center for Quantum Science and Engineering

2024 GENERAL ASSEMBLY OF THE QSE CENTER QUANTUM COMMUNITY
Friday April 26, 10:00 – 16:00
Room: BC 420

10:00 – 10:30	**Posters set up**		
10:00 – 10:30	**Welcome coffee**		
10:30 – 11:15	**QSE Center – Quantum Master's Program UPDATE**	**Philippe Caroff, Vincenzo Savona, Nicolas Macris, Ghalia Dhaoui**	
11:15 – 12:15	**Interactive exchange and Q&A between community and QSE Comex Members**	**Moderated by Philippe Caroff and Vincenzo Savona**	
12:15 – 12:30	**"Quantum interference of spin states as a measurement of time"**	**Hugo Dil, Spin Orbit Interaction Spectroscopy**	**Abstract:** The coherent superposition of spinors form one of the basics of of interference in a quantum system. In this talk I will show how we can measure the orientation of the resulting spinor on the Bloch sphere using spectroscopic techniques and from this extract the phase of the interference. The dependence of phase on energy gives us the access to fundamental time scales of quantum transitions as a function of interaction strength in the system of interest.

12:30 – 12:45	**"Exotic mechanical states in circuits optomechanics: from collective cooling to strong single-photon coupling"**	**Marco Scigliuzzo, Laboratory of Photonics and Quantum Measurement**	**Abstract:** Achieving precise control and measurement of the quantum state of macroscopic mechanical objects is crucial for investigating quantum phenomena in massive systems and probing the boundaries of quantum mechanics. In this presentation, I will discuss recent advancements in two key areas: collective cooling of nearly degenerate mechanical oscillators to their ground state and the development of perimeter mode resonators optomechanically coupled to a transmon qubit. Both projects, supported by the Quantum Science and Engineering (QSE) initiative at EPFL, represent significant milestones in enhancing control over mechanical degrees of freedom and lay the groundwork for future quantum technologies.
12:45 – 13:45	**Lunch and poster session**		
13:45 – 14:00	**"Microscopy of ultracold atomic gases with long-range photon-mediated interactions"**	**Aurélien Fabre, Laboratory for Quantum Gases**	**Abstract:** The experimental study of strongly correlated Fermi gases with competing orders not only requires a high degree of control, but also access to the key observables that characterize the underlying physics. I will present recent advances on detection techniques to probe ultracold atomic gases with both short- and long-range interactions, which feature charge-density-wave ordering. Using a microscope with high spatial resolution, we observe in-situ the formation of a density modulation as the system enters the ordered phase. This

			paves the way for the local manipulation of the atomic gas at the microscopic level.
14:00 – 14:15	**"Noise-induced shallow circuits and absence of barren plateaus"**	**Armando Angrisani, Laboratory of Quantum Information and Computation**	**Abstract:** The experimental study of strongly correlated Fermi gases with competing orders not only requires a high degree of control, but also access to the key observables that characterize the underlying physics. I will present recent advances on detection techniques to probe ultracold atomic gases with both short- and long-range interactions, which feature charge-density-wave ordering. Using a microscope with high spatial resolution, we observe in-situ the formation of a density modulation as the system enters the ordered phase. This paves the way for the local manipulation of the atomic gas at the microscopic level.
14:15 – 14:30	**“Integrated photonics for quantum sensing”**	**Kailyn Vaillancourt, Hybrid Photonics Laboratory**	**Abstract:** The measurement of vacuum field fluctuations is crucial for both fundamental physics research and potential technological applications. It allows scientists to validate theories, deepen our understanding of the quantum world, explore cosmological phenomena, and potentially pave the way for revolutionary technologies. In the Laboratory of Hybrid Photonics, we plan to use integrated photonics to directly measure the correlation of quantum fluctuations in the THz frequency range using a thin-film lithium niobate photonic platform. A

			THz coplanar waveguide cavity is designed to confine the vacuum field, which will be probed by ultrafast optical pulses in an on-chip interferometer through nonlinear optical processes.
14:30 – 14:45	**“Dissipative Quantum Chaos”**	**Fabrizio Minganti, Laboratory of Theoretical Physics of Nanosystems**	**Abstract:** The promise of quantum technologies relies on the possibility of fine engineering and controlling quantum states, despite the detrimental presence of the surrounding environment. This task is particularly challenging in the presence of chaos, where a system displays exceptional sensitivity to minor changes in the parameters. As the interplay of chaos and the open nature of the system represents a still largely unexplored field, we introduce a general and model-independent method able to distinguish chaos throughout the dynamics of an open quantum system [1]. Our approach is based on a combination of stochastic processes and random matrix theory, and it is especially effective in characterizing chaos in systems of continuous variables, such as electromagnetic radiation, where other method fails. Thanks to our method, we demonstrate how chaos can hinder the performance of quantum devices. Our theoretical predictions are confirmed by two preliminary experimental results [2]. [1] Filippo Ferrari, Luca Gravina, Debbie Eeltink, Pasquale Scarlino, Vincenzo Savona, and Fabrizio Minganti, *Steady-state quantum chaos in open quantum*

			systems, arXiv:2305.15479 [2] Leo Peyruchat, Fabrizio Minganti, Marco Scigliuzzo, Filippo Ferrari, Vincent Jouanny, Franco Nori, Vincenzo Savona, and Pasquale Scarlino, *Landau-Zener without a Qubit: Unveiling Multiphoton Interference, Synthetic Floquet Dimensions, and Dissipative Quantum Chaos*, arXiv:2404.10051
14:45 – 15:30	**Coffee break and poster session**		
15:30	**Poster removal**		

Posters:

"Continuous-Space Quantum Simulation: A Discretization-Free Approach with Hybrid Quantum-Classical Ansatze"	**Friederike Metz** and Giuseppe Carleo	**"Fermionic Neural Quantum States for the Homogeneous Electron Gas in 3D"**	**Gabriel Pescia**
"Overhead-constrained circuit knitting for variational quantum dynamics"	**Gian Gentinetta,** Friederike Metz, Giuseppe Carleo	**"Accurate neural quantum states for interacting lattice bosons"**	**Zakari Denis** and Giuseppe Carleo
"Light-induced phase transitions and their dynamics in strongly interacting ultracold fermions."	**Gaia Stella Bolognini,** Timo Zwettler, Giulia Del Pace, Tabea Nelly Clara Bühler, Aurélien Hadrien Fabre and Jean-Philippe Brantut	**"Spectroscopy of two-dimensional interacting lattice electrons using symmetry-aware neural backflow transformations"**	**Imelda Romero,** Jannes Nys, Giuseppe Carleo

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"Average-case hardness of learning Born distributions of symmetrised circuits"	**Oxana Shaya**, Armando Angrisani, Zoe Holmes	**"Algorithmic inversion to embed many-body interacting systems"**	**Alessandro Carbone**
"Quantum noise can enhance algorithmic cooling"	Zahra Farahmand, **Reyhaneh Aghaei Saem**, and Sadegh Raeisi	**"MC-PDFT embedding scheme for electronic stucture Quantum Algorithms"**	**Luca Righetti**, Pauline Ollitrault, Ivano Tavernelli
"Learning ground states of gapped quantum Hamiltonians with Kernel Methods"	**Clemens Giuliani,** Filippo Vicentini, Riccardo Rossi and Giuseppe Carleo	**"Can increasing the size and flexibility of a molecule reduce decoherence?"**	**Alan Scheidegger,** Nikolay Golubev, and Jiri Vanicek
"A cavity-microscope for micrometer-scale control of atom-photon interactions"	**Michael Alexander Eichenberger**, **Ekaterina Fedotova**, Francesca Orsi, Rohit Prasad Bhatt, Nick Sauerwein, Jonas Faltinath, Gaia Bolognini and Jean-Philippe Brantut	**"Metrology with critical open quantum systems"**	**F. Minganti**, G. Beaulieu, S. Frasca, R. Di Candia, S. Felicetti, P. Scarlino, and V. Savona
"Quantum phase estimation for efficient variational ground and excited state preparation"	**Khurshed P. Fitter** and Vincenzo Savona	**"Variational Quantum Time Evolution of Open Quantum Systems."**	**Sara Santos,** Xinyu Song and Vincenzo Savona.
"Quantum extreme learning and reservoir computing"	**Weijie Xiong**	**"Steady state and transient quantum chaos"**	**Filippo Ferrari**, Luca Gravina, Léo Paul Peyruchat, Debbie Eeltink, Pasquale Scarlino Vincenzo Savona and Fabrizio Minganti
"Multi-mode, ultra-coherent, and Josephson circuit optomechanics"	**Shingo Kono**	**"Terahertz Waveguides and Cavities on Chip"**	**Yazan Lampert**