

NBIA NEWSLETTER



A MESSAGE FROM THE DIRECTOR

Poul Henrik Damgaard

The race to build quantum computers has ignited new excitement and interest in fundamentals of quantum mechanics. That is the way theorists act: buzz-

words of the times are picked up, and suddenly new inspiration is found in old problems. Even the terminology changes. Today "Quantum" one way or another refers to quantum technology and the theoretical framework around it, but this was not so just 10-20 years ago. Next year, we can celebrate the hundred-year anniversary of quantum mechanics. In the intervening one hundred years quantum mechanics has driven physics in a multitude of different directions: to quantum field theory, atomic physics, nuclear physics, quantum optics, and elementary particle physics. All four fundamental forces of nature are described in terms of theories that beautifully combine relativity with quantum mechanics. Even quantum gravity is perfectly well described as an effective quantum field theory at all energy scales up to the so-called Planck energy (which is 19 orders of magnitude larger than the mass of the proton). Despite these established fields being built in fundamental ways on relativistic quantum mechanics, both theorists and experimentalists continue just these years to find new ways to explore quantum mechanical phenomena. This spring, Assistant Professors Berislav Buca and Apoorv Tiwari have established a new series of Quantum Seminars at NBIA that pursue these new pathways to the quantum world. Speakers and audience range from condensed matter physics, mathematics, quantum optics, and high energy physics. This interdisciplinary initiative requires special effort of both speakers and audience but it is rewarding to learn about completely new perspectives on the fundamentals of quantum mechanics. We can expect this area of research to grow significantly at NBIA over the coming years. But also classical physics continue to present us with surprises. The NBIA biophysics group finds new understanding of living matter based on the classical laws of physics, and classical gravity is being explored intensely from both general relativity and astrophysical angles due to the new observations of classical gravitational waves. It's an exciting mixture of new ideas that are being applied to physical phenomena at almost all scales.

NEWS IN BRIEF

NBIA signs Memorandum of Understanding with APCTP in Korea

NBIA Director Poul H. Damgaard has signed an Agreement of Cooperation for three years with the Asia Pacific Center for Theoretical Physics (APCTP) in Pohang, Korea.

APCTP was established in June 1996, with Nobel Laureate C. N. Yang as its founding President. It is an international non-governmental organization with currently 17 member countries & regions. Its aim is to lead in fundamental theoretical physics in the larger Asian-Pacific region. Every year, more than 4,000 researchers participate in the conferences, workshops, schools, or long-term academic programs at APCTP.

The agreement between NBIA and APCTP focuses specifically on developing financial plans to co-sponsor international workshops on theoretical physics on either the Pacific Rim or in Denmark, upon agreement between the two institutions.

Alessia Platania and Apoorv Tiwari receive Villum Young Investigator grants

Assistant Professor Alessia Platania joins NBIA with a Villum Young Investigator grant for her project titled "Non-perturbative strings, asymptotic safety, and the swampland". Central in her research has been the exploration of so-called asymptotically safe gravity and its potential relation to string theory. With her grant from the Villum Foundation she will establish a junior research group with a post-doc and a PhD-student.

Louis-Hansen Foundation Assistant Professor Apoorv Tiwari has received a Villum Young Investigator grant for his project titled "Global Categorical Symmetries and Phases of Quantum Matter". His current research interests are focused on the recent discovery of non-invertible symmetries known as categorical symmetries. These symmetries appear in systems of quantum matter ranging from condensed matter physics to high energy physics. Tiwari will hire a post-doc and a PhD-student to join him in a new junior research group at NBIA.

NEW NBIA MEMBERS

This Spring, NBIA welcomes a number of new staff members and visitors. You can find a brief description of their work below. We also give a warm welcome to our new PhD students, **Manuel Goimil Garcia**, **Elisa Gilli**, **Marta Cocco**, and **Beatrice Geiger**.

Mary Wood is a new assistant professor whose background is in surface chemistry. Her research involves applying a number of unusual techniques to probe buried interfaces relevant to new avenues in renewable energy technology, such as biophotovoltaics.



Sarah Pearson is a new assistant professor. Her research focuses on stellar streams and the nature of dark matter, which she tests through statistical model-to-data comparisons between theoretical predictions from various dark matter candidates, stellar stream data, and simulations.



Pablo Martínez-Miravé is a postdoctoral researcher on particle astrophysics. He is interested in exploring neutrino properties relying on terrestrial experiments, the Sun, the early Universe, as well as core-collapse supernovae and binary neutron star mergers.



Fabian Schuhmann is a new postdoctoral researcher working on computational biophysics. His research interests manifest in protein dynamics as simulated by molecular dynamics simulations and the detailed analysis of such simulation data.



Alessia Platania is a new assistant professor. Her research interests lie at the interface between quantum gravity, effective field theory, and black-hole physics. In the coming years she will investigate the theoretical and observational consistency of asymptotically safe gravity.



Lorenz Zwick is a postdoctoral fellow studying the variety of perturbations that astrophysical backgrounds imprint on gravitational waves. He works on a broad range of topics. These include the formation and the dynamical evolution of black hole binaries, accretion discs and the origin of high red-shift quasars.



NEWS IN BRIEF (CONTINUED)

Simon Caron-Huot receives Lars Kann-Rasmussen Prize

At an award ceremony on February 7th, former NBIA Assistant Professor Simon Caron-Huot received this year's Lars Kann-Rasmussen Prize by KU Associate Dean of Research Lise Arleth. The Prize was presented by Lars Kann-Rasmussen to Simon Caron-Huot in Auditorium A following speeches by Deputy Dean of Research Lise Arleth and NBIA Director Poul Henrik Damgaard.

Simon Caron-Huot receives the Lars Kann-Rasmussen Prize "For his fundamental and deeply original contributions to quantum field theory that have led to significant advancement of the understanding of physical systems ranging from high-density nuclear matter, statistical mechanics near critical points, to the interactions of black holes and the emission of gravitational waves".

Irene Tamborra receives Elite Research Award

At an award ceremony at the Black Diamond building in Copenhagen, Queen Mary and Minister of Higher Education and Science Christina Egelund presented the Elite Research Award to NBIA Professor Irene Tamborra for her research in the burgeoning field of multi-messenger astrophysics and in particular for her contributions to the understanding of the role neutrinos play in explosive astrophysical events such as supernova explosions and in collisions involving neutron stars. The Elite Research Award includes a research grant of 1 million DKK and 200,000 DKK as a personal recognition award.

Assistant Professor Jose Ezquiaga brings NBIA into the LIGO Collaboration

Assistant Professor Jose Maria Ezquiaga has led NBIA to become a member of the LIGO Scientific Collaboration. This represents the first LIGO group in Denmark and will join an international association with more than 1500 members, 120 institutions and 20 countries.

The LIGO Scientific Collaboration was responsible for the discovery of gravitational waves from coalescing black holes in 2015, which granted the founders of the project the Nobel Prize in physics in 2017. Since then about 100 other detections have been recorded, including a multi-messenger binary neutron star and neutron star black hole collisions.

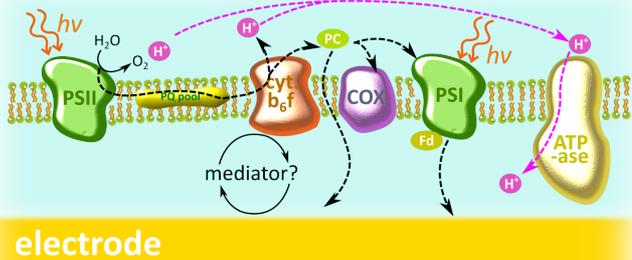
The NBIA team is actively working on the characterization of new events, searches of lensed gravitational waves, measurements of the expansion rate of the Universe and tests of Einstein's gravity in the strong field regime.

RESEARCH HIGHLIGHT on Bioelectronic membranes

Mary Wood



Biophotovoltaics, in which photosynthetic biofilms are grown onto electrode surfaces and used to harvest light energy, represent a promising new source of renewable energy and/or production of valuable chemical feedstocks. However, they are limited by slow electron transport at the biofilm/electrode interface. This can be improved by extracting the thylakoid membrane, which hosts all the photosynthetic proteins, and wiring it directly to the interface, but such systems are poorly characterised and lack reproducibility. By using a number of sophisticated surface analysis techniques, these interfaces can be revealed in unprecedented detail *in operando*; for example, neutron reflectometry allows us to observe and measure the binding of the lipid bilayers to the electrode with angstrom-level resolution whilst simultaneously charting the photocurrent output. Such experiments allow us both to more clearly inform future developments in this technology, and also lead to new directions in our understanding of the nature of photosynthesis itself.



NEWS IN BRIEF (CONTINUED)

Sarah Pearson receives an ERC Starting Grant

Assistant Professor Sarah Pearson, has been awarded an ERC starting Grant from the European Commission. With this ERC Starting Grant, Sarah Pearson will investigate the nature of dark matter, which makes up more than 80% of the matter in the Universe, through statistical model-to-data comparisons between theoretical predictions from various dark matter candidates (cold, warm, wave-like, self-interacting) and stellar stream data.

The grant, of 1.67 million Euro, will allow Sarah to hire two post-doctoral researchers and two PhD-students, who will work under her guidance for the next five years at the Niels Bohr Institute.

OUTREACH EVENT AT NBIA

Frontiers of Physics: News from the Niels Bohr International Academy

By Asst. Prof. Sarah Pearson (NBI); Prof. Peter Ditlevsen (NBI); Prof. Jørgen Christensen-Dalsgaard (Aarhus University); Prof. Eugene Polzik (NBI); and Prof. James Cline (McGill University). The assistant course editor for the program is Assoc. Prof. Emil J. Bjerrum-Bohr (NBI).

This course offers an exciting opportunity to stay up-to-date with the latest news from the Niels Bohr International Academy. You will attend lectures by five distinguished scientists who will share their fascinating research. The lectures will take place in the legendary Auditorium A of the Niels Bohr Institute.

Titles:

1. From stellar streams to the invisible universe (SP)
2. Tipping points in the climate (PD)
3. Probing the interiors of red giant stars with the Kepler mission (JC-D)
4. Quantum sensing for biomedical applications (EP)
5. What is dark matter? (JC)

Time: 5 Tuesdays at 17.15-19.00 (8/10-12/11), no lecture on 15/10

Place: NBI, Aud A, Blegdamsvej 17

UPCOMING WORKSHOPS AND SCHOOLS

Please visit our [NBIA web page](#) for details and updates.

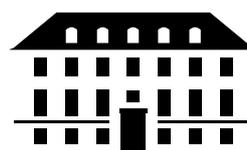
- Current Themes in Transient Astrophysics and Cosmology (June 24-28)
- NBIA Summer School on Astrophysical Dynamics of Gravitating Systems (Aug. 12 -16)
- New Ideas on the Origin of Black Hole Mergers (Aug. 12-16)
- Ringdown Inside and Out (August 22-24)
- Black Holes Inside and Out (August 26-30)

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The Niels Bohr
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