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DFS ABSTRACT BOOK

8-9 JUNE 2026 | ABSTRACT BOOK AVAILABLE ONLINE

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DFS ANNUAL MEETING 2026

TIME	MONDAY 8. JUNE	
8:30-9:00	Morning coffee and crossaint	
9:00-9:20	**Welcome** - O100 - Chair:Ian Bearden, Danish Physical Society	
9:20-10:20	**Plenum Talk** – O100 Associate Professor Thomas Tram, IFA Title: What Do We Really Know About the Universe? 	
10:30-12:00	**Quantum** – O100 *Chair: Morten Bache, Novo Nordisk Foundation*	**NICE,** Instrument Center for CERN Experiments. – U81 *Chair:Ian Bearden, Professor, Niels Bohr Institute, KU*
12:00-13:00	Lunch - SDU Restaurant & Coffee - Panorama	
13:00-14:30	**Education** – O100 *Chair: Sergio Ioppolo, Associate Professor, IFA, AU*	**Biophysics** – U81 *Chair: Liselotte Jauffred, Associate Professor, DTU Bio*
14:30-15:00	Coffee and Cake - Panorama	
15:00-16:30	**Industry** I – O100 *Chair: N. Asger Mortensen, Professor, POLIMA, Mads Clausen Institute (MCI), SDU-TEK*	
16:40-17:50	**Poster Session** – Panorama - Chair: Børge Svane	
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TIME	TUESDAY 9.JUNE	
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13:00-14:30	**Atmospheric physics & Black holes and gravitational physics** – O100 Co-Chair: *Carol Anne Oxborrow, DTU Space & Marica Minucci, NBI*	**Nano Quantum** – U75 *Chair: N. Asger Mortensen, Professor, POLIMA, Mads Clausen Institute (MCI), SDU-TEK*
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Day 1, 8th of June

Plenum Talk – O100

What Do We Really Know About the Universe?

Associate Professor Thomas Tram, Department of Physics and Astronomy, Aarhus University, Aarhus C, Denmark

Abstract:
A statement frequently attributed to Lev Landau says: "Cosmologists are often wrong, but never in doubt." Whether he ever said this is unclear, yet the quote has circulated widely and reflects a long-standing skepticism toward cosmology within parts of the physics community. Such skepticism is understandable: we observe only one Universe and cannot repeat the experiment, and for much of the 20th century cosmological data were sparse and uncertain.
Over the past 25 years, however, the situation has changed dramatically. High-precision measurements of the cosmic microwave background, large-scale structure, and distant supernovae have transformed cosmology into a precision science. At the same time, new tensions between independent datasets suggest that we may not yet have the full picture. Cosmologists are, perhaps, more in doubt than ever!
In this talk, I will review what we firmly know about the Universe, what we think we know, and where the genuine open questions lie, with the aim of placing modern cosmology in a broader physics perspective.

Quantum - O100 - Chair: *Morten Bache, Novo Nordisk Foundation*

Integrated quantum photonics devices for future quantum networks

Caterina Vigliar, Technical University of Denmark, Kongens Lyngby, Denmark

Abstract:
The future quantum internet will rely on controlling networks of entangled quantum states, enabling secure multi-point quantum communication by creating and distributing multi-partite photonic entangled states across quantum processors. This approach, while more complex than the commonly used two-point quantum communication, opens the door to a range of advanced applications beyond cryptography, such as Quantum Secret Sharing, Conference Key Agreement, and Blind Quantum Computation. Additionally, it facilitates Distributed Quantum Computation, where networks of quantum processors collaborate to enhance computational power while ensuring privacy and integrity. This method also paves the way for device-independent protocols that relax security assumptions on quantum devices.

Integrated quantum photonics technologies are crucial for developing the compact devices needed for the widespread adoption of such quantum processors. However, so far, quantum communications based on such a platform have been constrained by capacity and noise resilience. In this talk, we will explore how to build the necessary hardware to overcome these challenges and achieve the abovementioned applications. Specifically, we will examine the combination of three leading integrated quantum photonic platforms, silicon, silicon nitride, and indium phosphide, to create a network of miniaturized chips capable of processing high-dimensional photonic quantum systems with enhanced quantum state capacity and noise stability. We will also discuss our current plans for the hybrid integration of telecom quantum dot sources and high-speed optical components, outlining a realistic path from today's point-to-point Quantum Key Distribution systems to the widespread availability of quantum resources for advanced Quantum Communication and Remote Computing tasks.

Cavity optomechanics with suspended resonant mirrors

Aurelien Dantan, Aarhus University, Aarhus, Denmark
Trishala Mitra, Aarhus University, Aarhus, Denmark
Gurpreet Singh, Aarhus University, Aarhus, Denmark
Mikkel Kirkegaard, Aarhus University, Aarhus, Denmark
Ali A. Darki, Aarhus University, Aarhus, Denmark
Søren P. Madsen, Aarhus University, Aarhus, Denmark

Abstract:
Optomechanical microcavities provide strong confinement of light and enable enhanced interactions between light and mechanical motion, facilitating the control of mechanical motion in the quantum regime or high-sensitivity sensing applications.

In this work, we investigate the optomechanical properties of small mode-volume “Fano” cavities using ultrathin, flexible “Fano” mirrors, in the form of 150nm-thick suspended silicon nitride films patterned with subwavelength grating structures supporting high-Q optical resonances [1]. The interference between the cavity mode and these resonances gives rise to Fano line shapes with unconventional optical response.

We demonstrate that, at short cavity lengths (few microns), these Fano cavities exhibit significantly narrower spectral linewidths as compared to conventional broadband mirror cavities with identical length and internal losses [2,3], and experimentally observe much stronger than expected optomechanical interactions between light and the suspended mirror [4].

References

[1] A. Naesby and A. Dantan, Optics Express 26, 29886 (2018)
[2] T. Mitra, G. Singh, A. A. Darki, S. P. Madsen, and A. Dantan, Optics Express 32, 15667 (2024)
[3] M. Kirkegaard, T. Mitra, G. Singh, and A. Dantan, Optics Continuum 4, 2632 (2025)
[4] T. Mitra, G. Singh, S. P. Madsen, and A. Dantan, in preparation (2026)

Connecting individual atoms with light

Jean-Baptiste Béguin, Niels Bohr Institute, Copenhagen, Denmark

Abstract:
In the past few years, neutral-atom arrays have emerged as a formidable platform for quantum simulation and quantum computing. However, the speed at which entanglement and quantum information can propagate remains fundamentally constrained by the nature and range of the interactions between atoms.

Beyond the realization of controlled atom-atom interactions, another major challenge is the efficient preparation, manipulation, and readout of large-scale atomic systems.

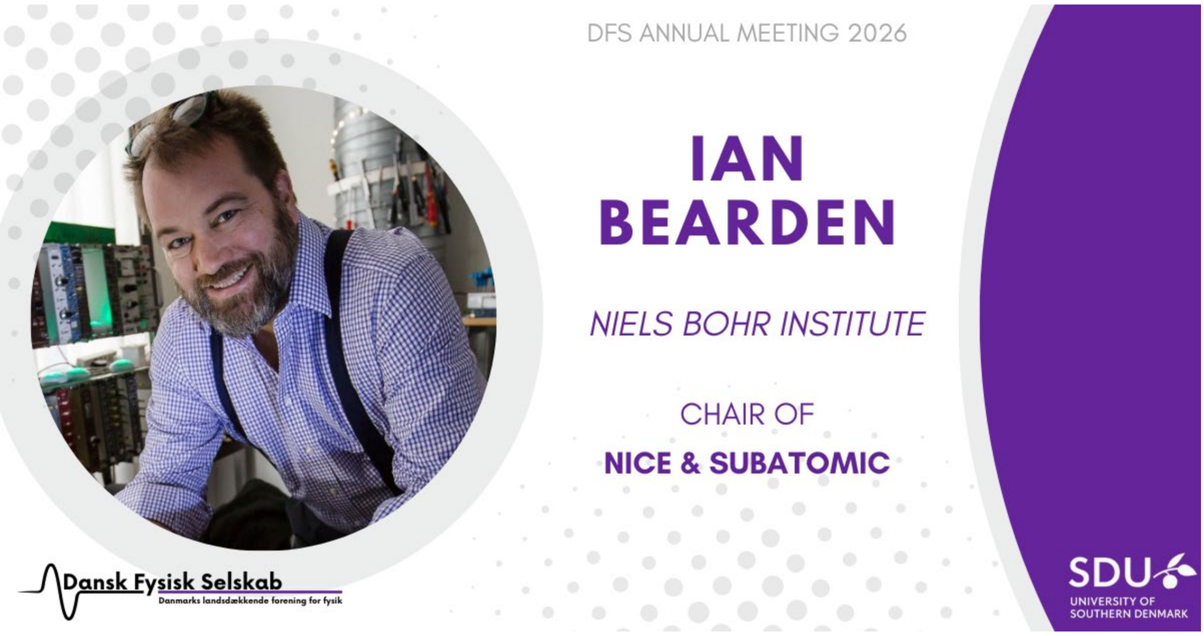
In this talk, I will discuss an emerging frontier in quantum optics that combines neutral atoms with engineered nanophotonic structures, where guided light can mediate long-range and programmable interactions, while enabling new approaches for quantum control, measurement, and sensing.

From Bell violations to trustworthy quantum technologies.

Laura Mancinska, University of Copenhagen, Copenhagen, Denmark

Abstract:
In this talk, I will address the fundamental question of how to certify the proper functioning of black-box quantum devices. We will see that violations of Bell inequalities provide a powerful tool for a classical user to certify that potentially malicious or uncharacterised devices behave in a trustworthy manner. These ideas lead to the framework of device-independent protocols, in which one makes minimal assumptions about the internal workings of the devices and bases all guarantees solely on observed statistics. Such protocols enable not only the certification of quantum states and measurements, but also more advanced functionalities, including private randomness generation.

NICE, Instrument Center for CERN Experiments. - U81 - Chair: Ian Bearden, Professor, Niels Bohr Institute, KU



Seeing the Future in Photons: Fast ECAL Smearing Simulation Studies for τ Physics at FCC-ee

Leonora Misciattelli Mocenigo Soranzo, Niels Bohr Institutet, Københavns Universitet, København, Denmark

Abstract:
At the FCC-ee, τ leptons will be produced in enormous numbers, turning them into precision messengers of the Standard Model (SM) and possible windows to Beyond Standard Model (BSM) physics. Their hadronic decays contain detailed information about τ polarisation, but accessing this information depends critically on the reconstruction of neutral pions (π^0) through their two-photon decay ($\pi^0 \rightarrow \gamma\gamma$).This project studies how electromagnetic calorimeter (ECAL) performance shapes the reconstruction of neutral pions (π^0 mesons) in $e^+e^- \rightarrow Z \rightarrow \tau^+\tau^-$ events at a center-of-mass energy of $\sqrt{s}$ = 91.2 GeV.

A dedicated Toy Model was developed using KKMCee-generated events to simulate $\pi^0 \rightarrow \gamma\gamma$ decays, apply detector-inspired smearing, include photon merging and fake-photon effects, and reconstruct neutral pions using a mass-constrained photon-pair fit.

By comparing ECAL parameterisations inspired by future FCC-ee detector concepts, the study evaluates how energy resolution, angular granularity, and photon contamination affect π^0 reconstruction. These detector effects propagate directly into τ-polarisation-sensitive observables, such as pion energy asymmetry, and therefore influence the precision potential of future τ physics.

The work highlights how the ability to resolve photons today may determine how clearly the FCC-ee can probe new physics tomorrow.

Flow in small systems at the LHC

Zhiyong Lu, Niels Bohr Institutet, Copenhagen, Denmark
Emil Gorm Dahlbaek Nielsen, Niels Bohr Institutet, Copenhagen, Denmark
Maxim Virta, Niels Bohr Institutet, Copenhagen, Denmark

Abstract:
Low-energy nuclear experiments have well constrained the structure of the nuclear ground state, but whether this established structural picture remains consistent at higher energies remains an open and critical question in nuclear physics. Geometry-driven observables, such as anisotropic flow measured in high-energy heavy-ion collisions, enable the extraction of nucleon spatial positions on an event-by-event basis, thereby providing a direct snapshot of the many-body correlations and collective behaviors within the colliding nuclei. These flow measurements, typically obtained via multiparticle correlation techniques, are particularly well-suited to probe nuclear geometry under the extreme conditions of heavy-ion collisions. This talk reviews the recent experimental progress in nuclear structure studies, spanning from heavy-ion to light-ion collision systems, at the Large Hadron Collider (LHC). Emphasis is placed on how high-energy collision observables complement low-energy measurements, offering new insights into the spatial distribution of nucleons and nuclear geometry.

The ATLAS Inner Tracker for the High-Luminosity LHC

Thomas Schiøler, Niels Bohr Institute, Copenhagen, Denmark
Craig Wiglesworth, Niels Bohr Institute, Copenhagen, Denmark

Abstract:
The High-Luminosity phase of CERN's Large Hadron Collider (HL-LHC) is due to start in 2030 and will deliver approximately an order of magnitude more data than previous runs. This dataset will enable precision measurements of the Higgs boson’s properties and enhance sensitivity to a wide range of new-physics scenarios. However, the increase in luminosity also introduces a number of experimental challenges and, as such, the ATLAS Experiment at CERN is undergoing a number of major detector upgrades. One such upgrade is a new, all-silicon, Inner Tracker (ITk), which is currently being built to replace the existing tracking system. In this talk I will present the status of the ATLAS Inner Tracker, with a focus on Denmark's contributions to the project. The operational performance of the new detector modules, as measured in test-beam experiments, will also be reported.

Education - O100 - Chair: Sergio Ioppolo, Associate Professor, IFA, AU

AI in higher education from a pedagogical perspective

Mads Dahl, Aarhus University, Århus C, Denmark

Abstract:
Artificial intelligence is rapidly reshaping higher education—but what does this mean for teaching and learning? This presentation explores AI not as a technical tool, but as a pedagogical and didactical challenge and opportunity. It highlights how AI can support personalised learning, enhance feedback, and increase student engagement when aligned with thoughtful teaching strategies. At the same time, the session critically addresses key tensions: the risk of over-reliance, challenges to critical thinking, and changing assessment practices. Particular attention is given to emerging issues of collaboration as pedagogical format and transparency of learning technology. When generative AI mediates student work, questions arise around authorship, shared responsibility, and the visibility of learning processes. The presentation emphasises the educator's role in guiding reflective learning and meaningful engagement with generative AI in pedagogical design.

AI in higher education from a lecturer's perspective

Jill Atsuko Miwa, Aarhus University, Aarhus, Denmark
Mads Hundahl, Aarhus University, Aarhus, Denmark
Rasmus Hansen, Aarhus University, Aarhus, Denmark
Ida Bang Hansen, Aarhus University, Aarhus, Denmark
Stephan Pieter Smuts, Aarhus University, Aarhus, Denmark
Christopher Neil Prilop, Aarhus University, Aarhus, Denmark
Rikke Frøhlich Hougaard, Aarhus University, Aarhus, Denmark

Abstract:
Generative AI is already part of how university students study, but its educational value depends

strongly on how it is designed and integrated into teaching. In STEM subjects such as physics, the goal is not simply to help students reach correct answers, but to support conceptual understanding, mathematical reasoning, problem-solving strategies, and critical reflection.

In this talk, I will present a lecturer's perspective on developing and testing two purpose-built AI tutors for a second-year electrodynamics course in the BSc Physics program at Aarhus University. Eddy is a conversational tutor designed to guide students through concepts and problem-solving steps without simply providing solutions. Ella is a feedback tutor that helps students reflect on and improve written work, presentations, and scientific communication. Together, they provide a concrete testbed for exploring whether AI tutors can support meaningful learning in physics.

Although the findings are preliminary, they suggest that carefully designed AI tutors can become valuable learning partners in physics education: not tools that replace student thinking, but tools that help students practice it more actively, confidently, and independently.

AI in higher education from a student's perspective

Emilie Jørgensen, Aarhus Universitet, Aarhus, Denmark

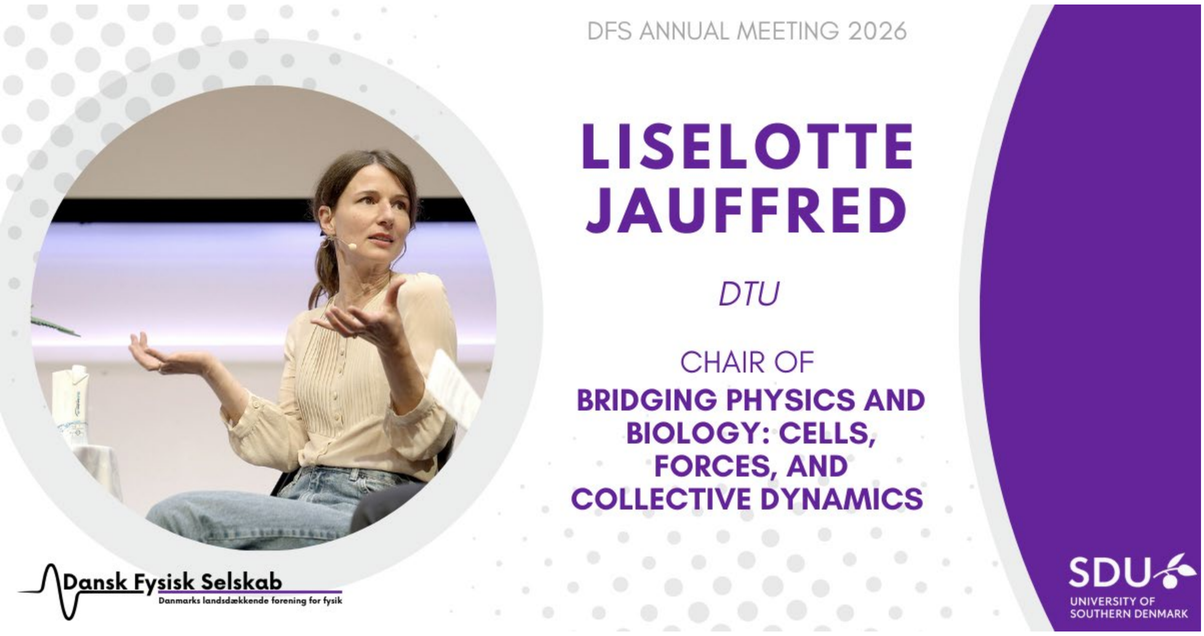
William Møller Johansen, Aarhus University, Aarhus, Denmark

Christoffer Emil Juul Hansen, Aarhus University, Aarhus, Denmark

Abstract:
The use of AI has vastly changed the way students learn and become educated. More now than ever, it is important to discuss challenges and useability of AI in education and when not to use it. How do three students approach AI in their higher education, and how do they use AI as students?In this talk, we are three students who will present personal insights and opinions on our own use of AI in our higher education and participate in the open panel discussion at the end of the session. This talk is part of a larger educational talk with Sergio Ioppolo as chair on the first day from 13:00-14:30.

Moderated panel discussion with audience participation.
Moderated by Rikke Frøhlich Hougaard (CED)

Biophysics - U81- Chair: Liselotte Jauffred, Associate Professor, DTU Bio



Cells as soft materials: order, disorder, shape and collective behavior

Francesca Serra, *Department of Physics, Chemistry and Pharmacy, SDU*

Abstract:
Cells are complex living systems, but they are also physical objects that interact with a soft and dynamic environment. As a result, many aspects of cellular behavior can be understood through the principles of soft matter physics, both at the single-cell and multicellular levels.

Our research focuses on the collective behavior of spindle-shaped cells, which spontaneously align with one another. This behavior resembles that of nematic liquid crystals—states of matter between liquids and solids, characterized by long-range orientational order and the presence of topological defects. Increasing evidence suggests that these defects act as organizational centers associated with elevated mechanical stress. We investigate how topological defects influence collective cell migration, tissue organization, and morphogenesis.

Cell polarity: a driver of morphological diversity and robustness?

Ala Trusina

The Force of Softness: How Cells Use Mechanics to Organize Tissues

Tianxiang Ma, Niels Bohr Institute, University of Copenhagen, Denmark

Abstract:
Cellular softness is a defining material property of living tissues, yet its role in regulating collective biological processes remains poorly understood. In this talk, I will discuss how differences in cell stiffness guide tissue-scale organization in two contexts: embryonic lineage

segregation and epithelial cell extrusion. Combining experiments with two- and three-dimensional phase-field modeling, we show that differential elasticity can drive the sorting of embryonic stem-cell populations, while contractility-induced stiffening can generate tensile stresses that promote epithelial extrusion. Together, these studies suggest that softness is not simply a mechanical signature of cellular state, but an active regulator of biological function, linking measurable material properties to collective tissue organization, development, homeostasis, and disease.

Industry I - O100 - Chair: N. Asger Mortensen, Professor, POLIMA, Mads Clausen Institute, SDU-TEK

Metalenses for imaging

Villads Egede Johansen, NIL Technology, Kgs Lyngby, Denmark

Abstract:
Optical metasurfaces are surfaces consisting of so-called meta-atoms, which are subwavelength structures designed to locally manipulate phase, amplitude and/or polarisation of the incident light. There are numerous applications of metasurfaces proposed within sensing, security, communication and other areas. However, there are also numerous artefact and manufacturing issues that could prevent the commercialisation of these applications.
In this presentation we focus on what it takes to design metalenses for imaging applications and all the advantages and disadvantages that follow. This include performance metrics such as size and image quality as well as how manufacturing tolerances and assembly affect metalenses differently to normal refractive optics.

Copenhagen Microsystems

Anpan Han, Copenhagen Microsystems, Risø, Denmark

Abstract:
Copenhagen Microsystems is a Danish startup from the Technical University of Denmark that aims to bring ice lithography to, and add value to R&D organizations. This innovative nanoscale 3D printing technology utilizes condensed vapors to build intricate structures at the nano and microscale. By precisely controlling the freezing, electron-beam direct writing, and thawing process, we can fabricate highly detailed patterns and components with unmatched accuracy.

This digital technology is applicable across important sectors, including microchip, quantum technologies, photonics, biomedicine, science, and education.

I will introduce our company and products, and my presentation will then pivots towards chemistry and physics.

ColorFoil – Non-Absorbing Customized-Colored Interlayers for Building-Integrated Photovoltaics

Catarina G. Ferreira, POLIMA —Center for Polariton-driven Light–Matter Interactions, University of Southern Denmark, Odense, Denmark, SDU Climate Cluster, University of Southern Denmark, Odense, Denmark, CAPE—Centre for Advanced Photovoltaics and Thin-film Energy Devices, University of Southern Denmark, Sønderborg, Denmark
Ananta Paul, SDU Climate Cluster, University of Southern Denmark, Odense, Denmark, CAPE—Centre for Advanced Photovoltaics and Thin-film Energy Devices, University of Southern Denmark, Sønderborg, Denmark
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Nanna L. Andersen, Department of Electrical and Photonics Engineering, Technical University of Denmark, Roskilde, Denmark
Sune Thorsteinsson, Department of Electrical and Photonics Engineering, Technical University of Denmark, Roskilde, Denmark
Peter B. Poulsen, Department of Electrical and Photonics Engineering, Technical University of Denmark, Roskilde, Denmark
Karlis Petersons, Stensborg A/S, Roskilde, Denmark
Leif Yde, Stensborg A/S, Roskilde, Denmark
Jan F. Stensborg, Stensborg A/S, Roskilde, Denmark
N. Asger Mortensen, POLIMA—Center for Polariton-driven Light–Matter Interactions, University of Southern Denmark, Odense, Denmark, SDU Climate Cluster, University of Southern Denmark, Odense, Denmark, Danish Institute for Advanced Study, University of Southern Denmark, Odense, Denmark
Joel D. Cox, POLIMA—Center for Polariton-driven Light–Matter Interactions, University of Southern Denmark, Odense, Denmark, SDU Climate Cluster, University of Southern Denmark, Odense, Denmark, Danish Institute for Advanced Study, University of Southern Denmark, Odense, Denmark
Morten Madsen, SDU Climate Cluster, University of Southern Denmark, Odense, Denmark, CAPE—Centre for Advanced Photovoltaics and Thin-film Energy Devices, University of Southern Denmark, Sønderborg, Denmark

Abstract:
Photovoltaic (PV) modules for building integration must not only fulfil the usual technical requirements – low cost, long-term stability, high power conversion efficiency – but also harmonize with the architecture of the host building and its surrounding environment. An effective route to meet these aesthetic demands relies on adding colored elements in front of the PV module. However, traditional coloration techniques typically employ absorbing dyes and

pigments, which severely compromises the efficiency of the underlying modules. To avoid it, recent efforts have been devoted to the use of structural colored elements that take advantage of nano-optical effects to produce vivid colors with low optical losses. This is the principle behind ColorFoil, a Danish-based project dedicated to the development of non-absorbing-colored interlayers that can be fabricated at large scale and incorporated into the PV laminate, regardless of its area or geometry. In their core lies a planar thin-multilayer element that takes advantage of light interference effects to produce a broad gamut of color hues. To meet the color demands of the consumers, the configuration of this multilayer structure is first optimized via inverse-design approach and then realized by roll-to-roll magnetron sputtering deposition onto a flexible polymeric foil incorporating optical diffusers to form the colored interlayer. To demonstrate the viability of the proposed technology, colored PV mini-modules were fabricated from such ColorFoil interlayers, demonstrating an outstanding matching to the target colors with low power conversion efficiency losses – between 10% to 18% depending on the color – approaching the theoretical limits.

[1] C.G. Ferreira et al. Optical design of structural colored photovoltaics for building integration: from periodic configurations to optimization algorithms. Nano Energy 148, 11659 (2025)
[2] C.G. Ferreira et al. Structural colored planar multilayers with minimal angular color dependence for building integrated photovoltaics. Solar RRL 9, e202500674 (2025)
[3] C.G. Ferreira et al. Design and optimization of structural colored interlayers for building-integrated photovoltaic applications. Proceedings of 41st EU PVSEC (2024)
[4] A. Paul et al. Customizable ColorFoil for photovoltaic modules: a new approach to aesthetic and efficient solar energy integration. Proceedings of 42nd EU PVSEC (2025)

Plenum Talk – O100

Atomic alchemy with Feynman-materials

Professor Peter Bøggild, DTU Physics

Abstract:
Today, we can stack very different atom-thin crystals almost at will, like a deck of cards made of quantum matter. Feynman once asked "What could we do with layered structures with just the right layers? What would the properties of materials be if we could really arrange the atoms the way we want them?". In one corner of physics, that future has now arrived. These stacks are not ordinary compounds. They are programmable designer materials, with properties completely different from those of the individual layers. Graphene, for example, can become metallic, insulating, or even superconducting, depending on how it is placed in the stack and what it touches. So what's next? Now, we want to combine 2D materials with nanometer thin oxide membranes disguised as 2D materials in search of new quantum phases of electrons. In this talk I would like to share some of the possibilities (and concerns) this sci-fi-like "atomic alchemy" presents.

Day 2, 9th of June

Plenum Talk - O100

Beyond Lambda-CDM: A Route to a New Cosmological Paradigm

Associate Professor Sofie Marie Koksbang, SDU Physics

Abstract:
Over the past decades, cosmology has rested on a single model: The standard model of cosmology, known as the Lambda-CDM model. The model has provided an extraordinarily successful description of a wide range of cosmological observations. As highlighted in the preceding talk by Thomas Tram, precision measurements of the cosmic microwave background, large-scale structure, and supernovae have elevated cosmology to a data-rich, quantitative science. At the same time, this wealth of data has begun to expose cracks in the standard picture.

In this talk, I will argue that we may be witnessing a transition point: not merely the appearance of isolated tensions, but indications that the data are beginning to outgrow the standard model itself. While the Lambda-CDM has long faced conceptual challenges, recent observational discrepancies may provide a new opportunity to move beyond the current paradigm.

I will briefly review the key observations driving this perspective before placing them in a broader historical context, tracing the roots of modern cosmology back to Albert Einstein's original construction of a static universe. This perspective highlights how deeply our current framework is tied to specific symmetry assumptions. Motivated by this, I will explore a new route forward: data-driven and model-independent approaches to cosmology.

The current situation in cosmology represents an opportunity. With rapidly improving observations and new analysis strategies, we are on the verge of uncovering a deeper and more fundamental description of the Universe.

Industry II - O100 - Chair: N. Asger Mortensen, Professor, POLIMA, Mads Clausen Institute, SDU-TEK

From Photonic Chips to Companies

Nick Volet, Aarhus University, Aarhus, Denmark

Abstract:
Integrated photonics has evolved from an academic research field into a technology platform supporting applications in telecommunications, quantum technologies, healthcare, and sensing. Using examples from Aarhus University, UV Medico, EMode Photonix, and QVersion, this talk will discuss how photonic ideas move from design and prototypes to products, software tools, and companies, highlighting both technical and organisational challenges encountered along the way.

Towards Fault-Tolerant Quantum Computation with Neutral Atoms in Optical Tweezer Arrays

Gerard Valentí-Rojas, Atom Computing, Copenhagen, Denmark
Alex Elliott Atom Computing, Copenhagen, Denmark

Abstract:
Quantum computing platforms based on arrays of tweezer-confined neutral atoms have emerged as a competitive modality thanks to a direct path towards high qubit count, rapidly advancing operation fidelities and their ability to execute circuits with arbitrary qubit connectivity. In this talk, we give an overview of the recent results at Atom Computing based on our zone-based architecture. We showcase high-fidelity two-qubit operations paired with reset, reuse and replacement of atoms. We demonstrate delayed erasure conversion, control of several logical qubits, many cycles of syndrome extraction, and a path towards fault-tolerant quantum computation.

Contribution from Sparrow Quantum

Oliver Luscombe Nørregaard Sparrow Quantum, Copenhagen, Denmark

Multispectral Imaging and Spectroscopic Analysis for Non-Destructive Investigation of Paintings

Mads Svanborg Peters, Newtec Engineering A/S, Odense M, Denmark

Jacek Fiutowski, Mads Clausen Instituttet, NanoSYD, Syddansk Universitet, Sønderborg, Denmark

Arkadiusz Goszczak, Mads Clausen Instituttet, NanoSYD, Syddansk Universitet, Sønderborg, Denmark

Abstract:

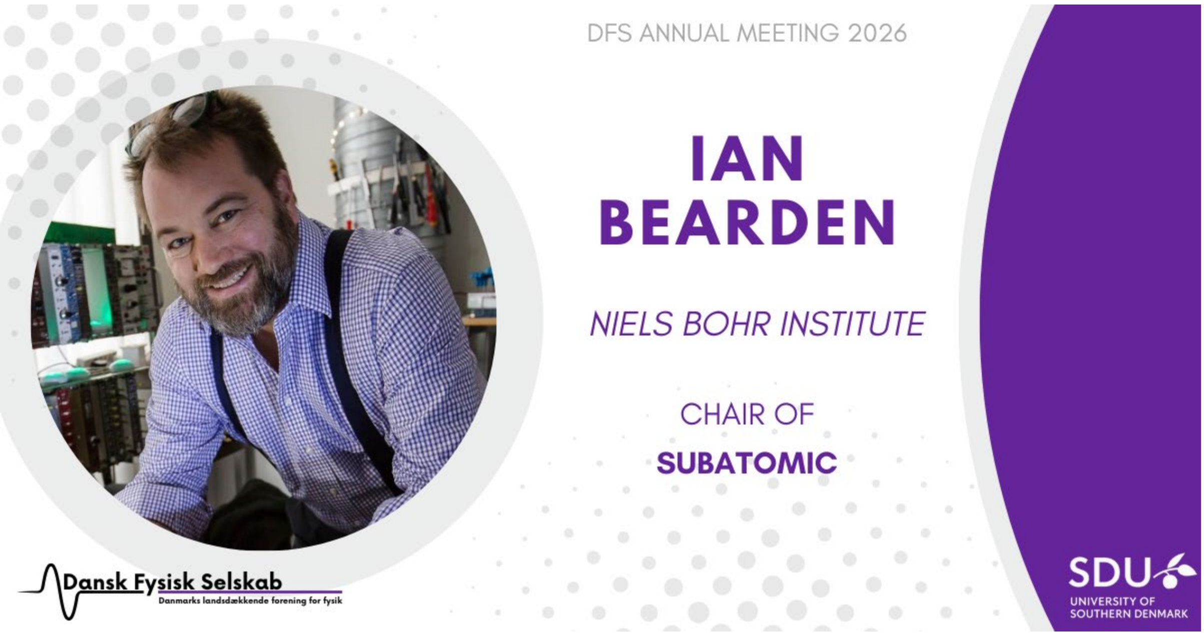
Multispectral imaging combined with microscopic and spectroscopic techniques provides a powerful approach for the non-destructive analysis of complex layered materials such as paintings. In this work, we investigate artworks by Vilhelm Lundstrøm using a custom-built multispectral imaging system covering 400–1700 nm.

The system acquires spectral data cubes, enabling pixel-wise reflectance analysis across visible and short-wave infrared wavelengths. This reveals hidden features such as underdrawings, compositional guidelines, and previously unobserved structures. Spectral unmixing is applied to identify and map pigment distributions, demonstrating that visually similar regions can exhibit distinct spectral signatures.

To validate and extend these results, complementary analyses using SEM-EDX and Raman spectroscopy are performed, providing detailed information on elemental composition and molecular structure of pigments.

The combined methodology integrates non-destructive imaging with micro-destructive techniques, offering a comprehensive framework for material characterization. This interdisciplinary approach highlights the potential of advanced optical methods in cultural heritage research, enabling deeper insight into both visible and hidden aspects of artworks.

Subatomic - U75 - Chair: Ian Bearden, Professor, Niels Bohr Institute, KU



Improving understanding of nuclear structures utilising Bayesian inference

Maxim Virta, Niels Bohr Institute, Copenhagen, Denmark

Abstract:
In the last decade, Bayesian interference has become a useful tool in heavy-ion collision modelling, where it has been mostly utilised to study the transport properties of quark-gluon plasma produced in heavy-ion collisions. These analyses have successfully constrained the temperature-dependent specific shear and bulk viscosities. However, more recent studies have extended the method to improve understanding of the initial stage mechanics, nuclear structure, and even jet quenching.

In this talk, we will discuss the latest advancements in Bayesian interference, with a focus on nuclear structure studies and the development of experimental measurements. We will present the latest results of extracting the 129Xe nuclear structure parameters. The findings answer the question of whether 129Xe is a deformed rigid rotor or whether it has a soft transition between deformed states. Furthermore, we present the current development of heavy-ion collision flow observable measurements and discuss how they can be utilised in extracting information about new collision systems, e.g. OO and Ne-Ne, in the future.

Flow in small systems at the LHC

Martijn Laarhoven, Niels Bohr institute, Copenhagen, Denmark

Abstract:
The formation of the quark–gluon plasma (QGP) in heavy-ion collisions has been established through the observation of collective behaviour, commonly quantified through anisotropic flow measurements. In recent years, similar flow-like

signatures have also been observed in smaller collision systems such as proton–proton and proton–nucleus collisions, bringing insight in the origin of collectivity and the conditions required for QGP formation.
This presentation provides an overview of the physical interpretation of flow observables and their role as probes of the medium created in relativistic collisions at the CERN's Large Hadron Collider. The analysis methods used to extract flow coefficients will be introduced, with particular focus on two particle correlation techniques and fitting procedures used to separate collective effects from non-flow contributions.
After this, comparisons between light-ion and heavy-ion collision systems will be discussed in order to investigate how collective behaviour evolves with system size and multiplicity. Recent experimental results will be presented alongside their implications for our understanding of initial-state effects, final-state interactions, and the emergence of hydrodynamic behaviour in small systems.
The talk will then show some of the most significant discoveries regarding flow in small systems, and show the recent paradigm shift regarding the formation of the QGP.

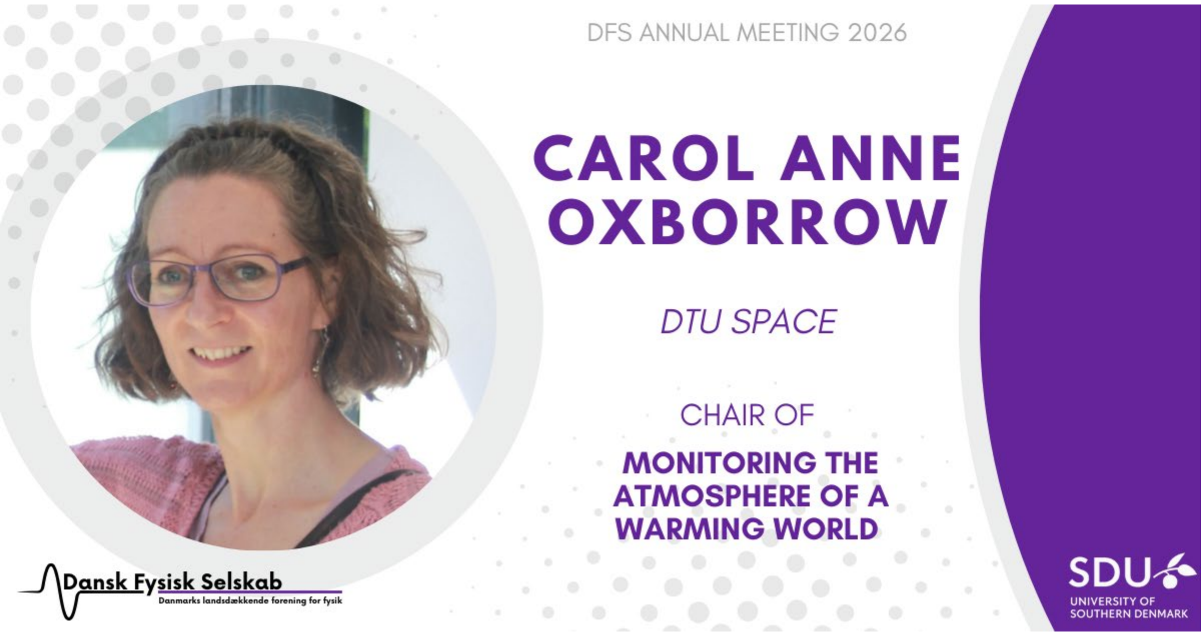
Developments in Machine Learning for the ATLAS Experiment and the HL-LHC Environment

Daniel Murnane, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark,
Lawrence Berkeley National Laboratory, Berkeley, United States

Abstract:
I will review a selection of recent work both from myself, but also from my coordination position as ML convener of the ATLAS collaboration, looking towards the High Luminosity era of the LHC. These developments include improving track reconstruction for primary particles as well as searches for long-lived particles in BSM scenarios; multimodal foundation models that can perform both predictive tasks (e.g. particle flow) and generative tasks (e.g. calorimeter simulation); learning representations ("tokens") of particle objects that are useful for downstream reconstruction and analysis goals; enabling both physicists and computer scientists to contribute with open data and AI/ML benchmarks (the ColliderML platform); and finally I will review our recent agentic additions to the ATLAS AI assistant system (chATLAS) for both information retrieval and tool usage.

Atmospheric physics & Black holes and gravitational physics - O100 -

Co-Chair: Carol Anne Oxborrow, DTU Space & Marica Minucci, NBI



Monitoring a Warming World with Earthshine: Ground Observations, juLIET, and Máni

Peter Thejll, Danish Meteorological Institute, Copenhagen, Denmark

Abstract:
Earthshine — sunlight reflected by Earth and then back to us from the dark side of the Moon — offers a rare way to observe our planet as an integrated object. In that sense it is both an astronomical signal and one relevant to climate monitoring: changes in clouds, aerosols, surface properties, and the large-scale state of the atmosphere can all affect Earth's reflectivity and colour. This makes Earthshine a potentially valuable complement to more conventional Earth observation systems.

In this talk I will show how ground-based Earthshine observations can contribute to monitoring a warming world, while also discussing the considerable observational challenges involved. The bright lunar crescent contaminates the faint Earthshine signal through scattered light in the atmosphere and instrument, and robust calibration across cameras, filters, and observing geometries is essential if long-term changes are to be given a physical interpretation. We are currently quantifying common-mode rejection in the Earth's reflectance function and its impact on terrestrial albedo determinations. A key part of the analysis is the treatment of scattered bright-side light and internal reflections in the ISS Cupola windows. The talk will outline this framework and present the first colour-resolved Earthshine time series.

I will place this work in the broader context of new Danish-led and proposed satellite activities, including juLIET at DTU Space and Máni at the University of Copenhagen. Together, these efforts point towards a future in which Earthshine can serve not only as a scientifically interesting astronomical observable, but also as a meaningful quantity for climate monitoring, linking ground observations, satellite measurements, and lunar calibration perspectives.

Solar Nowcasting for National Energy Grid Planning

Elloise Fangel-Lloyd, Danish Meteorological Institute, Copenhagen, Denmark,
Irene Livia Kruse, Danish Meteorological Institute, Copenhagen, Denmark
Kristian Holten Møller, Danish Meteorological Institute, Copenhagen, Denmark
Kasper Stener Hintz
Danish Meteorological Institute, Copenhagen, Denmark
Henrik Vedel, Danish Meteorological Institute, Copenhagen, Denmark
Kristian Pagh Nielsen, Danish Meteorological Institute, Copenhagen, Denmark
Eleni Briola, Danish Meteorological Institute, Copenhagen, Denmark
Simon Kamuk Christiansen, Danish Meteorological Institute, Copenhagen, Denmark
Ulrik Ankjær Borch, Danish Meteorological Institute, Copenhagen, Denmark
Julia Sommer, Danish Meteorological Institute, Copenhagen, Denmark

Abstract:
Approaches to Numerical Weather Prediction (NWP) are increasingly supplemented with weather nowcasting methods, which model weather development for up to six hours in the future, rather than multiple days. These shorter temporal scales may benefit from techniques or data that are not feasible to include in a traditional weather forecast.

High temporal resolution is of particular interest to certain sectors of industry. We present a collaboration between the Danish Meteorological Institute (DMI) and Energinet, the Danish Transmission System Operator (TSO), focusing on the end-to-end development and operationalisation of a solar nowcasting system exploiting satellite data products. The resulting high-resolution irradiance data provide significant benefits in balancing the national energy grid.

The project has successfully transitioned a current optical-flow model utilising Meteosat Second Generation (MSG) data into a live operational environment. The system operates at a 15-minute temporal resolution and update frequency. The transition to newer satellite data products with higher resolution in space and time will be presented, as well as validation techniques.

ASIM: The Atmosphere-Space Interactions Monitor.

Carol Anne Oxborrow, DTU Space,

Abstract:
In 2018 ASIM, a Danish-led lightning research project was launched to the International Space Station and has been monitoring violent thunderstorms from low-Earth orbit ever since. With a suite of instruments covering red, blue, ultraviolet, x-ray and gamma-ray wavelengths, ASIM's primary goal was to elucidate the mechanisms of inception and propagation of Terrestrial Gamma Flashes (TGFs) first discovered serendipitously in 1990. ASIM has been very successful in this respect, producing data showing the processes that lead one to another in the life of a TGF. As of May 2026 we have created a catalogue of 2346 confirmed TGF observations which is updated every month. The ASDC and its partners are also investigating secondary science targets either accidently observed in the ASIM data, or via timed observations of likely phenomena: GRBs, meteors, aurorae and stellar gamma-flashes have all been captured and studied by ASIM. Future work will aim to answer the question: will TGFs become more frequent in a warming atmosphere and if so what effect will this have on the chemistry and albedo of the Earth's atmosphere?

A Hyperboloidal Approach to Binary Black Hole Ringdown

Marica Minucci, Niels Bohr Institute, Copenhagen, Denmark

Abstract:
After two black holes merge, the final black hole settles down by emitting gravitational waves in a “ringdown” phase. This signal is dominated by quasinormal modes, damped oscillations whose frequencies depend only on the mass and spin of the remnant black hole. These modes provide a characteristic spectral fingerprint, and recent observations have begun to hint at the presence of additional modes, known as overtones. To fully exploit these signals, we need a better understanding of how quasinormal modes interact. Although numerical simulations show that the ringdown can often be modeled as a sum of modes, the connection to the underlying nonlinear dynamics of the merger remains unclear. A key challenge is that quasinormal modes of rotating black holes do not form a standard orthogonal basis, making it difficult to isolate and study them. In this talk, I will present a new framework based on conserved currents and symmetry operators that provides inner-product–like structures for

analysing these modes. I will discuss its properties on hyperboloidal foliations, using the Schwarzschild spacetime as a model example.

Nano Quantum - U75 -Chair: N. Asger Mortensen, Professor, POLIMA, Mads Clausen Institute, SDU-TEK

Prospects for nonlocal phenomena in phonon-image-polaritons

Jacob Terndrup Heiden, University of Southern Denmark, Odense, Denmark & Korea Advanced Institute of Science and Technology, Daejeon, Republic of Korea

Abstract:
Controlling light at the nanoscale requires understanding how light interacts with matter, including effects that occur at the scale of electrons. In this work, we study infrared light waves confined in thin layers of hexagonal boron nitride (hBN) on high-quality gold surfaces. Using nanoscale imaging, we observe extremely strong light confinement—more than 90 times smaller than the free-space wavelength—without significant nonclassical effects, even under extreme conditions.

Cavity-Material Engineering with Realistic Photonic Environments

Mikkel Have Eriksen, Technical University of Denmark, Kgs. Lyngby, Denmark
Simone Latini, Technical University of Denmark, Kgs. Lyngby,

Abstract:
Cavity–material engineering uses structured photonic environments and cavities to modify solid-state ground states, with proposed effects ranging from enhanced superconducting critical temperature [1] to hybridized exciton-photon-phonon excitations in hBN [2] and a paraelectric to ferroelectric phase transition in a perovskite material [3]. We develop a macroscopic QED approach [4] that treats realistic, lossy, and dispersive cavities and yields a consistent light–matter description beyond qualitative models.

Integrating out the electromagnetic degrees-of-freedom in the off-resonant limit, we show that the environment generates density-density, current-current and current-density couplings controlled by the transverse and longitudinal dyadic Green's tensors, enabling geometry-,

material-, and polarization-tunable electron–electron interactions. We demonstrate this using Fabry–Pérot and polaritonic cavity environments. In the on-resonant regime, electrons couple through transverse current-terms and longitudinal density-terms which results in a transparent decomposition that shows how we can tailor the mode structures from realistic cavities to select interaction channels in a solid-state system. The proposed theory delivers guidance for designing experimental platforms for cavity-material engineering.

[1] J. B. Curtis, Z. M. Raines, A. A. Allocca, M. Hafezi, V. M. Galitski, Phys. Rev. Lett., 122, 167002 (2019).

[2] S. Latini, U. De Giovannini, E. J. Sie, N. Gedik, H. Hübener, A. Rubio, Phys. Rev. Lett. 126, 227401 (2021).

[3] S. Latini, D. Shin, S. A. Sato, C. Schäfer, U. De Giovannini, H. Hübener, A. Rubio, Proc. Natl. Acad. Sci. U.S.A., 118, e2105618118 (2021).

[4] S. Scheel, S. Y. Buhmann, Acta Phys. Slovaca, 58, 675-809 (2008).

2D Semiconductors as On-Chip Light Sources for Integrated Nanophotonics

Christian Frydendahl, Aarhus University, Aarhus, Denmark
Torgom Yezekyan, University of Southern Denmark, Odense, Denmark
Vladimir Zenin, University of Southern Denmark, Odense, Denmark
Sergey Bozhevolnyi, University of Southern Denmark, Odense, Denmark

Abstract:
Efficient optical connection between integrated optics and the outside world remains one of the biggest challenges for widespread commercialization and adoption of photonic integrated circuits (PICs)1. To inject light into integrated nanophotonic waveguides, it must be coupled from the outside with a lensed fiber or microscope objective, limiting the scalability and promise of optical chips. Making direct, on-chip, light sources that directly inject radiation into the waveguide circuitry would circumvent the problem of external connection, making a crucial step towards delivering on numerous promises of future PICs, e.g., faster and greener (i.e., more energy efficient) data processing and communications, artificial neural networks, diagnostic lab-on-chip systems, and new chip-scale quantum technologies1.

We demonstrate here the efficient coupling and guiding of photoluminescence from TMDC monolayers of MoSe2 into gold plasmonic slot waveguides. Optical emission from the 2D material is stimulated by far-field optical pumping with a 620 nm laser, part of this emission is then coupled directly to the waveguide's fundamental mode, where it propagates and is emitted by the outcoupling plasmonic antenna, Fig.1a and b. By attaching a plasmonic antenna coupler that is resonant with the emission wavelength range of MoSe2, we make use of the Purcell effect to enhance the optical emission to the plasmonic slot waveguide's fundamental mode. We confirm this coupling to the fundamental mode via polarization (Fig.1c and d) and spectrally (Fig.1e) sensitive measurements. Our results highlight the mutual compatibility between plasmonic waveguide systems and 2D semiconductors, indicating a promising future direction for fully independent PIC systems based on 2D material light-sources and plasmonic waveguides.

Velocity-tunable exciton-photon hybridization in cathodoluminescence

Sven Ebel, POLIMA, University of Southern Denmark, Odense, Denmark
Martin Nørgaard, POLIMA, University of Southern Denmark, Odense, Denmark
Christian Nicolaisen Hansen, POLIMA, University of Southern Denmark, Odense, Denmark
N. Asger Mortensen, POLIMA, University of Southern Denmark, Odense, Denmark
Danish Institute for Advanced Study, University of Southern Denmark, Odense, Denmark
Sergii Morozov, POLIMA, University of Southern Denmark, Odense, Denmark

Abstract:
Exciton–photon hybridization is typically realised in geometrically defined optical cavities, where tunability is achieved by modifying either the cavity or the excitonic medium. Here we investigate transition-radiation interferences in suspended subwavelength films resembling a free electron-defined resonance and explore their interaction with excitons in transition metal dichalcogenides. We demonstrate that these resonances hybridize with excitonic transitions and can be tuned continuously by varying the electron energy. The resulting detuning depends on both film thickness and electron velocity, establishing the latter as an external and continuous knob for exciton–photon coupling. This approach enables tunable hybridization without structural modification and provides a free-electron-driven nanoscale platform for studying exciton–light interactions.

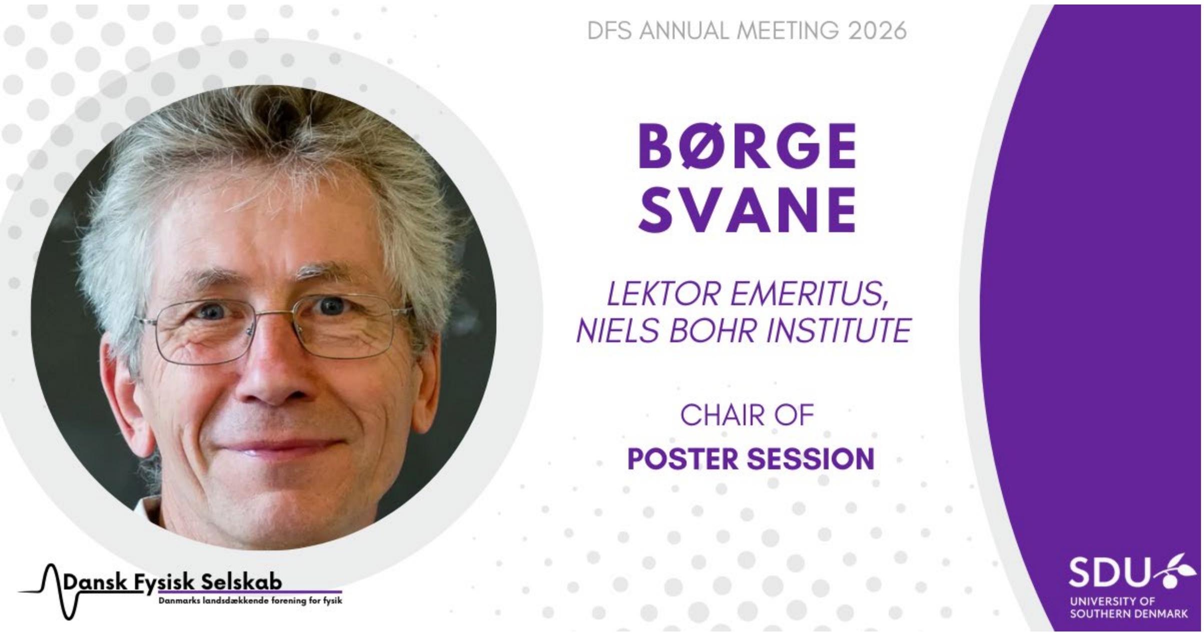
KIF prize winner talk – O100 - Chair: Maren Malling

The KIF Prize is awarded annually to raise awareness about the significance of women in physics. The prize aims to recognize a person with a background in the physical sciences as a role model, whether they work in research, industry, the public sector, teaching, or similar.

The prize will be awarded to a person who, through their professional work, outreach, mentoring, and volunteering, inspires women and other minorities in the physical sciences, motivates young women and girls to pursue a career in STEM, and advocates for gender equality, diversity, and inclusion in the broader community.

In this session, the 2026 KIF Prize winner will be announced, and she will give a presentation about her work and career path.

Poster Session – Panorama – Chair: Børge Svane



QTLab@AU: Quantum Teaching Lab at Aarhus University

Emre Aslan, Aarhus University, Aarhus, Denmark
Lucas C. Ahler, Aarhus University, Aarhus, Denmark
Jeppe H. Surrow, Aarhus University, Aarhus, Denmark
Adam S. Chatterley, Aarhus University, Aarhus, Denmark
Jan Arlt, Aarhus University, Aarhus, Denmark
Michael Drewsen, Aarhus University, Aarhus, Denmark
Aurélien Dantan, Aarhus University, Aarhus, Denmark

Abstract:
To support education and training in quantum science and technology, we have established the Quantum Teaching Laboratory (QTLab) at Aarhus University. QTLab consists of two complementary experimental facilities, a Photonics Lab and an Atomic Lab, designed to provide hands-on experimental training in quantum optics and atomic physics at Bachelor's and Master's levels, while also enabling demonstration and outreach activities for high-school students.

The Photonics Lab focuses on experimental investigations of the quantum properties of light and integrated photonics. It includes six free-space quantum optics platforms where students explore photon statistics using Hanbury Brown–Twiss interferometry, single-photon interference in Michelson interferometers, and quantum correlations via spontaneous parametric down-conversion sources. Additional experiments cover quantum erasure, polarization entanglement, and tests of Bell inequalities. Complementary platforms include a micro-ring resonator for studying nonlinear optics, resonance tuning, and optical switching, as well as an integrated waveguide system enabling photon-pair generation, coupling between free-space and guided modes, and Hong–Ou–Mandel interference.

The Atomic Lab provides training in laser cooling and trapping of neutral atoms and ions. A magneto-optical trap allows students to study cooling mechanisms, atomic fluorescence imaging, and trapping dynamics in ultra-high vacuum. An ion trapping setup with Ba^+ ions enables experiments on fluorescence detection, quantum jumps, motional modes, and quantum state control.

Together, these facilities form a modular and scalable platform that prepares students for research and emerging quantum technologies.Together, these facilities form a modular and scalable platform that prepares students for research and emerging quantum technologies.

X-ray and neutron analysis for industry

Erik Stieper Brok, FORCE Technology, Brøndby, Denmark

Torben Haugaard Jensen, FORCE Technology, Brøndby, Denmark

Abstract:
A physics education provides strong analytical and methodological skills that are increasingly valuable in industrial contexts. At FORCE Technology, physicists work directly with industrial clients to apply advanced experimental techniques typically associated with large-scale research facilities, such as synchrotron and neutron sources, to real-world challenges.

In this contribution, we present how methods including X-ray diffraction (XRD) and X-ray computed tomography (CT) are used in applied industrial projects ranging from product development and quality assurance to material identification and failure investigations. Access to international research infrastructures is made possible through long-standing collaborations and hands-on expertise, enabling industrial measurements to be carried out efficiently and with a clear focus on actionable results.

Examples span diverse sectors including pharmaceuticals, space and aerospace, food packaging, recycling, energy technologies, and building materials. In many cases, these analyses are not driven by curiosity-based research, but by concrete technical questions where deep materials insight is essential for decision-making.

Modelling the Galactic Diffuse Emission of Very-High-Energy Gamma-Rays and Neutrinos

Léa Zoé Bingler, Niels Bohr Institute, Copenhagen, Denmark

Abstract:
The interaction of cosmic rays with gas in our Milky Way is visible as a diffuse glow of gamma-rays and neutrinos. Recent data from the gamma-ray observatories Tibet AS-gamma, LHAASO, and HAWC as well as the neutrino observatory IceCube allow us to test the distribution and spectrum of very-high-energy cosmic rays in our galaxy, complementary to direct observations at Earth.

In this project we will model the Galactic diffuse emission at very-high energies via semi-analytic methods. We will derive and test analytic approximations for the Galactic cosmic-ray density as stationary solutions to the cosmic-ray transport equation that can be normalized to local cosmic-ray data. Our model will allow us to derive the morphology and intensity of the

diffuse Galactic emission and to estimate transport parameters by a fit to gamma-ray and neutrino data.

Initial analysis and characterisation of the prototype FoCal H hadronic calorimeter for ALICE

Jeppe Jersild, Niels Bohr Institute, Copenhagen, Denmark
Kristian Fæste, Niels Bohr Institute, Copenhagen, Denmark

Abstract:
The Forward Calorimeter (FoCal) is an upgrade to the ALICE detector at CERN. The hadronic component, FoCal-H, uses plastic scintillating fibers read out by silicon photomultipliers (SiPMs). This work presents a performance characterisation of a FoCal-H prototype.

Prior to test beam measurements, the detector components were characterised independently. SiPM response was studied as a function of overvoltage, UV light intensity, and pulse frequency, establishing optimal operating conditions. The attenuation length of scintillating fibers was measured using a UV laser.

Data Analysis of FoCal-H Test Beam Signals for Detector Response Characterisation

Daniel Borre, Niels Bohr Institutet, København, Denmark

Abstract:
This project analyzes test-beam data from a FoCal-H prototype for the ALICE experiment, with a focus on measurements taken at different operating voltages. The raw ADC signals are corrected and used to study how the detector response changes with voltage. The analysis also studies ToT information as a possible way to recover useful signal information when the ADC response becomes saturated. By comparing ADC and ToT data, the project investigates how voltage settings affect the detector response, linearity, and resolution.

Cosmogenic Neutrino Halos of Ultra-High Energy Cosmic Ray Sources

Emma Bruun, University of Copenhagen, Copenhagen, Denmark

Abstract:
Ultra-High Energy Cosmic Rays (UHE CRs) interact with the Cosmic Microwave Background (CMB) to produce secondary cosmogenic neutrinos, which form extended "halos" around extragalactic sources. This project models these halos across high and low rigidity regimes, (the degree to which particles are deflected by magnetic fields) and evaluates their detectability using angular power spectrum analysis. Results show that while UHE CRs in the high-rigidity regime exhibit significant anisotropies at low multipoles, the cosmogenic neutrino signal remains consistent with statistical noise due to the large isotropic background from distant sources. These findings suggest that detecting neutrino halos may require alternative statistical methods.

Analysis of Energy-response and resolution in the FoCal-H calorimeter prototype

Holger Ekstrand, NBI, København, Denmark
Anton Danielsen, NBI, København, Denmark

Abstract:
This project investigates the energy response and resolution of the FoCal-H calorimeter prototype, which is being developed for installation in the ALICE detector at CERN, due 2029. The main goal is to find a reliable relationship between measured ADC values and the actual energies of particles, so that unknown particle energies from collisions can be reconstructed accurately. To study this, eight proton beams with energies between 60 and 350 GeV were directed into the calorimeter and the detector response was analyzed. One of the main challenges is that the electronics saturate at an ADC value of 1023, meaning signals from higher-energy particles become clipped and cannot be measured directly. To deal with this limitation, two different methods were tested. The first simply uses the maximum ADC value in each signal. This method is straightforward and performs reasonably well at lower energies, but it becomes unreliable once saturation occurs. The second method fits a Gaussian curve to the signal shape, which allows the signal to be extrapolated beyond the ADC limit. This produces a more linear relationship between ADC and energy and also improves the energy resolution. Both methods introduce systematic uncertainties, but the Gaussian fitting approach gave the most consistent calibration across the full energy range that was tested. The maximum-value method was less accurate overall, although it required significantly less computing power. In the end, this project shows that some form of extrapolation beyond the measured ADC range is necessary, and while the Gaussian method performs well, further work is still needed to improve the conversion from high ADC values to particle energy.

Performance characterisation of the prototype FoCal H hadronic calorimeter for ALICE

Kristian Faeste, Niels Bohr Institute, København*, Denmark*
Jeppe Jersild, Niels Bohr Institute, København, Denmark

Abstract:
The Forward Calorimeter (FoCal) is an upgrade to the ALICE detector at CERN. The hadronic component, FoCal-H, uses plastic scintillating fibers read out by silicon photomultipliers (SiPMs). This work presents a performance characterisation of a FoCal-H prototype.
Prototype performance was evaluated using test beam data collected at CERN, where hadronic showers were recorded at beam energies from 60 to 350 GeV at SiPM bias voltages between 43 and 47 V. Energy linearity and resolution were extracted from ADC-based analysis across the full energy range. At high energies the ADC saturates due to its 10-bit dynamic range, motivating the use of Time-over-Threshold (ToT) readout as a complementary method. Comparisons between ADC and ToT-based analysis are presented.

Discovery of shallow non-dispersive bands in the family of mixed transition metal dichalcogenides Co0.25NbSe(2-y)Sy using photoemission spectroscopy

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Dominic Hache, Aarhus University, Aarhus, Denmark
Kristian F. Milla Nielsen, Aarhus University, Aarhus, Denmark
Alfred Jones, Aarhus University, Aarhus, Denmark
Philip Hofmann, Aarhus University, Aarhus, Denmark
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Zheshen Li, Aarhus University, Aarhus, Denmark
Younghun Wang, Ulsan College, Ulsan, Korea, Republic of
Federico Mazzola, Padua University, Padua, Italy
Jill A. Miwa, Aarhus University, Aarhus, Denmark

Abstract:
Transition metal dichalcogenides (TMDs) that have been intercalated with an additional transition metal have garnered considerable interest recently, since their distorted crystal structure can strongly impact their electronic band structure [1,2]. This type of intercalation has produced fascinating phenomenon like altermagnetism in Co0.25NbSe2 and valley Zeeman splitting in V0.33NbS2 [2,3]. Building upon the intercalated TMDs it is possible to partially substitute one of the chalcogens with a different type creating a family of mixed TMDs with different types of doping ratios between the two chalcogens [4]. In this study we investigate the electronic and chemical structure through angle resolved photoemission spectroscopy with micron spatial resolution (μARPES) and X-ray photoemission spectroscopy (XPS) of the mixed TMDs Co0.25NbSe(2-y)Sy. In Co0.25NbSe(2-y)Sy sulphur replaces some of the selenium atoms in its 2H polymorph structure, whilst cobalt is intercalated in between the layers, together with the measuring setup. We find that all measured samples show a similar electronic structure when compared to each other only varying in Brillouin zone size. The standout feature in this family of mixed TMDs is the non-dispersive band along the Γ-K cut arising from quantum interference effects between S 3p and Co 3d orbitals [5]. This flatband may be topological in nature and lies ~680meV below the Fermi level. These observed features could suggest the possibility of hosting such fascinating phenomena such as the quantum Hall effect as seen in Co0.25NbSe2 [1].

[1] De Vita, Alessandro, et al. "Optical switching in a layered altermagnet." arXiv e-prints (2025): arXiv-2502.

[2] Edwards, Brendan, et al. "Giant valley-Zeeman coupling in the surface layer of an intercalated transition metal dichalcogenide." Nature Materials 22.4 (2023): 459-465.

[3] Candelora, Christopher, et al. "Discovery of magnetic-field-tunable density waves in a layered altermagnet." arXiv preprint arXiv:2503.03716 (2025).

[4] Komsa, H. P., & Krasheninnikov, A. V. (2012). Two-dimensional transition metal dichalcogenide alloys: stability and electronic properties. The journal of physical chemistry letters, 3(23), 3652-3656.

[5] Peng, Yawen, et al. "Flat band generation through interlayer geometric frustration in intercalated transition metal dichalcogenides." Small 21.8 (2025): 2409535.

Raman Spectroscopy of Metal–Organic Frameworks.

Mohammad Elham Hussain, IFA, Aarhus, Denmark

Abstract:
Metal-organic frameworks (MOFs) are materials with tunable structural and physical properties, making them a versatile platform for investigating lattice dynamics and phonon behavior in complex systems. In this work vibrational properties of several porous lanthanide MOFs are studied by Raman spectroscopy. Measurements were performed at ambient conditions, at low temperatures and under applied magnetic fields in order to study changes in lattice dynamics.

Probing the onset of collectivity with identified hadrons in light-ion collisions at LHC-ALICE

Preet Pati, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark

Abstract:
Collective behaviors in pp and p–Pb collisions have sparked debate on the onset of hydrodynamics in small systems. However, the proton's poorly constrained geometry has hindered definitive conclusions. The 2025 LHC runs with O–O and Ne–Ne collisions provide a unique solution: their well-defined initial states allow a direct test of whether collectivity stems from hydrodynamic flow or initial-state correlations.

In this talk, we present the first ALICE measurements of anisotropic flow (v_n) for identified hadrons (π±, K±, p(p̄), $K^0{}_s$, and Λ) with pseudorapidity separation |Δη| > 1.2 in Ne–Ne and O–O collisions at the LHC. A clear mass ordering at low p_t and baryon–meson v_2 grouping and splitting at intermediate p_t are observed in light-ion collisions, consistent with partonic collectivity seen in heavy-ion systems. These data provide stringent constraints on initial-state models and medium dynamics.

This comprehensive study bridges the gap between pp and heavy-ion collisions, offering decisive insights into the origin and onset of hydrodynamic behavior in the smallest QCD systems.

Flow Cumulants as Probes of the Quark-Gluon Plasma

Misiki Bharadwaz, KU, Copenhagen, Denmark

Abstract:
Quark-gluon plasma (QGP) is a state of matter consisting of deconfined quarks and gluons, and is thought to have existed in the early universe, microseconds after the Big Bang. Relativistic heavy-ion physics aims to create and study QGP under controlled conditions, thus providing a better understanding of the early universe. Among the observables used to characterise QGP, anisotropic flow has proven particularly powerful, describing the collective motion of the particles produced in the collision, revealing significant information about properties of the medium. Due to experimental limitations, the flow coefficients are approximated by multiparticle cumulants. In this thesis, toy Monte Carlo simulations are used to study the statistical behaviour and limitations of higher-order flow measurements. Simulated events are generated and analysed using both the Generic Framework (GFW) and the Unified Algorithm (UA) approach. These studies provide insight into the statistical boundaries of multiparticle flow measurements and illustrate the challenges involved in extracting precise collective flow observables in heavy-ion collision experiments.

Study of Fourier Optical Cavities for Exciton Confinement in 2D Materials

Luigi Brusaferri, Danmarks Tekniske Universitet, Kongens Lyngby, Denmark

Abstract:
The study of light and matter interaction occupy a central role at the interface of optics and solid state physics. The presented work explores, within this framework, the ability of different Fourier optical cavities to confine excitons of 2D materials. The confinement happens as the excitons experience the periodic potential generated by the vacuum oscillations of the electromagnetic field. Fourier cavities are a novel optical structure where one of the surfaces of a conventional cavity is patterned with a sinusoidal shape. By exploiting the discrete translational symmetry of

the pattern, the light dispersion bends, thus forming a periodic band structure akin to the electronic structure of a solid state system. In the presented work, the focus is on three main types of cavities: dielectric cavities, plasmonic cavities, and hyperbolic cavities. They have been chosen as representatives of three distinct working principles, respectively: difference in refractive index, interaction with surface plasmon polaritons, and interaction with hyperbolic phonon polaritons (in hexagonal boron nitride). Their performances are assessed in terms of field strength and confinement length. The analysis is carried out by calculating the eigenmodes via numerical FEM simulations with the software COMSOL. In order to properly treat dispersive materials, the MAN (Modal Analysis of Nanoresonators) package is used.

Flow-vector fluctuations in OO and Ne-Ne at 5.36 TeV

Lukas Cernusak, Copenhagen University, Copenhagen, Denmark

Abstract:
Investigations of anisotropic flow have been conducted in heavy-ion collisions (such as Pb–Pb and Xe–Xe collisions) as well as in small systems (i.e., p–Pb and pp collisions). Run 3 of the LHC has, for the first time, collided light ions at 5.36 TeV, allowing us to bridge the gap between these two regimes. Compared to heavy systems, light-ion collisions are sensitive to sub-nuclear structure effects while still possessing a well-defined nuclear configuration compared to small systems.

In this poster, we present measurements of pT-dependent flow-vector fluctuations using both r_2 and $v_2\{2PC\}/v_2[2PC]$ in O–O and Ne–Ne collisions across a range of centralities. The results are compared with hydrodynamic calculations obtained using 3DGlauber + MUSIC + UrQMD with both Woods–Saxon (WS) and PGCM initial-state models.

Comparisons between O–O and Ne–Ne collisions, as well as between the WS and PGCM models, provide sensitivity to nuclear-structure-driven event-by-event flow-vector fluctuations. In addition, data–model comparisons offer unique constraints on the parameters governing fluctuations in the initial conditions.

Probing the Origins of Collective Flow in Small Systems

Amalie Clausen, Niels Bohr Institute, Copenhagen, Denmark

Abstract:
Quark–gluon plasma (QGP) is a rare state of matter in which quarks and gluons exist in a deconfined state under extremely high temperatures and energy densities. This state is believed to have dominated the early universe shortly after the Big Bang and can today be recreated in ultra-relativistic particle collisions at the Large Hadron Collider at CERN. One of the key signatures of QGP formation is the collective motion of produced particles, commonly referred to as collective flow.

While collective flow is well established in heavy-ion collisions, similar flow-like signatures have also been observed in much smaller collision systems such as proton–proton and proton–nucleus collisions. Understanding whether these signals originate from genuine collective behaviour or from other correlation sources remains one of the central open questions in high-energy nuclear physics.

This work investigates collective behaviour in light-ion collisions from the ALICE experiment using two-particle correlation techniques. By measuring anisotropic flow observables, v_n, the analysis probes how the collision geometry and dynamics influence the final-state particle

distributions. Light-ion systems such as oxygen–oxygen, neon–neon, and proton–oxygen collisions provide an ideal environment for studying collective effects across different system sizes.

A major challenge in small-system analyses is the presence of non-flow correlations from processes that can mimic collective behaviour, such as jets and resonance decays. This analysis therefore studies and compares of different non-flow suppression and subtraction techniques. These include pseudorapidity gap selections as well as different flow extraction methods such as template fit, improved template fit, and peripheral subtraction. By comparing these approaches, the analysis aims to isolate genuine collective signals and provide deeper insight into the origin of collectivity in small collision systems.

Studying the Emergence of Collective Flow in Small Collision Systems at the LHC

Dina Stryger, Niels Bohr Institute, København, Denmark

Abstract:
Quark–gluon plasma (QGP) is one of the rarest states of matter in the universe, consisting of nearly deconfined quarks and gluons. Formed under extreme temperatures and energy densities, it provides a unique window into conditions in the early universe and in the cores of neutron stars. At CERN, experiments at the Large Hadron Collider have shown that QGP can be created through ultra-relativistic heavy-ion collisions, such as lead–lead interactions.

In these large systems, hydrodynamic models successfully reproduce experimental observations, particularly multi-particle correlations, which track how many particles are correlated simultaneously and provide some of the most sensitive and direct evidence of collective behaviour in the medium. However, similar QGP-like signatures have also been observed in small systems, such as proton–proton and proton–lead collisions, where hydrodynamic descriptions fail to achieve the same level of agreement. This discrepancy raises important questions about the limits of hydrodynamic modelling and what physics may be missing in our understanding of small-system behaviour.

To address this gap, we explore light-ion collisions, oxygen–oxygen, neon–neon, and oxygen–proton, using multi-particle correlations as a central observable to probe the system dynamics across different system sizes. These systems occupy an intermediate regime between small and large collision systems that may help identify where current theoretical descriptions begin to break down.

Education in the Era of AI

William Møller Johansen,Aarhus University, Aarhus, Denmark
Christoffer Emil Juul Hansen, Aarhus University, Aarhus, Denmark
*Emilie Møller Jørgensen,*Aarhus University, Aarhus, Denmark

Abstract:
The use of AI has vastly changed the way students learn and become educated. More now than ever, it is important to discuss challenges and useability of AI in education and when not to use it. How do three students approach AI in their higher education, and how do they use AI as students?

In this talk, we are three students who will present personal insights and opinions on our own use of AI in our higher education and participate in the open panel discussion at the end of the

session. This talk is part of a larger educational talk with Sergio Ioppolo as chair on the first day from 13:00-14:30.

Two-photon polymerization-printed diffractive optical elements for hyperspectral imaging.

Pablo González, Newtec SDU, Odense, Denmark

Abstract:

Two-photon polymerization (2-PP) refers to the phenomenon in which a certain molecule gets excited only by the simultaneous absorption of two photons. This can be used in so-called 2-PP printing, where a laser gets focused on a liquid resin intiating a polymerization reaction that hardens it, creating the desired printed structure. Therefore, it is possible to quickly create elements with sub-micrometer resolution that can be used in a wide range of applications, in this case, printing optical elements. More in particular, the components to be printed are diffractive optical elements (DOEs) which due to their property of splitting light depending on its different spectral components or wavelengths, can then be used for hyperspectral imaging (HSI) systems. The ability to rapidly prototype and test different designs of DOEs can help speed up the research process to produce better and more accurate HSI cameras, hence the interest in using this particular technology. For the first part of this work, the printing process was studied through systematic parameter testing and analysis of print quality to determine optimal printing conditions. This was followed by printing of full scale DOEs ready to be tested in an optical setup to measure their performance, so that they can be compared to other off-the-shelf alternatives. This showed that, despite not reaching the same level of quality, the performance was acceptable while also benefitting from the speed and simplicity of fabrication.

Adapting Graph Neural Networks to identify exotic physics in ATLAS High Luminosity Inner Tracking Detector

Simon Kjær, Niels Bohr Institutet, KU, Denmark

Abstract:

For run 4, the LHC is being upgraded to the High-Luminosity LHC (HL-LHC), which is expected to reach a peak luminosity of 200 inelastic proton-proton collisions per beam crossing. In order to keep (or improve) event tracking performance, a new silicon tracking system (ITK) is implemented along with the track-reconstruction Graph Neural-Network (GNN4ITK).

With a Graph Neural Network as the tracking algorithm, it is possible to train it on simulated scenarios of Long Lived Particles, teaching the GNN to identify these cases. This project builds and analyses models to detect the R-parity violating decay of a 50 MeV neutralino. The neutralino is undetectable, but the quarks it decays into leave tracks that don't originate from the center.

This project demonstrates methods for adapting the main model to track the children of the neutralino. A baseline model, a finetuned model, and a model trained from scratch are compared in their efficiency at reconstructing Large Radius Tracks that appear only at distances larger than 0.1 mm. This allows us to quantify searches for particles that would not be visible in studies of missing transverse energy or included among the prompt decays.

Development of a Computational Data Analysis Pipeline for 3D Hyperspectral Cubes: A Comparative Spectral Analysis of Daguerreotypes and Ambrotypes

Malte Grau, Department of Physics and Astronomy, Aarhus University, 8000 Aarhus C, Aarhus, Denmark

Abstract:
The daguerreotype is the first publicly available photographic process, popular in the years 1830 to 1850, and was completely superseded by the ambrotype, which was cheaper and rendered more clear pictures compared to the daguerreotype. This project will focus on the computational pipeline of the data analysis of the 3-dimensional cube data acquired from the hyperspectral camera, specifically analyzing the daguerreotype and the ambrotype. This analysis evaluates the reflectance spectra of distinct regions on both the daguerreotype and the ambrotype to identify potential pronounced spectral variations. While daguerreotypes are fundamentally monochromatic images, this particular daguerreotype exhibits colored regions added post-creation; these specific regions will be analyzed to characterize their unique spectral signatures.

Design and Optimization of Diffractive Optical Elements for Snapshot Hyperspectral Imaging

Annabell Hannibalsen, Newtec SDU, Odense M, Denmark

Abstract:
Hyperspectral imaging enables detailed material and scene analysis due to its high spectral resolution. Snapshot hyperspectral imaging based on computed tomography imaging spectrometers (CTIS), which capture the spectral data in a single exposure, however suffer from reconstruction error, limiting in-field applications. This project addresses the issue by optimizing the design of a Diffractive Optical Element (DOE) which controls the light projection onto the image sensor. Using the Iterative Fourier Transform Algorithm (IFTA) to obtain a target diffraction pattern, a DOE was designed with lower reconstruction error than the DOE currently used in Newtec's CTIS camera.

Time Evolution of Polaritons from Coupled Light–Matter Dynamics

August Koppers, DTU, Kongens Lyngby, Denmark

Abstract:
Strong light-matter coupling in optical cavities gives rise to hybrid excitations, known as polaritons, whose properties emerge from the interplay between electromagnetic fields and quantum degrees of freedom in matter. While many polaritonic phenomena are well understood in equilibrium or steady-state settings, comparatively little is known about how such hybrid states form, evolve, and dissolve in real time. Addressing these questions requires theoretical frameworks that can capture the dynamical interaction between light and matter.

This project aims to study the time evolution of polaritonic states by explicitly coupling classical electrodynamics to quantum many-body dynamics and time-evolving both systems simultaneously. The propagation of confined electromagnetic fields is treated using finite-difference time-domain (FDTD) simulations for planar cavity structures, providing direct access to the spatial and temporal structure of the light field. The quantum material is modeled using

the Nonequilibrium Green's function (NEGF) framework, which enables a quantum-kinetic description beyond semiclassical Boltzmann dynamics. This framework provides a systematic incorporation of memory effects via collision integrals and interactions through self-energies.

A central objective is to study how polaritonic states dynamically emerge and how higher-order hybrid excitations involving multiple quasi-particles can form under nonequilibrium conditions. By time-evolving the light and matter systems simultaneously, this work aims to elucidate the mechanisms governing polariton formation, particle mixing, and ultrafast relaxation, and to establish a flexible theoretical framework for studying dynamical light-matter hybridization in quantum materials.

On Two-Plasmon Decay in Low Temperature Tokamak Plasmas

Marcus Nadybal, Technical University of Denmark, Kgs. Lyngby, Denmark

Abstract:
Proper control of energy deposition during plasma heating is essential for optimizing future fusion devices. This master's thesis investigates the occurrence and characteristics of the Two Plasmon Decay Instability (TPDI), a type of parametric decay instability in magnetized plasmas. During Electron Cyclotron Resonance Heating (ECRH) in tokamaks, part of the injected microwave power can drive TPDI rather than contribute to plasma heating, reducing heating efficiency and potentially affecting plasma stability.

Electron density profiles are reconstructed spatially and temporally by combining interferometry measurements with a Langmuir probe array. Together with magnetic field measurements, this provides insight into the Upper Hybrid resonance layer, where TPDI is expected to occur. Fourier analysis of signals from simultaneously inserted antennas is used to determine the frequency spectrum and temporal evolution of the instability. The occurrence of TPDI is then correlated with local electron density perturbations.

The experiments are conducted at the NORTH tokamak at DTU. Preliminary results indicate a strong dependence of TPDI activity on the magnetic field strength, while the precise correlation with local density perturbations remains under investigation. The diagnostic setup provides line-integrated density measurements together with spatial magnetic field profiles and 39 localized electron density measurements.

This work contributes to a better understanding of parametric decay instabilities in fusion plasmas and provides insight into the role of electron density variations in spherical tokamaks. Future work should investigate the influence of temperature fluctuations on the instability dynamics.

Exploring nuclear shape in OO and Ne–Ne collisions with ALICE at the LHC

Vojtech Machacek, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark

Abstract:
Recent LHC results have demonstrated that small collision systems can exhibit collective behavior reminiscent of that observed in heavy-ion collisions, opening a new frontier for exploring the connection between nuclear structure and collective dynamics at ultrarelativistic energies. One of the key observables in studying the collective behavior —elliptic flow v_2— was

widely used to investigate the shape of the heavy ions during Run 2. In this poster, we present the measurements of the multi-particle anisotropic flow coefficients v_2 together with the first reconstruction of the elliptic flow probability distribution function $P(v_2)$ in OO and Ne-Ne collisions, providing unique insight into a nuclear-geometry driven flow and flow fluctuations in both systems.

Cavity Materials Engineering: Light-Matter Ground States and Photonic Coherence

Max Matheussen, Technical University of Denmark, Kongens Lyngby, Denmark

Abstract:
The use of intense light fields to engineer and enhance material properties as well as induce novel phases has been an active and promising avenue in condensed-matter physics. However, unavoidable side-effects such as localised heating or structural deformations can destroy some of the states one might hope to stabilise. Understanding how to achieve strong coupling between light and matter, and its consequent novel phases at equilibrium, would be a major step forward for the real-world applications of quantum materials. Cavity materials engineering has emerged as one of the leading candidates for achieving this goal. By embedding a material in an optical cavity, one can tune the system such that the material couples strongly to the quantum vacuum fluctuations allowing for the material properties to be altered and exotic quantum states, that are otherwise only accessible in nonequilibrium settings, to be stabilised. In addition, light-matter hybrid quasiparticles carry characteristics of both the light and matter allowing for photons escaping the cavity to encode information about the material's quantum state. By making use of non-equilibrium Green's functions and Density functional theory, our study aims to simulate realistic cavity environments, understand what is required to access light-matter ground states, and unravel how photonic observables can serve as a non-invasive tool for the microscopics of cavity-embedded-materials.

Searches for spectral upturns due to photon to axion-like particle conversions using H.E.S.S. and Fermi-LAT and observations

Dominik Pastuszka Malek, University of Southern Denmark, Odense M, Denmark
Atreya Acharyya, University of Southern Denmark, Odense M, Denmark
Manuel Meyer, University of Southern Denmark, Odense M, Denmark

Abstract:
High and very high energy gamma rays from distant extragalactic sources are severely attenuated due to interactions with the extragalactic background light (EBL). This effect could be partially alleviated by introducing axion-like particles (ALPs), an extension to the Standard Model which allows for photon to ALP conversions within the magnetic fields of various astrophysical environments. These oscillations would allow photons to convert into light ALPs in the intergalactic magnetic field and propagate freely towards our galaxy, where they can then reconvert back into detectable photons, producing characteristic high-energy spectral upturns for each source. The search for these upturns offers a way to constrain the allowed parameter space of ALP models while studying gamma ray propagation over cosmological distances.

We analyze the intrinsic spectra of a large sample of extragalactic gamma-ray sources using observations from both the Fermi-LAT and H.E.S.S. instruments. We perform a statistical search for spectral upturns by introducing spectral break features in the intrinsic source models and comparing them to simulated ALP-induced signatures. This framework enables tests of the

photon-ALP oscillation hypothesis and places further constraints on the relevant ALP parameter space and its impact on gamma-ray propagation over cosmological distances.

Cluster Identification using Gaussian Boson Sampling

Josefine Bjørndal Robl, Centre for Quantum Mathematics, University of Southern Denmark, Odense, Denmark

Abstract:

Quantum computing continues to expand its impact beyond purely theoretical models, reaching into data science and machine learning. Among emerging approaches, Gaussian boson sampling (GBS) – a photonic quantum sampling protocol based on Gaussian states and linear interferometers – has shown distinct advantages in solving graph-related problems. The increasing availability of programmable photonic hardware motivates exploring how GBS can be used not only to demonstrate quantum advantage but also to support practical computational tasks such as clustering and graph analysis.

In this work, we explore the use of GBS to accelerate divisive hierarchical clustering (DHC), a technique in unsupervised learning that seeks to uncover nested cluster structures in complex datasets. However, DHC faces severe computational barriers, as the number of possible graph divisions grows exponentially with the system size for non-heuristic DHC. This work proposes a GBS-assisted framework that aims to address this bottleneck.

We show that the intrinsic bias of GBS towards detecting densely connected subgraphs can be exploited to identify clusters efficiently. By making use of the link between the sampling probabilities based on the matrix function Torontonian and the density – both connectivity and edge weights – of a graph, we argue that our GBS-based clustering seems to exponentially suppress non-clustered subgraphs. This suppression effectively prunes the sampling space, concentrating the computational resources on the densest, and thus most relevant, graph partitions.

Analytically, we provide arguments and approximations suggesting that the number of samples required for GBS-based DHC may be small compared to the typical approach on classical computers. Numerically, we provide results from simulations over a set of synthetic graph ensembles which seem to support this prediction and further suggest a potential for only a subexponential number of samples required for GBS-based DHC.

Towards a Cryogenic Optical Filtering System for Background Suppression in High-Efficiency Single-Photon Detectors

Joakim Rosenkilde, University of Southern Denmark, Odense, Denmark & Deutsche Electron-Synchrotron, Hamburg, Germany

Manuel Meyer, University of Southern Denmark, Odense, Denmark & Deutsche Electron-Synchrotron, Hamburg, Germany

Elmeri Rivasto, University of Southern Denmark, Odense, Denmark & Deutsche Electron-Synchrotron, Hamburg, Germany

Abstract:

Cryogenic Single-Photon Detectors, such as Transition-Edge-Sensors (TES) and Superconducting Nanowire Single-Photon Detectors (SNSPD), have achieved high detection

efficiency larger than 85\% for optical and near-infrared wavelengths. Fiber-Coupled Blackbody photons has been identified as the dominant source of background signals for both detector systems. In order the achieve ultra-low background rates while maintaining high detection efficiency an Optical Filtering System is currently in development. The system is a cryo-compatible optical U-bench, housing a ultra-narrow bandpass filter with a center wavelength of 1065 nm. The Cryogenic Optical Filter Bench (COFB) is mounted on the 50 kelvin stage of a dilution refrigerator, and is designed with eleven mechanical degrees of freedom (DOF), seven of which are remote-controllable and four requires manual adjustment. The seven remote-controllable DOF allows for ongoing alignment of the open optical beam through the ultra-narrowband filter to compensate for thermal contractions and the resulting transmission loses. In addition, the COFB enhances the energy-resolving capabilities of TES detectors and enables energy-selective single-photon detection for SNSPDs. We present the design, performance and current limitations of the COFB system and discuss it's applicability to ultra-low-background optical experiments, such as the rare-event search for the hypothetical axions and axion-like particles with the experiment Any Light Particle Search II (ALPS II).

Long-distance chip-to-chip entanglement distribution over multicore fiber

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Giulia Guarda, University of Florence, Sesto Fiorentino, Italy
Mujtaba Zahidy, Technical University of Denmark, Kongens Lyngby, Denmark
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Francesco Da Ros, Technical University of Denmark, Kongens Lyngby, Denmark
Davide Bacco, University of Florence, Sesto Fiorentino, Italy
Caterina Vigliar, Technical University of Denmark, Kongens Lyngby, Denmark

Abstract:
Quantum networks promise unconditionally secure communications through quantum cryptography and enable distributed quantum computing architectures. Realizing these networks at scale requires the distribution of entangled states over long distances, using compact and manufacturable hardware. Photonic integrated circuits are a promising platform for this, as they offer the ability to integrate hundreds of optical elements in centimeter-scale devices, and interface with the existing telecom infrastructure.

Path encoding, where quantum information is encoded in the physical route photons travel, is straightforward to realize on integrated devices and naturally scales to higher dimensions. However, it requires strict phase coherence between spatial modes, which is challenging to maintain once photons exit the chip and travel over extended fiber links. Here, we demonstrate the distribution of a path-encoded Bell state between integrated silicon photonic chips connected via a dual-core, actively stabilized multicore fiber link over distances up to 80 km, and evaluate the system's performance in the context of entanglement-based quantum key distribution.

Implementation of time-bin entanglement-based QKD on a Silicon Nitride Photonic Integrated Circuit

Jan Scarabelli Calopa, DTU, Lyngby, Denmark

Abstract:
As the development of large-scale quantum computers accelerates, Quantum Key Distribution (QKD) has become essential for securing information against adversaries with unprecedented computational capabilities. In this work, I present a QKD architecture implemented on a silicon nitride photonic integrated circuit of roughly 5x10mm that enables generation, processing and time-bin entanglement of quantum states and the followed steps for the characterization of its components (and maybe some other results). The protocol employs time-bin encoding, where logical states are represented by the precise arrival times of single photons, providing compatibility with integrated photonics and robustness against decoherence in standard telecommunication optical fibers. Moreover, it also allows for time-bin entanglement which is a key factor to perform device-independent QKD in case we cannot trust the hardware.

Data analysis on cell monolayers: how to quantify order

Julia Schmidt, SDU, Odense, Denmark
Prasoon Awasti, Universidad Autónoma de Madrid, Madrid, Spain
Francesca Serra, SDU, Odense, Denmark

Abstract:
We aim to quantify the degree of alignment and the dynamics of cells grown on topographically patterned surfaces, such as ridges and waves forming topological defects. We focus specifically on cells that show spontaneous nematic order such as fibroblasts and myoblasts. We try to quantify cells' dynamics and nematic order in monolayers of elongated cells grown in various conditions, and how these are affected by surfaces, for example by large-scale curvature, short-scale topography and chemical functionalization. We have tried to improve on the current method of data analysis based on OrientationJ, which uses optical flow to estimate the orientation field but does not analyse each cell as a separate particle. We propose a different method for data analysis, where each cell is segmented and fitted with an ellipse. The nematic order is then estimated taking into account the ellipticity of each cell. We think this may be important especially in systems where the cells' shape is correlated with the defects of the orientational field.

Harnessing Topological Defects to Control Cell Organization and Contraction in Nematic Cell Layers

Grecia Maria Valenzuela Portillo, SDU, Odense, Denmark

Abstract:
Active nematic theory is increasingly used to describe the complex organization of cells in dynamical processes such as morphogenesis and cell assembly. In this context, liquid crystal theory has shown that rod-like cells can form phases of nematic order. The physical laws governing liquid crystal behavior can therefore serve as tools to investigate the molecular forces

that drive these processes and to understand how they can be harnessed to improve our understanding of three-dimensional tissue architecture.

A notable feature of liquid crystals is the presence of topological defects. Previous work has demonstrated that topological defects also appear in cell layers and are linked to cell density, extrusion, and invasion. We used micropatterning techniques to introduce specific topological defects, including those that are less energetically favorable, and grew cell layers on these patterned substrates. Confocal and bright-field microscopy, together with bioimage analysis, allowed us to quantify the orientational order parameter of cells and their contraction upon detachment. This revealed how to induce specific curvature and influence cytoskeletal organization and cell migration.

Our results show that upon detachment from patterned substrates, NIH-3T3 fibroblast sheets contract anisotropically — contracting more along the nematic director than perpendicular to it — with a stretch factor of approximately 0.3 and a 2D Poisson ratio of approximately -0.55. This behavior mirrors that of nematic liquid crystal elastomers (LCEs) during their phase transition, and numerical modeling supports these findings. This approach can be extended to other cell types, and preliminary results demonstrate that C2C12 cells exhibit a similar response. Applying liquid crystal physics to biological samples in this way integrates both biological and physical cues to achieve specific geometric arrangements.

Safely simplifying redshift drift computations in inhomogeneous cosmologies: Insights from LTB Swiss-cheese models

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Abstract:
One of the most important discoveries in cosmology is the accelerated expansion of the Universe. Yet, the accelerated expansion has only ever been measured indirectly. Redshift drift offers a direct observational probe of the Universe's expansion history, with its sign revealing whether there has been acceleration or deceleration between source and observer. Its detection will mark a major milestone in cosmology, offering the first direct measurement of an evolving expansion rate. Given its epistemic importance, it is essential to understand how its measurements can be biased. One possibility of bias comes from cosmological structures. However, theoretical estimates of such effects are difficult to obtain because computing redshift drift in general inhomogeneous cosmologies is computationally demanding, requiring the solution of 24 coupled ordinary differential equations. In this work, we use Lemaitre-Tolman-Bondi Swiss-cheese models to show that only the two dominant contributions are needed to achieve percent-level accuracy up to $z = 1$. This allows the reduction of the full system of 24 ODEs to the standard null geodesic equations, significantly simplifying the calculation. Although our analysis is based on idealized Swiss-cheese models with spherical structures, we expect that similar simplifications apply to more complex scenarios, including cosmological N-body simulations. Our analysis thus underpins a practical and robust framework for efficient redshift drift computations applicable to a wider range of inhomogeneous cosmologies.

nHESEL Simulation and Analysis of Heat and Particle Transport in the JT-60SA Tokamak

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Abstract:
The new JT-60SA tokamak is currently in the process of entering its second operating phase, at which point the team will be operating with a power input ceiling of 19 MW. Their diverter configuration(s) will allow for a cooling of at least 10MW m2 , but the question remains whether the heat load will exceed this limit.

To examine whether this cooling limit might be exceeded, we employed the drift-fluid nHESEL model. This model can be used to simulate outer mid-plane plasma edge phenomena, without the use of effective diffusion factors. This stands in stark contrast to many other existing models, which reduce turbulence to effective coefficients, thereby lowering the accuracy of edge phenomena modelling. To allow for a sweep of the JT-60SA operating parameter space, a wrapper was developed for the nHESEL model. This was then deployed in conjunction with a model for coupling the outer-midplane domain of the nHESEL model to the downstream diverter(s).

It was found that the predicted operating parameters, inferred from the 19 MW input power, will not exceed the cooling limit of 10MW m2 for their planned 19 MW configuration(s), but that their future 33 MW configuration may exceed one or more limits. Within the examined parameter space, it was found that the heat load for the 19 MW case may reach values of ~ 2.3MW m2 for a dual-divertor configuration, and twice this value for the corresponding single-configuration case. Depending on the contribution of ions towards this heat load, values of ~ 4MW m2 may be reached for the dual-divertor case, and twice this value for the single-divertor case. For the 33 MW case we may reach heat loads of ~ 9MW m2 for the single-divertor case, and > 15MW m2 when including the ions. The dual-divertor cases are expected to have heat loads of 50% these values, or above.

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A sincere thank you to the University of Southern Denmark and its leadership for fostering a vibrant academic environment that makes it possible for all geeks and nerds to pursue the thrill of physics.

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