WACQT May review meeting 2025 - researcher presentations

Tuesday 13th May

Time	Person	Position	Pillar	University	Title	Abstract
16:10 - 16:25	**Adam Kinos**	Assist prof.	Quantum sensing, metrology and Control	LU	Developing rare-earth quantum processors: a path to a global quantum internet	I will present my research program as an Assistant Professor in Physics, focusing on advancing quantum technologies through the use of rare-earth crystals. These crystals exhibit unique properties, such as hour-long coherence times, optical integration, and high qubit densities, making them promising candidates for quantum computing and quantum communication. My vision is to develop a small-scale quantum processor that in the future can store quantum information that is physically transported on satellites, paving a path to a global quantum internet.
16:25- 16:40	**Joey Frey**	PhD student	Quantum communication	Chalmers	Release-free electromechanical crystals for quantum transduction	GHz-frequency acoustical devices are investigated as a platform for quantum transduction, computing and memory. However, to limit radiation into the bulk, phononic crystal devices are typically suspended. Particularly for quantum transduction, suspension severely reduces thermal anchoring, causing increased thermal noise. To combat these issues, we recently proposed release-free piezo-optomechanical transducers. As a building block towards this goal we demonstrate release-free electromechanical crystals (EMCs) with strong coupling.

Wednesday 14th May

Time	Person	Position	Pillar	University	Title	Abstract
09:00- 09:15	**Jaewon Lee**	PhD student	Quantum sensing, metrology and Control	SU	Universal super-resolution framework for imaging of quantum dots	In this work, we present a universal deep learning-based framework for super-resolution imaging of quantum dots. Our model, trained entirely on synthetically generated datasets spanning a wide range of optical conditions, eliminates the need for system-specific calibration or retraining. It directly reconstructs high-resolution images from low-resolution input, demonstrating strong generalization across diverse imaging scenarios. This efficient, calibration-free, and highly adaptable approach offers a solution for real-time, high-fidelity quantum dot imaging across a broad range of applications in nanophotonics and quantum technologies.
09:15- 09:30	**Hilma Karlsson**	PhD student	Quantum communication	KTH	Practical considerations for Twin Field QKD	Twin-field (TF) quantum key distribution (QKD) has emerged as a promising method for repeater-free long-distance secure communication, with the possibility to cover much longer distances than conventional or commercial devices, with the longest demonstration reaching 1000 km. There are, however, challenges regarding the implementation of TF-QKD, particularly in establishing high coherence between remote lasers. In previous implementations, narrow linewidth laser stabilised to ultra-low expansion cavities or gas cells have been used, to achieve high coherence throughout the entire system. These systems are particularly sensitive to misalignment and are expensive, bulky, and fragile. Here, we present an alternative to these existing techniques in the form of an all-fibre frequency reference for TF-QKD. This setup, built with telecom compatible components, also has a smaller footprint and increased tunability which makes it easier to deploy in existing fibre telecom infrastructures such as the National Quantum Communication Infrastructure in Sweden.
09:30- 09:45	**Kunal Helambe**	PhD student	Quantum computing experiment	Chalmers	Experimental realization of digital homodyne and heterodyne detection of a stationary mode	In continuous-variable quantum computation, the information is encoded in bosonic modes, which, thanks to the availability of a large Hilbert space, facilitate hardware-efficient quantum error correction. These systems also benefit from homodyne and heterodyne detection techniques for measuring the quadratures of the field. However, these techniques cannot be straightforwardly extended to the measurement of the stationary modes confined in superconducting resonators and microwave cavities. Here, we overcome this limitation using the qubitdyne protocol. The protocol utilizes repeated measurements on a transmon qubit coupled to a bosonic mode to accurately reproduce the measurement statistics of homodyne and heterodyne detection. We perform a sequence of partial-swap using the |g,n+1> - |f,n> transition between the qubit and bosonic mode and measure the qubit in the Pauli X basis. The qubit is reset to |g> state for reuse, and the sequence is repeated to measure the trajectory of the mode. By measuring a large ensemble of these trajectories, the full probability distribution of the state can be determined. These measurements are sufficient to perform quantum state verification, efficient boson sampling and demonstration of verifiable quantum advantage.
09:45- 10:00	**David Busto**	Assist prof.	Quantum sensing, metrology and Control	LU	Ultrafast quantum photoelectronics	The interaction of high energy light with matter leads to the emission of electrons in a process known as photoionization. This process underpins numerous measurement techniques in atomic and molecular physics, and material science to study the structure and properties of matter. Despite the inherently quantum nature of the photoionization process, existing photoelectron based measurement techniques mostly rely on measuring the classical momentum of the emitted electrons, overlooking fundamental quantum aspects of the photoionization process. The emergence of a new research field at the border between attosecond physics and quantum information offers the opportunity to revisit the photoionization process and to investigate the possibility to develop photoelectron-based quantum metrology. In this talk, I will outline some of the open questions we aim to address, followed by recent experimental results.
11:05- 11:20	**Assist. Prof. Mizanur Rahaman**	Assist prof.	Quantum computing theory	Chalmers	Capacities of quantum Markovian noise for large times	Building a quantum memory capable of reliably storing multiple qubits for a long time is one of the main challenges of quantum information science. To understand the fundamental limits of quantum information processing in the presence of noise, we formulate the question of the optimal information storage over time in an abstract Shannon-theoretic model and determine an efficiently computable formula for information capacities when taking the limit of large time. This work takes a first step towards designing optimal encoding and recovery mechanisms for information processing in a noisy environment. This talk will be based on two joint works, one (https://arxiv.org/abs/2402.18703) with Nilanjana Datta (University of Cambridge) and Satvik Singh (University of Cambridge), and the other (https://arxiv.org/abs/2408.00116) with Mostafa Taheri (ENS de Lyon) and Omar Fawzi (ENS de Lyon).
13:15- 13:30	**Erica Magnusson**	PhD student	Quantum computing theory	Chalmers	Quantum computation of chemistry	Presenting two works from Rahmlab group: TC-AVQITE, an algorithm for quantum chemistry on quantum computers able to obtain more accurate results with shorter circuits, and MREM, a chemically motivated error mitigation method for near-term quantum computation
13:30- 13:45	**Anastasiia Ciers**	Research Specialis t	Quantum sensing, metrology and Control	Chalmers	High quality factor piezoelectric AlN nanomechanical resonators for hybrid quantum systems	High quality factor nanomechanical resonators find applications as precise displacement sensors, low-noise transducers between different (quantum) information carriers, or as massive probes of quantum mechanics. While SiN is a leading material for realizing low noise nanomechanics in the kHz to MHz frequency range, it is amorphous and as a result lacks built-in functionality. We demonstrate nanomechanical resonators in tensile-strained aluminum nitride, which is a piezoelectric material, and, thus, offers built-in electromechanical coupling. We exploit the tensile strain in the film to reach quality factors of up to 3×107 and Q×f -products surpassing 1013 Hz at room temperature. Future devices could exploit the built-in piezoelectricity for exploring tunable phononic circuits or adaptive mechanical quantum sensors.
13:45- 14:00	**Isak Lyngfelt**	PhD student	Quantum computing theory	Chalmers	Transferability of optimal QAOA parameters	In our recent work we examine the possiblity of re-using optimal parameters to the variational algorithm QAOA. This greatly reduces the complexity of running the algorithm, effectively by-passing the classical aspect of QAOA. We find that the symmetries of the problem being solved can guide or search for re-usable instances, and give a qualitative understanding of when and why such a method is possible.
14:00- 14:15	**Robin Thomm**	PhD student	Quantum computing experiment	SU	Addressed and Coherent Control of Rydberg States in Trapped Ion Strings	Trapped ions are a leading platform for quantum computing, offering naturally identical qubits with state-of-the-art gate fidelities and coherence times ranging from milliseconds to hours. While entangling gates with all-to-all connectivity have been demonstrated in medium-sized ion crystals, scaling to very long ion strings remains challenging. In these systems, gate performance is hindered by the increasing spectral density of motional modes, which reduces gate fidelities and slows down gate operations. Rydberg excitation of trapped ions provides a complementary approach, enabling fast, local entangling operations - on the sub-microsecond timescale - whose speed is independent of the total number of ions in the string. I will present recent results on the coherent addressing and excitation of individual ions to Rydberg states within a linear chain, demonstrate coherent population transfer between Rydberg levels, and discuss how these techniques can be combined to realize fast and scalable entangling operations in large ion chains.

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Thursday 15th May						
09:00-09:30	**Erika Andersson**	Professor SAB	Quantum communication	Heriot Watt University	Quantum cryptography beyond quantum key distribution: variants of quantum oblivious transfer	Modern cryptography is more than sending secret messages, and quantum cryptography is more than quantum key distribution. One example is oblivious transfer, which is interesting partly because it can be used to implement secure multiparty computation. We discuss a protocol for quantum XOR oblivious transfer, and how non-interactive quantum oblivious transfer protocols can be “reversed”, so that oblivious transfer is still implemented from a sender to a receiver, but so that it is the receiver who sends a quantum state to the sender, who measures it, instead of the other way round. This is useful when one party can only prepare and send quantum states, and the other party can only measure them, which is often the case in practical quantum communication systems. Both the “original” XOR oblivious transfer protocol and its reversed version have been implemented optically. We also discuss how quantum random access codes can be connected with quantum oblivious transfer.
09:30-10:00	**Jörg Wrachtrup**	Professor SAB	Quantum sensing, metrology and Control	Stuttgart University	Spins for Quantum Technology	Spin defects in wide band gap semiconductors are leading contenders in various areas of quantum technology. Early forerunners in the field, like the NV center in diamond have shown impressive progress for sensing, communication, and quantum computing. Single NV electron spin qubits, e.g., have matured into a new tool for imaging and sensing in material science. Multiple interacting spins in a spin network enable quantum algorithms for signal analysis, for example via a quantum Fourier transformation of AC signals. In the talk I will highlight the use of new multiqubit spin systems like spin defects in silicon carbide, to apply quantum algorithms to quantum sensing and simulation of a quantum thermodynamic processes. I will also show the use of quantum non-linear spectroscopy for enhanced quantum sensing and discuss the role of quantum spin microscopy in the discovery of a new magnetic phase.
10:00-10:30	**Steven Girvin**	Professor SAB	Quantum computing theory	Yale University	Tutorial Introduction to Quantum Random Access Memory (QRAM)	Classical random-access memory (RAM) is a black box that accepts an input bitstring (binary vector) A defining an address and returns the data bit string D stored in memory at that address. We can think of it as evaluating a function D(A). Quantum random-access memory (QRAM) works in a similar manner except that the address bitstring A is presented to the black box in the form of a quantum state and the black box returns an entangled quantum state with each data entry attached to its corresponding address. Unlike RAM, QRAM works even when the input is a large superposition of different addresses. No QRAMs have ever been constructed and yet they are required in many quantum algorithms that involve the input of large amounts of classical data. This talk will provide an elementary introduction to the subject.
11:00-11:30	**William Oliver**	Professor SAB	Quantum computing experiment	MIT	Directional Photon Emission, Absorption, and Remote Entanglement via Waveguide QED	In this talk, we present a demonstration of remote entanglement via chiral photon emission and absorption along a waveguide [1]. Superconducting qubits couple to the waveguide at multiple, well-separated locations through modules that deterministically emit and absorb single microwave photons. Using this architecture, we demonstrate directional single-photon emission with 96% fidelity and single-photon absorption exceeding 60% efficiency. We then use partial emission and absorption to generate remote entanglement – a four-qubit W-state – between qubits in the emitter and absorber modules with 62% fidelity. These works along with 3D integration target modular and extensible quantum information processing mediated by quantum interconnects. [1] A. Almanakly, et al., Nature Physics (2025) | arXiv:2408.05164 (2024)
11:30-12:00	**Mikael Rönnholm**		Director Emerging Technologies	Volvo Group	Quantum technologies at Volvo	
13:30-13:45	**Adithi Udupa**	Postdoc	Quantum computing theory	Chalmers	Performance of bosonic codes in the presence of random telegraph noise	Decoherence in quantum devices, such as qubits and resonators, is often caused by bistable fluctuators modeled as random telegraph noise (RTN), leading to significant dephasing. We analyze the impact of individual and multiple fluctuators on a bosonic mode in continuous variable systems, identifying non-Markovian behavior governed by two timescales: the fluctuator's switching rate (ξ) and coupling strength (ν). We further evaluate the performance of rotation symmetric bosonic (RSB) codes under simultaneous loss and RTN dephasing using a teleportation-based Knill error-correction circuit in both the markovian and non-markovian regimes. Average gate fidelity exhibits oscillations due to RTN noise yet stays above the break-even point across a range of parameters. Extending to multiple fluctuators that produce 1/f noise, we observe that non-Markovianity decays with increasing fluctuator count, but RSB codes remain effective within experimentally relevant limits.
13:45-14:00	**Shishir Khandelwal**	Postdoc	Quantum sensing, metrology and Control	LU	Current-based metrology with two-terminal mesoscopic conductors	The traditional approach to quantum parameter estimation focuses on the quantum state, deriving fundamental bounds on precision through the quantum Fisher information. However, in most experimental settings, performing arbitrary quantum measurements is highly unfeasible. An alternative approach to quantum parameter estimation involves the measurement of a stochastic transport observable, the thermodynamic current. However, the present understanding of current-based metrology is mostly limited to Markovian master equations. Considering a current-based parameter problem in a two-terminal mesoscopic conductor, we identify the key elements that determine estimation precision within the Landauer-Büttiker formalism. Crucially, this approach allows us to address arbitrary coupling and temperature regimes. In linear-response and zero-temperature regimes, we derive general expressions for the precision. For the specific parameter estimation task that we consider, we demonstrate that the boxcar transmission function is optimal for current-based metrology in all parameter regimes.
14:00-14:15	**Tangyou Huang**	Postdoc	Quantum computing experiment	Chalmers	Practical SPAM-Error Mitigation in Quantum Process Tomography	Accurate and robust quantum process tomography (QPT) is crucial for verifying quantum gates and diagnosing implementation faults in the experiments aimed at building a universal quantum computer. However, the reliability of the QPT protocols is often compromised by faulty probes, particularly state preparation and measurement (SPAM) errors, which introduce fundamental inconsistencies into the traditional QPT algorithms. In this work, we investigate an enhanced version of QPT for multi-qubit systems by integrating the error matrix into a digital twin of the identity process matrix, enabling the statistical refinement of SPAM error learning and improving the precision of QPT. Through numerical simulations, we demonstrate that this approach enables highly accurate and faithful process characterization, which is further experimentally validated using superconducting quantum gates, achieving an order-of-magnitude fidelity improvement over the standard QPT. Our results provide a practical and precise method for assessing quantum gate fidelity and enhancing QPT on a given hardware.
14:15-14:30	**Daiheng Fu**	PhD student	Quantum communication	KTH	Counter-propagating Nonlinear Interactions in Periodically Poled Thin Film LiNbO3	We discuss counter-propagating parametric three-wave mixing processes in x-cut periodically poled lithium niobate on insulator (PPLNOI) and present experimental results in frequency upconversion in photonic-wire waveguides with continuous-wave pumps in the telecom range. The quasi-phase-matching condition is fulfilled to third-order using a PPNOI grating with a period of 1.1 µm. With two tunable counterpropagating continuous-wave pumps in the telecom band around 1550 nm, we observed asymmetric acceptance bandwidths of 3 and 45 nm in the backward and forward direction, respectively. The device generates1.9 µW at 771.5nm from two 5.23 mW pumps near a degeneracy wavelength, around 1543nm.