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Scientific Quantum Conference 2025

Conference programme

April 8 - 9 2025

Aarhus Institute of Advanced Studies, Aarhus University

Conference programme – Day 1

09:30	10:00	Arrival/registration
10:00	10:10	**Welcome to DQC's Scientific Quantum Conference 2025** Nikolaj Zinner, AU, Kvantify & chairman of DQC
Chairperson day 1 – morning		Andreas Roepstorff, AIAS
10:10	10:55	**Keynote: Overview of quantum technologies - ion trapping in particular** Michael Drewsen, AU IFA
10:55	11:00	Short break
11:00	11:20	**First Experiences from Master of Science programme in Quantum Information Sciences** Jan Philip Solovej, KU/DTU
11:20	11:40	**New master in Quantum Computing at SDU** William Mistegård, SDU QM
11:40	12:00	Coffee break
12:00	12:15	**Optimization for Quantum Computing and Quantum Computing for Optimization** Rafal Wisniewski, AAU
12:15	12:30	**New Chip Competence Centre activities at DTU, AU, NBI and DFM** Farshad Moradi, DKCCC & AU
12:30	12:45	**Educational Quantum Advantage** Kim Splittorff, KU
12:45	13:00	**Societal implications of quantum computing and -technology** Peter Alexander Earls Davis, KU Law
13:00	14:00	Lunch break
Chairperson day 1 - afternoon		Kim Guldstrand, AAU
14:00	14:45	**Keynote: Quantum Computing - state-of-the-art - Software and Algorithm perspective – QUEX** Jørgen Ellegaard Andersen, SDU QM
14:45	15:05	**Hybrid Quantum Chemistry on Hybrid Quantum Computers** Karl Michael Ziems, DTU Chemistry
15:05	15:25	Coffee break
15:25	15:45	**Equivalence Checking of Quantum Circuits** Christian Schilling, AAU
15:45	16:05	**Tensor network state preparation and complexity** Daniel Malz, KU Mathematics
16:05	16:25	**Feedback-Based Quantum Algorithms for Eigenstate Preparation** Salahuddin A. Rahman, AAU Electronic
16:25	16:30	Short break
16:30	16:50	**Topological Quantum Computing with Quantinuum** Greyson Potter, SDU QM
16:50	17:10	**Enabling Quantum Chemistry Using Quantum Computers** Erik Kjellgren, SDU
17:10	17:30	Drinks
17:30	18:30	**Pre-dinner talk & discuss: Quantum Imaginaries linking Labs and Society** Andreas Roepstorff, AU AIAS
18:30	19:00	Walk or bus to **Restaurant Anker**, at Fiskerivej 12, 8000 Aarhus Centrum (20 minutes walk from AU AIAS)
19:00	23:00	Dinner

Conference programme – Day 2

09:00	09:30	Arrival and coffee
Chairperson Day 2 - Morning		Kim Splittorff, NQCP/KU
09:30	10:15	Keynote: Copenhagen Center for Biomedical Quantum Sensing Alexander Huck, DTU/KU
10:15	10:30	**Applications of Quantum Gravimetry: Activities at DTU Space** Tim E. Jensen, DTU Space
10:30	10:45	**Quantum enhanced Raman spectroscopy for bioimaging applications** Yijian Meng, DFM
10:45	11:05	Coffee break
11:05	11:20	**Private Product Computation Using Quantum Entanglement** René B. Christensen, AAU Mathematics
11:20	11:35	**QCI.dk** Michael Galili, DTU Electro
11:35	11:50	**Post Quantum Cryptography - Security proofs for crypto algorithms against quantum computing attacks** Christian Majenz, DTU Compute
11:50	12:40	Lunch break
Chairperson Day 2 – Afternoon		Rafal Wisniewski, AAU
12:40	13:25	Keynote: Towards state-of-the-art quantum computing hardware: NQCPs mission to the entanglement frontier Morten Kjaergaard, NQCP/KU
13:25	13:40	**Multi-Qubit Photonics Devices** Nika Akopian, DTU
13:40	13:55	**Quantum Computing and Material Physics** Jill Miwa, AU IFA
13:55	14:10	**NMR Spectroscopy and Quantum Physical Applications** Anders B. Nielsen, AU Chemistry
14:10	14:25	**Quantum Computing Applied to Weather Models and Related PDE Systems** Gard Olav Helle, SDU QM
14:25	14:30	**Wrap-up and adjourn: See you next year!** Kristine H. Falgren, DQC

WELCOME

by professor Nikolaj Zinner, chair of Danish Quantum Community

April 8, 10:00

Bio

This year's annual Scientific Quantum Conference will be opened with a welcome by the newly elected chair of Danish Quantum Community, Nikolaj Zinner. Nikolaj is a long-serving board member of DQC and is among the founders of Danish quantum startup, Kvantify. Nikolaj holds a PhD in nuclear physics, has worked as a postdoc at Harvard University, and has been in research collaborations with some of the world's most prestigious universities. This year's conference is also held at the home turf of Nikolaj, seeing as he also works as Professor at the Department of Physics and Astronomy at this year's venue, Aarhus University. Nikolaj is looking forward to welcoming you all to the conference.

Keynote: Overview of quantum technologies - ion trapping in particular

Professor Michael Drewsen, Department of Physics and Astronomy, Aarhus University

April 8th, 10:10-10:55

Abstract

Quantum technologies are advancing fast these years with important milestones being met by all major physical platforms. In the presentation, I will briefly present the advantage and status of the various platforms in a worldwide picture and discuss how they relate to the Danish Quantum Community as well as the national strategy on quantum technology. Admittedly, the presentation might be a bit biased towards trapped ions, the platform I know most about.

Speaker bio

Michael Drewsen is a professor in experimental physics at Aarhus University with interests in fundamental atomic and molecular investigations, as well as quantum technology with cold, trapped ions.

First Experiences from Master of Science programme in Quantum Information Sciences

Professor Jan Philip Solovej, Department of Mathematics, University of Copenhagen

April 8th, 11:00-11:20

Abstract

The joint DTU/ UCPH master's program on Quantum Information Science QIS started September 2023. I will give a short overview of the scope of the program and how interdisciplinarity plays an important role. I will give some statistics on the student applications and the current student body, i.e., total numbers, geographic and gender distributions, and student backgrounds. I will describe our international collaboration within the consortium Digiq. Finally, I will talk about two recent initiatives. One is to embed the QIS education in a broader educational landscape. The other is to build closer collaborations with industry partners.

Speaker bio

Jan Philip Solovej is Professor of Mathematics at University of Copenhagen. His research is within mathematical physics. He is the Head of studies of QIS and Center leader of QMATH, the VILLUM center for the Mathematics of Quantum Theory. He is currently also the President of the European Mathematical Society and Editor in Chief of the Journal of Mathematical Physics.

New Master in Quantum Computing at SDU

Assistant Professor William Mistegård, Department of Mathematics and Computer Science, University of Southern Denmark

April 8th, 11:20-11:40

Abstract

University of Southern Denmark (SDU) has launched a new master's program in quantum computing, which will start in the fall of 2025. In this talk, I will explain the main vision behind this master's degree, and I will highlight essential features and discuss how this program is complementary to similar programs in Denmark. Moreover, I will illuminate how this program is supported by a strong scientific environment with many quantum computing initiatives currently undertaken by the center for quantum mathematics at SDU.

Speaker bio

William Elbæk Mistegård (WEM) completed a PhD in mathematics (field: topological quantum field theory) at the University of Aarhus in 2019. Subsequently, WEM was a postdoc at Institute of Science and Technology, Austria, before he went to Center for Quantum Mathematics at University of Southern Denmark (SDU), where he is now an assistant professor. WEM was part of the group launching the new master's program in quantum computing at SDU.

Optimization for Quantum Computing and Quantum Computing for Optimization

Professor Rafal Wisniewski, Department of Electronic Systems, Aalborg University

April 8th, 12:00-12:15

Abstract

Control theory offers a framework for analyzing dynamical systems in terms of stability and optimality. It plays a role in quantum optimization, while quantum optimization, in turn, has the potential to address unresolved challenges in control theory. In this short talk, I will concentrate on one contribution of control theory to quantum optimization inspired by Lyapunov control theory. Feedback-based quantum algorithms were proposed as an alternative to VQAs to solve optimization problems. These algorithms have the advantage of deterministically assigning the circuit parameters by measuring the qubits from previous layers, avoiding the classical optimization problem associated with VQAs

Speaker bio

Rafal Wisniewski is a professor and a deputy head in the Department of Electronic Systems, AAU. He was a control specialist at Danfoss A/S, later a Vestas professor. He spent his sabbaticals at NASA Goddard Center, Mittag-Leffler Institute in Stockholm, Rise University, and ETH, Zürich. His research is in optimization, classical and quantum, and theory of decisions and learning

New Chip Competence Centre activities at DTU, AU, NBI and DFM

Professor Farshad Moradi, Danish Chips Competence Center & Aarhus University

April 8th, 12:15-12:30

Abstract

As the global demand for semiconductors grows, Europe's ambition to strengthen its chip ecosystem is more urgent than ever. The EU Chips Act aims to secure supply chains, boost innovation, and ensure Europe's competitiveness. Denmark is contributing to this mission through the Danish Chips Competence Center (DKCCC), which supports research, development, and skills in chip design and fabrication and related areas.

In this presentation, I will introduce the role of DKCCC, highlight our activities and services, especially for SMEs and academia—and explain how we are building capacity in advanced chip design and fabrication to support both national and European ambitions.

Speaker bio

Farshad Moradi is a Professor at Aarhus University and leads the national activities in chip design under the Danish Chips Competence Center. He holds a PhD in Nanoelectronics and began his academic career at Aarhus University as an Assistant Professor in 2011. His research focuses on chip design for sensing and computing, with a particular emphasis on energy-efficient integrated circuits. He is also the Chief Scientific Officer at CENEXUM, a spin out company developing brain-inspired computing solutions for monitoring and treating neurological disorders.

Educational Quantum Advantage

Associate professor Kim Splittorff, University of Copenhagen

April 8th, 12:30-12:45

Abstract

Talent within quantum technology is already now in high demand and lack of a well trained quantum workforce can be a severe bottleneck for the future expansion of the Danish quantum ecosystem.

This talk highlights some of the new initiatives at the Niels Bohr Institute and the Novo Nordisk Foundation Quantum Computing Programme which aims to give Denmark an Educational Quantum Advantage.

Speaker bio

Kim Splittorff is an associate professor at the Niels Bohr Institute, head of section for Quantum Information Science and Technology at the Niels Bohr Institute which hosts the Novo Nordisk Foundation Quantum Computing Programme. Ina addition Kim leads the Education and Outreach unit of Novo Nordisk Foundation Quantum Computing Programme.

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Societal Implications of Quantum Computing and -technology

Peter Alexander Earls Davis, Center for Advanced Studies in Bioscience Innovation Law, University of Copenhagen

April 8th, 12:45-13:00

Abstract

The development of quantum computers is increasingly a geopolitical and social issue. Legal tools are often reached for to encourage their development, reduce rivals' access to key resources, and to mitigate against their anticipated threats. Peter will discuss recent export controls on key quantum computing technologies and regulatory efforts in the post-quantum encryption space. He will also provide an overview of the quantum and law research efforts within the University of Copenhagen's Inter-CeBIL project.

Speaker bio

Peter Davis is a Postdoctoral Research for the Inter-CeBIL project at the Faculty of Law in the University of Copenhagen. His research activities focus on the regulation of emerging technologies like artificial intelligence and quantum computing.

Keynote: Overview of the latest results and development at Centre for Quantum Mathematics, SDU

Professor Jørgen Ellegaard Andersen, Department of Mathematics and Computer Science, University of Southern Denmark

April 8th, 14:00 -14:45

Abstract

We will in this talk give an overview of some of the research results obtained the past year at the centre, with special focus on our results on using Gaussian Boson Sampling to approximate Gaussian Weighted Integrals, achieving exponential speedup over Monte Carlo Sampling under certain conditions. We will further cover major recent events and industry projects and partnerships, which the centre is involved in currently.

Speaker bio

Jørgen Ellegaard Andersen is Professor and chair of Quantum Mathematics at the Danish Institute for Advanced Studies and he is the Director of both the Center for Quantum Mathematics and the SDU Q-Hub at University of Southern Denmark. He holds simultaneous a Simon Collaborator grant and an ERC-Synergy Grant, the two most prestigious grants in America and Europe respectively. He is further the founder and CEO of the spin off company Qpurpose, which produces Quantum Software to a brought range of the largest Danish and International companies.

Hybrid Quantum Chemistry on Hybrid Quantum Computers

Postdoc Karl Michael Ziems, Department of Chemistry, Technical University of Denmark

April 8th, 14:45 -15:05

Abstract

The talk will present quantum linear response (qLR) for modelling of spectroscopic properties on quantum computers. This is a reformulation of classic linear response (LR) using a unitary and truncated active-space version of the multi-configurational self-consistent field LR ansatz. Therein, different near-term qLR formalisms and extensions in the form of reduced density matrices, subspace approaches and polarizable embedding will be investigated.

The talk presents results in terms of absorption spectra, electronic circular dichroism spectra, and polarizabilities of small molecule. It studies in-depth the impact of noise and show proof-of-concept results from experiments on the IBM Osaka machine.

Speaker bio

Karl Michael Ziems is a Lecturer in Computational Chemistry at the University of Southampton (UK) and has an Adjunct position at the Technical University of Denmark within the “Hybrid Quantum Chemistry on Hybrid Quantum Computers” (HQC2) project. His research focusses on the development of algorithms for quantum chemistry and dynamics on quantum computers.

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Equivalence Checking of Quantum Circuits

Associate Professor Christian Schilling, Department of Computer Science, Aalborg University

April 8th, 15:25 -15:45

Abstract

In traditional software, an algorithm (a sequence of high-level instructions) is compiled to low-level hardware instructions to run on a computer. In quantum computing, a quantum circuit (a sequence of high-level quantum gates) is compiled to low-level quantum gates to run on a quantum computer.

This motivates equivalence checking between two quantum circuits to guarantee that the computation yields the same result. However, the straightforward approach scales exponentially in the number of qubits.

We discuss a new technique for equivalence checking of quantum circuits that can often avoid the exponential blow-up in practice. Specifically, we combine tensor networks and decision diagrams.

Speaker bio

Christian Schilling is a computer scientist, associate professor, and steering member of the Quantum Hub at AAU. His research interests are safe artificial intelligence, formal verification of cyber-physical systems, and symbolic analysis of quantum circuits. He is principal investigator of a Sapere Aude project on safe neural-network controllers, and co-investigator of a DeiC project on verification of quantum circuits.

Tensor network state preparation and complexity

Assistant Professor Daniel Malz, Department of Mathematics, University of Copenhagen

April 8th, 15:45 -16:05

Abstract

I'll tell you about some of our recent work on preparing tensor network states on quantum devices. The general research question is motivated by the observation that ground states of gapped (and often also gapless) models are well described by tensor network states. To explore and simulate such states on quantum devices, we need to find ways to prepare them efficiently. More recently I've also wondered about what we could say about computational complexity (both quantum and classical) of tensor network states and I'll talk about some results in this direction as well. This work has been done together with Zhi-Yuan Wei, Georgios Styliaris, Rahul Trivedi, Freek Witteveen and Ignacio Cirac and my talk will be based on arXiv:2107.05873, 2307.01696, 2402.07975 and some ongoing work.

Speaker bio

Daniel Malz is an Assistant Professor at the Department of Mathematics at the University of Copenhagen, affiliated with QMATH. His research is supported by a 7-year RECRUIT grant from the Novo Nordisk Foundation. Daniel holds a PhD in physics from the University of Cambridge (UK), supervised by Andreas Nunnenkamp, and has completed postdoctoral work at the Max Planck Institute for Quantum Optics (Germany), with Ignacio Cirac, and at TU Munich.

Feedback-Based Quantum Algorithms for Eigenstate Preparation

Research Assistant Salahuddin A. Rahman, Department of Electronic Systems, Aalborg University

April 8th, 16:05 -16:25

Abstract

As quantum computing advances, variational quantum algorithms (VQAs) are among the most promising approaches to leverage near-term quantum devices for tasks that could demonstrate quantum advantage. Two primary challenges VQAs face are the design of the ansatz and the need to solve a challenging classical optimization problem to update the parameters of the parameterized quantum circuit. Inspired by control theory, feedback-based quantum algorithms are proposed as an alternative approach by replacing the classical optimizer with a control law that directly updates the quantum circuit's parameters. This talk will present feedback-based quantum algorithms tailored for calculating excited states and solving constrained optimization problems, highlighting their potential advantages and applications in quantum optimization.

Speaker bio

Salahuddin Abdul Rahman received his B.Sc. and M.Sc. in electrical engineering from Kuwait University in 2012 and 2016. From 2012 to 2020, he worked as an electrical engineer and part-time lecturer in the Public Authority for Applied Education and Training, Kuwait. He is currently a PhD fellow at Aalborg University, Denmark, researching the intersection of control theory and quantum computing.

Topological Quantum Computing with Quantinuum

Postdoc Greyson Potter, Department of Mathematics and Computer Science, University of Southern Denmark

April 8th, 16:30 -16:50

Abstract

The Jones polynomial is a powerful knot invariant, which was shown to be intimately related to Topological Quantum Field Theory (TQFT) by Witten. Subsequently, the work of Freedman, Kitaev, Larsen and Wang showed that TQFT provides an alternative "topological" model for quantum computation. It follows that approximating the Jones polynomial is a BQP-complete problem. Aharonov, Jones, and Landau were the first to describe an explicit quantum algorithm to compute such approximations. We will present an optimized implementation of this algorithm, with several improvements for special cases. Finally, we will discuss how such an implementation can be used to probe various conjectures in knot theory, as well as benchmark Quantinuum's hardware.

Speaker bio

Greyson Potter, Ph.D., is a Quantum Computing Infrastructure Developer at DeiC and a Postdoctoral Researcher at the Centre for Quantum Mathematics, SDU. He earned a Ph.D. in Mathematics from Boston University focusing on computational aspects of topological recursion and knot invariants. He is currently researching topological quantum computing and quantum algorithms for invariants from knot theory and TQFT.

Enabling Quantum Chemistry Using Quantum Computers

Postdoc Erik Kjellgren, Department of Physics, Chemistry and Pharmacy, University of Southern Denmark

April 8th, 16:50 -17:10

Abstract

Quantum chemistry is poised to be one of the killer applications of quantum computing, promising to revolutionize our ability to simulate and understand molecular systems. As we navigate the noisy intermediate-scale quantum (NISQ) era, the variational quantum eigensolver (VQE) has emerged as a leading algorithm for tackling quantum chemistry problems on currently available quantum hardware. This talk will explore the challenges and opportunities of performing molecular property calculations on real NISQ devices, using IBM's superconducting quantum architecture. Specific limitations, such as noise, hardware constraints, and algorithmic bottlenecks, will be discussed, along with potential strategies to mitigate them.

Speaker bio

Erik Kjellgren is a postdoctoral researcher in quantum chemistry at the University of Southern Denmark with a focus on quantum chemistry on quantum computers. His research activities focus on the utilization of noisy intermediate-scale quantum computing algorithms

Quantum Imaginaries linking Labs and Society

Director of Aarhus Institute of Advanced Studies, professor Andreas Roepstorff

April 8th, 17:30 - 18:30

Abstract

There is a certain quantum craze unfolding. A quantum perspective seems to offer and challenge the status quo across multiple domains, spanning natures of reality and cultures of practice, also outside the classical lab setting. Indeed, the Q word has become part of cool business strategies and high stringed international agreements. Irrespective of whether the physical realizations of these promises will ultimately deliver, this makes it an important topic to explore from a societal perspective for at least four reasons:

- because 'quantum' is part of global (knowledge) politics and contemporary (science) diplomacy.
- because it may offer different tools to think with also in domains that has hitherto been dominated by more classical linear models.
- because all of the above matters for future business and societal solutions, real and imaginary.
- because we should prepare future generations for entering competently into all of these strange loops...

Speaker bio

Andreas Roepstorff is professor, Department of Anthropology, and Director of Aarhus Institute of Advanced Studies, Aarhus University. Situated at interfaces of humanities, social sciences, natural sciences and medicine, his research is interdisciplinary. A key focus has been on how forms of knowledge are made, validated and negotiated in complex meshworks that span research traditions and technologies, imaginaries and materialities.

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Keynote: Copenhagen Center for Biomedical Quantum Sensing

Associate Professor Alexander Huck, Department of Physics, Technical University of Denmark

April 9th, 09:30-10:15

Abstract

In recent years, colour centres in diamond have appeared as a promising platform for quantum sensing. Owing to the unique material properties of diamond, even at room temperature these colour centres possess long quantum coherence, the possibility for coherent control, optical initialization and readout. In this talk, I will focus on the fundamentals of quantum sensing and how colour centres in diamond may be used for sensing in biological systems such molecules, cells or neuronal activity in the brain.

Speaker bio

Alexander Huck is Associate Professor at the Physics Department of the Technical University of Denmark. Together with his team, he is conducting research on colour centre physics, investigating their fundamental optical and spin properties and applying to to quantum sensing and information processing.

Applications of Quantum Gravimetry: Activities at DTU Space

Researcher Tim Enzlberger Jensen, Department of Space Research and Technology, Technical University of Denmark

April 9th, 10:15-10:30

Abstract

In collaboration with the French Aerospace Lab (ONERA), DTU Space carried out the first airborne gravity survey using quantum gravimetry in 2017. Since then, the GIRAFE quantum gravimeter, developed by ONERA, has demonstrated gravity results comparable and superior to modern instruments.

Additionally, DTU Space is engaged in deployment of terrestrial gravimeters. This summer we plan to use the Absolute Quantum Gravimeter (AQG) from Exail to measure gravity in Greenland. The measurement site is collocated with a permanent GNSS station located next to the rapidly retreating Ilulissat Icefjord. The AQG has primarily been used in laboratory environments, leaving the potential for climate monitoring in arctic regions to be demonstrated.

Speaker bio

Tim Enzlberger Jensen is a researcher at the department of Geodesy and Earth Observation at DTU Space. His research concerns gravity field modelling with a focus on gravity mapping using airborne platforms. Several recent research projects have focused on the deployment of quantum gravimeters, representing one of the most mature quantum sensing technologies.

Quantum enhanced Raman spectroscopy for bioimaging applications

Yijian Meng, scientist at Danish National Metrology Institute

April 9th, 10:30-10:45

Abstract

Stimulated Raman scattering (SRS) microscopy is crucial for label-free imaging of living biological samples. However, the Raman signal from small biological samples is typically weak, requiring high optical powers to achieve satisfactory signal-to-noise ratio levels, which can risk damaging or altering delicate biological samples. To overcome this challenge, we utilize quantum-enhanced SRS, which surpasses the quantum shot-noise limit by employing squeezed light. Our results demonstrate an improvement of more than 3 dB over shot-noise-limited SRS when imaging biological tissues.

Speaker bio

Yijian Meng is a research scientist and a member of the Quantum Metrology Department at the Danish National Metrology Institute (DFM). His research focuses on spectroscopy using squeezed light and single photons.

Private Product Computation Using Quantum Entanglement

Assistant Professor René Bødker Christensen, Department of Mathematical Sciences, Aalborg University

April 9th, 11:05 -11:20

Abstract

The differences between classical information and quantum information are highlighted through the 'No-cloning' theorem and the fact that quantum states collapse when measured. Initially, this may seem like a challenge or a nuisance. Used strategically, however, it can be seen as an opportunity, e.g. by using it to guarantee security in the BB84 key distribution protocol. In this talk, we exploit quantum properties in a similar way. More precisely, we show how entangled quantum states can be used to compute products in a privacy-preserving fashion.

Speaker bio

René Bødker Christensen is an assistant professor at Aalborg University, where he is associated with both the Department of Mathematical Sciences and the Department of Electronic Systems. His main research interests are in the area of quantum information, particularly when combined with techniques and applications from classical coding theory and private multiparty computation.

QCI.dk

Associate Professor Michael Galili, Department of Electrical and Photonics Engineering, Technical University of Denmark

April 9th, 11:20 -11:35

Abstract

QCI.DK is a quantum communication infrastructure being installed in Denmark under the Euro QCI program. It comprises several QKD technologies servicing a long distance link connecting Odense and Copenhagen, a metropolitan area network in Copenhagen and testbed links for emerging QKD technologies connecting university campuses of DTU-Lyngby, -Risø and NBI. In this talk we will discuss the structure and status of the QCI.DK infrastructure and the different QKD technologies present in the network.

Speaker bio

Michael Galili is Associate Professor at the Technical University of Denmark (DTU) in the department of Electrical and Photonics Engineering. Here he teaches and studies classical and quantum communication. Furthermore, he leads the QCI.DK workpackage on network components for QKD.

Post-Quantum Cryptography — Security Proofs for Cryptographic Algorithms against Quantum Computing Attacks

Associate Professor Christian Majenz, Department of Applied Mathematics and Computer Science, Technical University of Denmark

April 9th, 11:35 -11:50

Abstract

It is well-known that many important cryptographic algorithms are vulnerable to attacks based on Shor's algorithm. The solution of this problem is to switch to algorithms whose security is based on computational hardness assumptions that are believed to hold even for quantum computers. A lesser known fact is, that the mathematical proofs relating an algorithms security to the underlying hardness assumptions need to be changed as well in many cases, requiring the explicit use of quantum theory. In this talk, I will explain how the need for the explicit modelling of quantum attacks arises. Finally, I will give examples of contributions from the DTU cryptography group

Speaker bio

Christian Majenz has an M.Sc. in physics from University of Freiburg and a PhD in Mathematics from University of Copenhagen. Afterwards, he has been a postdoctoral researcher at the QuSoft center, University of Amsterdam and CWI. Currently, Christian is an Associate Professor at Technical University of Denmark. His main research interests are quantum aspects of cryptography.

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Keynote: Towards state-of-the-art quantum computing hardware: NQCPs mission to the entanglement frontier

Associate Professor Morten Kjaergaard, Novo Nordisk Foundation Quantum Computing Programme, University of Copenhagen

April 9th, 12:40 -13:25

Abstract

The Novo Nordisk Foundation Quantum Computing Programme (NQCP) is on a mission to enable the realisation of a fault-tolerant quantum computer and develop its applications. In this talk I will give a high level introduction to the programme, our approach and give early technical examples of how we are working on this ambituous goal. NQCP combines research and engineering in a data-driven project-based framework that enables cross-stack collaboration from fundamental materials R&D to advanced quantum processor design, sophisticated qubit control and processor-scale benchmarking. We are working on multiple chip-based quantum computing technologies and I will discuss early work particularly focused on superconducting qubits at NQCP.

Speaker bio

Morten Kjaergaard is associate professor of quantum information physics at the Niels Bohr Institute. He is the platform leader for superconducting qubits at the Novo Nordisk Foundation Quantum Computing Programme and is the principal investigator of the Superconducting Quantum Information Device Lab (SQuID Lab) with about 20 students and researchers working on theory and experiments for quantum information and computing with superconducting qubits.

Multi-Qubit Photonic Devices

Nika Akopian, Quantum Networks at DTU Electro

April 9th, 13:25 -13:40

Abstract

Semiconductor quantum dots are one of the best on-demand sources of single and entangled photons to date, simultaneously merging the highest brightness and indistinguishability of the emitted photons. They are, therefore, among the strongest candidates for practical single-qubit quantum photonic devices. However, to exploit the full advantage of quantum physics, multi-qubit photonic devices are vital. This talk will present our approach to realizing practical multi-qubit photonic devices for quantum photonic networks based on novel location qubits in crystal-phase quantum dots in nanowires.

Speaker bio

Nika Akopian leads the Quantum Networks group at DTU Electro. His research aims at exploring quantum information science at the nanoscale and developing novel quantum photonic devices that lie at the basis of the forthcoming Quantum Internet. He focuses on quantum control and manipulation of novel nanostructures at the single-photon and single-electron level, using nanowires, quantum dots, and hybrid atomic-solid state systems.

Quantum Computing and Material Physics

Associate Professor Jill Miwa, Department of Physics and Astronomy, Aarhus University

April 9th, 13:40 -13:55

Abstract

Altermagnets have recently emerged as a distinct class of magnetic materials driven by specific crystal symmetries. Unlike collinear ferromagnets and antiferromagnets, they exhibit a spin-polarized electronic band structure similar to ferromagnets while maintaining zero net magnetization, akin to antiferromagnets. This unique combination makes them highly promising for spintronic devices free from stray fields. Using angle-resolved photoemission spectroscopy with micron-scale spatial resolution, complemented by theoretical modeling, we identify Co1/4NbSe2 as the first layered altermagnetic material. Moreover, we demonstrate control over its low-temperature phase with ultrafast optical pulses. These findings not only advance spin-based technologies but also establish 'altertronics' as a new field, integrating altermagnetism into next-generation electronic devices.

Speaker bio

Jill Miwa is an Associate Professor in the Department of Physics & Astronomy at Aarhus University. She heads an experimental condensed matter physics group based at the ASTRID2 synchrotron exploring quantum materials to uncover new physics. She focuses on investigating their remarkable electronic and structural properties using angle-resolved photoemission spectroscopy with micron spatial resolution (microARPES) and scanning probe techniques

NMR Spectroscopy and Quantum Physical Applications

Anders Bodholt Nielsen, Academic Technical Staff, Department of Chemistry, Aarhus University

April 9th, 13:55 -14:10

Abstract

We discuss Magnetic resonance (MR) based quantum sensors exploiting electron spins to sense the nuclear spin environment. While nuclear spins sense nearby nuclei on a 1-10 Å length scale, electrons can sense nuclei within 0.1-10 nm giving rich opportunities for nanoscale sensing. To achieve specific and sensitive sensing, we need to control the electron-nuclear spin systems with sufficient precision while avoiding losses due to decoherence effects. To tackle this, we discuss our recent findings by designing and applying pulsed MW methods to extract information from unpaired electrons in radical systems in a static magnetic field of approximately 0.35 T.

Speaker bio

Anders Bodholt Nielsen has a position as an academic technical personal at the Department of Chemistry at Aarhus University working with Nuclear Magnetic Resonance (NMR) and Electron Paramagnetic Resonance (EPR). His research activities focus on the development of radio-frequency and micro-wave pulse techniques to improve the information content extraction in magnetic resonance.

Quantum Computing Applied to Weather Models and Related PDE Systems

Postdoc Gard Olav Helle, Department of Mathematics and Computer Science, University of Southern Denmark

April 9th, 14:10-14:25

Abstract

It has been theoretically demonstrated that quantum computers can offer significant computational advantage in solving various ordinary and partial differential equations. Despite these promising results, it remains challenging to extract the advantage in practice, even in the fault-tolerant realm. In this talk Gard will present an efficient quantum circuit that implements a high-order numerical scheme for solving the advection-diffusion equation, an important benchmark in computational fluid dynamics. This will illustrate some of the potential benefits and obstacles in leveraging quantum computers in this field.

Speaker bio

Gard Olav Helle is a postdoctoral researcher at the Center for Quantum Mathematics at SDU specializing in quantum algorithms.

His research is focused on developing quantum algorithms solving systems of PDEs related to weather and climate models.

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About the organizers

Scientific Quantum Conference 2025 is hosted by Danish Quantum Community in collaboration with Aarhus University and the Novo Nordisk Foundation. The conference will be held at Aarhus Institute of Advanced Studies at Aarhus University.

Danish Quantum Community is an initiative to bring together all quantum stakeholders in Denmark with the purpose of building a unified ecosystem and strengthening Denmark's efforts in quantum research and quantum technologies. DQC was established in 2021 and now has 50+ partners, including universities, quantum startups, established companies, funding agencies, industry associations, and more.

Learn more: https://dqc.dk/

Aarhus Institute of Advanced Studies (AIAS) was established in June 2013, based on the classical ideas of an Institute for Advanced Study, with IAS Princeton as a model. The mission of AIAS is to advance highest quality research at Aarhus University (AU) by attracting talented, highly qualified fellows worldwide and within all disciplines. Fellows are proved ideal opportunities to further develop their research in short to long fellowship periods by ensuring fellows' participation in various kinds of collaboration and exchange with researchers, research groups and advanced students at AU and abroad.

Learn more: About us

Danish Quantum Community

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