:30

An emergent atom pump driven by global dissipation in a quantum gas

Tobias DONNER
ETH Zürich

The time evolution of a driven quantum system can be strongly affected by dissipation. Although this mainly implies that the system relaxes to a steady state, in some cases it can lead to the appearance of new phases and trigger emergent dynamics. In our experiment, we study a Bose-Einstein condensate dispersively coupled to a high finesse optical resonator. The cavity is populated by scattering photons from a transverse drive illuminating the atoms. The sum of the drive and the self-consistent intracavity field provides a lattice potential. When the dissipation via cavity losses and the coherent timescales are comparable, we find a regime of persistent oscillations where the cavity field does not reach a steady state. In this regime the atoms experience a potential that periodically deforms itself, even without providing an external time dependent drive. Eventually, the dynamic lattice triggers a pumping mechanism. We show complementary measurements of the light field and of the atomic transport, proving the connection between the emergent non-stationarity and the pump.

Wednesday, May 5th, 17:30

Trapped ions: A versatile experimental platform for few-body quantum physics

Ulrich POSCHINGER
Mainz

Trapped-ion-based platforms have seen a rapid technological progress, enabling groundbreaking experiments in fields such as quantum computation and quantum simulation. We present a trapped-ion platform based on shuttling ions in a segmented microchip ion trap [1]. Current developments aim at operation with up to 20 qubits, maintaining high fidelities of all required operations. The current state of the art, limitations and future prospects are discussed.

We describe ongoing work on fault-tolerant parity readout sequence for a single plaquette of a [[7,1,3]] color code for quantum error correction, where errors occurring during the readout process are captured by a single additional 'flag' ancilla qubit [2].

The possibility to engineer dissipative interactions enables experiments in the emerging field of quantum thermodynamics. We present results on the characterization of a heat engine based on a single spin as working agent [3]. Furthermore, we discuss ongoing work on the detection of a heat leak in a multi-qubit system.

[1] V. Kaushal et al., Shuttling-Based Trapped-Ion Quantum Information Processing, AVS Quantum Sci. 2, 014101 (2020)

[2] A. et al., Assessing the Progress of Trapped-Ion Processors Towards Fault-Tolerant Quantum Computation, Phys. Rev. X 7, 041061

[3] D. von Lindenfels et al., A spin heat engine coupled to a harmonic-oscillator flywheel, Phys. Rev. Lett. 123, 080602 (2019)

Wednesday, May 5th, 18:00

Experimental realization of the many-body quantum kicked rotor

David WELD
UC Santa Barbara

The kicked rotor is a paradigmatic model of chaos in driven systems: dynamical localization and a consequent failure to thermalize in the quantum kicked rotor contrasts sharply with classically-expected ergodicity. Despite a quarter-century of atom-optical experimental studies, the effect of interactions on the dynamically localized state has remained unexplored. I will discuss the recent experimental realization of a many-body kicked quantum rotor with Feshbach-tunable interparticle interactions, using a degenerate gas of bosonic lithium in a pulsed optical lattice. As interactions are increased from zero, we observe the emergence of many-body dynamical delocalization and a subdiffusive approach to infinite temperature. Time permitting, I will also discuss recent experimental results on a spiritual relative of the kicked rotor: the kicked Aubry-André-Harper model, in which time-dependent quasiperiodicity can either drive a localization transition or give rise to rapid heating.

Wednesday, May 5th, 18:30

Non-stationary quantum many-body dynamics

Berislav BUCA
Oxford

The assumption that quantum systems relax to a stationary (time-independent) state in the long-time limit underpins statistical physics and much of our intuitive understanding of scientific phenomena. For isolated systems this follows from the eigenstate thermalization hypothesis. When an environment is present the expectation is that all of phase space is explored, eventually leading to stationarity. However, real-world phenomena, from life to weather patterns are persistently non-stationary. I will discuss simple algebraic conditions that prevent a quantum many-body system from ever reaching a stationary state, not even a non-equilibrium one. I call these algebraic conditions dynamical symmetries. This unusual state of matter, characterized by persistent oscillations, has been recently called a time crystal. Based on examples we will argue that persistent periodic motion is can be generically stable. We show that its existence can be even, counter-intuitively, induced through the dissipation itself. We give several physically relevant examples in both closed and open quantum many-body systems, including an isolated XXZ spin chain that for which the frequency of the persistent oscillations is fractal function of the interaction strength, a quasi-1D magnet with attractor-like dynamics, a spin-dephased Fermi-Hubbard model and an experimentally realized spinor BEC in an optical cavity.

[1] B Buca, J Tindall, D Jaksch. Nat. Comms. 10 (1), 1730 (2019)
[2] M Medenjak, B Buca, D Jaksch. arXiv:1905.08266 (2019)
[3] B Buca, D Jaksch. Phys. Rev. Lett. 123, 260401 (2019)
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Wednesday, May 5th, 19:30

An Optical Lattice with Sound

Ben LEV
Stanford University

Phonons, quantized sound waves in crystals, play an integral role in the properties of materials. These lattice vibrations determine a crystal's heat capacity and thermal and electrical conductivity. By binding electrons together, they induce the superconductivity common to simple metals at low temperature. Despite their ubiquity, however, phonons are absent in simulators of quantum materials constructed of neutral atoms and light: unlike real solids, traditional optical lattices are silent because they are perfectly rigid. Adding sound to the toolbox of quantum simulation would allow the emulation of a wider range of quantum materials. Here, we create an optical lattice with phonon modes by scattering photons off a BEC coupled to a confocal optical resonator. Playing the role of an active quantum gas microscope, the multimode cavity QED system both images phonons imprinted onto the BEC and induces the phonons arising from photon-mediated, momentum-exchanging atom-atom interactions. Dynamical susceptibility measurements reveal the Goldstone mode dispersion relation of transverse-oscillating phonons. These collective excitations exhibit a speed of sound dependent on the BEC-photon coupling strength. The compliant optical lattice provides access to quantum many-body physics where phonons play a critical role, such as Peierls transitions and polarons, or where phonon-bath engineering may lead to novel nonequilibrium phases of matter.

Wednesday, May 5th, 20:00

Correlation engineering via non-local dissipation

Kushal SEETHARAM
MIT

Controlling the spread of correlations in quantum many-body systems is a key challenge at the heart of quantum science and technology. Correlations are usually destroyed by dissipation arising from coupling between a system and its environment. Here, we show that dissipation can instead be used to engineer a wide variety of spatio-temporal correlation profiles in an easily tunable manner. We describe how dissipation with any translationally-invariant spatial profile can be realized in cold atoms trapped in an optical cavity. A uniform external field and the choice of spatial profile can be used to design when and how dissipation creates or destroys correlations. We demonstrate this control by preferentially generating entanglement at a desired wavevector. We thus establish non-local dissipation as a new route towards engineering the far-from-equilibrium dynamics of quantum information, with potential applications in quantum metrology, state preparation, and transport.

Young Scholars Abstracts

Dicke transition in open many-body systems determined by fluctuation effects

Alla BEZVERSHENKO
University of Cologne

We develop an approach to describe the Dicke transition of interacting many-particle systems strongly coupled to the light of a lossy cavity. A mean-field approach is combined with a perturbative treatment of fluctuations beyond mean-field, which becomes exact in the thermodynamic limit. Fluctuations are crucial to determine the mixed state character of the transition and to unravel universal properties of the emerging self-organized states. A rate equation is used to calculate an effective temperature. We validate our results by comparing to time-dependent matrix-product-state calculations.

Cavity-induced quantum spin liquids

Alessio CHIOCCHETTA
University of Cologne

Recent developments at the interface between quantum materials and photonics are opening novel avenues to engineer hidden phases of matter.

Among these, quantum spin liquids provide paradigmatic examples of highly entangled quantum states of matter, hosting fractionalized excitations and emerging gauge fields.

In this talk, I will propose to engineer these phases by exploiting the coupling of quantum magnets to the quantized light of an optical cavity.

The interplay between the quantum fluctuations of the electromagnetic field and the strongly correlated electrons results in a tunable long-range, frustrating interaction between spins. This cavity-induced interaction robustly stabilizes spin liquid states, which occupy an extensive region in the phase diagram spanned by the range and strength of the tailored interaction. Remarkably, this occurs even in originally unfrustrated systems, as we showcase for the Heisenberg model on the square lattice.

Finally, I will outline perspectives on how this implementation can be used for engineering further exotic states of matter, and for novel measurement protocols.

Challenges for simulating quantum spin dynamics in two dimensions by neural network quantum states

Damian HOFMANN
MPI for Innovation and Competition, Munich

Neural-network quantum states are a versatile ansatz for the representation of quantum states and in particular have shown promise for highly entangled ground states in two-dimensional spin systems. They have also been successfully applied to simulating dynamics by propagation with time-dependent variational Monte Carlo (t-VMC) [1-4], which is a stochastic version of the time-dependent variational principle (TDVP). However, there are a number of open challenges on the way to achieving stable time propagation for a wider range of systems and excitations [2,5,6].

In this work, we employ both t-VMC and deterministic TDVP-based propagation to spin-1/2 Heisenberg systems and take a closer look at various sources of error which can affect the stability and accuracy of the resulting dynamics. In particular, we analyze the influence of network expressiveness, the TDVP equation of motion and its numerical solution, and stochastic effects originating from VMC sampling.

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Dynamical phase transition in an optically driven 2D Heisenberg antiferromagnet

Mona KALTHOFF
MPI for Innovation and Competition, Munich

Recent theory results [Walldorf et al., Phys. Rev. B 100 121110 (R) (2019)], obtained in a one loop non-interacting magnon theory, demonstrate a dynamical phase transition in the antiferromagnetic phase of the 2D Hubbard model upon laser driving. The transition is characterized by a qualitative change in the magnon distribution function as the drive strength is varied. Here we investigate the effects of magnon-magnon interactions using an interacting spin-wave theory in a large spin expansion and a Boltzmann formalism. The scattering leads to qualitative changes with respect to the noninteracting results, in particular to steady states that can be characterized by a generalized Bose-Einstein distribution with an effective drive-dependent chemical potential. Implications for the dynamical phase transition and the Mermin-Wagner theorem for nonthermal states are discussed.

Effect of active photons on dynamical frustration in cavity QED

Shane KELLY
Johannes-Gutenberg University, Mainz

We study the far-from-equilibrium dynamical regimes of a many-body spin boson model with disordered couplings relevant for cavity QED and trapped ions experiments, using the discrete truncated Wigner approximation (DTWA). We focus on the dynamics of spin observables upon varying the disorder strength and the frequency of the photons, finding that the latter can considerably alter the structure of the system's dynamical responses. When the photons evolve at a similar rate as the spins, they can induce qualitatively distinct frustrated dynamics characterized by either logarithmic or algebraically slow relaxation. The latter illustrates resilience of glassy-like dynamics in the presence of active photonic degrees of freedom, suggesting that disordered quantum many body systems with resonant photons or phonons can display a rich diagram of non-equilibrium responses, with near future applications for quantum information science.

A Luttinger Liquid coupled to Ohmic-class environments

Andisheh KHEDRI
ETH Zurich

We investigate the impact of an Ohmic-class environment on the conduction and correlation properties of one-dimensional interacting systems. Interestingly, we reveal that inter-particle interactions can be engineered by the environment's noise statistics. Introducing a backscattering impurity to the system, we address Kane-Fisher's metal-to-insulator quantum phase transition in this noisy and realistic setting. Within a perturbative renormalization group approach, we show that the Ohmic environments keep the phase transition intact, while sub- and super-Ohmic environments, modify it into a smooth crossover at a scale that depends on the interaction strength within the wire. The system still undergoes a metal-to-insulator-like transition when moving from sub-Ohmic to super-Ohmic environment noise. We cover a broad range of realistic experimental conditions, by exploring the impact of a finite wire length and temperature on transport through the system.

Self-organized topological insulator due to cavity-mediated correlated tunneling

Rebecca KRAUS
Saarland University

We discuss an extended Bose-Hubbard model with cavity-mediated global-interactions. We observe a emergence of topological non-trivial phase due to the quantum interference between single-particle dynamics and global interactions. The onset of quantum interference leads to spontaneous breaking of the lattice translational symmetry, the corresponding phase resembles nontrivial states of the celebrated Su-Schriefer-Heeger model. Like the fermionic Peierls instability, the emerging quantum phase is a topological insulator and is found at half fillings. Nevertheless, here it arises from an interference phenomenon that has no known fermionic analog. We argue that these dynamics can be realized in existing experimental platforms, such as cavity quantum electrodynamics setups, where the topological features can be revealed in the light emitted by the resonator.

Adiabaticity enhancement via quantum non-demolition measurement

Raphael MENU
Saarland University

The realization of quantum adiabatic dynamics lies at the core of quantum annealers and adiabatic quantum computers. The major issue is to realise the dynamics over sufficiently short times, thereby minimizing detrimental effects due to the coupling with the environment, and yet minimize deviations from adiabaticity, which unavoidably increase with the rate at which the Hamiltonian parameters are tuned. In this talk we propose a protocol which achieves fast adiabatic dynamics in a Landau-Zener problem via the implementation a quantum non-demolition (QND) measurement of the qubit. In the limit where the effective dynamics can be described by a Born-Markov master equation, the QND measurement induces an effective dephasing and dissipative dynamics which enforce adiabaticity. We show that the resulting fidelity of the adiabatic transfer significantly increases withthe strength of the QND coupling.

Atom-only theories for U(1) symmetric cavity-QED models

Roberta PALACINO
University of St. Andrews

We consider a generalized Dicke model with U(1) symmetry, which can undergo a transition to a superradiant state that spontaneously breaks this symmetry. By exploiting the difference in timescale between atomic and cavity dynamics, one may eliminate the cavity dynamics, providing an atom-only theory. We show that the standard Redfield theory cannot describe the transition to the superradiant state, but including higher-order corrections does recover the transition. Our work reveals how the forms of effective theories must vary for models with continuous symmetry, and provides a template to develop effective theories of more complex models.

Topological transition in weak-measurement-induced geometric phases

Kyrylo SNIZHKO
KIT, Karlsruhe

Geometric phases can be induced in a quantum system not only by Hamiltonian evolution but also via a sequence of projective measurements (in which case they are known as the Pancharatnam phase). We have explored what happens upon replacing the projective ("strong") measurements with so-called weak measurements. The induced phase exhibits an abrupt change of behaviour as the measurement is tuned from infinitely strong to infinitely weak [1–3]. This transition happens at a certain critical measurement strength and is related to a change in the topology of the surface spanned by measurement-induced quantum trajectories. Recently this transition has been observed in a system based on a superconducting qubit [4].

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Yang-Baxter Integrable Lindblad Equations

Aleksandra ZIOLKOWSKA
University of Oxford

Open quantum systems are ubiquitous in the contexts of atomic and molecular physics, circuit QED and optomechanics. Couplings to an environment can also have very interesting effects on the dynamics of many-particle quantum systems. To arrive at a tractable description of such problems, it is customary to work within the Markovian approximation with the dynamics averaged over the environment, whereby the system is described by a Lindblad master equation. While much progress has been made in analysing Lindblad equations for many-particle systems by employing, for example, perturbative and matrix product states methods, it is clearly highly desirable to have exact solutions in specific, and hopefully representative, cases. This talk aims to show that for a number of interacting open quantum systems, it is possible to obtain exact analytic solutions through a connection with integrable models. I will describe how a correspondence between a Lindblad equation and an integrable Hamiltonian can be established and what information about the open systems it provides. The talk is based on the work presented in SciPost Phys. 8, 044 (2020)

Phases of Gaussian fermionic circuits protected by hidden dynamical symmetries

Yumu BAO
University of California, Berkeley

Gaussian fermionic circuits consisting of unitary gates and local measurements that preserve the gaussianity of the wave function have been shown to undergo an entanglement phase transition tuned by the measurement rates. The subsystem entanglement entropy exhibits a critical scaling at moderate measurement rates and sharply changes to an area-law scaling when the rate is increased. In this talk, we show the physical circuit symmetry does not govern the phase transition on its own. Instead, it is extended by hidden dynamical symmetries to form an enlarged symmetry. In the circuits that only conserves fermion parity, we show an enlarged U(1) symmetry, which explains the U(1) critical phase and predicts a Kosterlitz-Thouless transition to an area-law phase. We examine our theoretical predictions via numerical simulations. We further discuss the enlarged symmetry in the circuits with physical U(1) symmetry and identify the relevant symmetry for the phase transition.

Transport controlled by Poincaré orbit topology in a driven inhomogeneous lattice gas

Alec CAO
University of California, Santa Barbara

In periodic quantum systems which are both homogeneously tilted and driven, the interplay between drive and Bloch oscillations controls transport dynamics. Using a quantum gas in a modulated optical lattice, we show experimentally that inhomogeneity of the applied force leads to a rich variety of dynamical behaviors controlled by the drive phase, from self-parametrically-modulated Bloch epicycles to adaptive driving of transport against a force gradient to modulation-enhanced monopole modes. By examining Poincaré portraits of the semiclassical transport equations, we demonstrate that the observed dynamics reflect the rich topological structure of stroboscopic orbits on a Brillouin phase-space cylinder. The long-time dynamics of a localized initial state is dictated by the stability of nearby fixed points in the Poincaré map, leading to either coherent oscillatory pumping or rapid spreading of the wavefunction.

Physics-Based Machines for Optimization

Sri KRISHNA VADLAMANI
University of California, Berkeley

Optimization is built into the fundamentals of physics. For example, physics has the principle of least action, the principle of minimum power dissipation, also called minimum entropy generation, and the adiabatic principle, which, in its quantum form, is called quantum annealing. Machines built on these principles can solve the mathematical problem of optimization, even when constraints are included. Further, these machines become digital, in the same sense that a flip–flop is digital, when binary constraints are included. A wide variety of machines, including coupled driven dissipative electrical oscillators, coupled exciton-polariton condensates, and others, have had recent success at optimizing the Ising magnetic energy. We demonstrate that almost all those machines perform optimization according to the principle of minimum power dissipation as put forth by Onsager. Further, we show that this optimization is in fact equivalent to Lagrange multiplier optimization for constrained problems.

Kramers' degeneracy for open systems in thermal equilibrium

Simon LIEU
University of Maryland

Time-reversal symmetry (TRS) plays an important role in closed quantum systems, highlighted by developments in symmetry-protected topological phases of matter. By contrast, the role of TRS in open systems remains less thoroughly understood, since such systems propagate irreversibly in time. For example, different symmetry-based classification schemes have been proposed to understand open generalizations of topological band insulators. Here, we prove a generalization of Kramers' degeneracy theorem which applies to open systems described by a Lindblad master equation. We find that a system needs to be coupled to a thermal environment via TRS-respecting terms for spectral degeneracies to survive. We provide simple examples of this phenomenon and show that the degeneracy is reflected in the standard Green's functions, which can be experimentally detected using spectroscopic techniques. While open quantum systems propagate irreversibly in time, our work points to TRS-protected features which survive coupling to a thermal environment.

Encoding Phase Transitions in Random Classical Circuits

Anasuya LYONS
University of California, Berkeley

Recent studies have shown that the interplay between unitary dynamics and projective measurements leads to a novel phase transition characterized by the dynamics of quantum entanglement, entropy, and the Fisher information. In this work, we study a classical analogue of the phase transition by investigating random classical circuits interspersed by bit-erasure errors in one dimension. We find evidence of a phase transition from an “encoding” to a “non-encoding” phase above a critical error rate. In the encoding phase, a nonzero amount of Shannon entropy per bit can be retained in the system, indicating at least a subset of initially encoded information is protected from errors. In contrast, in the non-encoding phase, the Shannon entropy approaches zero within a finite circuit depth independent of system sizes. We extract the phase transition point and the dynamical scaling exponents near the transition point using numerical simulations. Furthermore, we develop an exact method to map the average behavior of the classical circuit dynamics to an infectious disease model, providing a new framework to study universal aspects in the dynamics of classical information.

Universal Lindblad equation for open quantum systems

Frederik NATHAN
California Institute of Technology

We develop a Markovian master equation in the Lindblad form that enables the efficient study of a wide range of open quantum many-body systems that would be inaccessible with existing methods. The validity of the master equation is based entirely on properties of the bath and the system-bath coupling, without any requirements on the level structure within the system itself. The master equation is derived using a Markov approximation that is distinct from that used in earlier approaches. We provide a rigorous bound for the error induced by this Markov approximation; the error is controlled by a dimensionless combination of intrinsic correlation and relaxation timescales of the bath. Our master equation is accurate on the same level of approximation as the Bloch-Redfield equation. In contrast to the Bloch-Redfield approach, our approach ensures preservation of the positivity of the density matrix. As a result, our method is robust, and can be solved efficiently using stochastic evolution of pure states (rather than density matrices). We discuss how our method can be applied to static or driven quantum many-body systems, and illustrate its power through numerical simulation of a spin chain that would be challenging to treat by existing methods.

Dark states from superradiant decay of multilevel atoms in a cavity

Asier PIÑEIRO ORIOLI
University of Colorado

We investigate the collective decay dynamics of atoms with a generic multilevel structure F -> F' coupled to two light modes of different polarization inside a cavity. Due to the multiple decay channels, the eigenstate structure and superradiant behavior is much richer and more complex than for two-level atoms. In particular, we find that, in contrast to the two-level case, multilevel atoms can harbour eigenstates that are perfectly dark to cavity decay even within the subspace of permutationally symmetric states (collective Dicke manifold). As a consequence, the superradiant decay of multilevel atoms can end up stuck in one of these dark states, where a macroscopic fraction of the atoms remains excited. These dark states should be readily observable in current setups of optical cavity experiments with alkaline-earth atoms or Raman-dressed transitions. Their long-lived nature further anticipates potential applications in quantum sensing and metrology, and quantum simulation. Specifically, the ubiquity of dark states in such multilevel systems opens exciting research directions for the generation of long-lived entangled states of matter or new driven-dissipative phases with multiple steady-states.

Quantum mechanical detailed balance and steady-state solutions of open quantum systems

David ROBERTS
University of Chicago

It has been well-known that classical Markov processes satisfying detailed balance are exactly solvable. Attempts to solve quantum problems in a similar way have often relied on artificial phase-space representations to map onto effectively classical problems. In this talk, we derive an quantum-mechanical formulation of detailed balance for quantum master equations, which enables solutions of nontrivial steady states. These ”quantum” detailed balance conditions can be rephrased as the condition of a certain cascaded network relaxing into a dark state, and hence represent a generalization of coherent quantum absorber (CQA) approaches to finding steady states in quantum optics. Finally, we connect quantum detailed balance with its classical counterpart, unveiling the existence of a hidden "quantum-classical dictionary" that shows how these quantum detailed balance conditions ultimately enabled the symmetries exploited by classical phase space methods first used to solve driven-nonlinear cavity problems in quantum optics.

Measurement-induced negativity transition in an open quantum circuit

Zack WEINSTEIN
University of California, Berkeley

In quantum circuits consisting of random unitary evolution interspersed with random measurements, a volume-law to area-law phase transition in the averaged pure state entanglement entropy is known to occur at a critical measurement rate. As a first step towards understanding similar phase transitions in open quantum systems with more realistic decoherent processes, we study the entanglement dynamics of two weakly coupled qubit chains, where one chain can be viewed as an effective bath for the other. We find a second order volume-law to area-law transition in the logarithmic entanglement negativity, a robust measure of mixed state entanglement, between the two halves of the "system chain". No corresponding transition is observed in the entanglement entropy for any bi-partition of the two chain ladder, which always remains in a volume-law phase. We present numerical evidence of this transition in classically simulable Clifford circuits, and discuss a possible analytical understanding of the transition using an effective statistical mechanics model.

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Buca	Berislav	Non-stationary quantum many-body dynamics
Carleo	Giuseppe	Simulations of driven and open quantum systems with neural-network quantum states
Chitra	Ramasubramanian	Anomalous dissipative transitions
Clerk	Aashish	Driven-dissipative quantum systems and hidden time-reversal symmetries
Demler	Eugene	Nonperturbative approach to ultrastrong coupling waveguide quantum electrodynamics
Diehl	Sebastian	Measurement induced phase transitions in monitored fermion systems
Donner	Tobias	An emergent atom pump driven by global dissipation in a quantum gas
Eckstein	Martin	Non-equilibrium steady-state description of photo-induced orders in Mott insulators
Fazio	Rosario	Dissipative transitions in Floquet-Lindblad systems
Fleischhauer	Michael	Nonlinear transport of Rydberg excitations: From topolopgical lattice hamiltonians to emerging gauge fields
Kollár	Alicia	Engineering Qubit-Qubit Interactions in Circuit QED Lattices
Lenarčič	Zala	Critical behavior near the many-body localization transition in driven open systems
Lev	Ben	An Optical Lattice with Sound

Surname	**Name**	**Talk Title**
Macieszczak	Katarzyna	Classical metastability in open quantum systems
Morigi	Giovanna	Criticality, Entanglement and topology of self-organized phases in many body cavity quantum electrodynamics
Narang	Prineha	Ab initio Approaches to Non-Equilibrium Dynamics in Quantum Matter
Piazza	Francesco	Fermi polaron laser in two-dimensional semiconductors
Poschinger	Ulrich	Trapped ions: A versatile experimental platform for few-body quantum physics
Rosch	Achim	Archimedean screw and time quasicrystals in driven chiral magnets
Seetharam	Kushal	Correlation engineering via non-local dissipation
Semeghini	Giulia	Exploring new scientific frontiers with programmable atom arrays
Tserkovnyak	Yaroslav	Topological Transport of Deconfined Hedgehogs in Magnets
Viola Kusminskiy	Silvia	Cavity Magnonics
Weld	David	Experimental realization of the many-body quantum kicked rotor
Widera	Athur	Nonequilibrium dynamics of quantum gases in time-dependent disorder

List of Contributions - Young Scholars Session

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Nathan	Frederik	Universal Lindblad equation for open quantum systems
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Roberts	David	Quantum mechanical detailed balance and steady-state solutions of open quantum systems

Surname	**Name**	**Talk Title**
Snizhko	Kyrylo	Topological transition in weak-measurement-induced geometric phases
Weinstein	Zack	Measurement-induced negativity transition in an open quantum circuit
Ziolkowska	Aleksandra	Yang-Baxter Integrable Lindblad Equations