OpenQMBP2023: New perspectives in the out-of-equilibrium dynamics of open many-body quantum systems

Report of Contributions

https://indico.ijclab.in2p3.fr/e/8925

Contribution ID: **4** Type: **not specified**

TBA

Presenter: KHEMANI, Vedika (Stanford University)

Contribution ID: **5** Type: **not specified**

Statistical mechanics insights into the complexity of tensor network calculations

Monday, June 19, 2023 11:50 AM (40 minutes)

Tensor network states offer memory-efficient representations of quantum many-body states, and play a key role in classical simulations of quantum materials, chemistry, and circuits. However, rigorous results show that exactly computing observables from a tensor network state is generically a computationally hard problem outside of special instances such as 1d matrix-product states. Yet, approximation schemes for computing properties of 2d projected entangled pair states (PEPS) have been widely and successfully used without encountering any sign of exponential hardness. Adopting the philosophy of random matrix theory, in this talk I will analyze the complexity of approximately contracting a 2d PEPS by exploiting an analytic mapping to an effective replicated statistical mechanics model that permits a controlled analysis at large bond dimension. Through this statistical-mechanics lens, I will argue that: although approximating individual wave-function amplitudes of a PEPS faces a computational-complexity phase transition above a critical bond dimension, one can generically efficiently estimate physical properties, such as correlation functions, for any finite bond dimension.

Presenter: VASSEUR, Romain (University of Massachusetts Amherst)

Contribution ID: **6** Type: **not specified**

Observing the effect of many measurements

Monday, June 19, 2023 2:30 PM (1 hour)

Presenter: ALTMAN, Ehud (University of California, Berkeley)

Contribution ID: **7** Type: **not specified**

Simulating quantum transport on classical computers: Bridging the high- and low-temperature limits

Tuesday, June 20, 2023 10:00 AM (20 minutes)

Can we efficiently estimate transport coefficients (conductivities etc) in many-body quantum systems using classical computers? Drawing on lessons learned from studying scrambling and entanglement entropy dynamics in generic many-body systems, I propose an upper bound on the computational resources required to simulate transport at high temperatures: CPU time/memory $\sim e^{O(\log(\epsilon^{-1}))^2}$, where ϵ is the desired degree of precision. I'll describe a method (DAOE) achieving this bound. I'll explain why DAOE in its original form fails at low temperatures/extreme filling, and then propose an extension of it which shows encouraging signs of working in these limits.

Presenter: VON KEYSERLINGK, Curt (KCL)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **8** Type: **not specified**

Monte Carlo matrix-product-state approach to the false vacuum decay in the monitored quantum Ising chain

Tuesday, June 20, 2023 10:25 AM (20 minutes)

In this work we characterize the metastable dynamics in the ferromagnetic quantum Ising chain with a weak longitudinal field subject to continuous monitoring of the local magnetization. To this end we exploit a numerical approach based on the combination of matrix product states with stochastic quantum trajectories which allows for the simulation of the trajectory-resolved non-equilibrium dynamics of interacting many-body systems in the presence of continuous measurements. We show how the presence of measurements affects the false vacuum decay: at short times the departure from the local minimum is accelerated while at long times the system thermalizes to an infinite-temperature incoherent mixture. For large measurement rates the system enters a quantum Zeno regime. The false vacuum decay and the thermalization physics are characterized in terms of the magnetization, connected correlation function, and the trajectory-resolved entanglement entropy.

Presenter: BIELLA, Alberto (Pitaevskii BEC Center, CNR-INO and Università di Trento)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **9** Type: **not specified**

Phases of quantum information on a noisy quantum processor

Monday, June 19, 2023 11:00 AM (40 minutes)

Abstract: I will discuss the experimental realization of measurement-induced phases of quantum information on Google Quantum AI's superconducting processor. By using a hybrid quantum-classical order parameter, which correlates experimental data with simulation, we observe signatures of distinct entanglement structures up to 70 qubits. We further show that noise, an inevitable limitation of the hardware, can be exploited as an independent probe of the phases.
Reference: https://arxiv.org/abs/2303.04792

Presenter: IPPOLITI, Matteo (Stanford University)

Contribution ID: **10** Type: **not specified**

Topological transition in a continuously monitored free fermion model

Tuesday, June 20, 2023 11:25 AM (20 minutes)

Local quantum measurements of many-body systems can induce phase transitions between volume and area law scaling of entanglement entropy.
Here we present a Gaussian fermionic model where continuous measurements of two non-commuting sets of observables induce a transition between area-law entanglement scaling phases of distinct topological order. We characterize the phase transition in terms of the topological entanglement entropy.
We find numerically that the area-to-area law phase transition differs from its projective measurement counterpart and that the topologically distinct phases are separated by a sub-volume scaling phase when unitary dynamics are introduced. We further introduce a partial post-selection that continuously connects the phase diagram to that of a non-Hermitian model whose phases are characterized by distinct topological numbers.

Presenter: ROMITO, Alessandro (Lancaster University)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **11** Type: **not specified**

TBA

Tuesday, June 20, 2023 11:50 AM (20 minutes)

Presenter: TURKESHI, Xhek (College de France)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **12** Type: **not specified**

Entanglement dynamics with non-local measurements: Theoretical framework for Gaussian systems.

Tuesday, June 20, 2023 3:25 PM (20 minutes)

I will present the theory needed to apply a Gaussian-preserving operator to a fermionic Gaussian state. Then I will use this formalism to derive the equations of motions of a fermionic Kitaev chain following two different dynamic protocols, induced by the presence of the monitoring apparatus: a quantum-jump evolution with string operators and a quantum diffusion dynamics with long-range operators decaying as a power-law with the distance.

Presenter: PICCITTO, Giulia (Università degli studi di Pisa)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **13** Type: **not specified**

Entanglement dynamics with non-local measurements: Numerical results.

Tuesday, June 20, 2023 3:50 PM (20 minutes)

I will discuss some numerical results for the entanglement entropy dynamics along the quantum trajectories of a fermionic Kitaev chain, in the presence of measurements with a non-local character. The first part addresses a quantum-jump evolution with fixed-range string operators: a variety of behaviors emerge, ranging from volume-law, for extensive ranges of the string, to subvolume- and area-law, for finite-range strings. The second part deals with a quantum state diffusion dynamics with power-law decaying measurements: depending on the exponent of the power-law, we observe qualitatively different behaviors as those appearing in the previous scenario; these are reflected also in the probability distribution function of the measurement operator.

Presenter: ROSSINI, Davide (University of Pisa)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **14** Type: **not specified**

Monitored Fermions: Phenomenology, Effective Theory and Dark State Phase Transitions

Tuesday, June 20, 2023 2:25 PM (20 minutes)

Monitored Fermions provide a rich playground for the study of entanglement phase transitions in non-unitary quantum dynamics. We will discuss the phenomenology of entanglement transitions in several classes of monitored Hamiltonian systems and in fermion circuits and introduce effective theories describing both setups. We will then utilize adaptive feedback to reduce the configurational entropy of random measurement outcomes in the wave function ensemble. In short-range correlated, area law phases, each wave function is then steered into a unique dark- or absorbing state with macroscopic order, replacing the mixed stationary state of the unconditioned ensemble. This scheme creates a link between measurement-induced phase transitions and new forms of quantum absorbing state transitions.

Presenter: BUCHHOLD, Michael (University of Cologne)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **15** Type: **not specified**

Triviality of quantum trajectories close to a directed percolation transition

Tuesday, June 20, 2023 3:00 PM (20 minutes)

In this talk, I will discuss a variation of the standard framework of measurement-induced phase transitions, where the projective measurements are followed by control operations steering the system toward a pure absorbing state. In these dynamics, two types of phase transition occur as the rate of these control operations is increased: a measurement-induced entanglement transition, and a directed percolation transition into the absorbing state. I will present analytical and numerical evidence showing that these transitions are generically distinct, with the quantum trajectories becoming disentangled before the absorbing state transition is reached. To this end, I will introduce simple classes of models where the measurements in each quantum trajectory define an effective tensor network (ETN) where the nontrivial time evolution takes place. By analyzing the entanglement properties of the ETN, I will show that the entanglement and absorbing-state transitions coincide only in the limit of the infinite local Hilbert-space dimension. Focusing on a Clifford model which allows numerical simulations for large system sizes, I will then present data supporting these predictions and allowing one to study the finite-size crossover between the two transitions at large local Hilbert space dimension.

Presenter: PIROLI, Lorenzo (ENS Paris)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **16** Type: **not specified**

Diffusion and subdiffusion in the disordered quantum and classical Heisenberg spin chains

Tuesday, June 20, 2023 2:00 PM (20 minutes)

I will present some work on disordered Heisenberg model on a chain which shows that, depending on the strength of the disorder, both the classical and quantum model have a transition from diffusive to subdiffusive transport.
Based on:

AJ McRoberts, F Balducci, R Moessner, A Scardicchio
arXiv preprint arXiv:2304.05423

IV Protopopov, RK Panda, T Parolini, A Scardicchio, E Demler, DA Abanin
Physical Review X 10 (1), 011025

Presenter: SCARDICCHIO, Antonello

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **17** Type: **not specified**

Magic Phase transition with Random Quantum Circuits

Wednesday, June 21, 2023 12:00 PM (40 minutes)

Magic is a property of quantum states that enables universal fault-tolerant quantum computing using simple sets of gate operations. Understanding the mechanisms by which magic is created or destroyed is, therefore, a crucial step towards efficient and practical fault-tolerant computation. We observe that a random stabilizer code subject to coherent errors exhibits a phase transition in magic, which we characterize through analytic, numeric and experimental probes. Below a critical error rate, stabilizer syndrome measurements remove the accumulated magic in the circuit, effectively protecting against coherent errors; above the critical error rate syndrome measurements concentrate magic. A better understanding of such rich behavior in the resource theory of magic could shed more light on origins of quantum speedup and pave pathways for more efficient magic state generation.

Presenter: NOEL, Crystal (Duke University)

Contribution ID: **18** Type: **not specified**

Replica field theories for measurement transitions and random tensor networks

Thursday, June 22, 2023 11:50 AM (40 minutes)

I will describe how continuum field theory can in some cases give exact results for dynamical phase transitions driven by repeated measurement, and also for entanglement transitions in random tensor networks. I will discuss both free and interacting systems.

Presenter: NAHUM, Adam (CNRS)

Contribution ID: **20** Type: **not specified**

Phase Transitions in Benchmarking and Mitigation of Noisy Quantum Circuits

Friday, June 23, 2023 11:00 AM (40 minutes)

Two central challenges in NISQ devices are the characterization and mitigation of the effects of noise. Originally introduced to analyze quantum random circuit sampling experiments, the linear cross-entropy benchmark (XEB) has emerged as a paradigmatic tool for characterizing noise in NISQ devices. A key question in the theory of XEB is whether it approximates the fidelity of the quantum state preparation. Previous works have shown that the XEB generically approximates the fidelity in a regime where the noise rate per qudit ε satisfies $\varepsilon N \ll 1$ for a system of N qudits and that this approximation breaks down at large noise rates. Here, we show there is a breakdown of XEB as a fidelity proxy at a sharp phase transition at a critical value of εN. Next, we discuss the application of quantum error mitigation to reducing the effects of noise in current devices. Error mitigation relies on precise characterization of the noise, but the robustness of these techniques to noise characterization disorder are not well studied. We adapt an Imry-Ma argument to predict the existence of a disorder-driven error mitigation threshold for random spatially local circuits in two or more dimensions. We study these two noise-driven phase transitions using mappings of average two-copy quantities to statistical mechanics models of randomly driven quantum dynamics. We discuss implications of our results for tests of quantum computational advantage, fault-tolerant probes of measurement-induced phase transitions, and quantum algorithms in near-term devices.

Presenter: GULLANS, Michael (QuICS, NIST/University of Maryland, College Park)

Contribution ID: **21** Type: **not specified**

Complete Hilbert Space Ergodicity in Quantum Dynamics of Generalized Fibonacci Drives

Thursday, June 22, 2023 2:30 PM (40 minutes)

Ergodicity in quantum systems is often defined through statistical properties of energy eigenstates, such as Berry's conjecture for single particle chaotic systems, and the eigenstate thermalization hypothesis (ETH) for many-body systems. In this talk, I would like to pose the question whether there are quantum systems which can exhibit a stronger form of ergodicity, namely whether dynamics is such that any time-evolved state visits every point in Hilbert space uniformly over time. We call such a phenomenon Complete Hilbert Space Ergodicity (CSHE), and it represents a notion of ergodicity more akin to the intuitive notion of ergodicity as an inherently dynamical concept, i.e., that a system eventually explores all of its allowed 'phase space'. Naturally, CSHE cannot hold for systems which are time-independent or even time-periodic (owing to the existence of energy eigenstates which precludes exploration of the full Hilbert space), but I will show that there exists a family of simple, aperiodic, yet deterministic driving protocols — drives generated by the Fibonacci word and its generalizations — for which CQE can be proven to occur. Our results provide a basis toward understanding how thermalization arises in general time-dependent quantum many-body systems, and in fact implies a more stringent form of local equilibration called deep thermalization.

Presenter: HO, Wen Wei (National University of Singapore)

Session Classification: Eigenstate thermalisation and k-designs

Contribution ID: **22** Type: **not specified**

Trapped-ion quantum state and process engineering using dissipation

Thursday, June 22, 2023 11:00 AM (40 minutes)

I will discuss a number of results on quantum state engineering and dissipative control with trapped ions. Primarily this will relate to oscillator state control, where the engineering of open-system dynamics has allowed us to create a range of quantum steady-states, perform quantum error-correction using the Gottesmann-Kitaev-Preskill code, and to observe phase transitions in systems with competing dissipation. Furthermore I will outline how these methods might be extended to multi-partite systems, and present first results along these lines.

Presenter: HOME, Jonathan (ETH Zürich)

Contribution ID: **23** Type: **not specified**

Emergent hydrodynamics in constrained quantum matter

Wednesday, June 21, 2023 3:00 PM (40 minutes)

The far-from-equilibrium dynamics of generic interacting quantum systems is characterized by a handful of universal guiding principles, among them the diffusive transport of globally conserved quantities. Certain systems with kinetic constraints or constrained interactions, however, defy these expectations and exhibit anomalous transport instead. In this talk, we will discuss some of these exceptions. For example, systems with conserved, and sometimes hidden, spin patterns, including XNOR or tJz models, show anomalously slow spin relaxation dynamics. In these models, spin transport is governed by tracer diffusion, which describes the diffusion of a tagged particle with hard-core constraints. Another example are fracton systems, which conserve the dipole moment (or equivalently the center of mass). Fracton systems exhibit a localization transition as a function of the density separating an ergodic dynamical phase from a frozen one; a phenomena known as Hilbert space fragmentation. Even in the ergodic phase, transport is anomalously slow and exhibits sub-diffusive scaling. We will discuss relations and differences between the two cases and also draw connections to recent quantum simulation experiments with ultracold atoms.

Presenter: KNAP, Michael (Technical University of Munich)

Contribution ID: **24** Type: **not specified**

Post-selection-free Measurement-Induced Phase Transition in Driven Atomic Gases with Collective Decay

Friday, June 23, 2023 12:00 PM (40 minutes)

I will discuss the properties of a monitored ensemble of atoms driven by a laser field and in the presence of collective decay.
By varying the strength of the external drive, the atomic cloud undergoes a measurement-induced phase transition separating
two phases with entanglement entropy scaling sub-extensively with the system size. The critical point coincides with the transition
to a superradiant spontaneous emission. This setup is implementable in current light-matter interaction devices, and most notably,
the monitored dynamics is free from the post-selection measurement problem, even in the case of imperfect monitoring.

G. Passarelli, X. Turkeshi, A. Russomanno, P. Lucignano, M. Schirò, R. Fazio https://arxiv.org/abs/2306.00841

Presenter: FAZIO, Rosario (The Abdus Salam International Centre for Theoretical Physics)

Contribution ID: **25** Type: **not specified**

Coherences and fluctuations in noisy mesoscopic systems & Q-SSEP

Friday, June 23, 2023 3:00 PM (40 minutes)

An alternative title could have been "How to characterise fluctuations in diffusive out-of-equilibrium many-body quantum systems?"In general, the difficulty to characterise non-equilibrium systems lies in the fact that there is no analog of the Boltzmann distribution to describe thermodynamic variables and their fluctuations. Over the last 20 years, however, it was observed that fluctuations of diffusive transport show universal properties that do not depend on the microscopic details. The general framework to characterise these systems from a macroscopic point of view is now called the "Macroscopic Fluctuation Theory"(MFT). A natural question is whether this framework can be extended to the quantum realm to describe the statistics of purely quantum mechanical effects such as interference or entanglement in diffusive out-of-equilibrium systems. With this aim in mind, I will introduce the Quantum Symmetric Simple Exclusion Process (Q-SSEP), a microscopic model system of fluctuating quantum diffusion, and present in particular the recent observation that fluctuations of coherences in Q-SSEP have a natural interpretation as free cumulants, a concept from free probability theory, and heuristic arguments why we expect free probability theory to be an appropriate framework to describe coherent fluctuations in generic mesoscopic systems.

Presenter: BERNARD, Denis (LPENS & CNRS)

Session Classification: Quantum trajectories and monitoring in Gaussian models

Contribution ID: **26** Type: **not specified**

Assembling and probing strongly correlated fluids of light

Monday, June 12, 2023 11:00 AM (40 minutes)

Learning how to create and manipulate highly-entangled many-body systems is a central challenge of modern quantum science, with promising applications from quantum computation to many-body physics and quantum-enhanced metrology. Analog quantum simulators provide a rich playground for exploring the emergent collective phenomena in synthetic quantum systems, and how to harness these many-body effects for future quantum technologies.

In this talk, I will describe various approaches for assembling quantum matter from strongly interacting microwave photons. Our quantum circuit platform consists of an array of capacitively coupled transmon qubits acting as a Hubbard lattice for photons. I will highlight a novel approach to constructing low-entropy quantum fluids of light by employing particle-resolved assembly combined with adiabatic control of lattice disorder. Studying these fluids with site-resolved microscopy of entanglement and two-body correlations reveals how the photons delocalize and avoid one another, behaving as noninteracting fermions.

The precise time- and space-resolved control of the lattice potential landscape presents another unique capability in our platform for investigating out-of-equilibrium quantum dynamics. Using controlled perturbations in the lattice potential, we can spectroscopically probe quasiparticle excitations, prepare superpositions of many-body eigenstates and observe the propagation of sound modes of light in the lattice. Towards developing practical tools for quantum computers, I will show how we can leverage many-body dynamics in these fluids for preparing highly-entangled states useful for quantum information processing and metrology.

Presenter: VRAJITOAREA, Andrei (University of Chicago)

Contribution ID: **27** Type: **not specified**

Novel Non-equilibrium Phenomena in Quantum Fluids of Light

Monday, June 12, 2023 11:50 AM (40 minutes)

Presenter: SZYMANSKA, Marzena (University College London)

Contribution ID: **28** Type: **not specified**

Negative tripartite information after quantum quenches in integrable systems

Tuesday, June 13, 2023 10:00 AM (20 minutes)

We build the quasiparticle picture for the tripartite mutual information (TMI) after quantum quenches in spin chains that can be mapped onto free-fermion theories. A nonzero TMI (equivalently, topological entropy) signals quantum correlations between three regions of a quantum many-body system. The TMI is sensitive to entangled multiplets of more than two quasiparticles, i.e., beyond the entangled-pair paradigm of the standard quasiparticle picture. Surprisingly, for some nontrivially entangled multiplets the TMI is negative at intermediate times. This means that the mutual information is monogamous, similar to holographic theories. Oppositely, for multiplets that are "classically" entangled, the TMI is positive. Crucially, a negative TMI reflects that the entanglement content of the multiplets is not directly related to the Generalized Gibbs Ensemble (GGE) that describes the post-quench steady state. Thus, the TMI is the ideal lens to observe the weakening of the relationship between entanglement and thermodynamics. We benchmark our results in the XX chain and in the transverse field Ising chain. In the hydrodynamic limit of long times and large intervals, with their ratio fixed, exact lattice results are in agreement with the quasiparticle picture.

Presenter: ALBA, Vincenzo (University of Pisa)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **29** Type: **not specified**

An open quantum safari: Criticality, Computing, and Chaos

Monday, June 12, 2023 3:00 PM (1h 30m)

Presenter: MINGANTI, Fabrizio (EPFL)

Contribution ID: **30** Type: **not specified**

Presentation of Institut Pascal

Wednesday, June 14, 2023 10:30 AM (30 minutes)

Presenter: BALKANSKI, Yves (Institut Pascal - UPSaclay)

Contribution ID: **31** Type: **not specified**

Gaussian quantum trajectories for open and closed systems

Wednesday, June 14, 2023 11:00 AM (40 minutes)

I will discuss the use of Gaussian states for the modeling of open quantum systems within the quantum trajectory framework, with applications to bosonic systems and spin systems: the to two-photon driven cavities and the dissipative XYZ model. Thanks to the dissipation, the quantum fluctuations typically remain small at all times, therefore improving the validity of the Gaussian states as compared to their use for the dynamics of closed systems. It is therefore suggested to introduce some fictitious dissipation to closed systems in order to improve their simulability.

Presenter: WOUTERS, Michiel

Contribution ID: **32** Type: **not specified**

Laser-driven superradiant ensembles

Wednesday, June 14, 2023 3:15 PM (40 minutes)

I will present our recent studies on superradiance in dense clouds of ultracold atoms, that are indistinguishably coupled to a mode of the electromagnetic field, akin to cavity or waveguide QED systems, but here in free space. We are in particular interested in the case where the atomic ensemble is continuously driven by a resonant laser that leads to a competition between laser driving and collective spontaneous emission. We observed that this competition induces a transition to a steady-state superradiant phase. Beyond measuring the field intensity, we measure photon-photon correlations. This precious tool of quantum optics allows us to question wether atomic correlations can impart non-trivial photonic correlations. I will show that indeed photonic correlations emerge, and despite the system's simplicity, their description poses a challenge to many-body theories.

Presenter: FERRIER-BARBUT, Igor (CNRS, Institut d'Optique Graduate School, Université Paris Saclay)

Contribution ID: **33** Type: **not specified**

Search as (quantum) selforganized process

Thursday, June 15, 2023 11:00 AM (40 minutes)

Efficient retrieval of information is a core operation in the world wide web, it is essential for the sustainance fof living organism. Search dynamics, moreover, is a paradigm for optimization algorithms: Searches permeate our everyday life. Inspired by the food search dynamics of a living organism, the Physarum polycephalum, we analyse the role of noise in finding the optimal path on a graph with multiple constraints and where the weight of the edges connecting the nodes is a dynamical variable. The network dynamics results from the interplay between a nonlinear function of the flow, dissipation, and Gaussian, additive noise. At a finite value the noise amplitude, the network selforganizes in the most robust topology with a resonant-like behavior. This specific topology maximizes the transport efficiency, it is reached with the maximal convergence rate, and it is not found by the noiseless dynamics. We argue that this dynamics is a manifestation of noise-induced resonances in network self-organization. Drawing from this knowledge, we then discuss the perspectives of designing quantum search algorithms that are assisted by stochastic dnamics.

Presenter: MORIGI, Giovanna (University of Saarland)

Contribution ID: **34** Type: **not specified**

Density wave ordering in a unitary gas with photon-mediated interactions

Thursday, June 15, 2023 11:50 AM (40 minutes)

I will present the realization of a quantum degenerate Fermi gas interacting simultaneously via unitary-limited contact interaction and long-range, photon mediated interaction induced by an optical cavity. We observe the onset of density-wave order above a critical strength of the photon-mediated interaction, and characterize the phase diagram as a function of both interactions type. This system is very promising for the investigation of the interplay of charge-density wave order with superfluidity with a fully controlled microscopic Hamiltonian. I will then present briefly the perspectives open in the mid-term for the realization of the SYK interactions in quantum gases.

Presenter: BRANTUT, Jean-Philippe (EPFL)

Contribution ID: **35** Type: **not specified**

Phantom relaxation in local many-body Floquet systems

Thursday, June 15, 2023 2:30 PM (40 minutes)

We would like to understand relaxation towards a long-time steady state under unitary pure-state evolution. Focusing on a bipartite entanglement or out-of-time-ordered correlations, one sometimes finds that relaxation is not a simple exponential with a fixed rate, but that the rate exhibits a jump at an extensive time. Studying some solvable
cases of random circuits one finds that this two-step relaxation can be traced back to interesting non-Hermitian physics. Despite relaxation being described by a gapped Markovian matrix the rate is in the thermodynamic limit not given by the 2nd largest eigenvalue, but rather by a phantom eigenvalue – an "eigenvalue" that is not in the spectrum. Resolution of this puzzle will lead to a pseudospectrum, Jacobi theta
functions, and realization that when dealing with non-Hermitian matrices being exact can actually be wrong, while being slightly wrong is correct.

Presenter: ZNIDARIC, Marko (University of Ljubljana)

Contribution ID: **36** Type: **not specified**

Driven-Dissipative Systems: two messy experiments and one developing theory

Friday, June 16, 2023 11:00 AM (40 minutes)

As an example of driven-dissipative systems, I discuss two recent experiments: (1) strongly interacting excitons in moire heterostructures, (2) orbital angular pumping of quantum Hall states of graphene with vortex light. In the end, I briefly discuss our recent progress in verifying measurement-induced phases by avoiding the post-selection barrier.

https://arxiv.org/abs/2304.09731
https://arxiv.org/abs/2306.03417

Presenter: HAFEZI, Mohammad

Contribution ID: **37** Type: **not specified**

Phase transitions at a many-body exceptional point

Friday, June 16, 2023 11:50 AM (40 minutes)

Presenter: DIEHL, Sebastian

Contribution ID: **38** Type: **not specified**

TBA

Presenter: ALBA, Vincenzo (University of Pisa)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **39** Type: **not specified**

Inelastic Cooper pair tunneling in the strongly interacting regime

Tuesday, June 13, 2023 10:25 AM (20 minutes)

Superconducting circuits have recently emerged as a new platform to explore the physics of open many body systems using microwave photons in strongly non-linear media. In this talk, we will present some experimental results that were obtained in Orsay and in Grenoble where photons confined in a waveguide interact strongly through an impurity, here a Josephson junction. The system may be driven by applying a dc voltage across the junction. At finite voltages, Cooper pairs tunnel and relax their energy by emitting photons in the waveguide. Such system may be modeled by a driven boundary Sine Gordon problem. We will present some preliminary theoretical results to initiate the discussion.

Presenter: ESTEVE, Jérôme (Laboratoire de Physique des Solides)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **40** Type: **not specified**

Neural-Network Quantum States for Entanglement Phase Transitions

Tuesday, June 13, 2023 11:00 AM (20 minutes)

The success of Machine Learning owes to the development of neural-networks, variational approximators that can efficiently represent unknown functions living in high-dimensional spaces. Recently, those techniques have been ported to the field of numerical physics and used to approximate inherently high dimensional objects such as the Many-Body Wave-Function [1] or Density-Matrix [2] in an approach generally known as Neural-Network Quantum States (See Ref.3 for a general introduction).

In this seminar I will first discuss why estabilished approaches in NQS literature are incompatible with the simulation of the dynamics undergoing strong measurements, and then I will present a new approach that allowed us to avoid previous limitations [4].
Finally, I will showcase some recent results on the entanglement dynamics of large 2-Dimensional, non integrable systems.

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[1] Carleo and Troyer, Science 355, 602 (2017)

[2] F Vicentini, A Biella, N Regnault, C Ciuti, Phys. Rev. Lett 122 (25), 250503

[3] A. Dawid et Al, arXiv:2204.04198 (2022)

[4] A. Sinibaldi, C. Giuliani, G. Carleo, F. Vicentini, arXiV: 2305.14294 (2023)

Presenter: VICENTINI, Filippo (Ecole Polytechnique)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **41** Type: **not specified**

Adiabatic atom losses in nearly integrable quantum gases

Tuesday, June 13, 2023 11:25 AM (20 minutes)

Cold atom gases are never perfectly isolated, and they typically suffer from atom losses. Different mechanisms for losses can be present, which are distinguished by the number of atoms K (K = 1, 2, 3, . . .) involved in each loss event. When the dynamics of the isolated gas is integrable, atom losses weakly break integrability, and the evolution of the gas can be captured by a slowly varying Generalized Gibbs Ensemble. I will briefly review this theory of 'adiabatic losses'and discuss some perspectives.
The talk will be based on joint work with Isabelle Bouchoule, Benjamin Doyon, Francois Riggio, Lorenzo Rosso, Dragi Karevski.

Presenter: DUBAIL, Jérôme (CNRS)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **42** Type: **not specified**

Phase transitions in finite-component systems: Superradiance beyond the Dicke paradigm

Tuesday, June 13, 2023 11:50 AM (20 minutes)

The experimental control of the coherent interaction between light and matter is one of the corner stones of the recent developments in the field of quantum technologies. In this context, cavity quantum electrodynamics has reached an important milestone in the last decade with the achievement of the ultrastrong coupling (USC) regime, where the coupling strength becomes comparable or even larger than the cavity frequency [1-3]. Furthermore, recently developed quantum simulation techniques made it possible to observe [4] the physics of the ultrastrong coupling regime even in systems that do not naturally achieve the required interaction strength.
These effective implementations of USC can reach extreme regimes of parameters, where phase transitions emerge, even in systems with a finite number of components [5]. These finite-component phase transitions are easier to control than their many-body counterparts and offer an interesting framework for the study of critical phenomena both in closed and open quantum, systems. For instance, it was recently shown that some features of a superradiant phase are universally determined by key spectral properties of the model, and thus by the underlying symmetry of the light-matter interaction [6].

Here we introduce a new class of quantum optical Hamiltonians characterized by three-body couplings, and propose a circuit-QED scheme based on state-of-the-art technology that implements the considered model [4]. Unlike two-body light-matter interactions, this three-body coupling Hamiltonian is exclusively composed of terms which do not conserve the particle number.
In this model, the superradiant phase transition that emerges in the ultrastrong coupling regime is of first order, is characterized by the breaking of a Z2 x Z2 symmetry, and has a strongly non-Gaussian nature. Indeed, in contrast to what is observed in any two-body-coupling model, in proximity of the transition the ground state exhibits a divergent coskewness, i.e., quantum correlations that cannot be captured within semiclassical and Gaussian approximations. Furthermore, these features are robust and persist when dissipative processes are included in the model.

[1] A. Frisk Kockum, A. Miranowicz, S. Savasta, S. De Liberato, F. Nori, Nat. Rev. 1, 19 (2019)
[2] P. Forn-Díaz, L. Lamata, E. Rico, J. Kono, and E. Solano, Rev. Mod. Phys. 91, 025005 (2019)
[3] A. Le Boité, Adv. Quantum Technol. 3, 1900140 (2020)
[4] D. Markovic et al., Phys. Rev. Lett. 121, 040505 (2018)
[5] M.-J. Hwang, R. Puebla and M. B. Plenio, Phys. Rev. Lett. 115, 180404 (2015)
[6] S. Felicetti and A. Le Boité, Phys. Rev. Lett. 124, 040404 (2020)
[7] F. Minganti, L. Garbe, A. Le Boité and S. Felicetti, arXiv:2204.03520 (2022)

Presenter: LE BOITE, Alexandre (Laboratoire MPQ, CNRS, Université de Paris Cité)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **43** Type: **not specified**

Comparing bipartite entropy growth in open-system matrix product simulation methods

Tuesday, June 13, 2023 2:00 PM (20 minutes)

In this talk I will discuss the "entanglement" entropy growth dynamics in open spin models, comparing different matrix product representations of the many-body density matrix. Recently we discovered mechanisms behind a logarithmic growth of operator entanglement (OE) in XXZ model dynamics subjected to dephasing [1]. I will contrast this behavior to the growth of trajectory entanglement (TE), when the density matrix is unravelled into quantum trajectories [2]. I will further discuss latest advances into entanglement optimized trajectory methods.

[1] Phys. Rev. Lett. 129, 170401 (2022)
[2] https://arxiv.org/abs/2303.09426

Presenter: SCHACHENMAYER, Johannes (CESQ/ISIS, CNRS & University of Strasbourg)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **44** Type: **not specified**

Effect of slow losses in quantum gases with short range interactions: UV divergence in higher dimensions and breakdown of Tan's relation in 1D gases

Tuesday, June 13, 2023 2:25 PM (20 minutes)

We investigate the effect of losses on interacting quantum gases with contact interaction. We show that, for gases in dimension higher than one, assuming a vanishing correlation time of the reservoir where dissipation occurs leads to a divergence of the energy increase rate. This divergence orginiates from the ghost singularity of the wavefunction immediately after a loss event. We show how the divergence is regularized when taking into account the finite energy width of the reservoir. We will for this consider the specific case of a weakly interacting Bose Einstein condensate, that we describe using the Bogoliubov theory. Assuming slow losses so that the gas is at any time described by a thermal equilibrium, we compute the time evolution of the temperature of the gas.

We then focus on the 1D case where the above divergence is absent. We show however that the ghost singularity produced by losses induce a breakdown of the Tan's relation, which relates the large momentum tails of the momentum distribution and the adiabatic derivative of the energy with respect to the gas'coupling constant or scattering length. Such a breakdown is possible in 1D for a peculiar class of stationary states, which exist thanks to the infinite number of conserved quantities in the system. This phenomenon is discussed for arbitrary interaction strengths, and it is supported by exact calculations in the two asymptotic regimes of infinite and weak repulsion.

We conclude by experimental considerations.

Presenter: BOUCHOULE, Isabelle

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **45** Type: **not specified**

Quantum-Darwinism-encoding transitions

Tuesday, June 13, 2023 3:00 PM (20 minutes)

Quantum Darwinism (QD) is a theory of how classical objectivity emerges from quantum mechanics. Its key idea is that the environment has objective knowledge of a qubit only if small fractions of the former are correlated with the latter (like in a GHZ state). However generic unitary dynamics in a many-body system scrambles and encodes information, instead of broadcasting it. Are the two distinct behaviours as dynamical phases separated by sharp transitions? We introduce solvable models exhibiting such Quantum-Darwinism-encoding transitions (QDETs). The models are defined as a unitary circuit on an expanding tree, whose root is entangled with a reference bit. The order parameter is the knowledge of a small fraction of the leaves (the environment) about the reference. Relation with the measurement-induced transitions will be discussed.

Based on joint work with Benoît Ferté (arXiv: 2305.03694 and in progress).

Presenter: CAO, Xiangyu (CNRS/LPENS)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **46** Type: **not specified**

Continuous superradiance sustained by a stream of excited atoms

Tuesday, June 13, 2023 3:25 PM (20 minutes)

Superradiance of cold atoms in an optical cavity can be harvested to act as an optical frequency reference. By using an electronic transition much narrower spectrally than the cavity mode (i.e., by operating in the bad cavity limit), the frequency of the outcoming light is little affected by mirror position fluctuations –a signifiant limitation to short term stability in standard optical clocks.

For these new frequency references, called superradiant lasers [1], the present challenge is to demonstrate a continuous emission regime. Here, we will discuss one of the proposed architectures to sustain indefinitely superradiant emission: using a continuous stream of excited atoms to inject energy into the optical cavity mode. We will briefly introduce the experimental project in our laboratory, and then focus on a theoretical description of this object. Our efforts [2] provide intuition into the synchronization mechanism of new atoms onto the collective atomic dipole in cavity; into the role and importance of inter-atomic correlations; and into the coherence time of the collective atomic dipole, setting the linewidth.

[1] J. G. Bohnet, Z. Chen, J. M. Weiner, D. Meiser, M. J. Holland, J. K. Thompson: A steady-state superradiant laser with less than one intracavity photon, Nature 484, 78 (2012)

[2] B. Laburthe-Tolra, Z. Amodjee, B. Pasquiou, M. Robert-de-Saint-Vincent: Correlations and linewidth of the atomic beam continuous superradiant laser, SciPost Phys. Core 6, 015 (2023)

Presenter: ROBERT DE SAINT VINCENT, Martin (Laboratoire de Physique des Lasers, CNRS, USPN)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **47** Type: **not specified**

Sensing dynamical phase transitions

Tuesday, June 13, 2023 3:50 PM (20 minutes)

We will consider a parallel quantum dot as an example of an open quantum system that can feature a strong parity symmetry. For the dot, due to the presence of interactions, this symmetry results in the bistability characterised by distinct particle currents, while its explicit breaking leads to metastability. We will discuss when parameters of the dynamics can be estimated by continuously measuring the particle currents, despite their fluctuations diverging in the proximity to such a dynamical phase transition.

Reference: S. Matern, K. Macieszczak, S. Wozny, and M. Leijnse, Metastability and quantum coherence assisted sensing in interacting parallel quantum dots, Phys. Rev. B 107, 125424 (2023).

Presenter: MACIESZCZAK, Katarzyna (University of Warwick)

Session Classification: Conference: Dissipative Many-Body Quantum Systems

Contribution ID: **48** Type: **not specified**

Full counting statistics in integrable and chaotic systems

Monday, June 26, 2023 11:00 AM (40 minutes)

Presenter: GOPALAKRISHNAN, Sarang (Princeton University)

Contribution ID: **49** Type: **not specified**

TBA

Presenter: GOPALAKRISHNAN, Sarang (Princeton University)

Contribution ID: **50** Type: **not specified**

Quantum gas microscopy of Hubbard models in and out of equilibrium

Monday, June 26, 2023 12:00 PM (40 minutes)

Neutral atoms trapped in optical lattices are a versatile platform to study many-body physics in and out of equilibrium. Quantum gas microscopes provide an excellent toolbox to prepare, control and detect such systems at the level of individual atoms.
In the first part of my talk, I will present our recent work on implementing passively phase-stable square and triangular lattices for bosonic rubidium atoms. Combining these base lattices with fine-tuned local on-site blocking potentials, we realize several derived lattice configurations, among them Lieb and kagome lattices. As a first application of our system, we characterize the superfluid-to-Mott-insulator transition through a measurement of brane parity, a non-local observable derived from string correlators. Our measurements demonstrate that brane parity can act as an order parameter for the Mott-insulating state in two dimensions.
In the second part of the talk, I will focus on recent experiments on characterizing spin transport in Heisenberg chains. Using a direct mapping between the two-component Bose-Hubbard model and the Heisenberg model, we study the relaxation of spin domain walls. We track the evolution of the magnetization transported across the initial location of the domain wall, from which we find that transport is superdiffusive. Furthermore, our microscopic detection sheds light on the fluctuations in the transported spin, which indicate that transport falls in the celebrated Kardar-Parisi-Zhang universality class.

Presenter: ZEIHER, Johannes

Contribution ID: **51** Type: **not specified**

Kardar-Parisi-Zhang universality in a one-dimensional polariton condensate

Monday, June 26, 2023 2:00 PM (40 minutes)

Cavity polaritons are hybrid exciton-photon quasi-particles emerging from the strong coupling regime between photons confined in an optical cavity and excitons confined in quantum wells. They present physical properties reflecting their mixed nature. From the photon part, they inherit a small effective mass and can be confined in lattices with typical dimensions of the order of a few microns. Their excitonic part endows them with inter-particle interactions resulting in a giant Kerr non linearity. Cavity polaritons exhibit fascinating properties such as Bose Einstein condensation at elevated temperature, superfluidity, multistability… Importantly, the system is driven-dissipative in nature: the driving field maintains an out-of-equilibrium steady-state by compensating the constant leakage of photons.
Recent theoretical works have shown that the phase dynamics of out-of-equilibrium condensates obeys the celebrated Kardar Parisi Zhang (KPZ) equation [1-3]. In this talk, I will present our recent experimental observation of universal KPZ scaling laws in the first order coherence of a 1D polariton condensate [4]. I will first explain how we generated highly elongated polariton condensates in a 1D polariton lattice. I will then describe our measurements of the condensate coherence. Finally, I will show that data points lying within a well-defined spatio-temporal window collapse onto a single scaling function, characteristic of the KPZ universality class.

Presenter: RAVETS, Sylvain

Contribution ID: **52** Type: **not specified**

Floquet Quantum East: Localization Transition in Thermodynamic Limit

Wednesday, June 28, 2023 11:00 AM (40 minutes)

We define and study the Floquet quantum east circuit model, a kinetically constrained quantum dynamics in discrete space-time, exhibiting a localization transition in infinite volume. The localization is established using perturbative arguments as well as clearly convergent TEBD (time-evolving block decimation) method in real time.

Presenter: Mr PROSEN, Tomaz

Contribution ID: **53** Type: **not specified**

Quantum Transport and cold atomic gases

Wednesday, June 28, 2023 2:30 PM (1h 30m)

Quantum transport of a system which is between two reservoirs, at e.g. different chemical potentials, is one of the most common but also most important ways to put a quantum system out of equilibrium. Such a situation is relevant not only for charge transport but also for other transport properties such as spin transport or Hall transport for systems which are put under a magnetic field. I will discuss in this talk the recent progress done on the theoretical front, using in particular Keldysh technique, to deal with various situations such as the transport between two superconducting reservoirs with and without loss of particles, or to the transport in presence of a time dependent noise. These situations can be directly relevant for experimental situations encountered in cold atomic gases and I will present such realizations, and in particular recent experiments concerning Hall transport.

Presenter: GIAMARCHI, Thierry (University of Geneva)

Contribution ID: **55** Type: **not specified**

On the dynamics of fractional quantum Hall clouds

Thursday, June 29, 2023 2:30 PM (1 hour)

I will first present recent results on the dynamics of anyonic molecules, namely composite objects emerging from the binding of a massive impurity with a quasi-hole excitation in a fractional quantum Hall fluid. In particular, I will highlight how the angular cross section for the scattering of such polarons gives direct information on the fractional statistics in the underlying fluid. I will then present a nonlinear chiral Luttinger liquid theory of the quantum Hall edge and I will discuss basic features of its quantum dynamics in response to external perturbations. The exciting perspectives towards extending the concepts of quantum nonlinear optics to chiral excitations on the quantum Hall edge will be finally sketched.

Presenter: CARUSOTTO, Iacopo (Pitaevskii BEC Center, INO-CNR and Università di Trento)

Contribution ID: **56** Type: **not specified**

Quantum Work Statistics in Chaotic Fermion Systems

Thursday, June 29, 2023 12:00 PM (40 minutes)

We study the full distribution of quantum work in driven chaotic fermion systems by using a random matrix approach. We find that work statistics is generically non-Gaussian.
At longer times, quantum work distribution is well-described in terms of a simple ladder model and a symmetric exclusion process in energy space, and bosonization and mean field methods provide accurate analytical expressions for the work statistics.
At finite temperatures, a cross-over between diffusive and superdiffusive work statistics is found.
The probability of adiabatic evolution crosses over from an exponential to a stretched exponential behavior. Our findings can be verified by measurements on nanoscale circuits and via single qubit interferometry, and have important implications for adiabatic quantum optimization.

Presenter: ZARAND, Gergely (Budapest University of Technology and Economics)

Contribution ID: **57** Type: **not specified**

Fast rotation of a superfluid in a shell

Friday, June 30, 2023 11:00 AM (40 minutes)

Quantum gases provide us with a very convenient and widely tunable system for the study of superfluidity. In particular, they can be confined in a large variety of traps, enabling the study of superfluid dynamics with specific geometry. In this talk I will present the behaviour of a superfluid quantum gas confined at the surface of an ellipsoid: the atoms can move freely in directions parallel to the surface and are strongly confined in the transverse direction. The atoms initially at rest at the bottom of the shell -because of gravity- are set into rotation. At moderate rotation frequencies, a vortex lattice develops, and melts for large rotation speeds or low atom numbers. We explore the transition from a vortex crystal to a disordered vortex and eventually random phase fluctuations. At large rotation frequencies, the centrifugal force leads to the formation of a metastable dynamical ring which rotates with linear speeds widely exceeding the speed of sound in the gas.

Presenter: PERRIN, Hélène (LPL/CNRS/USPN)

Contribution ID: **58** Type: **not specified**

Gas of wavepackets and an ab initio derivation of generalised hydrodynamics

Thursday, June 29, 2023 11:00 AM (40 minutes)

The hydrodynamic approximation is an extremely powerful tool to describe the behaviour of many-body systems such as gases. At the Euler scale, the approximation is based on the idea of local entropy maximisation: locally, within fluid cells, the system relaxes to a state that takes the Gibbs form. In conventional gases, these are thermal states, which include the few conserved quantities admitted by the model. In integrable systems, these are the so-called generalised Gibbs ensembles, which include the infinite set of conserved quantities, and the corresponding hydrodynamic theory is called generalised hydrodynamics (GHD). GHD applies for instance to experimentally realized one-dimensional interacting Bose gases described by the Lieb-Liniger model, and many more one-dimensional integrable systems, such as classical soliton gases and the hard-rod model. However, the local entropy maximisation is an assumption, and in general it is hard to establish the hydrodynamic equations from first principles (from the microscopic dynamics of the model). The GHD equations have a very specific structure: they can be interpreted as "kinetic" equations for a phase-space density, in position-quasimomentum space. Thus suggests that there is a more kinetic way of deriving them. In this talk I will explain how to construct a gas of wavepackets in the Lieb-Liniger model, whose effective dynamics gives rise, without the assumption of local entropy maximisation, to the GHD equations. I will explain how this provides a blueprint for deriving the GHD equations from the Schroedinger equations. The main idea is a map to the scattering coordinates of the wavepackets' dynamics, and is similar in spirit to the techniques used in the known rigorous proof of the hydrodynamic equations for the hard-rod gas.

Presenter: DOYON, Benjamin (King's College London)

Contribution ID: **59** Type: **not specified**

Wigner dynamics for quantum gases under inhomogeneous gain and loss processes with dephasing

Friday, June 30, 2023 12:00 PM (40 minutes)

We present a Wigner function-based approach for the particle density evolution in fermionic and bosonic open quantum many-body systems, including the effects of dephasing. In particular, we focus on chains of noninteracting particles coupled to Lindblad baths. The dissipative processes, described by linear and quadratic jump operators, are modulated by inhomogeneous couplings. Following a semiclassical approach, we find the differential equation governing the Wigner function evolution, which can be solved in closed form in some particular cases. We check the accuracy of the Wigner approach in different scenarios (ie, Gaussian jump rates), describing the density evolution and the transport phenomena in terms of classical quasiparticles.
M Coppola, GT Landi, D Karevski
Physical Review A 107 (5), 052213

Presenter: Mr KAREVSKI, Dragi (univ-lorraine)

Contribution ID: **60** Type: **not specified**

Implementation of protocols for measuring the rapidities distribution of a 1D Bose gas

Tuesday, June 27, 2023 10:30 AM (20 minutes)

After relaxation, an integrable quantum system, in particular a one-dimensional gas of bosons, is characterized by the rapidities distribution, a quantity preserved throughout the dynamics. The rapidities distribution is nothing else than the asymptotic momentum distribution of particles after a one-dimensional expansion of the system. This definition is directly linked to an experimental procedure allowing to access this quantity. It is also possible to realize a bi-partite protocol: the rapidities distribution is then deduced by studying the deformation of the edge of a half-infinite cloud thanks to Generalized HydroDynamics, an emerging hydrodynamic theory applicable to quantum integrable systems. In our experiment, 87ˆRb atoms are trapped by an atom chip to reach the one-dimensional regime. A spatial selection tool has been integrated allowing to realize one-dimensional expansions of homogeneous clouds as well as to implement the bi-partite protocol. We will present the first measurements of rapidities distribution on our system using the two protocols described above.

Presenter: DUBOIS, Lea

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **61** Type: **not specified**

One-particle density matrix of the out-of-equilibrium Tonks-Girardeau gas: exact results from Quantum Generalized Hydrodynamics

Tuesday, June 27, 2023 10:50 AM (20 minutes)

Understanding the non-equilibrium dynamics of many-body quantum systems is a notoriously hard task due to the exponential increase of the Hilbert space dimension with the number of the system's components. This prevented, for a long time, a direct comparison between theory and the available experimental measures with ultracold atoms and ions. In recent years, the advent of Generalized Hydrodynamics enabled significant steps forward, allowing quantitative predictions for some transport properties (e.g. density and current profiles during the dynamics) of experimentally-feasible quantum setups. But despite its great predictive power, Generalized Hydrodynamics (like any hydrodynamic theory) does not capture important quantum effects, such as equal-time correlations among different points and zero-temperature entanglement. A way to account for these missing quantum effects is established by the so-called Quantum Generalized Hydrodynamics, where an effective field theory description of the leading quantum fluctuations is incorporated over the evolving background set by Generalized Hydrodynamics. In this talk, I will present some progresses in the calculation of the out-of-equilibrium one-particle density matrix enabled by the framework of Quantum Generalized Hydrodynamics and comment on their experimental relevance. The focus will be mainly on the 1D Bose gas in the limit of strong repulsion (or Tonks-Girardeau limit).

Presenter: SCOPA, Stefano

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **62** Type: **not specified**

Spin Transport in Perturbed Quantum Integrable Chains

Tuesday, June 27, 2023 2:50 PM (20 minutes)

In the context of quantum transport, the XXZ (or anisotropic Heisenberg) chain is a paradigmatic many-body model, featuring a wide spectrum of spin transport behaviour at finite temperature. Although the unperturbed model is analytically solvable, understanding the effects of even weak integrability-breaking perturbations (IBP) remains an open problem. The primary aim of this talk is to highlight the effects of IBP on the spin transport i) in the easy-axis regime and ii) at the isotropic point of the XXZ chain. In particular, I will show that the anomalous (dissipationless) spin diffusion of the integrable easy-axis XXZ chain is replaced by a normal spin diffusion upon the addition of perturbation. Such a fundamental change in the nature of diffusion is reflected via discontinuous variation of the dc diffusion constant as a function of the perturbation. Next, the impact of the symmetry of IBP on the spin superdiffusion at the isotropic point of the integrable XXZ chain will be addressed. In this context, our study unveils several remarkable properties: i) the effects of IBP preserving spin isotropy being qualitatively different from anisotropic IBP, ii) isotropic IBP leads to a pronounced maximum of the diffusion constant at the isotropic point as the function of spin anisotropy, and iii) robustness of superdiffusion on finite systems even at appreciable perturbation strengths.

Presenter: NANDY, Sourav

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **63** Type: **not specified**

TBA

Tuesday, June 27, 2023 3:20 PM (20 minutes)

Presenter: FOINI, Laura (CNRS)

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **64** Type: **not specified**

Hidden strong symmetries and quasi-local charges in a local Lindblad system

Tuesday, June 27, 2023 12:40 PM (20 minutes)

We consider an open spin chain with external driving in the bulk, described by the Lindblad equation. We show that in certain cases the system can have hidden strong symmetries, in the form of quasi-local operators. These lead to conserved charges, and the existence of multiple NESS: The system will keep memory of the initial state, even though the obvious symmetries of the Hamiltonian are broken.

Presenter: POZSGAY, Balázs

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **65** Type: **not specified**

Emergent hydrodynamics and Pauli blocking in quasi-1D Bose gases

Tuesday, June 27, 2023 11:10 AM (20 minutes)

Confining atoms to a single line (1D) results in a system, whose elementary excitations are quasi-particles with properties that may differ significantly from the atoms; in a Bose gas, correlation effects due to interactions in 1D prevent two quasi-particle excitations from occupying the same quantum state. This imposed Pauli exclusion leads to effective fermionization of the quantum Bose gas in 1D, even for weak interatomic repulsion.

In our experiment, we study the dynamics of a Bose gas of weakly interacting rubidium atoms under tight transverse confinement on an Atom Chip. We probe a regime far beyond conventional limits of 1D, where excitations in the transverse confining potential are energetically possible. However, even deep in this regime, we observe dynamics in agreement with purely 1D physics. Our observations represent a manifestation of the emergent Pauli blocking of excitations, resulting in the gas remaining effectively 1D.

Presenter: MOLLER, Frederik Skovbo (TU Wien)

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **66** Type: **not specified**

TBA

Presenter: FAGOTTI, Maurizio (LPTMS)

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **67** Type: **not specified**

Anomalous fluctuations

Tuesday, June 27, 2023 2:30 PM (20 minutes)

I will discuss several examples of non-ergodic dynamical systems with anomalous charge fluctuations.

Presenter: ILIEVSKI, Enej (University of Ljubljana)

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **68** Type: **not specified**

Long-range correlations from Euler hydrodynamics

Tuesday, June 27, 2023 3:40 PM (20 minutes)

Long-range correlations have been known to exist in various situations in many-body systems. In this talk, I will show that novel hydrodynamic long-range correlations can occur in many-body systems that support ballistic transport. To describe these correlations quantitatively, I will also introduce a ballistic version of macroscopic fluctuation theory (MFT), which we call ballistic MFT (BMFT).

Presenter: YOSHIMURA, Takato

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **69** Type: **not specified**

Dynamics of charge fluctuations and symmetry-resolved entanglement

Tuesday, June 27, 2023 12:20 PM (20 minutes)

Due to its probabilistic nature, a measurement process produces a distribution of possible outcomes. This distribution —or its Fourier transform known as full counting statistics (FCS) — contains much more information than say the mean value of the measured ob- servable and accessing it is sometimes the only way to obtain relevant information about the system.
In fact, the FCS is the limit of an even more general family of observables —the charged moments —that characterise how quantum entanglement is split in different symmetry sectors in the presence of a global symmetry. In the talk I will consider the evolution of the FCS and of the charged moments of a U (1) charge truncated to a finite region after a global quantum quench. For large scales these quantities take a simple large-deviation form, showing two different regimes as functions of time: while for times much larger than the size of the region they approach a stationary value set by the local equilibrium state, for times shorter than region size they show a non-trivial dependence on time. I will show that the leading order in time of FCS and charged moments in the out-of-equilibrium regime can be determined by means of a space-time duality. Namely, it coincides with the stationary value in the system where the roles of time and space are exchanged. This observation can be used to find some general properties of FCS and charged moments out-of-equilibrium, and to derive an exact expression for these quantities in interacting integrable models.

Presenter: Dr KLOBAS, Katja (University of Nottingham)

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **70** Type: **not specified**

Dynamics of scrambling of information, from shock waves to Fisher-KPP

Quenched disorder slows down the scrambling of quantum information. I will explain how conventional tools of quantum transport theory can be adapted to derive an effective field theory of scrambling. Specifically, I'll focus on realistic metals with both inelastic and elastic scattering, due to interaction and disorder. I will demonstrate that disorder drives a phase transition in the scrambling dynamics, from shock-wave dynamics to dynamics belonging to the Fisher-KPP class. More generally, this approach can be used to gain insight into the mysterious relationship between transport properties and chaos.

Presenter: ARON, Camille

Session Classification: Conference: Transport, Generalised Hydrodynamics and open systems

Contribution ID: **71** Type: **not specified**

Nonlinear sigma model description of monitored Majorana dynamics

Friday, June 23, 2023 3:40 PM (30 minutes)

Presenter: FAVA, Michele (Philippe Meyer Institute, Ecole Normale Superieure (ENS))

Session Classification: Quantum trajectories and monitoring in Gaussian models

Contribution ID: **72** Type: **not specified**

Elusive phase transition in the replica limit of monitored systems

Tuesday, June 20, 2023 10:50 AM (20 minutes)

We study an exactly solvable model of monitored dynamics in a system of N spin $1/2$ particles with pairwise all-to-all noisy interactions, where each spin is constantly perturbed by weak measurements of the spin component in a random direction. We make use of the replica trick to account for the Born's rule weighting of the measurement outcomes in the study of purification and other observables, with an exact description in the large-N limit. We find that the nature of the phase transition strongly depends on the number n of replicas used in the calculation, with the appearance of non-perturbative logarithmic corrections that destroy the disentangled/purifying phase in the relevant $n \to 1$ replica limit. Specifically, we observe that the purification time of a mixed state in the weak measurement phase is always exponentially long in the system size for arbitrary strong measurement rates.

Presenter: GIACHETTI, Guido (CY Cergy Paris Université)

Session Classification: Quantum Trajectories and Measurement Induced Phase Transitions

Contribution ID: **73** Type: **not specified**

Designs by Free Probability: an ETH inspired approach

Thursday, June 22, 2023 3:15 PM (30 minutes)

Presenter: PAPPALARDI, Silvia (Ècole Normale Superièure, Paris)

Session Classification: Eigenstate thermalisation and k-designs

Contribution ID: **74** Type: **not specified**

Projective measurements in highly energetic but slightly entangled excited States

Wednesday, June 28, 2023 12:00 PM (30 minutes)

Presenter: FAGOTTI, Maurizio (LPTMS)

Contribution ID: **75** Type: **not specified**

Dynamics of scrambling of information, from shock waves to Fisher-KPP

Wednesday, June 28, 2023 12:30 PM (30 minutes)

Presenter: ARON, Camille

Contribution ID: **76** Type: **not specified**

KPZ

Wednesday, June 28, 2023 4:30 PM (20 minutes)