Q-Open Kick-off Workshop

COST Action CA24109

Conference Booklet

Lisbon, 27 April - 1 May 2026

COST Action CA24109 – QOpen
European Cooperation in Science and Technology

Funded by
the European Union

https://qopen.eu/
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Contents

1 Workshop Information

The Action Kick-off will mark the formal launch of QOpen (COST Action CA24109) and the beginning of its four-year collaborative programme. The meeting will bring together representatives from participating countries to establish the Management Committee, confirm the Working Group structure, and define priorities for the first year of activities.

The agenda will include presentations outlining the scientific vision of the Action, discussions on coordination mechanisms, Short-Term Scientific Missions (STSMs), training schools, and upcoming workshops. Dedicated sessions will also focus on inclusiveness, industry engagement, and communication strategies to ensure strong visibility and impact from the outset.

This inaugural meeting will set the strategic and operational foundations of the network, fostering early collaboration and alignment across all Working Groups.

Webpage

https://qopen.eu/events/action-kick-off-1st-mc-meeting/

Venue

Tecnico Innovation Center

Av. Duque de Avila 417, 1000-135 Lisboa

Venue map

COST Acknowledgement

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Organization

Role	Name
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Action Vice-Chair	Zala Lenarcic
Science Communication Coordinator	Federico Roccati
WG1 Leader	Katja Klobas
Vice-Leader WG1	Alberto Biella
WG2 Leader	Andrea De Luca
Vice-Leader WG2	Lucas Sá
WG3 Leader	Sergiy Denysov
Vice-Leader WG3	Nadir Samos Saenz De Buruaga
WG4 Leader	Brendon Lovett
Vice-Leader WG4	Alexander Schnell
Event Planning & Training - Coordinator	Masudul Haque
Event Planning & Training - Co-Coordinator	Ivana Vasic
Grant Awarding Coordinator	Paul McClarty
STSM Committee - Co-Coordinator	Jens Paaske
Inclusivity & Sustainability - Coordinator	Tony John George Apollaro

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3 Speakers

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Speaker	Institution	Day
Alessandro Romito	Lancaster University	Monday 27 Apr
Nicola Lorenzoni	Ulm University	Monday 27 Apr
Mauro Paternostro	Quantum Theory group, Department of Physics and Chemistry E. Segrè, University of Palermo	Monday 27 Apr
Gaia Stella Bolognini	École polytechnique fédérale de Lausanne (EPFL)	Monday 27 Apr
Pascu Catalin Moca	University of Oradea	Monday 27 Apr
Pietro Brighi	University of Vienna	Monday 27 Apr
Achilleas Lazarides	Loughborough University	Tuesday 28 Apr
Peter Kirton	University of Strathclyde	Tuesday 28 Apr
Dariusz Chruscinski	Nicolaus Copernicus University	Tuesday 28 Apr
Adi Pick	Hebrew University	Tuesday 28 Apr
Marton Kormos	Budapest University of Technology and Economics	Tuesday 28 Apr
Vincenzo Alba	University of Pisa	Tuesday 28 Apr
Andrew Mitchell	University College Dublin	Wednesday 29 Apr
Martijn Wubs	Technical University of Denmark	Wednesday 29 Apr
Kimmo Luoma	University of Turku	Wednesday 29 Apr
Khrystyna Gnatenko	Ivan Franko National University of Lviv, SoftServe Inc.	Wednesday 29 Apr
Ahsan Nazir	University of Manchester	Wednesday 29 Apr
Michele Coppola	Jožef Stefan Institute	Wednesday 29 Apr
André Eckardt	TU Berlin	Thursday 30 Apr
Anthony Kiely	University College Cork	Thursday 30 Apr
Irene D'Amico	University of York	Thursday 30 Apr
Lucas Sá	U. Cambridge	Thursday 30 Apr
Jakub Zakrzewski	Jagiellonian University	Thursday 30 Apr
Sebastian Diehl	University of Cologne	Thursday 30 Apr
Jonathan Keeling	University of St Andrews	Friday 1 May
Valentin Link	TU Berlin	Friday 1 May
Christiane Koch	Freie Universität Berlin	Friday 1 May
Oliver Lunt	University of Oxford	Friday 1 May
Grazia di Bello	University of Naples Federico II	Friday 1 May
Moritz Cygorek	Technische Universitat Dortmund	Friday 1 May
Ege Gorgun	FSU Jena	Friday 1 May

4 Poster List

1. **Mariana Gil Guerra de Almeida Abreu**: *Relevance of Electronic Interactions at Quasiperiodicity-Driven Localization Transitions*
2. **João Manuel Alendouro Oliveira Pinho**: *Applications of Smooth Absorving Potentials on Mesoscopic Transport*
3. **Gabriel Almeida**: *Dissipation- vs chaos-induced relaxation in non-Markovian quantum many-body systems*
4. **Antonio Ruiz Molero**: *Neural-assisted time-dependent Lindblad tomography*
5. **Tony John George Apollaro**: *Precision is not limited by the second law of thermodynamics*
6. **Riya Baruah**: *TBA*
7. **Fainberg Boris**: *Stability of superradiant state and fundamental soliton under exciton-phonon interactions in open quantum systems: application to quasi-2D hybrid perovskites*
8. **Eoin O'Connor**: *TBA*
9. **Conor Sexton**: *Optimised quantum feedback control protocols: Advantages and limitations*
10. **Dara Murphy**: *Ergotropy transport in a one dimensional spin chain*
11. **Doru Sticlet**: *Nonstabilizerness in open XXZ spin chains*
12. **Gianluca Frazzei**: *Bistability in the dissipative far-east model*
13. **Ivana Vasic**: *Bosonic Dynamics in Optical Lattices: Effects of Driving and Dissipation*
14. **Veljko Jankovic**: *Self-Consistent Method for Studying Excitation Energy Transfer in Multichromophoric Systems*
15. **Tiago Jorge**: *Out-of-Equilibrium Criticality and Order Parameter Dynamics in a Driven Magnetic Quantum Dot*
16. **Marco Pezzutto**: *Non-Markovian Memory-Mediated Collision Models for Open Quantum Dynamics*
17. **Martin Žonda**: *Individual Assembly of Radical Molecules on Superconductors*
18. **Mrinmoyee Saha**: *Negative Currents and Heat Pulses in Electron Quantum Optics*
19. **Vram Mughnetsyan**: *Spin configuration of an array of quantum rings controlled by cavity photons*

5 Talks

5.1 WG1 - Monday 27 Apr

09:30 - 10:30 - Alessandro Romito

Title: *Open Quantum Systems Beyond Average Dynamics: Measurement-Induced Phase Transitions from Quantum Trajectory Ensembles to Most-Likely Dynamics*

Institution: Lancaster University

Abstract:

Monitored quantum systems are open quantum systems whose average dynamics is governed by Lindblad master equations. Beyond the average, when measurement outcomes are retained, individual quantum trajectories reveal a far richer picture: local measurements alter many-body unitary dynamics by freezing local degrees of freedom, giving rise to new stationary states and measurement-induced phase transitions (MiPTs). While measurement-induced dynamics is inherently stochastic, post-selecting specific detector readouts to isolate individual quantum trajectories yields deterministic dynamics with distinct phase transition characteristics - raising the question of how individual trajectories relate to the collective statistical behaviour of the ensemble.

In this talk, I address this question by contrasting the dynamics of individual post-selected trajectories with that of the full ensemble. I introduce a novel partially post-selected stochastic Schrödinger equation that interpolates between single trajectories and ensemble-averaged dynamics, and exploit it to define and identify the most likely trajectory. I demonstrate this framework on paradigmatic systems of Gaussian fermions and bosons, showing that the most-likely dynamics captures key qualitative features of the full ensemble. I further apply the formalism to interacting bosons in the Sine-Gordon model, where the most-likely trajectory approach accesses the dynamics through a self-consistent harmonic approximation and reveals an entanglement phase transition from area-law to logarithmic-law scaling.

These results establish a powerful and broadly applicable framework for studying MiPTs in monitored quantum systems through deterministic nonlinear equations, bridging the gap between individual quantum trajectories and ensemble dynamics.

[1] Chun Y. Leung, Dganit Meidan and Alessandro Romito, Phys. Rev. X 15, 021020 (2025)

[2] Anna Delmonte, Zejian Li, Rosario Fazio and Alessandro Romito, SciPost Phys. 20, 109 (2026)

11:00 - 11:30 - Nicola Lorenzoni

Title: *Non-perturbative simulations of open quantum systems in presence of highly structured environments.*

Institution: Ulm University

Abstract:

Accurately simulating open quantum systems coupled to highly structured environments beyond the perturbative regime requires efficient methods capable of capturing memory effects. Such situations arise broadly in multipartite systems coupled to harmonic environments, as commonly encountered in the study of electronic dynamics in molecular systems, including excitation and charge-energy transfer processes, as well as in polaritonic systems, where emitter-photon coupling spectra can be highly structured. On the one hand, pseudomode theory identifies an effective finite environment composed of dissipative oscillators that can nevertheless reproduce, with arbitrarily high accuracy, the influence of the full environment on the system dynamics. On the other hand, tensor network representations are capable of encoding hundreds of pseudomodes efficiently. In this talk, we show how combining these two approaches, leading to the dissipation-assisted matrix product factorisation method (DAMPF), can makes such complex open-system scenarios tractable. As an example, we present the first non-perturbative simulations of electronic dynamics in pigment-protein complexes based on a full microscopic model.

11:30 - 12:30 - Mauro Paternostro

Title: *Quantum neuromorphic approaches to the characterisation and control of quantum systems*

Institution: Quantum Theory group, Department of Physics and Chemistry E. Segrè, University of Palermo

Abstract:

I will illustrate how neuromorphic approaches based on the use of uncontrolled reservoirs could help enhancing our ability to validate quantum processes and states, thus characterising delicate features such as the entanglement between quantum systems in an resource-economic manner, and provide key information on quantum open system dynamics. I will show how the theoretical framework presented in this talk has been applied, quite successfully, to photonics-based quantum computers.

14:00 - 14:30 - Gaia Stella Bolognini

Title: *Density-Wave Ordering in Strongly Interacting Fermi Gases*

Institution: École polytechnique fédérale de Lausanne (EPFL)

Abstract:

Analog quantum simulations with ultracold atoms provide a powerful platform to investigate many-body systems in controllable settings. In our experiment, an atomic ensemble is strongly coupled to a high-finesse optical resonator, whose photons mediate effective long-range interactions. Photon leakage and external driving render the system driven-dissipative, and above a critical interaction strength, the non-equilibrium steady state undergoes a phase transition into a density-wave ordered state - marked by superradiant buildup of the cavity field and atomic self-organisation. We explore this transition in a degenerate two-component Fermi gas with tunable short-range interactions, extending previous studies beyond the bosonic regime.

Using high-resolution microscopy, we report the first real-space observation of the periodic density modulation characterizing the ordered state. Single-shot simultaneous recording of the intracavity field and atomic density reveals correlations between the macroscopic order parameter and its microscopic spatial structure. Strikingly, we observe large correlated fluctuations of the order parameters, pointing to a beyond-mean-field nature of the density matrix of the hybrid system. Additionally, the micrometer-scale resolution grants access to high-frequency spatial correlations in the gas density, providing insight into the system's response function across the phase transition. This rich set of probes opens the way to investigating how cavity-mediated long-range interactions reshape the many-body state of the paired Fermi gas.

14:30 - 15:00 - Pascu Catalin Moca

Title: *Two-parameter Family-Vicsek scaling in a dissipative XXZ spin chain*

Institution: University of Oradea

Abstract:

Family-Vicsek (FV) scaling provides an understanding for the growth and finite-size saturation of fluctuations in classical systems. Here, we extend the FV roughness to transferred segment magnetization after quantum quenches in a dissipative XXZ spin chain with homogeneous gain and loss, starting from a nonequilibrium steady state with finite magnetization. In the non-interacting limit, we derive a closed-form expression for the roughness in the presence of dissipation. It displays two-parameter FV scaling and smoothly interpolates between the clean ballistic behavior and the dissipation-dominated scalings. For interacting chains, tensor-network simulations show that the non-dissipative ballistic growth at finite magnetization is robust, whereas the full Lindblad evolution is generically controlled by the dissipative relaxation time and exhibits a dissipation-dominated collapse.

15:00 - 15:30 - Pietro Brighi

Title: *Dynamics and phase transitions in non-reciprocal and kinetically constrained open quantum many-body systems*

Institution: University of Vienna

Abstract:

In recent years, the great progress of quantum simulation platforms has boosted the study of non-equilibrium dynamics and phases of matter. Open quantum many-body systems provide a particularly intriguing setting, where coherent and dissipative processes conspire to generate non-trivial phenomena. In this talk, I will present recent results where the combination of interactions, kinetic constraints and dissipation provides an exciting playground for the study of non-equilibrium dynamics. I will first focus on non-reciprocal systems, where the system-environment coupling results in directional motion, and show how its interplay with interactions can be used to distinguish different types of excitations, and how it can generate novel non-equilibrium phases of matter. In the second part of the talk I will introduce dissipative kinetically constrained models as a platform for the study of anomalous dynamics and genuinely quantum novel phases.

5.2 WG2 - Tuesday 28 Apr

09:00 - 10:00 - Achilleas Lazarides

Title: *TBA*

Institution: Loughborough University

Abstract:

TBA

10:00 - 10:30 - Peter Kirton

Title: *PT Symmetry Breaking in Open Quantum Systems*

Institution: University of Strathclyde

Abstract:

Parity-time symmetry breaking in coupled systems with balanced gain and loss has recently attracted considerable attention and has been demonstrated in various photonic, electrical and mechanical systems in the classical regime. In this talk I will show how these ideas can be generalised to microscopic models [1] based around master equation descriptions. The symmetries required by these equations can be realised in a variety of models which can be engineered to show novel phenomena including non-equilibrium phase transitions. Models I will describe include lattices with alternately driven and dissipative sites [2] and coupled non-linear spins [3].

[1] J. Huber, P. Kirton, S. Rotter, P. Rabl, SciPost Phys, 9, 052 (2020)

[2] J. Huber, P. Kirton, P. Rabl, Phys. Rev A, 102, 012219 (2020)

[3] S. Kothe, P. Kirton arXiv:2504.18426 (2025)

11:00 - 12:00 - Dariusz Chruscinski

Title: *Spectral properties of random Markov generators: classical vs quantum*

Institution: Nicolaus Copernicus University

Abstract:

The spectral properties of operators generating Markov evolution provide essential information about the corresponding classical and quantum processes they induce. After appropriate rescaling, the spectra of Markov generators are confined to the unit disk within the left half of the complex plane. I present the fundamental properties of random Markov generators and evaluate their universal spectral features, including the eigenvalue distribution in the complex plane. These results are derived using methods of free probability and explained via non-Hermitian random matrix models.

12:00 - 12:30 - Adi Pick

Title: *Scalable Adiabatic Quantum Algorithms for MIS*

Institution: Hebrew University

Abstract:

Recent advances in neutral-atom quantum computers enable scaling their computation power toward solving large combinatorial optimization problems (COPs) [1,2]. Hybrid algorithms, combining classical and quantum computing, offer a promising path forward. This talk presents two hybrid adiabatic quantum computation (AQC) approaches for solving prototypical COP - finding the Maximum Independent Set (MIS) of a graph - on neutral-atom quantum annealers, potentially extending the reach to problem sizes beyond current capabilities. Our first algorithm utilizes mathematical graph properties to inflate the spectral gap of the Hamiltonian, which limits the complexity of traditional AQC. Even though finding the MIS of a graph requires, in principle, checking independent sets across the entire graph, we show that information regarding the local density of edges can be used to engineer the controls and accelerate the convergence towards the desired solution state. Secondly, we present a pulse optimization method for accelerating adiabatic control protocols [3]. Our method finds control pulses that keep the quantum system in its instantaneous ground state during the evolution. It is efficient, using gradient-free optimization, and robust, using analytic adiabatic solutions in the optimization cost function. To validate our results, we perform digitized adiabatic protocols on IBM's quantum cloud and run numerical simulations of Rydberg atom arrays. References:

[1] S. Ebadi, A. Keesling, et al., Science, 376(6598):1209 - 1215 (2022).

[2] K. Kim, M. Kim, et al., Scientific Data, 11(1):111 (2024).

[3] D. Turyansky, Y. Zolti, Y. Cohen, and A. Pick., Phys. Rev. Research 8, 013206 (2026)

14:00 - 15:00 - Marton Kormos

Title: *Observing quantum criticality at finite temperature through nonanalytic correlation times*

Institution: Budapest University of Technology and Economics

Abstract:

I will report recent results on the finite temperature dynamical correlation functions of the magnetization operator in the quantum Ising spin chain. First I will present our findings in the Ising quantum field theory describing the scaling limit of the spin chain. We derived a new closed form expression for the correlation length for space-like separations that has some unusual properties: it is a non-analytic function of both the space-time direction and the temperature, and its temperature dependence is non-monotonic. I will then turn to the spin chain, where using methods based on hydrodynamic fluctuations I will show that the correlation length of the order parameter shows similar non-analytic behavior as the magnetic field, space-time direction, and temperature are varied. As a function of the magnetic field, the non-analyticity occurs at a value that continuously approach that of the zero-temperature quantum critical point as the velocity is decreased and reach it within the light cone, where we obtain a new, temperature-independent logarithmic divergence characterizing the collective dynamics. Thus, collective effects induced by quantum fluctuations persist in the dynamics of local observables even at finite temperature.

https://arxiv.org/abs/2406.05100, SciPost Phys. 17, 162 (2024)

https://arxiv.org/abs/2602.00794

15:00 - 15:30 - Vincenzo Alba

Title: *ν-QSSEP: A toy model for entanglement spreading in diffusive systems*

Institution: University of Pisa

Abstract:

I will discuss the out-of-equilibrium entanglement dynamics in a generalization of the so-called QSSEP model, which is a free-fermion chain with stochastic in space and time hopping amplitudes. In our setup, the noisy amplitudes are spatially-modulated satisfying a ν-site translation invariance but retaining their randomness in time. For each noise realization, the dynamics preserves Gaussianity, which allows to obtain noise-averaged entanglement-related quantities. The statistics of the steady-state correlators satisfy nontrivial relationships that are of topological nature. They reflect the Haar invariance under multiplication with structured momentum-dependent random SU(ν) matrices. I will discuss in detail the case with ν=1 and ν=2. For ν=1, i.e., spatially homogeneous noise we show that the entanglement dynamics is describable by a stochastic generalization of the quasiparticle picture. Precisely, entanglement is propagated by pairs of quasiparticles. The entanglement content of the pairs is the same as for the deterministic chain. However, the trajectories of the quasiparticles are random walks, giving rise to diffusive entanglement growth.

5.3 Cross-WP - Wednesday 29 Apr

09:00 - 09:30 - Andrew Mitchell

Title: *Quantum impurities as strongly-coupled non-Markovian open systems*

Institution: University College Dublin

Abstract:

'Quantum impurity models' treat system and environment explicitly as one giant quantum system, thereby allowing the strong-coupling regime to be explored rigorously. When the environment is non-interacting, emergent system-bath correlations and strong non-Markovian effects can be accounted for exactly, even in the thermodynamic limit. Such a treatment is essential to describe boundary-critical phenomena arising due to frustrated system-environment interactions. Here we consider the dissipated work in such a setup for a sudden system quench, as well as the full work distribution due to finite-time external driving.

[1] Phys. Rev. Lett. 135, 130402 (2025)

09:30 - 10:00 - Martijn Wubs

Title: *TBA*

Institution: Technical University of Denmark

Abstract:

TBA

10:00 - 10:30 - Kimmo Luoma

Title: *Open Quantum System Dynamics and Strong-Light Matter Interaction*

Institution: University of Turku

Abstract:

In this talk I will give an overview of the research of my group on open quantum system dynamics and strong light matter interaction. I will introduce the non-Markovian Quantum State Diffusion (NMQSD) approach which we use to describe the dynamics of the open system. I will focus on organic microcavity

polariton systems and present how NMQSD can be used to compute absorption and emission spectrum. I will present an outlook on how the approach can be extended to transient absorbtion spectroscopy.

11:00 - 11:30 - Khrystyna Gnatenko

Title: *Entanglement of Multi-Qubit Quantum Graph States and Quantifying Graph Properties Using Quantum Programming*

Institution: Ivan Franko National University of Lviv, SoftServe Inc.

Abstract:

Quantum graph states have recently attracted significant attention due to their important role in quantum information science and quantum computing. These states form a class of multi-qubit systems that can be described using graph representations.

We study multi-qubit quantum states associated with bipartite [1] and tripartite graphs, as well as weighted and directed graphs [2,3]. For a general quantum state corresponding to graphs of arbitrary structure, we derive an analytical expression for the entanglement distance. We demonstrate that the entanglement of a qubit with other qubits in a graph state is directly related to the degrees of the graph vertices. We also compute quantum correlators for graphs with arbitrary topology and show that they depend on the structural properties of the graphs. In particular, we identify how quantum correlators relate to the number of vertices with odd and even degrees in bipartite graphs [1]. Additionally, quantum algorithms for detecting closed cycles in tripartite graphs are proposed. A relationship between the geometrical properties of quantum graph states representing weighted graphs and the weights of edges forming closed cycles is established [3]. The obtained results provide a foundation for developing quantum algorithms for studying graph properties on quantum devices and open the possibility of achieving quantum supremacy in such tasks. In particular cases of quantum graph states, their entanglement and graph properties are calculated on IBM's quantum devices as well as on the AerSimulator [1 - 3].

[1] Kh, P. Gnatenko, Phys. Lett. A 566, 131191 [7 p.] (2026).

[2] Kh. P. Gnatenko, Eur. Phys. J. Plus 140(3), 241 [7 p.] (2025).

[3] Kh, P. Gnatenko Phys. Lett. A 521, 129815 [5 p.] (2024).

11:30 - 12:00 - Ahsan Nazir

Title: *Numerically exact open quantum system work statistics with process tensors*

Institution: University of Manchester

Abstract:

Accurately quantifying the thermodynamic work costs of quantum operations is essential for the continued development and optimisation of emerging quantum technologies. This present a significant challenge in regimes of rapid control within complex, non-equilibrium environments - conditions under which many contemporary quantum devices operate and conventional approximations break down. Here, we introduce a process tensor framework that enables the computation of the full numerically exact quantum work statistics of driven open quantum systems. We demonstrate the utility of our approach by applying it to a Landauer erasure protocol operating beyond the weak-coupling, Markovian, and slow-driving limits. The resulting work probability distributions reveal distinct quantum signatures that are missed by low-order moments yet significantly impact the erasure fidelity of the protocol. Our framework delivers non-perturbative accuracy and detail in characterising energy-exchange fluctuations in driven open quantum systems, establishing a powerful and versatile tool for exploring thermodynamics and control in the operating regimes of both near-term and future quantum devices.

12:00 - 12:30 - Michele Coppola

Title: *Learning the non-Markovian features of subsystem dynamics*

Institution: Jožef Stefan Institute

Abstract:

The dynamics of local observables in a quantum many-body system can be formally described in the language of open systems. The problem is that the bath representing the complement of the local subsystem generally does not allow the common simplifications often crucial for such a framework. Leveraging tensor network calculations and optimization tools from machine learning, we extract and characterize the dynamical maps for single-and two-site subsystems embedded in an infinite quantum Ising chain after a global quench. We consider three paradigmatic regimes: integrable critical, integrable non-critical, and chaotic. For each we find the optimal time-local representation of the subsystem dynamics at different times. We explore the properties of the learned time-dependent Liouvillians and whether they can be used to forecast the long-time dynamics of local observables beyond the times accessible through direct quantum many-body numerical simulation. Our procedure naturally suggests a novel measure of non-Markovianity based on the distance between the quasi-exact dynamical map and the closest CP-divisible form and reveals that criticality leads to the closest Markovian representation at large times.

5.4 WG3 - Thursday 30 Apr

09:00 - 10:00 - André Eckardt

Title: *Floquet engineering of open systems*

Institution: TU Berlin

Abstract:

In recent years, we have seen tremendous progress in the control of quantum systems by means of time-periodic driving. This includes the realization of effective time-independent Hamiltonians with interesting properties, such as artificial magnetic fields coupling to the motion of charge neutral particles in quantum simulators (such as ultracold atoms in optical lattice and photons in superconducting circuits or optical wave guides). Also phenomena without equilibrium counterpart, like chiral edge modes connecting Bloch bands with zero Chern number, have been discovered. Another paradigm of controlling quantum systems is reservoir engineering. Here a system is coupled to a controlled environment that is designed to either cool the system or to stabilize a non-equilibrium steady state of interest. In my presentation, I will introduce open Floquet systems and present recent results about how to combine Floquet and reservoir engineering for the preparation and stabilization of interesting states of matter (or light).

I will start with an introduction to isolated Floquet systems, Floquet engineering and Floquet heating. The latter necessarily occurs in generic driven many-body systems and spoils Floquet engineering. I will then describe the interplay of periodic driving and dissipation in open Floquet systems. For that purpose, first simple systems given by driven ideal gases shall be considered. Here I will first report on how to use engineered baths for the preparation of both equilibrium-like fermionic topological insulators and non-equilibrium Bose condensates at high environment temperatures. Finally, I will present recent results on how to prepare and stabilize gapped ground states of effective Hamiltonians in interacting systems, such as bosonic Mott insulators and topologically ordered fractional Chern insulators. Here the suppression of Floquet heating requires a theoretical description beyond ultraweak system-bath coupling.

10:00 - 10:30 - Anthony Kiely

Title: *Extracting filtered signal statistics of continuously measured quantum systems*

Institution: University College Cork

Abstract:

The joint state of a continuously monitored quantum system and the classical filtered measurement record has recently been shown to be described by a quantum Fokker-Planck master equation [Phys. Rev. Lett. 129, 050401 (2022)]. We present a deterministic approach to compute the steady state of the system and detector. The method is shown to become particularly efficient in the absence of feedback, which we exploit to develop a perturbative approach valid for weak feedback. We show that through this

method we can extract the full counting statistics of the signal, the quantum-classical mutual information between the system and signal, and the Fisher information of the signal, which can be used for sensing applications. Our results are illustrated with both single-qubit models and the spin chains governed by the one-dimensional transverse field Ising model or the Lipkin-Meshkov-Glick model.

11:00 - 12:00 - Irene D'Amico

Title: *Bridging thermal density functional theory and nonequilibrium work statistics*

Institution: University of York

Abstract:

We present a fully microscopic framework for evaluating full quantum work statistics in inhomogeneous many-body systems driven out of equilibrium[1]. The approach combines generalized linear-response theory for quantum work distributions[2] with linear-response thermal time-dependent density functional theory[3], providing first-principles access to the relaxation function governing all cumulants of the dissipated-work distribution in linear response. The relaxation function is expressed via finite-temperature density-density response functions and decomposed into adiabatic and nonadiabatic contributions. This enables separating irreversibility due to spectral deformations of the instantaneous Hamiltonian from genuine dissipative dynamics associated with nonadiabatic transitions. The adiabatic component contributes only to the first two moments of the work distribution, while all higher cumulants arise from nonadiabatic processes, consistent with Gaussian statistics in the slow-driving limit. The formalism is implemented in the Kohn-Sham representation of thermal density functional theory and closed using the thermal adiabatic local-density approximation (thALDA). Despite its local and memory-free character, thALDA captures the dominant many-body contributions and yields quantitatively accurate results in the linear-response regime, as confirmed by benchmarking. As an application, we study the nonequilibrium quantum thermodynamics of the 1D Hubbard model under a staggered potential. By computing the first three cumulants of the dissipated-work distribution for finite-temperature finite-time driving protocols, we identify distinct thermodynamic signatures of its rich phase diagram[4]. This framework provides a transferable and scalable route to describe nonequilibrium quantum thermodynamics in correlated systems, offering a platform for quantitative investigation of irreversible processes in complex quantum materials and ultracold atomic systems.

[1] Antonio Palamara, Francesco Plastina, Antonello Sindona, Irene D'Amico, arXiv:2512.18338(2025)

[2] Giacomo Guarnieri, Jens Eisert, and Harry J. D. Miller, PRL133, 070405 (2024)

[3] Aurora Pribram-Jones, Paul E. Grabowski, and Kieron Burke, PRL 116, 233001 (2016)

[4] Michele Fabrizio, Alexander O. Gogolin, and Alexander A. Nersesyan, PRL 83, 2014 (1999)

12:00 - 12:30 - Lucas Sá

Title: *Spectral statistics in dissipative quantum chaos: from random matrices to quantum computers*

Institution: U. Cambridge

Abstract:

More than four decades of research on chaos in isolated quantum systems have led to the identification of universal signatures—such as level repulsion—that serve as cornerstones in our understanding of complex quantum dynamics. The emerging field of dissipative quantum chaos explores how these properties manifest in open quantum systems, where interactions with the environment play an essential role. Here, I will discuss the theoretical proposal, numerical observation, and first experimental detection of dissipative quantum chaos and integrability using complex spacing ratios (CSR). Theoretically, I will discuss how to compute universal CSR distributions for non-Hermitian random matrices and uncorrelated random variables. Numerically, I will show how we can use CSR distributions to probe chaos and integrability in several open many-body quantum systems. Experimentally, I will review a recent experiment where, employing gradient-based tomography, we retrieved the CSR distributions for chaotic and integrable dissipative circuits. Increasing circuit depth induces an integrability-to-chaos

crossover, demonstrating that intrinsic hardware noise is itself a source of dissipative quantum chaos. Together, our results reveal universal spectral features of dissipative many-body systems and establish modern quantum processors—typically used for unitary simulations—as a new experimental platform for dissipative quantum chaos.

14:00 - 15:00 - Jakub Zakrzewski

Title: *The least open quantum system revisited*

Institution: Jagiellonian University

Abstract:

I will consider interacting bosons in an optical cavity where the leakage from the cavity is the only source of "openess" and dissipation. While standard description and most of experiments consider the bad cavity limit in which the cavity field adiabatically follows atomic degrees of freedom, I will discuss an approach in which the cavity mode is treated self-consistently within the truncated Wigner approximation. It will be shown that the long time dynamics of the system goes through metastable states that may be falsely considered as true asymptotic NESS of the system. The analysis indicates that phase transitions resulting from the adiabatic approach are of different character if viewed with long time dynamics.

15:00 - 16:00 - Sebastian Diehl

Title: *TBA*

Institution: University of Cologne

Abstract:

TBA

5.5 WG4 - Friday 1 May

09:00 - 10:00 - Jonathan Keeling

Title: *Modelling realistic open quantum systems with process tensors*

Institution: University of St Andrews

Abstract:

When an open quantum system is strongly coupled to a structured environment, describing the dynamics of that system becomes a challenging problem. Moreover, traditional approaches, based on time evolution of the reduced density matrix are generally harder to use when calculating higher-order or multi-time correlations.

I will review recent progress that addresses both these issues, by showing how the time evolution of the system can be efficiently simulated using tensor network methods [1]. Such a tensor network naturally leads one to consider the process tensor (PT), an object which encodes all multi-time correlations of the reservoir [2,3]. A key insight is that one can construct efficient MPO representations of the PT [4]. This idea makes possible many otherwise challenging tasks, including optimisation of non-Markovian systems [5,6], and modelling the non-Markovian dynamics of many-body open quantum systems [7], and calculation of two dimensional spectroscopy[8].

The algorithm underpinning this work is publicly available [9], and we are keen to help support other researchers in using this approach.

[1] Efficient non-Markovian quantum dynamics using time-evolving matrix product operators. A. Strathearn, P. Kirton, D. Kilda, J. Keeling, B. W. Lovett. Nature Commun. 9, 3322 (2018)

[2] Exploiting the causal tensor network structure of quantum processes to efficiently simulate non-markovian path integrals, M. R. Jørgensen and F. A. Pollock. Phys. Rev. Lett. 123, 240602 (2019).

[3] Simulation of open quantum systems by automated compression of arbitrary environments. M. Cygorek, M. Cosacchi, A. Vagov, V. M. Axt, B. W. Lovett, J. Keeling, E. M. Gauger. Nat. Phys. 18, 662 (2022)

[4] Process Tensor Approaches to Non-Markovian Quantum Dynamics. J. Keeling, E. M. Stoudenmire, M.-C. Bañuls, D. R Reichman. arXiv:2509.07661

[5] Efficient exploration of hamiltonian parameter space for optimal control of non-markovian open quantum systems. G. E. Fux, E. P. Butler, P. R. Eastham, B. W. Lovett, J. Keeling. Phys. Rev. Lett. 126, 200401 (2021).

[6] Optimizing Performance of Quantum Operations with Non-Markovian Decoherence: The Tortoise or the Hare? E. P. Butler, G. E. Fux, C. Ortega-Taberner, B. W. Lovett, J. Keeling, and P. R. Eastham. Phys. Rev. Lett. 132 060401 (2024)

[7] Efficient many-body non-Markovian dynamics of organic polaritons. P. Fowler-Wright, B. W. Lovett, J. Keeling. Phys. Rev. Lett. 129 173001 (2022)

[8] R. de Wit, J. Keeling, B. W. Lovett, A. W. Chin. Phys. Rev. Research 7, 013209 (2025)

[9] The OQuPy package, https://github.com/tempoCollaboration/OQuPy

10:00 - 10:30 - Valentin Link

Title: *Exact open quantum system dynamics using infinite tensor network influence functionals*

Institution: TU Berlin

Abstract:

I present an efficient numerical framework for describing exact non-Markovian dynamics of open quantum systems based on tensor network influence functionals. This method works by replacing the dynamical map of a large Gaussian quantum environment with a numerically feasible semigroup embedding within a reduced auxiliary space [1]. Such an embedding corresponds to an infinite matrix product state representation of the influence functional and can be obtained systematically through an infinite-time variant of the TEMPO algorithm. I show various applications to equilibrium and out-of-equilibrium dynamics of open quantum systems with general non-interacting reservoirs, including fermionic impurity models [2] and dissipative Floquet systems [3].

[1] Link, Tu, Strunz, PRL 132, 200403 (2024)

[2] Sonner, Link, Abanin, PRL 135, 170402 (2025)

[3] Mickiewicz, Link, Strunz, arXiv:2511.08754 (2025)

11:00 - 12:00 - Christiane Koch

Title: *Optimal control of open quantum systems — lessons to date*

Institution: Freie Universität Berlin

Abstract:

Control is the prerequisite to exploit the two essential elements of quantum physics, non-locality and coherence, for practical applications. The control of open quantum systems is thus at the core of any quantum technology. Optimal control theory (OCT) is a versatile set of tools to identify control strategies in the presence of decoherence, either avoiding or exploiting the environment. In this talk, I will discuss examples for both, with applications in Rydberg atoms, trapped ions and superconducting qubits. Furthermore, I will assess prospects for quantum control in reservoir engineering where the desired dissipation is realized via quantum measurements.

12:00 - 12:30 - Oliver Lunt

Title: *TBA*

Institution: University of Oxford

Abstract:

TBA

14:00 - 14:30 - Grazia di Bello

Title: *Simulating Open Quantum Systems and Their Environments with Matrix Product States*

Institution: University of Naples Federico II

Abstract:

Describing open quantum systems often requires modelling strategies that go beyond weak-coupling and Markovian approximations. In this talk, I will present simulations based on matrix product states in which the system and the bath are treated together, so that one can access not only the reduced dynamics of the system, but also bath observables and system-environment correlations. This is particularly useful in situations where the environment is not simply a source of dissipation, but actively shapes the critical and non-equilibrium behavior of the dynamics. As concrete examples, I will discuss dissipation-driven quantum criticality in the open quantum Rabi model [1], where the environment plays an active role in shaping the phase structure and the dynamical response, and environment-induced dynamical quantum phase transitions in the open two-qubit Rabi model [2], where the interplay between interactions and dissipation gives rise to non-analytic real-time signatures. I will then briefly comment on related applications to work extraction protocols and information-theoretic diagnostics, including local ergotropy (the maximum extractable work) [3] and quantum Fisher information (a key quantity in quantum parameter estimation) [4]. Finally, I will mention some recent extensions of this framework to other non-equilibrium phenomena, such as the Kibble-Zurek mechanism in the open quantum Rabi model [5] and the quantum Mpemba effect in the spin-boson model [6]. Taken together, these examples show how treating the system and the bath explicitly can reveal features of the dynamics that are not easily accessible in reduced-dynamics approaches.

References

[1] G. De Filippis, A. de Candia, G. Di Bello, C. A. Perroni, L. M. Cangemi, A. Nocera, M. Sassetti, R. Fazio, and V. Cataudella, "Signatures of Dissipation Driven Quantum Phase Transition in Rabi Model," Physical Review Letters 130, 210404 (2023).

[2] G. Di Bello, A. Ponticelli, F. Pavan, V. Cataudella, G. De Filippis, A. de Candia, and C. A. Perroni, "Environment induced dynamical quantum phase transitions in two-qubit Rabi model," Communications Physics 7, 364 (2024).

[3] G. Di Bello, D. Farina, D. Jansen, C. A. Perroni, V. Cataudella, and G. De Filippis, "Local ergotropy and its fluctuations across a dissipative quantum phase transition," Quantum Science and Technology 10, 015049 (2024).

[4] D. Parlato, G. Di Bello, F. Pavan, G. De Filippis, and C. A. Perroni, "Quantum Fisher information as a witness of non-Markovianity and criticality in the spin-boson model," Physical Review B 112, 224314 (2025).

[5] T. Pirozzi, G. Di Bello, V. Cataudella, C. A. Perroni, and G. De Filippis, "Kibble-Zurek Mechanism in the Open Quantum Rabi Model," arXiv:2603.16709 (2026).

[6] P. Chirico, G. Di Bello, G. De Filippis, and C. A. Perroni, "Geometry and restoration of the quantum Mpemba effect beyond weak-coupling regime in the spin-boson model," arXiv:2603.17565 (2026).

14:30 - 15:00 - Moritz Cygorek

Title: *TBA*

Institution: Technische Universitat Dortmund

Abstract:

TBA

15:00 - 15:30 - Ege Gorgun

Title: *Simulating Open Continuous-Variable Many-Body Dynamics with Neural Quantum States*

Institution: FSU Jena

Abstract:

The simulation of open quantum systems presents a significant computational challenge due to the exponential scaling of the Hilbert space when solving the Lindblad Master Equation. To circumvent this dimensionality curse, we apply a framework that maps the system dynamics onto a phase-space representation, which we then solve using a variational Ansatz parameterized by an invertible neural network. By integrating this generative architecture with the time-dependent Variational Monte Carlo (t-VMC) method, we demonstrate a scalable approach capable of capturing complex physical phenomena in coupled driven-dissipative bosonic systems across diverse parameter regimes. Our results indicate that this neural-network-based representation maintains high numerical accuracy even in strongly quantum regimes where semi-classical approximations, such as the truncated Wigner method, typically break down. Furthermore, we show that our method provides superior scaling compared to numerically exact solvers, offering a robust and efficient pathway for exploring many-body dissipative quantum dynamics that were previously computationally inaccessible.

6 Poster Abstracts

Mariana Gil Guerra de Almeida Abreu

Title: *Relevance of Electronic Interactions at Quasiperiodicity-Driven Localization Transitions*

Institution: Center of Physics and Engineering of Advanced Materials

Abstract:

In real materials, disorder can induce localization of single-particle states, resulting in the so-called Anderson insulating phases. Notably, quasiperiodic modulations can also strongly affect wavefunction localization. As the quasiperiodic potential increases, single-particle states transition from delocalized to critical and finally to localized, with metal-insulator transitions distinct from those in systems with uncorrelated disorder.

The simplest model capturing this transition is the Aubry-André model. Recently, studies were extended to 1D systems of interacting spinless fermions. Interestingly, such interactions were found to become irrelevant around the transition.

This project explores the effects of spinful interactions in quasiperiodicity-driven localization transitions, specifically, whether they become relevant, as in higher-dimensional disorder-driven transitions, or remain irrelevant, as in the spinless case. To study the system's ground-state properties, we employ the Density Matrix Renormalization Group (DMRG), which determines many-body quantum states with polynomial complexity in system size.

João Manuel Alendouro Oliveira Pinho

Title: *Applications of Smooth Absorving Potentials on Mesoscopic Transport*

Institution: Universidade do Porto

Abstract:

In this work, we recast the semi-infinite leads in the Caroli Formula as finite leads with complex absorving potentials and expand the Green functions in Faber Polynomials to obtain an efficient calculation of the transmission in mesoscopic samples. We showcase the method for a simple 1D tight-binding chain.

Gabriel Almeida

Title: *Dissipation- vs chaos-induced relaxation in non-Markovian quantum many-body systems*

Institution: CeFEMA, Instituto Superior Técnico, University of Lisbon

Abstract:

In interacting quantum many-body systems, relaxation toward equilibrium reflects a competition between internal chaotic dynamics and environmental dissipation. We study this interplay in an open Sachdev-Ye-Kitaev (SYK) model coupled to a pseudogapped fermionic bath, using the Keldysh formalism to compute steady-state correlations in the large-N limit. Our results uncover a rich dynamical phase diagram, with regimes of bath-driven power-law relaxation, chaos-driven exponential decay, and an intermediate pre-relaxation phase where exponential decay crosses over to algebraic decay.

Antonio Ruiz Molero

Title: *Neural-assisted time-dependent Lindblad tomography*

Institution: INL International Iberian Nanotechnology Laboratory

Abstract:

In this poster, we introduce a Machine Learning technique to infer the time-dependent open dynamics of a system given a set of informationally complete data for different evolution times. In this way, we are able to characterize unknown dynamics with, possibly, complex non Markovian behavior.

Tony John George Apollaro

Title: *Precision is not limited by the second law of thermodynamics*

Institution: University of Malta

Abstract:

Physical devices operating out of equilibrium are affected by thermal fluctuations, limiting their operational precision. This issue is particularly pronounced at microscopic and quantum scales, where its mitigation requires additional entropy dissipation. Understanding this constraint is important for both fundamental physics and technological design. Clocks, for example, need a thermodynamic flux towards equilibrium to measure time, resulting in a minimum entropy dissipation per clock tick. Although classical and quantum models often show a linear relationship between precision and dissipation, the ultimate bounds on this relationship remain unclear. In this talk an autonomous quantum many-body clock model is presented. Such a clock achieves a precision that scales exponentially with entropy dissipation due to the coherent transport in a spin chain with tailored couplings, where dissipation is confined to a single link. The result demonstrates that coherent quantum dynamics can surpass traditional thermodynamic precision limits.

Florian Meier, Yuri Minoguchi, Simon Sundelin, Tony J. G. Apollaro, Paul Erker, Simone Gasparinetti, Marcus Huber, Precision is not limited by the second law of thermodynamics, Nature Physics 21, 1147 - 1152 (2025), https://doi.org/10.1038/s41567-025-02929-2

Riya Baruah

Title: *TBA*

Institution: Aalto University

Abstract:

TBA

Fainberg Boris

Title: *Stability of superradiant state and fundamental soliton under exciton-phonon interactions in open quantum systems: application to quasi-2D hybrid perovskites*

Institution: Holon Institute of Technology

Abstract:

The use of macroscopic coherent states is crucial in modern quantum technologies. In light of recent experiments demonstrating high-temperature superfluorescence in hybrid perovskite thin films, in this work we investigate the stability of the superradiant state concerning exciton-phonon interactions. We focuse on a quasi-2D Wannier excitons interacting with longitudinal optical phonons. We derive nonlinear equations in the coordinate space that govern the complex-valued polarization. The resulting equations take the form of a 2D nonlocal nonlinear Schrodinger equation. We perform a linear stability analysis of the superradiant state. Our findings indicate that, when the exciton interacts with phonons, the superradiant state is modulationally stable, provided that the square of its amplitude does not exceed a critical intensity defined by the exciton-phonon interaction. We also solve the 2D nonlocal nonlinear Schrodinger equation in the polar coordinates and obtain its fundamental soliton solution, which is stable.

Eoin O'Connor

Title: *TBA*

Institution: University of Milan

Abstract:

TBA

Conor Sexton

Title: *Optimised quantum feedback control protocols: Advantages and limitations*

Institution: University College Cork

Abstract:

Standard projective quantum measurements are instantaneous and irreversible, resulting in the complete collapse of the state ket into an eigenstate of the measured observable. However, continuous measurement allows for the quantum system to be monitored in time while only weakly perturbing it. This alternate measurement paradigm results in a stochastic measurement record and quantum trajectories which are otherwise inaccessible by projective measurement. The measurement record enables the design of time-dependent feedback protocols to guide the system to a target state despite unwanted noise and errors. It has been previously shown that feedback with a delayed measurement record or signal can be described by the quantum Fokker-Planck master equation [Phys. Rev. Lett. 129, 050401 (2022)]. We first extend this to also include the effects of measurement inefficiencies, allowing for the modelling of more realistic experimental conditions. Next, we present numerically optimised feedback control protocols which maximise the target state fidelity in steady state, and finally, we explore the performance of the optimised protocols for imperfect measurement signal such as delay and loss and compare against standard open loop coherent control.

In this poster, we present the theoretical foundations of continuous measurement and their application within quantum feedback systems, an overview of the QFP master equation, and the methodology involved in optimising a steady state feedback protocol.

Dara Murphy

Title: *Ergotropy transport in a one dimensional spin chain*

Institution: University College Dublin

Abstract:

We examine the transport of useful energy, i.e. extractable work as quantified by the ergotropy, along a spin chain with tuneable exchange couplings between the sites. We focus on, and interpolate between, the two physically relevant limits of uniform interaction strengths and engineered couplings which achieve perfect state transfer (PST). By modelling the individual constituents as quantum batteries, we consider how the manner in which the extractable work appears in the initial state of the first site impacts the chain's ability to transport ergotropy to the final site. For non-PST couplings, we establish that there is a clear quantum advantage when the ergotropy is initially endowed in quantum coherences and demonstrate that this ergotropy is more efficiently transferred. For extractable work encoded in a population inverted state, we show that this considerably limits the length of chain over which any ergotropy can be faithfully transported. For PST couplings, we consider the robustness to disorder and again demonstrate a quantum advantage for coherently endowed ergotropy. Finally, we examine the work probability distribution associated with quenching on the interactions which provides insight into the work cost in switching on the couplings. We show that PST couplings lead to smaller fluctuations in this work cost, indicating that they are more stable.

Doru Sticlet

Title: *Nonstabilizerness in open XXZ spin chains*

Institution: National Institute for Research and Development of Isotopic and Molecular Technologies

Abstract:

Understanding the origin of quantum advantage remains a central challenge in contemporary quantum science. A promising direction in this endeavor involves quantifying non-classical resources through the so-called stabilizer Rényi entropy (SRE) [Phys. Rev. Lett. 128, 050402 (2022)], which quantifies the deviation of a state from the set of stabilizer states. We explore the generation and dynamics of SRE in quantum many-body systems, focusing on one-dimensional spin chains where matrix product states techniques enable efficient simulations. We study open quantum system dynamics in boundary-driven and dephasing XXZ spin models. The analysis reveals new behaviors of magic, including sharp signatures of different transport regimes, universal scaling, and transient enhancements. To isolate the role of correlations, the concept of mean-field magic is introduced, capturing the contribution of many-body correlations to the growth of SRE during time evolution.

Gianluca Frazzei

Title: *Bistability in the dissipative far-east model*

Institution: University of Trento

Abstract:

TBA

Ivana Vasic

Title: *Bosonic Dynamics in Optical Lattices: Effects of Driving and Dissipation*

Institution: Institute of Physics Belgrade

Abstract:

Cold atoms in optical lattices provide a clean realization of the Hubbard model. We study dynamical regimes of strongly correlated bosonic atoms under driving and dissipation. First, we analyze dynamics induced by a dissipative local defect using a Gutzwiller master-equation approach. In the superfluid phase, repulsive nearest-neighbor interactions enhance dissipation, and in the strong-dissipation limit we recover the quantum Zeno effect. Next, we examine the stability of a bosonic Laughlin state under periodic driving. Despite heating from the interplay of driving and interactions, we identify an optimal parameter regime - set by interaction strength and driving frequency - where stroboscopic dynamics supports the Laughlin state on experimentally realistic time-scales. Finally, we study optical conductivity in the strongly interacting Bose - Hubbard model at high temperatures. We find a regime of linear-in-temperature resistivity with a coefficient set by the tunneling amplitude, and at half filling and very strong coupling, a distinct low-temperature linear regime consistent with hard-core bosons.

Veljko Jankovic

Title: *Self-Consistent Method for Studying Excitation Energy Transfer in Multichromophoric Systems*

Institution: Institute of Physics Belgrade, Serbia

Abstract:

Further progress in fundamental understanding of the initial steps of solar-energy conversion in both natural and artificial systems requires computationally inexpensive yet reasonably accurate methods for quantum dynamics of excitons in bosonic environments. We advocate that an appropriate generalization of the self-consistent Born approximation (SCBA) widely used in condensed-matter physics can be employed to that end [1]. Our SCBA is formulated in the Liouville space and frequency domain, and it

handles arbitrary spectral densities of the exciton-environment interaction. Our extensive numerical examples, including the Fenna - Matthews - Olson complex immersed in a realistic structured environment, uncover the potential of the SCBA to describe electronic-excitation dynamics. Furthermore, our formal developments could motivate higher-order generalizations of the SCBA, and strengthen ties between communities of condensed-matter physics and open quantum systems.

[1] V. Janković and T. Mančal, J. Chem. Phys. 161, 204108 (2024).

Tiago Jorge

Title: *Out-of-Equilibrium Criticality and Order Parameter Dynamics in a Driven Magnetic Quantum Dot*

Institution: Instituto Superior Técnico, University of Lisbon

Abstract:

We study non-equilibrium phase transitions in an open, voltage-biased magnetic quantum dot modeled by its collective spin, a minimal model for spintronic devices near criticality. Using a Keldysh path-integral approach, we derive an effective theory for the dot's collective degrees of freedom, bridging equilibrium and far-from-equilibrium regimes. We map the steady-state phase diagram and identify an open quantum critical point at V,T→0, with a universality class distinct from the closed system, while showing that any finite bias restores thermal scaling. We obtain a stochastic equation for the order parameter, demonstrating that, near criticality, non-equilibrium driving enables a controlled semiclassical description with a microscopically derived free energy. Using this framework, we show that noise can stabilize metastable configurations in the out-of-equilibrium regimes, revealing a subtle interplay between noise and dissipation. These results shed light on how bias-induced driving and dissipation can reshape classical quantum critical behavior and provide a controlled route to effective thermal descriptions in bias-driven systems.

Marco Pezzutto

Title: *Non-Markovian Memory-Mediated Collision Models for Open Quantum Dynamics*

Institution: CeFEMA and LAPMET, Instituto Superior Técnico, Universidade de Lisboa

Abstract:

The dynamics' non CP-divisibility of an open quantum system, undergoing repeated interactions with individual environment particles mediated by a memory, is witnessed by non-positive values of the energy Kirkwood-Dirac quasiprobability (KDQ) distribution associated with the bare Hamiltonian of the system. The initial states of the system, memory and environment particles are thermal at a given inverse temperature. Then, the system-memory and memory-environment interactions are Heisenberg exchange terms, and the system reduced dynamics is described by a phase covariant map. The witness works whenever anomalous energy fluxes, due to non-Markovianity, are realized. Anomalous fluxes are also detected by the non-Markovianity measure built over the quantum mutual information between the states of the open system and of a quantum correlated reference. A discussion of the experimental verification of these results is also included.

Martin Žonda

Title: *Individual Assembly of Radical Molecules on Superconductors*

Institution: Charles University Department of Condensed Matter Physics

Abstract:

We use high-precision molecular manipulation to control the spacing and coupling of radical molecules adsorbed on superconducting substrates. Individual molecules are shown to host localized spin states associated with single-electron occupancy. By tuning the tip - sample interaction, we drive quantum phase transitions between different many-body ground states, which are tracked through the evolution of Yu - Shiba - Rusinov resonances and described within the superconducting Anderson impurity framework.

For molecular dimers, we observe multiple subgap excitations whose spectral weight and energy depend sensitively on intermolecular separation, reflecting the interplay between exchange coupling, screening, and charge redistribution. These systems exhibit transitions between singlet and doublet ground states, accompanied by deviations from simple localized spin models due to hybridization and charge fluctuations.

Extending this approach to multi-molecule assemblies, we investigate both linear chains and triangular trimers. In the triangular geometry, the system undergoes successive quantum phase transitions between singlet, doublet, and triplet ground states, governed by the balance of interaction strength and local energy. The corresponding charge state is consistent with correlated multi-electron occupation predicted by theory.

In longer chains, we observe emergent charge ordering patterns with alternating neutral and charged configurations. In particular, tetramer structures support two nearly degenerate charge arrangements that differ by a single-site shift. We demonstrate reversible and nondestructive switching between these configurations using the scanning probe, establishing these molecular assemblies as controllable platforms for single-electron charge manipulation and functional nanoscale information units.

Mrinmoyee Saha

Title: *Negative Currents and Heat Pulses in Electron Quantum Optics*

Institution: Aalto University

Abstract:

Electron quantum optics aims to realize ideas from the quantum theory of light with the role of photons being played by charge pulses which are excited by time-dependent voltages in electronic conductors. At low temperatures, electronic excitations can experience quantum coherence over an entire mesoscopic structure, such that interference effects become observable. We present an analytic theory for time-dependent currents in mesoscopic Fabry - Pérot cavities which can turn negative even if the applied voltage pulses are always positive . Making use of Floquet scattering theory we show that the negative currents are caused by interferences between scattering paths through the cavity with different numbers of round trips. Instead of charge pulses, one could also generate heat pulses by doing work on an electrode that changes its temperature with time. Using the same theoretical framework we investigate the transport properties of heat pulses which, in contrast to the charge pulses, are uncharged. This charge neutrality results in a zero electric but non-zero heat current and Wigner function becomes anti-symmetric in energy for any shape of heat pulses.

Vram Mughnetsyan

Title: *Spin configuration of an array of quantum rings controlled by cavity photons*

Institution: Yerevan State University

Abstract:

We model changes in spin configuration in a two-dimensional array of quantum rings (a lateral superlattice) subjected to a perpendicular magnetic field and coupled to a circularly symmetric far-infrared cavity photon mode. Our results show that the spin ordering of the electron gas can be controlled by the electron - photon coupling strength and photon energy. Electron - electron interactions are treated within spin-density functional theory, while electron - photon interactions are described using a configuration interaction approach in a truncated Fock space. In the absence of external pulses, changes in spin configuration are reflected in the orbital magnetization, while strong electron - photon coupling can suppress these changes. Time-dependent calculations further reveal spin fluctuations under cavity excitation, with enhanced diamagnetic interaction driven by the rotational electric field of the cavity mode.