

NBIA NEWSLETTER

A MESSAGE FROM THE DIRECTOR

Poul Henrik Damgaard

The saga of the new Niels Bohr Building has been unfolding over more than a decade by now and it is still developing in new twists and turns. The fate of the buildings of the Niels Bohr Institute on the Blegdamsvej complex has been closely tied to this, some times divided into two parts: what constituted the original historical buildings, and what resulted from the more recent expansion into buildings next to those historical buildings. It is now known that these more recently acquired buildings will be transformed into a center for the Novo Nordisk Foundation Quantum Computing Program that has just been launched. With a budget of approximately 1.5 billion DKK for the first seven-year period, this will have significant impact on the Niels Bohr Institute and it offers a unique opportunity for NBIA to contribute by seeking synergistic possibilities. In short term, and also due to the current rapid expansion of NBIA, it is going to present challenges with office space. An effort is underway to turn every suitable space into offices, while retaining the important infrastructure of auditoria, library facilities, and a few meeting rooms. Longer term, the vision of a shining center for physics for the full complex that will include the major research initiative into quantum computing is evident to all. This will be win-win: great opportunities for both the new Novo Nordisk Foundation Quantum Computing Program and NBIA. Because the eventual aim of the quantum computing center is in applications to life sciences, the recent expansion of NBIA into biophysics fits beautifully into this strategy. Looking beyond the obvious, also possibilities for research that currently may look far removed from life sciences can play an important role in shaping the future developments of quantum computing in sciences, and for society. This curiosity-driven research strategy is crucial for the success of any fundamental development in the sciences. NBIA is ready to take up the challenge and capitalize on these new opportunities, to the benefit of all.



NEWS IN BRIEF

VITOR CARDOSO RECEIVES DNRF CHAIR FROM THE DANISH NATIONAL RESEARCH FOUNDATION

The Danish National Research Foundation has awarded NBIA's Vitor Cardoso a DNRF Chair to study and quantify quantum effects on astrophysical black holes. With the overall purpose of strengthening and enriching Danish research communities, the aim of the DNRF Chair grant instrument is to motivate and support Danish universities to attract and recruit particularly outstanding researchers from abroad. Vitor Cardoso's research uses black holes as new engines of discovery, using them to understand the dark content of our universe but also to test the very tenets of General Relativity. With this grant, Vitor Cardoso will build up a group of young researchers in the field who will join a rapidly expanding group of scientists in gravitational physics at NBIA. The DNRF Chair will allow Vitor to hire two post-docs and two PhD-students who will join Vitor's research group later this year.

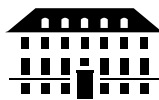
ERC STARTING GRANT TO JOHAN SAMSING

Johan Samsing has been awarded an ERC starting Grant from the European Union for his project "Gravitational Wave Astrophysics and Dynamical Formation of Black Hole Mergers." With his ERC Starting Grant, Johan Samsing will study the astrophysical landscape of dynamical formation mechanisms that could bring black holes to merge. This will provide new theoretical insight and observational tools to help answer the major outstanding questions of how black holes form and merge in our Universe using current and future gravitational wave data. The grant, of 1.9 million Euro, will allow Johan to hire post-doctoral researchers and PhD-students who will work under his guidance for the next five years.

UPCOMING WORKSHOPS AND SCHOOLS

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

- Nordic PhD Winter School on Gravitational Astrophysics
(January 29 - February 3, 2023)



NEW NBIA MEMBERS

This Fall the NBIA welcomes several new staff members. You can find a brief description of their work below. We also give a warm welcome to our new PhD students, **Juno Chun Lung Chan**, **Conor Dyson**, **Gaia Fobj**, **Marcela Grcic**, **Valeriia Grudt-syna**, **Kai Hendriks**, **Roger Morales**, **David O'Neill**, **Jaime Redondo Yuste**, **Thomas Spieksma**, **Dana Taylor Kamp** and **Bernanda Telalovic**, our new MSc students, **Mikkel Andersen**, **Ariel Avanzi**, **Anirudh Bhatnagar**, **Jonathan Bödewadt**, **Thomas Cope**, **Jorge Expósito Patiño**, **Manuel Goimil Garcia**, **Johan Møller Christensen**, **Jo Nykrem**, **Samuel John Pädraig Bensted**, **Gowtham Rishi Mukkamala**, **Marcos Santos**, **Garðar Sigurðarson**, **Amit Singh**, **Haochun Sun**, **Toni Teschke** and **Tianyi Zhou**, and our new research assistants, **Lasse Bonn**, as well as new student assistants, **Marta Christiansen** and **Marcos Santos**.

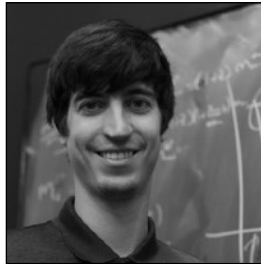
Post-doc **Yifan Chen** works in the intersection of particle physics, strong gravity, string theory and quantum sensor. At NBIA, he focuses on turning supermassive black holes into detectors for ultralight bosons, such as axions and dark photons, by exploiting Event Horizon Telescope observations.



Post-doc **Annika Lena Rudolph**'s work focuses on high-energy astrophysical phenomena like gamma-ray bursts and active galactic nuclei in a multi-messenger context: she studies neutrino and photon signatures of cosmic-ray interactions in these sources by means of numerical radiation modelling.



Jose M. Ezquiaga is a new Assistant Professor working with gravitational waves to explore the Universe. His research lies at the intersection of fundamental physics, cosmology and astrophysics and aims at probing gravity and unveiling the nature of dark energy and dark matter.



Post-doc **Siavash Monfared**'s research is at the interface of granular physics, statistical mechanics and active matter. He is interested in the link between the physics of force transmission and collective self-organization in biological systems through developing theoretical models and computational tools.



Neda Rahmani is a post-doctoral researcher whose focus is on exploring biomaterials and biological processes using multiscale computer simulation techniques. She has a background in finding new functional materials for photovoltaics and spintronics through density functional theory calculations.



NEWS IN BRIEF (CONTINUED)

AMIN DOOSTMOHAMMADI RECEIVES THE "2021 MAJOR ADVANCES IN BIOLOGY PRIZE" FROM THE FRENCH ACADEMY OF SCIENCES

Amin Doostmohammadi receives the Prize for his work on unravelling the nature of forces in cellular tissues, as described in a recent paper published in *Nature Materials*. Changes in the way that cells stick to each other and to their surrounding environment are involved in mechanisms essential for tissue and organ formation, as well as in pathological mechanisms such as tumor progression. To understand these changes between the individual and the collective, Amin, in collaboration with experimental groups in France, Singapore, and Australia, developed a new model for connecting single cell-level forces to multicellular scale. The results revealed the impact of cell adhesion on the dynamics of cellular organization. This multidisciplinary work at the interface between biophysics and cell biology offers a new framework for understanding the self-organization of tissues based on the analogy with nematic liquid crystals and the nature of internal forces.

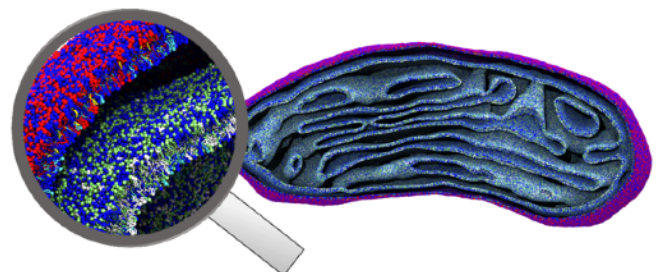
EU MARIE CURIE FELLOWSHIPS

Three researchers have been awarded two-year EU Marie Curie individual fellowships hosted by NBIA.

Aleksandra Ardaševa has received a fellowship to work on the project titled "Topography-mediated cell communication." Aleksandra works under supervision of Amin Doostmohammadi within the Active & Intelligent Matter Group at NBIA.

Kristian Thijssen has been awarded a fellowship for a project called "SIMMS." His research project proposes that the collective dynamics exhibited by swimming bacteria play a role in restructuring their material surroundings as active "ecosystem engineers."

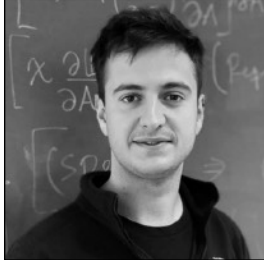
NBIA post-doc Bin Liu has been awarded a Fellowship to work on the dynamics and merger of compact objects near super-massive black holes in active galactic nuclei discs.



Maarten van de Meent is a new assistant professor in the Strong gravity group. He is interested in the dynamics of binary black holes and modelling their gravitational waves. He focusses on developing the gravitational self-force formalism, describing binaries with small mass-ratios.



David Pereñiguez is a new postdoctoral researcher interested on black hole physics. He is currently working on black hole perturbation theory beyond general relativity, and how this can be applied to study the dynamics and thermodynamics of black holes in several regimes.



Sameer Kumar is a new postdoctoral researcher interested in active matter. His research focuses on active system in the presence of extrinsic or intrinsic disorder in the system. He will work on the structural and dynamical properties of polar active particles in a dense medium.



Post-doc **Christopher Tiede**'s research interests are in astrophysical gas dynamics where he works with high-performance simulations to study flows around binary black holes. He explores how such accretion phases alter the life-cycles of binaries and enable their multi-messenger observational prospects.



Post-doc **Zhengwen Liu** is interested in scattering amplitudes and loop integrals, from their mathematical structures to their applications to collider physics and gravitational-wave observations. He focuses on developing computational techniques to solve the gravitational two-body problem.



Gregorio Carullo joins NBIA as an Interactions Fellow in the newly formed Strong gravity group. His research focuses on extracting fundamental physics implications from gravitational waves observations and testing the black hole paradigm, mainly using black hole spectroscopy techniques.

RESEARCH HIGHLIGHT on Biophysics

Weria Pezeshkian

Biological membranes are molecular assemblies with a thickness of two molecules and lateral extensions exceeding micrometers. They provide identity to the cell as a whole and compartmentalize its internal structure into specialized subunits called organelles. Known as the powerhouse of the cell, mitochondria are multifunctional organelles that produce cellular energy parcels from food. A mitochondrion is surrounded by two membranes. The inner membrane hosts the energy conversion machinery and exhibits intricate and astonishing architectures. In response to bioenergetic demands and metabolic changes, the inner membrane morphology undergoes significant changes, on a millisecond time scale. However, due to the lack of experimental methods for studying this supramolecular complex at the required spatiotemporal resolution, it remains unclear how molecular activities shape mitochondrial membranes. Here at NBIA, we develop multiscale computer simulation schemes to couple molecular activities with mesoscopic forms. Our goal is to understand how mitochondrial architectures emerge from molecular interactions and how the level of energy production alters these structures.



OUTREACH EVENT AT NBIA

The lecture series "From the Research Frontier at the Niels Bohr International Academy" shows a glimpse of various exciting front lines of modern research and was created in collaboration with the Niels Bohr International Academy (NBIA). All lectures are in the famed Auditorium A, Niels Bohr Institute, Blegdamsvej 17.

"Developing Quantum Computing" - April 11, 2023

Prof. Peter Krogstrup Jeppesen, NBI

"Is the climate running amok?"

About the risk of tipping points" - April 18, 2023

Prof. Peter Ditlevsen, NBI

"Searching for Structure in Unfalsifiable Claims"

April 25, 2023

Prof. Serge Belongie, Dept. of Computer Science

"The four-color problem" - May 2, 2023

Prof. Nathalie Wahl, Dept. of Mathematical Sciences

"The bright side of black holes" - May 9, 2023

Prof. Vitor Cardoso, NBI

organized by Assoc. Prof. Emil J. Bjerrum-Bohr, NBI