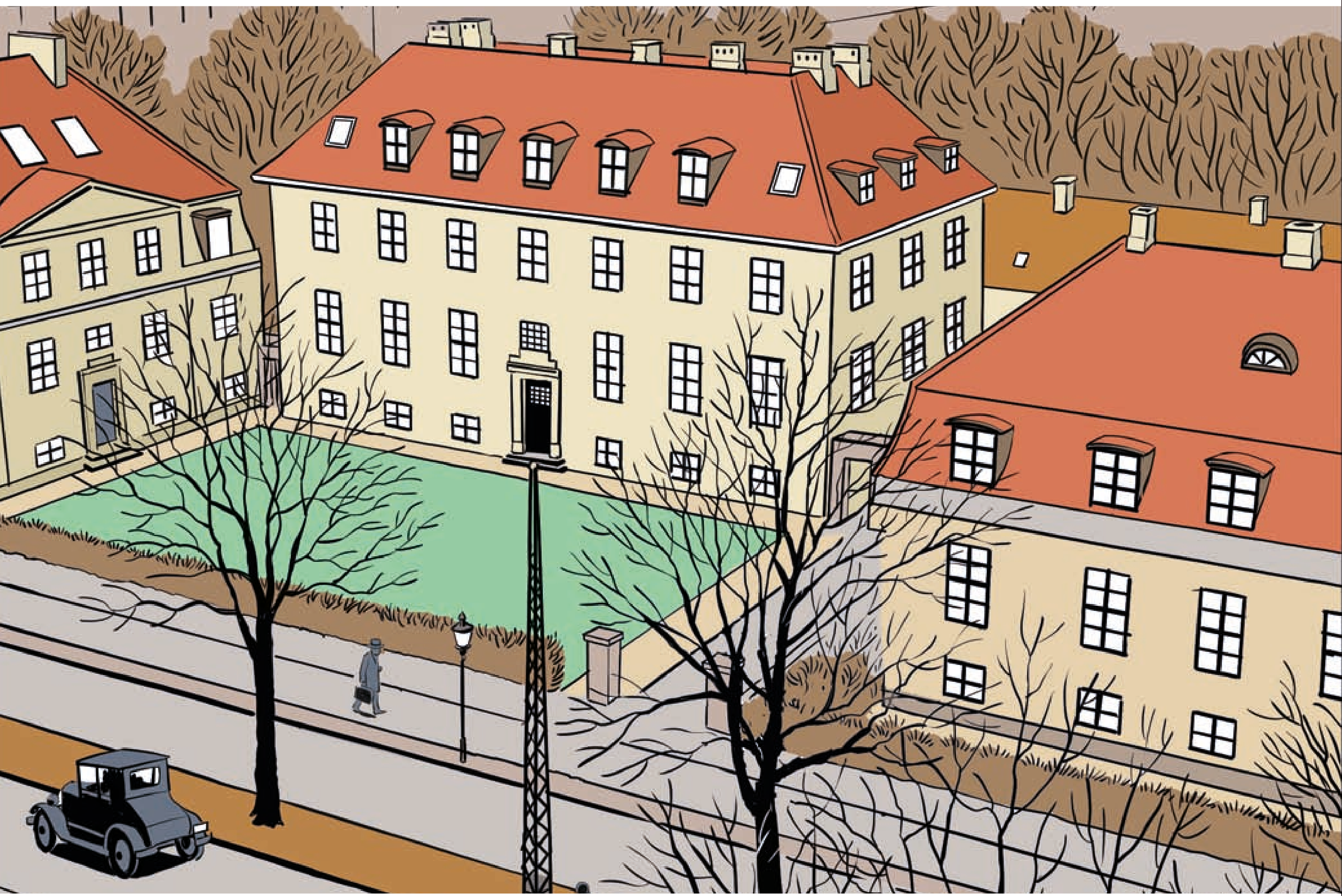
The Niels Bohr International Academy



Annual Report 2023

The Niels Bohr International Academy

Contact: Gosia Dekempe
NBIA Administrative Officer
Email: malgorzata.dekempe@nbi.ku.dk
Tel: +45 35 32 72 56

Web: http://www.nbia.nbi.ku.dk/

Editor: Martin E. Pessah
Professor, Deputy Director
Niels Bohr International Academy
Niels Bohr Institute

Email: mpessah@nbi.ku.dk

Cover drawing by Niels Roland, from his upcoming book "Niels Bohr - Kvantespring i København"

Table of Contents

The Academy


Paul Steinhardt
David Gross

NBIA Governance

International Advisory Board and Director's Council:

The Niels Bohr International Academy receives scientific advice from an International Advisory Board consisting of leading names in today's theoretical and mathematical physics as well as important advice and support from its Director's Council, which consists of prominent members of Danish society.

Current Members of the International Advisory Board:

- **Poul Henrik Damgaard**, Niels Bohr Institute (Director)
- **Martin E. Pessah,** Niels Bohr Institute (Deputy Director)
- **David Gross**, KITP Santa Barbara
- **Irene Tamborra**, Niels Bohr Institute (Chair)
- **Itamar Procaccia**, Weizmann Institute
- **Steve Simon**, Oxford University
- **Paul Steinhardt**, Princeton University
- **Frank Wilczek**, Massachusetts Institute of Technology

Current Members of the Director's Council:

- **Peter Landrock** (Chair)
  Founding Director of Cryptomathic, Professor of Mathematics and Fellow, Churchill College
- **Kirsten Smedegaard Andersen**
  Board Chair Movotec, Board member LD, Bodum, and other public and private organizations
- **Bertel Haarder**
  Former MP, Minister and former member of European Parlament
- **Niels Due Jensen** (Vice Chair)
  Former CEO of Grundfos and former Chairman of Poul Due Jensen Foundation
- **Anne Birgitte Gammeljord**
  Lawyer, Rovsing & Gammeljord
- **Bjørn Nørgaard**
  Prof. Royal Academy of Fine Arts, Guest Prof. China National Academy of Arts
- **Michael K. Rasmussen**
  Former Vice President, Brand in VELUX Group, private consultant

The Niels Bohr International Academy


Landrock
Irene Tamborra
Itamar Procaccia

From the Director

The playwright George Bernard Shaw once wrote: “If you have an apple and I have an apple and we exchange these apples, then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas”. I recently saw this quote in a short note on scientific creativity sponsored by the World Economic Forum. It may seem odd that the World Economic Forum is concerned about scientific creativity. We normally think of this organization in terms of annual meetings at Davos, a gathering point for heads of state, big movers and shakers in industry and international organizations, etc. The fact that it also cares about fundamental science shows the understanding that our future is crucially dependent on the scientific breakthroughs of today. Exchange of ideas, interactions across different fields, thinking out of the box, enabling creativity: the importance of these strategies for society is fortunately recognized. Tellingly, the World Economic Forum currently has a strong focus on all the new prospects of quantum computing as well as on associated cybersecurity issues (the catchphrase is “quantum cyber readiness”).

How well is science doing overall in terms of creativity? In January 2023 Nature published a study with the title “Papers and patents are becoming less disruptive over time”. Without going into details about how the authors could reach this conclusion one must add a qualifier: The number of disruptive papers and patents during the 65-year interval 1945-2010 has not declined (according to the way of measuring defined by the authors) but has remained essentially constant. However, during the same period the total number of papers and patents has literally exploded. The conclusion seems to be that all the extra effort has not led to a corresponding acceleration in new breakthroughs. If correct, why could it be? The tendency in science to naturally drift into higher and higher degrees of specialization may be at the root of the problem. This is why it is so important to resist this natural narrowing of scope.

One superb way to ensure renewal in science is to bring in young scientists with fresh ideas and unbiased minds. During 2023 NBIA expanded into many new directions driven entirely by young talent. Topics range greatly and all of them reflect the bottom-up approach to science that is so important for the success of NBIA. One track explores bioelectronic interfaces and the related physical and biological mechanism behind photosynthesis. This can lead to breakthroughs in the efficiency of green energy solutions based on biomaterials. Another track focuses on a new and critical reassessment of what has become the commonly accepted model of cosmology. Many other new topics have been introduced by new junior faculty members of NBIA and let me list a few: the discovery of what is known as non-invertible symmetries in physics has implications ranging from condensed matter physics and quantum optics to high energy physics. New methods have been introduced for computing gravitational wave emission from the merging of black holes based on quantum field theory methods, astrophysical implications of gravitational wave signals have been analyzed, and, quite remarkably, the general relativistic effect of the gravitational bending of gravitational waves is now being pursued by a junior research group at NBIA. These topics all bridge across several disciplines, highlighting the strength of interdisciplinary research.

Poul Henrik Damgaard

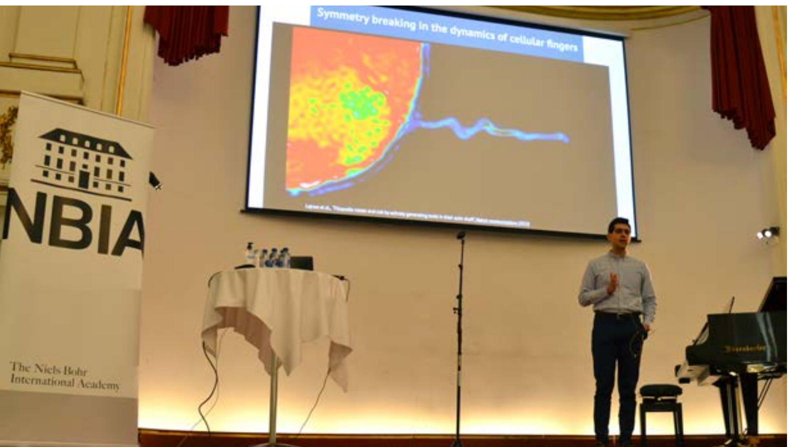

NBIA


SOCIAL RULES AND SOCIAL LIFE IN DENMARK
How to make friends and avoid offending anybody
NBIA
The Niels Bohr International Academy


The Strong team
NBIA


NBIA
The Niels Bohr International Academy


The Elusive Neutrino
Three neutrino flavours
Very small masses (unknown origin)
Large mixing between flavor and mass states (unknown mechanism)
Second most abundant particle in the Universe (impact on cosmology)
Unique probe of high-energy particle physics & astrophysics
Standard Model of Particle Physics
(+ Higgs boson)
NBIA
The Niels Bohr International Academy


Symmetry breaking in the dynamics of cellular fingers
NBIA
The Niels Bohr International Academy

From the Chair of the Council

NBI and NBIA have recently been assessed by an international committee. The verdict was nothing short of absolute eminence: In brief: "Quality that is world-leading in originality, significance and rigor, with highest score given in particular for NBI's excellence in quantum technologies; PICE, a worldwide beacon for ice research; World-leading excellence in quantum optics theory and experiment; The biocomplexity section, instrumental in introducing a quantitative component into molecular biology; The theoretical high energy, astro particle and gravitational physics. In addition, Astrophysics, Condensed matter physics, and High energy theory are all uniformly strong, with high international reputations."

This begs the question: What does it take to build an outstanding scientific staff and to ensure people remain? On a personal level, I have some experience from my own alma mater, University of Chicago, from the IAS (Institute for Advanced Study) in Princeton and from being associated with Cambridge University for 28 years.

In the USA, financial supremacy is a dominating factor for successful hiring. This was the approach of Rockefeller when he founded University of Chicago in 1893, and similar when the Bambergers founded the IAS In 1930, now known to millions as Oppenheimer was its most famous director. But that does not explain how you persuade researchers to remain.

In Europe salaries are predominantly regulated, so financial temptations are limited. On the other hand, it is an old saying that second-class researches will hire third class researchers to continue to stand out, whereas first class researchers will do their utmost to attract even better researchers. As the evaluation committee stressed: The leading international status of NBI is reflected in its ability to repeatedly pull off "coups" to hire world leading researchers, a reflection of the outstanding collaborative culture and the high quality of student education. In addition, since founded, the NBIA has established itself as an important institution that attracts excellent young researchers who in turn attract numerous grants, including the most prestigious ones like those from the ERC. NBIA's leadership is explicit that scientific quality is the primary selection hiring criterion. This in turn benefits the entire NBI as a source of excellent candidates for tenured positions in all sections. In addition, this policy ensures research within the NBI in the current "hot" fields of physics. The ambience of the NBIA within the historic buildings on Blegdamsvej adds to the attraction for young ambitious researchers.

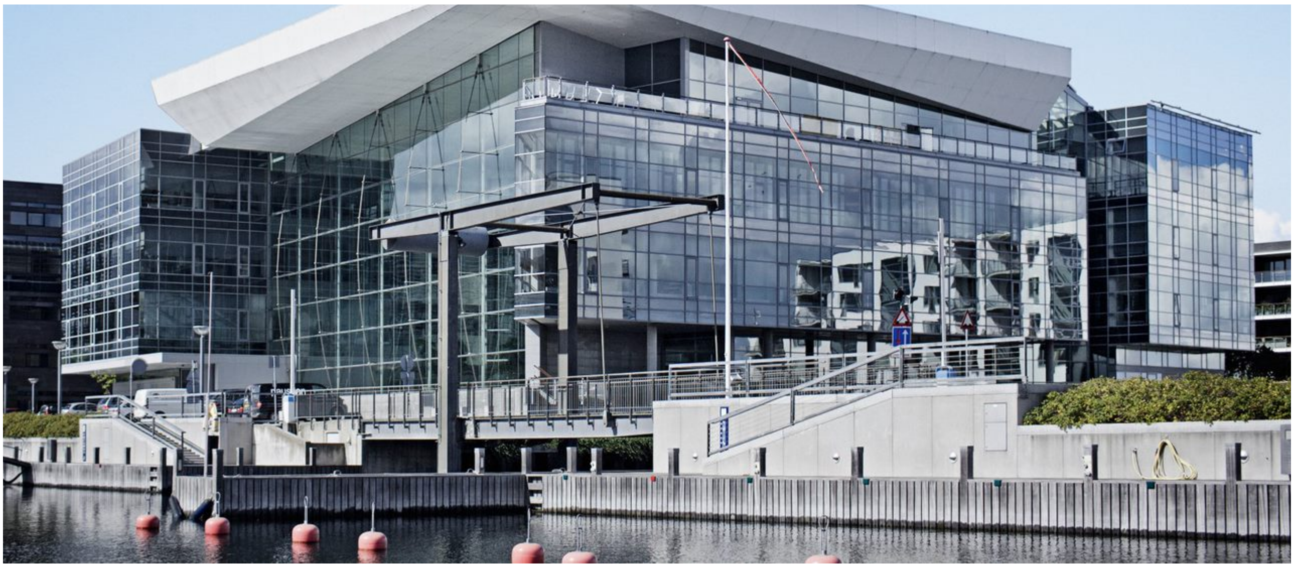
There are two universities in Europe that manage year after year to attract top-notch researchers even though salaries are limited: Cambridge and Oxford in the UK. One of their greatest attractions is that they are collegial: All undergraduates are attached to a college, the most famous in science being Trinity in Cambridge, Newton's college. A great majority of the university researchers are also Fellows at a college. This entails the duty to supervise students in small groups, and the option to attend "High Table" dinners in College where you have an excellent chance of meeting other fellows or visiting fellows from other colleges or universities, an enormous source of inspiration and collaboration.

In a nutshell, if you thrive to hire the best researchers, nourish the young ones - who may stay or be your best ambassadors if they leave - and create an attractive environment – scientific as well as social - you may be successful as NBI/NBIA in achieving persistent excellence.

Peter Landrock

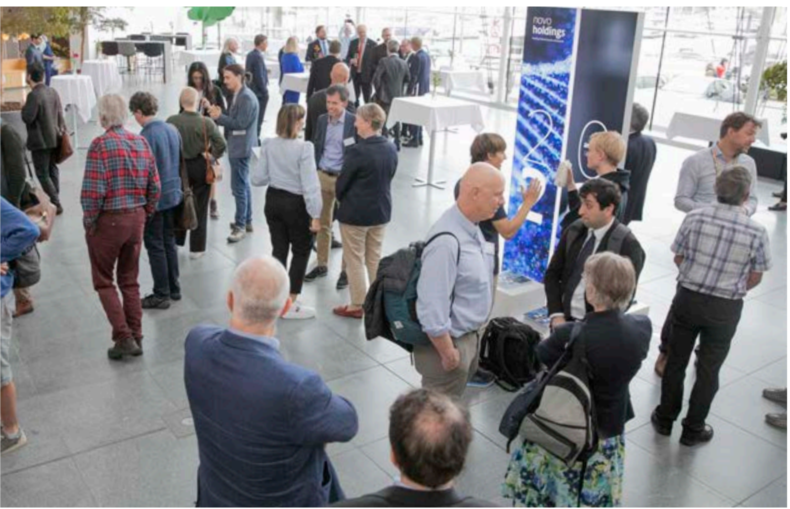
Novo Nordisk Foundation Grant

This grant of 35 MDKK aims at establishing up to five Novo Nordisk Foundation Assistant Professors, Novo Nordisk Foundation Associate Professors, or Novo Nordisk Foundation Full Professors at NBIA. The new research directions should have potential for relevance within life science research. The time is indeed ripe for this expansion into areas in life sciences that are bordering physics, and it has for several years been the ambition of NBIA to again establish a stronghold in theoretical biological physics (one of the first topics of research when NBIA was founded in 2007). The large grant from the Novo Nordisk Foundation takes this to a much larger scale. It will support research at NBIA that may potentially have large impact on the life sciences. These are research areas where physics-driven methods may provide new and groundbreaking results. In addition to making these new fixed-term appointments NBIA will provide the interdisciplinary atmosphere, the close contact with both theoretical physicists and mathematicians, and the steady flow of leading scientists that normally visit NBIA every year. The first Novo Nordisk Foundation Assistant Professor Amin Doostmohammadi started his NBIA appointment in the fall of 2019 and based on a personal Villum Young Investigator grant, support from Independent Research Fund Denmark, the NERD program under the Novo Nordisk Foundation, and, most recently, an ERC Starting Grant, he has already established a large junior research group. Amin Doostmohammadi received tenure at the Niels Bohr Institute in 2023. In 2021 the NBIA life-science program extended further by the simultaneous hire of Weria Pezeshkian (who works on computational biophysics) and Karel Proesmanns (who works on applying thermodynamic and statistical mechanics methods to biological systems). Weria Pezeshkian, who has also received an EU Marie Curie Fellowship, has already established his own junior research group based on Sapere Aude grant from Independent Research Fund Denmark and a project grant from the Novo Nordisk Foundation. Karel Proesmanns has also received an EU Marie Curie Fellowship and has already started his own junior research group based on a project grant from the Novo Nordisk Foundation. In the fall of 2023 the NBIA bio-group extended further in new directions through the hire of Mary Wood who has a background in chemistry and who is pushing for new understanding of bio-electronic materials.




welcomes
Crossing the Disciplinary Boundaries of Physics
Lene Oddershede, SVP, Professor
+1


novo
nordisk
fonden
Benefiting people and society


novo
holdings


CROSSING THE DISCIPLINARY
BOUNDARIES OF PHYSICS
2023 Centennial Conference
7–11 August 2023
Copenhagen

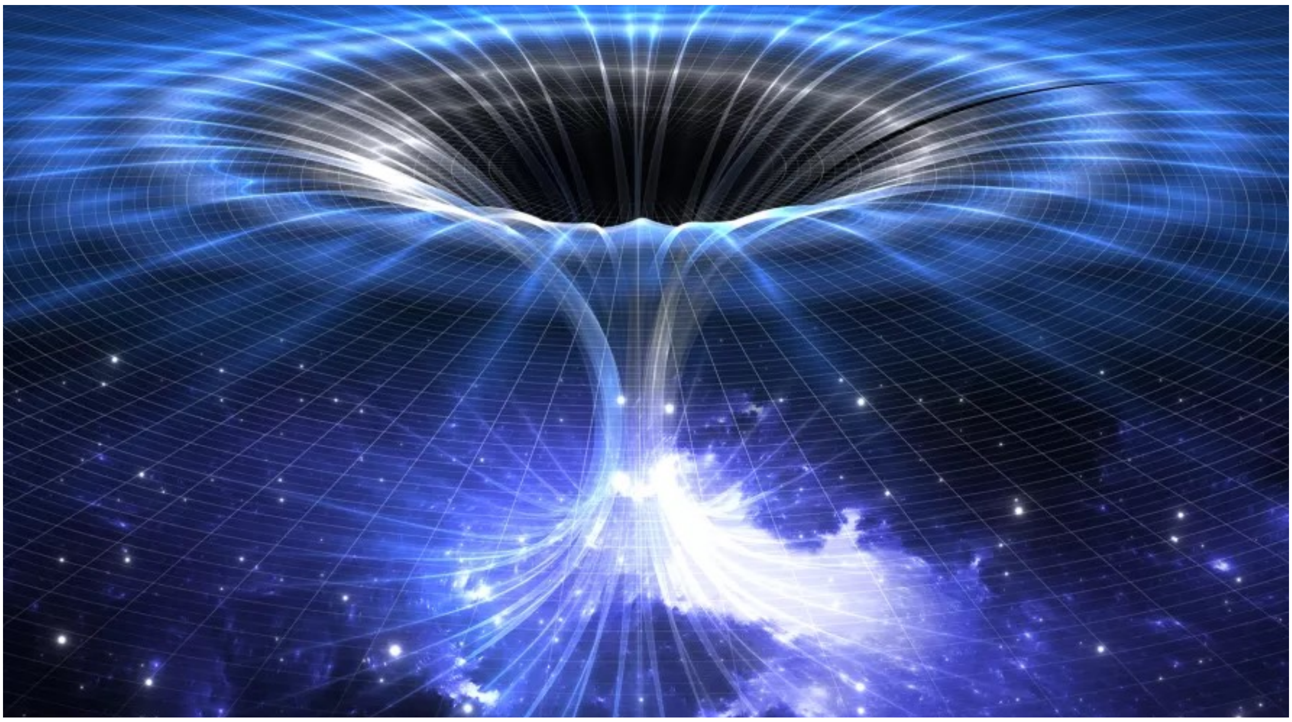
Husman Foundation Grant

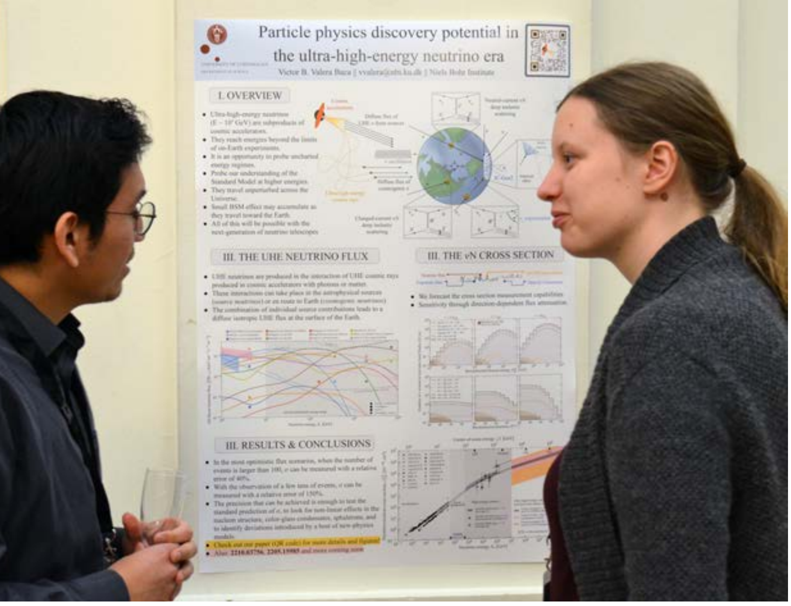
A large donation from the Ernst & Vibeke Husman Foundation given to NBIA allows us to attract top talent from around the world as Husman Foundation Visiting Scholars. After a two-year hold 2020-21 due to the pandemic, the Husman Foundation Visiting Scholar program has been up and running since 2022. Stays at the NBIA can last from less than a week for researchers invited to speak in our series of NBIA Colloquia and/or more specialized seminars, and up to four or six weeks for longer research visits as well as Husman Foundation Visiting Professorships. This program builds on and expands the internationalization that is at the core of NBIA's activities, and which is so important for keeping scientists at NBIA abreast of new scientific developments. Husman Foundation Scholarships are also available for invitations of collaboration partners for NBIA scientists and funds from the grant can be used to organize specialized smaller workshops.

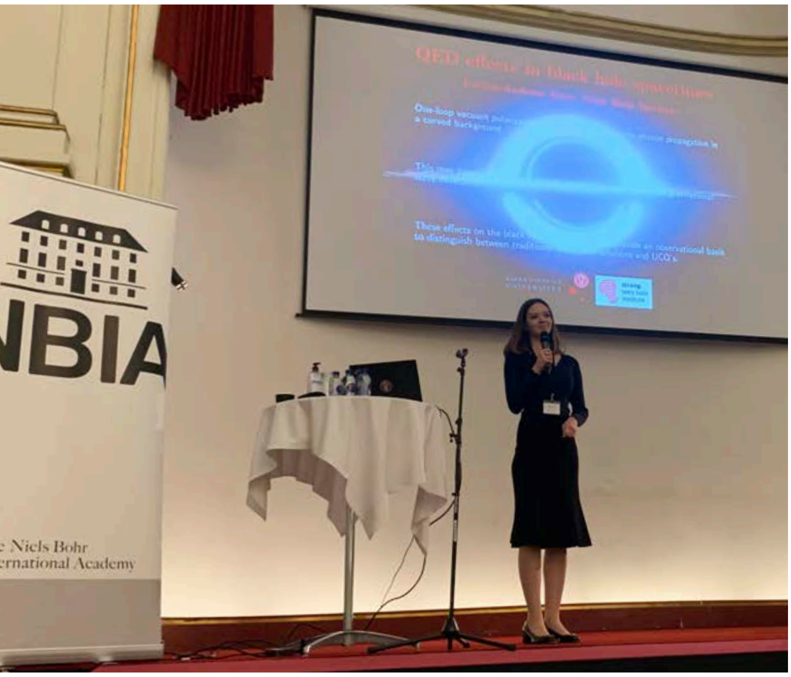
ERNST & VIBEKE HUSMANS FOND

Louis-Hansen Foundation Grant

In 2018 the Aage & Johanne Louis-Hansen Foundation provided NBIA with an important grant of 10 MDKK to hire Louis-Hansen Foundation Assistant Professors on 5-year fixed-term contracts at NBIA. The grant is totally flexible and has allowed NBIA to seek the brightest young scientists in all areas of the physical sciences. This strategy is at the heart of the foundation of NBIA and it has opened up the opportunity to strike out in brand-new research directions that are not currently pursued at NBIA or at the Niels Bohr Institute itself. The overarching principle when making these new appointments is to let the individual talent of applicants be the decisive criterion while simultaneously hoping for a renewal of research topics. Fortunately, these two strategic points of view often merge together, demonstrating that the best scientists move towards areas that are most promising. No one has better noses for this than young scientists who have had a PhD-education from some of the best universities in the world, followed by some postdoctoral years where they have been able to liberate themselves from their thesis topics and thus define their own research directions. These are scientists who can drive the NBIA in the coming years and who we now have invited to join us. The generous grant from the Louis-Hansen Foundation is a most important milestone in the short history of NBIA and it is leaving its strong mark. Current Louis-Hansen Foundation Assistant Professor Johan Samsing has already received an individual EU Marie Curie Fellowship, a Villum Young Investigator grant, and, most recently, an ERC Starting Grant which enabled him to establish his own research group. In 2023 NBIA appointed Apoorv Tiwari as new Louis-Hansen Foundation Assistant Professor. Apoorv Tiwari, who has just received a Villum Young Investigator grant, works in the new and rapidly growing field of non-invertible or so-called categorical symmetries which bridges between condensed matter physics and quantum sciences to high energy physics.




Particle physics discovery potential in
the ultra-high-energy neutrino era
Victor B. Valera Baca | vvalera@nbi.ku.dk | Niels Bohr Institute
I. OVERVIEW
II. THE UHE NEUTRINO FLUX
III. THE νN CROSS SECTION
III. RESULTS & CONCLUSIONS


QED effects in black hole spacetimes
NBIA
e Niels Bohr
ernational Academy


Harmonic chain of active particles

INTERACTIONS — EU-COFUND

Close interactions among scientists from a wide range of cultures is in the DNA of the Niels Bohr International Academy and it is a tradition dating back to the original institute Niels Bohr created on the premises on Blegdamsvej a century ago. In 2019, with the valuable support of the European Commission through the COFUND program under the Marie Skłodowska-Curie Actions, NBIA launched an ambitious Fellowship Program with the aim to enhance interactions among young scientist in theoretical physics.

The INTERACTIONS Fellowship Program promotes and ensures exposure of the fellows to other scientists within neighboring areas. The program also encourages interactions among scientists with different cultural backgrounds and from different scientific traditions. To this end, NBIA has teamed up with five of the strongest theoretical physics institutes in Europe who are partners of the INTERACTIONS program:

- University of Cambridge — Department of Applied Maths & Theoretical Physics
- University of Oxford — Department of Theoretical Physics
- Max Planck — Institute for Astronomy, Heidelberg
- CERN — Theoretical Physics Department
- Saclay — Institut de Physique Theorique

These institutions have been chosen for their excellence in research, for their existing strong ties to NBIA, for their breadth in theoretical physics, and for their wide distribution both geographically and in terms of science culture. It is a unique opportunity for fellows to be introduced to different research environments, to build personal networks within Europe, and to intensify long-term collaborations between these institutions. This increases the network and research opportunities for the fellows, and at the same time has the potential to bring our institutions closer together. The last call for new INTERACTIONS fellows closed in 2022 but towards the end of 2023 NBIA was given permission to extend some of the current contracts beyond the original end-date of 2024 so that some INTERACTIONS Fellows will now continue longer, some all the way to the end of 2026. More detailed information can be found at http://nbia.nbi.ku.dk/interactions.

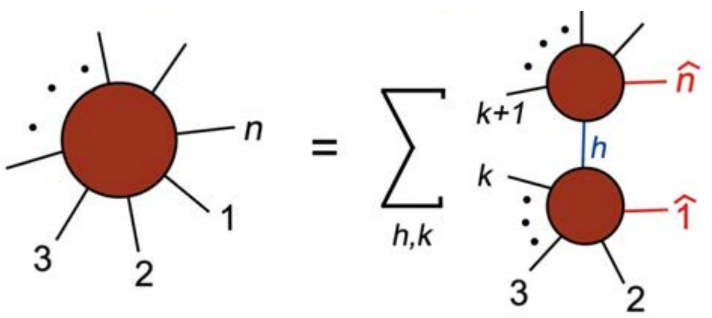
NBIA Research

Theoretical Particle Physics

The theoretical particle physics group focuses on the research frontier of various topics ranging from physics at the Universe's enormous scales to the microscopic foundation of physics. The group has recently extended its investigations to include new subjects, such as investigations of the properties of maximally supersymmetric conformal gauge theories, physics of integrable models, string theory, and gauge/gravity duality. Another recent theoretical area is applying AdS/CFT methods to model condensed matter systems and studying defect conformal field theories. Such methods permit new insight into strongly coupled supersymmetric quantum field theories, for instance, ABJM theory in three dimensions and spin matrix theory in four dimensions. This research is required to understand fundamental particle physics at energy scales much higher than we can analyze in particle accelerators nowadays.

Research in the theoretical particle physics group at NBIA has been expanding in the direction of classical gravity over the past few years; here, black holes - Nature's most puzzling wonders play an essential role in investigations. Extreme gravitational forces hold them together, so strong that time stops at the edge of a black hole, and even light cannot escape. It raises interesting physical questions about their quantum nature, and to make progress, group members have investigated applications of quantum holography and the AdS/CFT gauge/gravity duality in string theory to potentially understand how black holes store quantum information.

Einstein hypothesized in his general theory that the gravitational pull from colliding black holes is so strong that it can tear space-time and form propagating space-time ripples. Yet, it took another century before the ultra-sensitive Laser Interferometer Gravitational-Wave Observatory (LIGO) could glimpse them on Earth. Prompted by the new observational capabilities that permitted the detection of gravitational waves, gravity has become an exciting central theme in particle physics. Since the underlying high-energy realization of quantum gravity is still a mystery, we treat the quantized theory as an effective field theory. That extends the theory with an infinite number of operators that prevent infinities at very high energies and deliver solid low-energy theory predictions. Current frontier investigations of gravitational dynamics of binary mergers range from exploring the phenomenology of the detected gravitational wave signals to researching the theoretical interpretation of strong-field gravity to testing Einstein's theory employing improved computational methods. Remarkably, quantum field theory methods have proven highly efficient for computing classical quantities in general relativity. At the core are new developments that have revolutionized the way we calculate scattering amplitudes in Standard model particle physics.



Modern particle physics relies theoretically on the Standard Model consisting of 17 fundamental particles (gauge bosons, fermions, and a single scalar particle, the Higgs particle) governed by unified electromagnetic, strong, and weak forces. An important research frontier is thus testing the Standard Model via experiments. Such experiments predominantly target the most elusive particles: The Higgs boson, where detections come with low statistics, and the neutrinos, whose oscillations we now know violate basic concepts in the Standard Model. Exploring the Higgs boson's properties will be a vital focus area for the foreseeable future at the CERN Large Hadron Collider (LHC).

The experimental facilities at the Large Hadron Collider have also urged a search for new and efficient theoretical methods for scattering amplitude computations. Reformulation of perturbation theory in quantum field theories using new scattering amplitudes methods, such as devising new computational techniques for computations and loop integration, creates an exciting intersection between pure theory, informed phenomenology, and applied mathematics. Developing new methods for computing scattering amplitudes indicates a new geometric way to regard quantum field theory computations. It is relevant for generating efficient computations in particle physics and making precise theoretical predictions for the Standard Model. Such methods can also be recycled using the double copy for gravity processes. Such progress has produced a rapidly progressing field. A recent noteworthy application of this progress is the computation of amplitudes relevant to general relativity, as mentioned above. It complements precision input for analyzing new observational data for gravity from LISA and LIGO / VIRGO experiments. NBIA scientists have recently found corrections to the two-body scattering angle until the fourth post-Minkowskian order using techniques based on amplitudes. At the same time, fifth-order results are on the way. Work on gravitational waveforms and black holes with classical spin in a post-Minkowskian framework is another focus area at the post-Minkowskian gravitational research frontier, and such computations are crucial for accurately determining physical parameters such as masses and spins of merging black holes from observations of gravitational waves.

By developing new computational techniques for particle physics scattering and loop integration, we can make theoretical predictions for the scattering processes relevant to the Large Hadron Collider by pushing Standard Model computations to high accuracy and thus match current experimental precision. Such techniques have modernized original methods for computations (based on so-called Feynman diagrams) and have permitted analyses up to complexities considered unthinkable just a few years ago. In the latter direction, the NBIA particle physics group has focused on efficiently computing scattering amplitudes and providing the availability of new methods that allow the calculation of scattering amplitudes in the Standard Model to a higher order. Such computations rely on two essential ingredients: efficient computation of integral coefficients in particle interaction processes and new integration technology. The current particle physics framework allows us to reach the third order in perturbation theory, corresponding to evaluating two-loop integrals. Several techniques are being investigated in the particle physics group to improve the situation. The latter problem, the computation of scattering amplitudes at what is known as high loop order, is a generically daunting task. An exciting proposition is using the so-called intersection theory and the Baikov representation to simplify the problem of integral computations in particle physics. Such methods have demonstrated unexpected ways to simplify loop-order calculations by defining new and simplified paths to project loop integrals on suitable basis integrals. Fundamental relationships among different parts of amplitudes that date back to first studies by Landau and, later, Steinmann are also analyzed by the NBIA group to gain an improved understanding of loop corrections to amplitudes. The discovery of a so-called antipodal self-duality relating form factors to scattering amplitudes is one of the highlights of the NBIA group in recent years. Many surprises have thus appeared in the theory with a large amount of supersymmetry, and they will surely leave their marks on high loop-order calculations in the Standard Model of particle physics.

Particle Astrophysics

The research of the Particle Astrophysics Group lies at the rich interface between astrophysics, cosmology, and fundamental physics. We are particularly interested in exploring the Universe through cosmic rays (energetic charged particles), photons, neutrinos, and gravitational waves. The range of scientific questions that can be addressed with these cosmic messengers is quite broad.

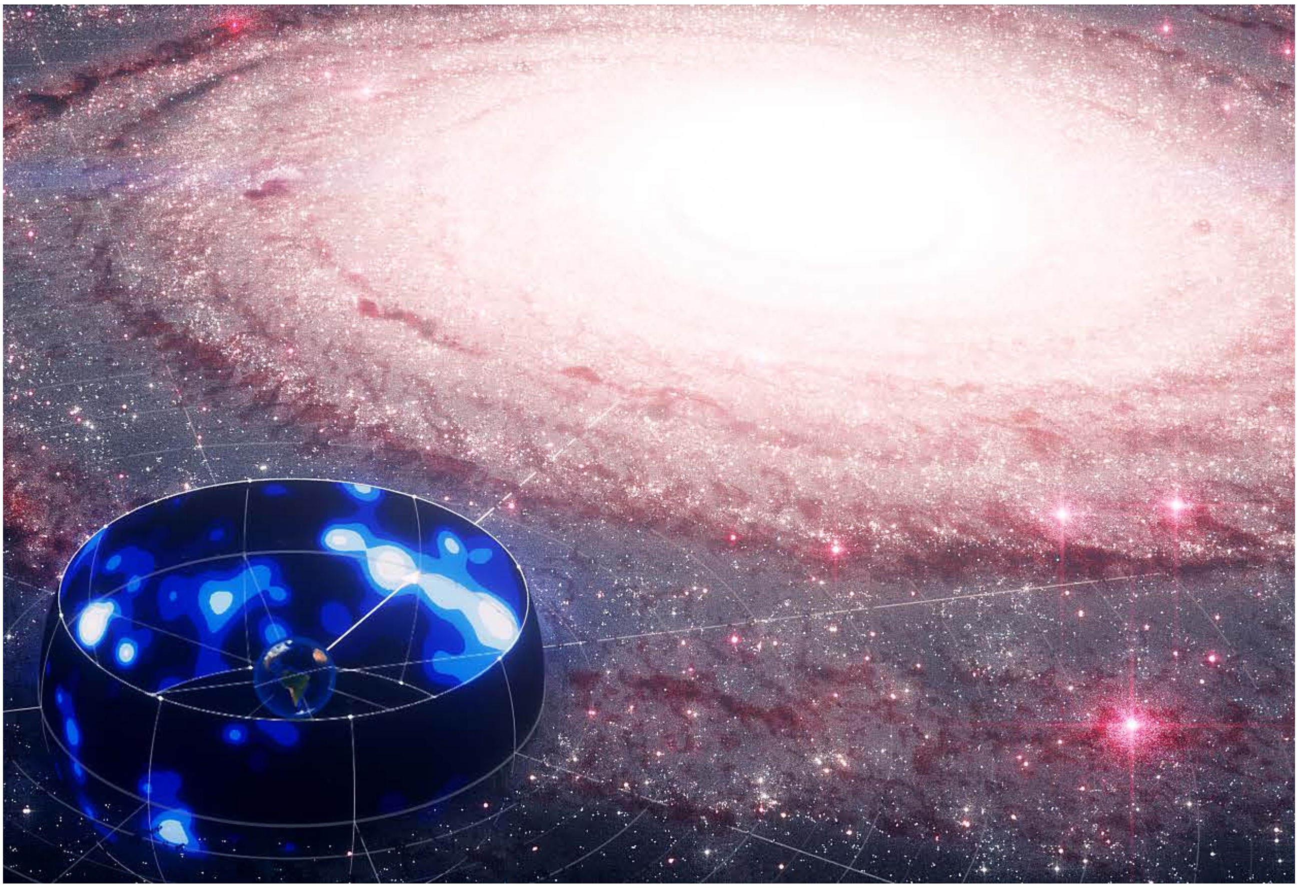
A strong focus of our research lies on neutrinos. Neutrinos are weakly interacting elementary particles emitted from various terrestrial, astrophysical, and cosmological sources over a wide energy range. We work to grasp the role of neutrinos in powering their sources, use them as powerful probes of the hidden source interiors, and seek to unveil the fundamental properties of neutrinos from investigating their interactions in dense environments, on cosmic backgrounds, as well as from their detection in neutrino telescopes.

Presently, the most sensitive neutrino telescope in the TeV-PeV energy range is the IceCube observatory at the South Pole. Our group maintains a strong collaboration with the experimental IceCube group at NBI, and participates in the planning of future neutrino telescopes. In 2013, IceCube made the first observation of high-energy (TeV-PeV) neutrinos whose origin is presently unknown and one of the main scientific questions presently addressed in our research. This observation does not only probe the origin of cosmic rays, but also allows to test fundamental neutrino physics at extreme energy and distance scales, and probe the physics of extreme cosmic accelerators.

One of the most exciting results from IceCube in 2023 was the first detection of high-energy neutrinos from the Milky Way. They were detected from the direction of the Galactic Plane, the edge-on view of the Milky Way from our vantage point, where most of the matter in our Galaxy lies. Because these neutrinos are produced in the interactions of high-energy cosmic rays with their environment, their discovery brings us important clues about the star-formation activity in the Milky Way and the identity of Galactic PeVatrons, the long-sought sources of cosmic rays.

In 2023, we have modeled the production of neutrinos and electromagnetic radiation in a number of astrophysical transients (such as short gamma-ray bursts and super luminous supernovae), pinpointing the efficient sites of particle acceleration. In order to do that, we have solved the particle transport equations relying on general relativistic magnetohydrodynamic simulations. We have shown that it is crucial to move beyond naive models of particle production and take into account the non-linear mixing of matter in the source to model the electromagnetic and neutrino signals. In this context, we have also provided a possible solution to the long-standing open question of the origin of the non-thermal photon spectral distribution observed in gamma-ray bursts. We have also investigated the most promising multi-messenger detection strategies, highlighting the need for multi-wavelength electromagnetic data to inform neutrino searches. Moreover, we have also explored the possibility of using neutrinos to drive gravitational waves searches.

One of the most burning questions in Particle Astrophysics revolves around the role of neutrinos in compact astrophysical sources. In particular, neutron star mergers and core-collapse supernovae host a high density of neutrinos such that neutrino-neutrino interactions are not negligible. We have focused on understanding under which conditions such interactions could lead to non-negligible flavor conversions. To this purpose, we have developed sophisticate numerical simulations that track the neutrino flavor conversion in the core of compact sources, even before neutrinos decouple from matter. Our work highlights a complex interplay between neutrino collisions with the medium and flavor conversion that we



are in the process of understanding. Importantly, although neutrino flavor conversion is currently not included in state-of-the-art hydrodynamical simulations of the stellar collapse, our work shows that taking into account this physics could dramatically modify the conditions under which massive stars are expected to explode.

The nature of dark matter as well as the possible interactions of neutrinos beyond the ones foreseen by the Standard Model remain to be unraveled. Our group has focused on modeling and constraining various scenarios of non-standard physics by employing neutrinos of astrophysical and cosmological origin as well as electromagnetic and gravitational wave signals. For example, we have worked on constraining the existence of axions relying on the recent multi-messenger observations of the neutron star merger even GW 170817. At higher neutrino energies, we have studied the prospects of using the relative number of each type of neutrino that arrives at Earth to test non-standard neutrino properties, testing the decay of heavy dark matter, and measuring the neutrino-nucleon cross section at energies higher than ever before.

In 2023, scientists in our group have maintained strong ties with researchers at the Max Planck Institutes in Garching through the Collaborative Research Center sponsored by the Deutsche Forschungsgemeinschaft. We have been active in a number of outreach activities, in particular through a research project at the interface between art and science in collaboration with Copenhagen Contemporary.

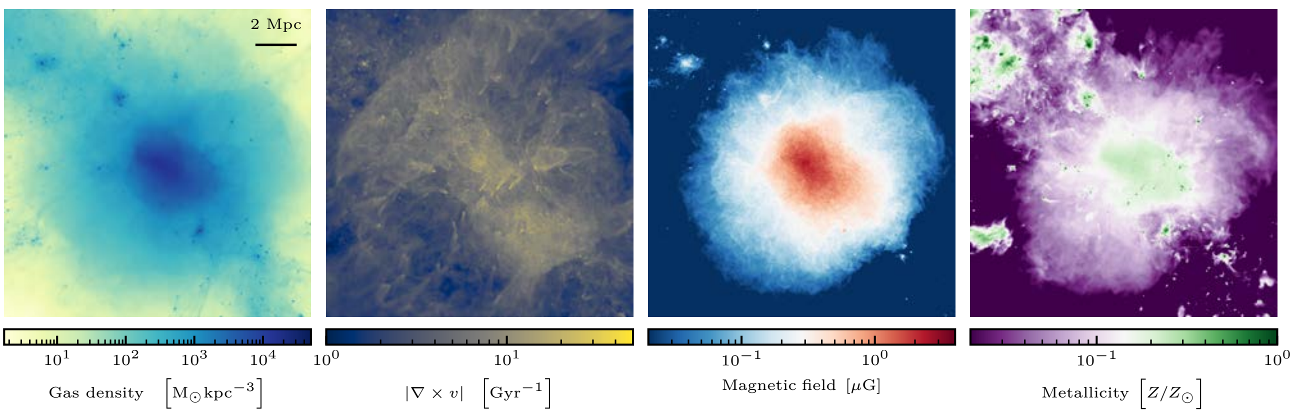
Members of our group joined forces in 2023 to organize the NBIA International PhD Summer School on Neutrinos: "Here, There & Everywhere." This one-week school brought graduated students up to date with the latest developments in neutrino physics, from theoretical issues to experimental results, including astrophysical and cosmological aspects. The school was attended by about 40 PhD and advanced MSc students from Europe, North and South America, and Asia. This is the third year in a row that the School is organized. Like before, the student and lecturer feedback was overwhelmingly positive and we hope to be able to host more editions in coming years.

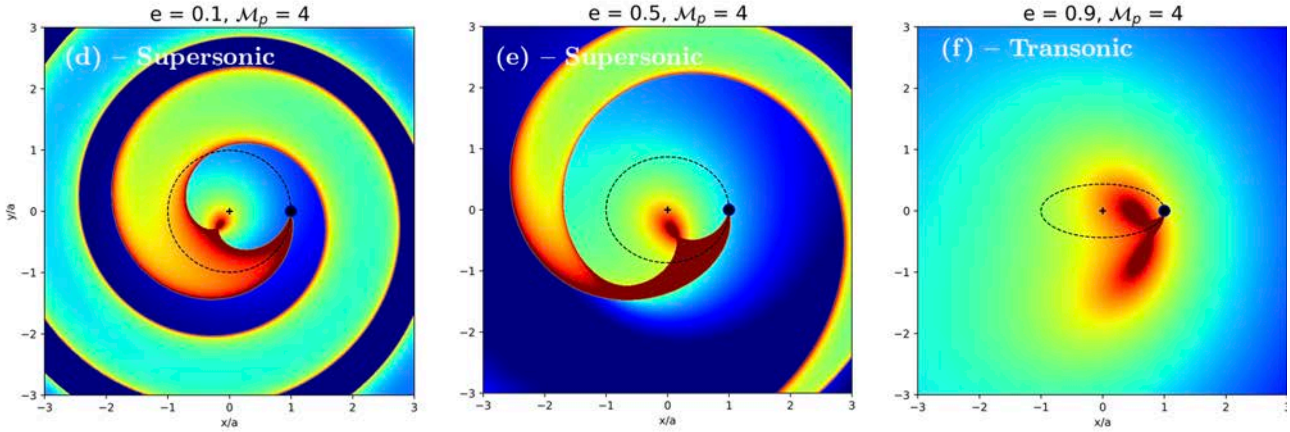
Theoretical Astrophysics

The Theoretical Astrophysics Group at NBIA strives for a comprehensive approach to astrophysics. Current research areas encompass protoplanetary disks and planet formation, accretion disks surrounding compact objects, galaxy clusters, and the physics of gravitational-wave sources. All problems are tackled with a wide perspective, ranging from fundamental theoretical aspects to state-of-the-art simulations with the aim of linking theory and models with observations. A summary of research activities during 2023 follows below.

The formation and evolution of planetary systems remains a major open problem. Fast inward migration of planetary cores embedded in gaseous disks is a common problem in the current planet formation paradigm. Even though dust is ubiquitous in protoplanetary disks, its dynamical role in the migration history of planetary embryos has not been considered until recently. Group members have shown that the scattered pebble-flow induced by a low-mass planetary embryo leads to an asymmetric dust-density distribution that is able to exert a net torque. After carrying out the first study showing that dust torques can have a significant impact on the migration and formation history of planetary embryos, we are currently incorporating more physical processes relevant to dust evolution and planetesimal accretion to better understand how planetary embryos may form and evolve in dusty protoplanetary disks.

Galaxy clusters are the largest gravitationally bound objects in the Universe and provide the opportunity to study cosmology, structure formation, and plasma astrophysics. The intracluster medium is an ionized gas which permeates the space between galaxies in galaxy clusters. It has a very low density but due to its sheer volume it nevertheless contains more mass than all the stars found in the galaxies themselves. The intracluster medium has a very high temperature and consequently emits copious amounts of X-rays, carrying energy out. This cooling appears in many clusters to be offset by injection of energy by a super-massive black hole which resides at the center of the cluster, a so-called active galactic nucleus (AGN). How the energy in relativistic jets emitted by the AGN is transported from the center and ultimately transferred to the ambient intracluster medium is not yet well understood. Answering this question is important for understanding why the intracluster medium does not collapse and why some clusters are colder at their centers. Members of the Theoretical Astrophysics Group study galaxy clusters using a variety of methods, including pen and paper, idealized simulations and state-of-the-art cosmological simulations. The latter start with a universe which is merely 12 million years old and evolve it all the way to its present age of 13.8 billion years, thus capturing the formation of galaxy clusters, the driving of turbulence by mergers and AGN, and the amplification of magnetic fields.





Magnetohydrodynamic turbulence plays a fundamental role in many astrophysical processes. In disks around compact objects, turbulence driven by the magnetorotational instability is responsible for efficient angular momentum transport, determining their structure and evolution. The majority of numerical studies on neutron star binary mergers are often ideal (with dissipation determined by the grid) and/or axisymmetric (invoking ad hoc mean-field dynamos). However, binary neutron star mergers (similar to X-ray binaries and active galactic nuclei inner discs) are characterised by large magnetic Prandtl numbers (the ratio of viscosity to resistivity). This is a key parameter determining dynamo action and dissipation but it is ill-defined (and likely of order unity) in ideal simulations. To bridge this gap, group members investigated the magnetorotational instability and associated dynamo at large magnetic Prandtl numbers using three-dimensional, vertically stratified simulations of a local patch of a disc. This study led to valuable scaling relations for the turbulent intensity and the saturated magnetic field energy density, produced by the MRI dynamo, as a function of the magnetic Prandtl number. This insight should be valuable for developing sub-grid models for more realistic simulations of neutron star mergers.

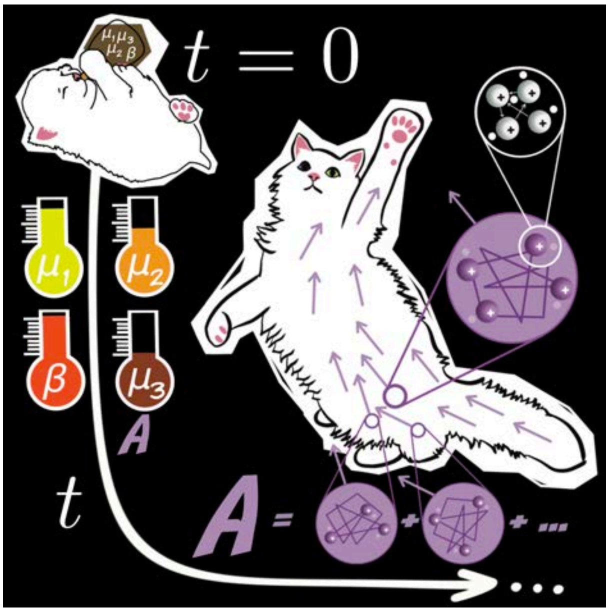
Gravitational wave astrophysics continues developing vigorously at NBIA. Since the first pioneering gravitational wave observation of two merging black holes in 2015, we have now seen ~90 stellar mass black hole mergers with many more to come in the near future. This has sparked a new research field with unique potential to gain insight into how black holes form, grow and interact over cosmic time. In the Theoretical Astrophysics group we are developing new ideas and computational tools for describing these processes over a wide range of black hole masses and astrophysical environments. We commit special focus to the dynamical formation of stellar-mass black holes in dense star clusters and in active galactic nuclei. We are also working on the yet undetected mergers of supermassive black holes. Such events result from the pairings of black holes millions to billions of times more massive than our Sun in the center of galaxies. Detection of supermassive black hole mergers, expected in the coming decade, will offer the next great milestone in gravitational wave astrophysics, lending insight into the formation of the biggest black holes in our Universe, and their mutual evolution with their host galaxies. The Theoretical Astrophysics group is modeling the physical processes that bring these monstrous black holes together, specifically focusing on the interaction of these pairs with surrounding gas. This will help us to predict how often such mergers should happen and importantly what imprints of formation will be visible in the emitted gravitational waves, as well as through the electromagnetic emission that results from gas accretion onto the black holes. Ultimately, we aim to build a multi-messenger approach, providing predictions that combine both electromagnetic and gravitational wave observables into a tool kit that will help us to unravel the mysteries of black hole binary formation and merger across the mass spectrum in our Universe.

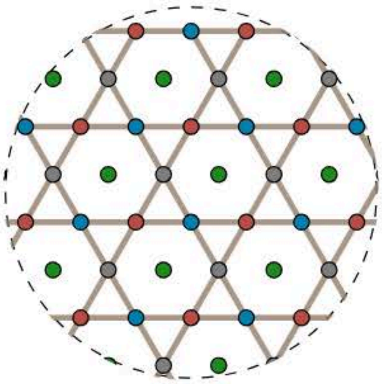
Condensed Matter Physics

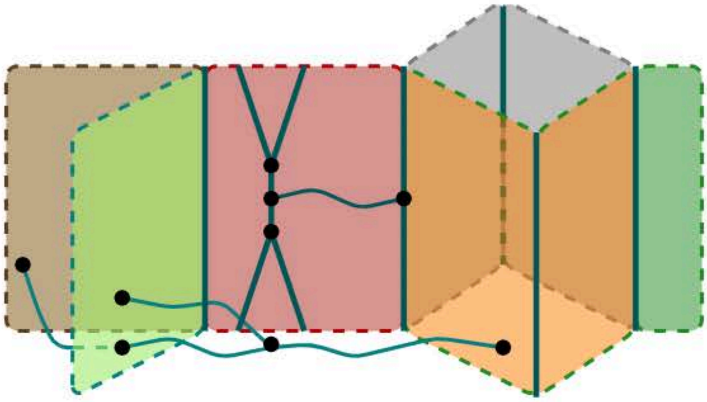
The condensed matter theory group at NBIA researches two broad topics (i) non-equilibrium dynamics in quantum many-body systems and (ii) applications of generalized symmetries in the understanding of the phase structure of interacting quantum matter.

Non-equilibrium dynamics in quantum many-body systems is one of the most active areas in physics interconnecting diverse fields in physics, including condensed matter physics, atomic physics, and even high energy physics and gravity. One of the main topics of the group is non-stationary quantum dynamics, described by time-dependent states. Non-stationary is all around us in day-to-day life e.g., average temperature oscillations from summer to winter and all types of biophysical processes. Understanding such dynamics from the exact microscopic laws is of both fundamental importance to theoretical physics and of potential technological significance, i.e., such an understanding would contribute to the development of quantum technology, e.g., quantum computers. Only with the very recent work of the group have we started to understand non-stationary behavior in such a way. The groups approach is based on identifying novel algebraic structures that can be used to find analytical solutions to the dynamics. The work of the group is therefore mainly mathematical, but the group also has collaboration with experimentalists including those working on light-driven non-equilibrium phases of matter at Max Planck Institute for the Structure and Dynamics of Matter in Hamburg, and cold atomic gases at ETH Zurich.

A notable theoretical result from this year is a new theory solving the dynamics of quantum systems composed of many particles with short-range interactions. Short-range interactions include the effective interactions of electrons and nuclei in numerous kinds of materials and understanding these has finally settled a long-standing problem in physics. Fundamental laws of physics describe how any two particles interact, but to compute dynamics of many-particle systems one needs to apply them to all the pairs of particles, e.g., all the pairs of atoms of a cat, in order to understand the dynamics of existence of the cat, which is otherwise intractable. The theory proves that the dynamics of all short-range interacting systems, including very complex ones, is unified within an effective description based on a few elegant principles that determine macroscopically relevant motion of the particles in the system, e.g., the dynamics of a cat as a whole. The only difference between the dynamical behavior of these systems and their behavior when they do not display any dynamics (equilibrium) is that the chemical potentials determining the state of the system in general is changing in time, thus giving the collective dynamics. This theory provides analytical solutions for the dynamics of otherwise intractable many-particle systems including those with exotic (non-ergodic) dynamics, which could have significant technological applications in the future.







In another recent result is the discovery of a quantum many-body systems with interactions and dissipation (under friction) that displays bistability the property of having two stable states. Bistability is important from a technological point of view because of e.g., its memory storage potential The possibility of bistability in such systems has long been controversial. The work settles this issue. The system in question is a toy model of electrons on a lattice, but it is an important proof of concept, and it can be simulated with cold atoms.

In our second research area, we are examining different aspects of generalized symmetries in quantum matter. Symmetry is a key concept in modern physics, and lately, there's been a renewed interest in using symmetry-based approaches to classify and understand quantum phases of matter. The realization that topological operators can serve as symmetry operators in quantum systems has driven this renewed interest.

The mathematical structures of higher fusion categories play a crucial role in describing generalized symmetries, with connections to quantum condensed matter physics, high-energy theory, mathematical physics, and quantum information theory. Over the past year, our work has focused on understanding how to manipulate symmetries in quantum systems. These manipulations are applicable to both quantum field theories and quantum lattice models, leading to the development of new dual theories characterized by rich generalized symmetry structures.

We are currently investigating the dynamic implications of symmetries in quantum lattice models, aiming to understand how these symmetries contribute to the classification of quantum matter. Our research is guided by key questions, such as exploring the potential emergence of new phases and phase transitions stabilized by these symmetries. We seek to identify general order parameters and characterize the excitation spectra within these phases.

Additionally, we are exploring whether an understanding of the structure of symmetry and topological operators can lead to the development of quantum platforms capable of realizing universal gate sets for quantum computation. Our research also encompasses the examination of how these symmetry structures interact with non-topological symmetries, particularly crystalline symmetries.

In the upcoming year, our research agenda will be centered around addressing these questions, with the aim of deepening our understanding of the intricate interplay between symmetries and the dynamic behaviors exhibited by quantum lattice models.

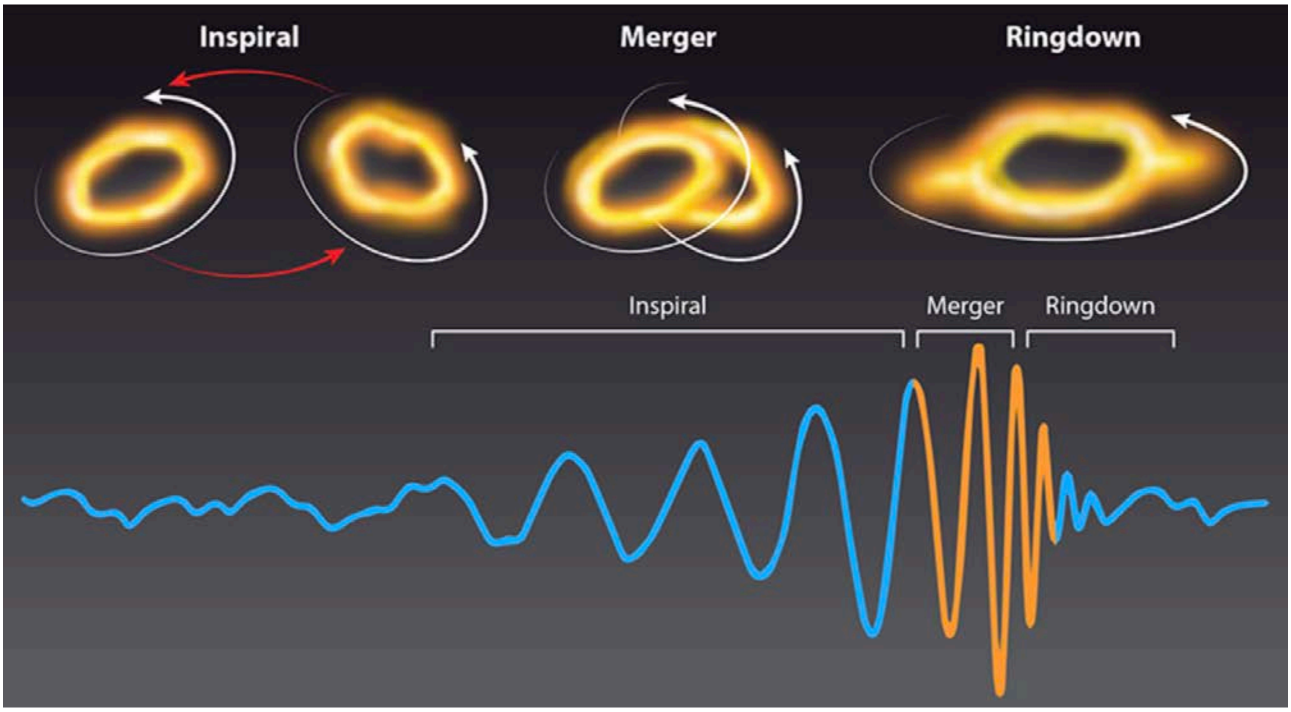
Gravitational Physics

The Strong group at NBIA studies fundamental questions, which relate to gravity in mostly unexplored regimes. We want to shine light on the biggest unknowns in the cosmos: is gravity described by Einstein's theory? Do black holes exist? What happened at the beginning of the Universe? Can we use black holes as probes of other interactions? To realize the tremendous underlying discovery potential, we combine unique know-how in theory together with observations.

Our ability to understand gravity is at a turning point. Increasingly precise LIGO/Virgo gravitational-wave observations and imaging of black hole shadows by long-baseline radio interferometry opened unprecedented windows onto gravity at its strongest. The decision of the European Space Agency to devote its third large-class mission to a gravitational-wave observatory (LISA) highlights the timeliness and relevance of the topic. During the next few years, we expect to observe hundreds of black-hole mergers from operating detectors worldwide. Strong-field gravity is expanding beyond the domain of mathematical physics to become a precision experimental science. Black holes are the simplest, most compact, and physically elusive macroscopic objects in the Universe, playing a central role in this new era. Among astronomical targets, they are extraordinary in their ability to convert energy into radiation, and the study of their stability and dynamics challenges our knowledge of partial differential equations and of numerical methods. Meanwhile, the information paradox and the existence of unresolved singularities in classical general relativity point to deep inconsistencies in our current understanding of gravity and quantum mechanics. It is clear that the main conceptual problems in black hole physics hold the key to many fundamental issues in physics.

One of the holy grails of gravitational-wave astronomy is to provide observational evidence for the general relativistic prediction that black holes in our universe belong to the Kerr family. An exciting tool to address this issue is *black hole spectroscopy*, introduced and led by the Strong team, and explored by a wide community worldwide. Here, black hole vibration spectra are used to infer its properties, relying on uniqueness results of General Relativity and the ensuing simplicity of vacuum black holes. We pioneered innovative analysis techniques rigorously incorporating statistical and systematic uncertainties, included nonlinearities as well as predictions of theories that extend General Relativity. Gravitational waves are direct probes of gravity down to the horizon scale and can also shed light on one of the outstanding open issues in physics: the nature of compact, dark objects. It has been tacitly assumed that these are black holes, but several arguments suggest that new physics might set in during gravitational collapse. Large efforts of our group are devoted to the challenge of quantifying the presence of horizons in spacetime. These efforts have shown that gravitational waves have the potential to inform us on the nature of compact objects (do black holes exist?) and on the strong-field behavior of gravity (do they behave as in General Relativity?). One of the unexpected findings by our team concerns the sensitivity of the spacetime response to fluctuations close to resonances, and the instability of the spectrum itself under small perturbations of the scattering potentials. Because astrophysical black holes are not isolated, this question is of paramount importance, as it may have an impact across disciplines.

A complementary opportunity to probe the nature of black holes and their dynamics is offered by gravitational waves produced by small black holes orbiting massive ones. The small black hole acts as a sensitive probe mapping the geometry of the massive one (and possibly its environment), providing unequaled measurements of its properties as predicted by General Relativity.



We have world-leading expertise in the modeling of such extreme mass-ratio inspirals as a perturbative series in the smaller mass, i.e., the gravitational self-force formalism.

With precise tests of the black hole geometry under control with spectroscopy, one needs to step away from the vacuum paradigm. There is overwhelming evidence for the existence of dark matter interacting gravitationally. Understanding its microscopic nature is arguably one of the outstanding challenges. The Strong team at NBIA is a well-known leader in the study of the gravitational physics of new fundamental fields. We showed that massive bosons outside black holes lead to smoking-gun effects (superradiant instabilities and floating orbits), allowing new competitive constraints on their masses and couplings.

In addition to encoding details about their sources, gravitational waves carry precious information about their astrophysical environments. It is hard to overstate the role of black holes in the search for new fields or environmental properties. However, to realize the immense potential of gravitational-wave astronomy, it is imperative to model accurately the interaction with matter. For example, to quantify the impact of an entire galaxy on the propagation of gravitational waves, one needs to model accurately the geometry, and to solve the dynamics of the binary in this complex environment.

As the sensitivity of detectors improves, more distant black holes will be observed. Inevitably, along the billions of years of travel, gravitational waves will encounter inhomogeneities, in the form of galaxies at the largest scales or compact objects at the smallest scales. Lensing of gravitational waves opens unique frontiers to understand the foundations of our Universe. It allows us to map the dark matter distribution in uncharted regions of the cosmos, and it offers a precise gravity laboratory, where gravitational fields can be constrained to their limits. The Strong group leads the search for lensed waves and their implications for fundamental physics.

We are exploring foundational issues, deepening our understanding of matter and of gravitation as a fundamental interaction. Wherever possible, we will confront our predictions with gravitational waves and other observational data, addressing critical problems: how can we use current and future gravitational-wave data to test fundamental physics? How can we optimally design next-generation detectors to probe the nature of black holes? The road ahead is challenging, but exciting.

Soft Matter Physics & Active Matter

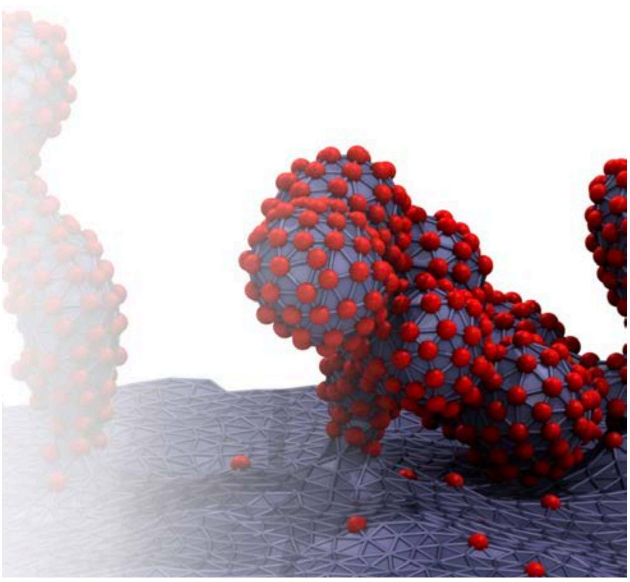
Soft matter physics lies at the heart of a quantitative understanding of many biological processes. From subcellular protein-driven flows to multicellular organ formation, biological matter continuously drives itself away from thermodynamic equilibrium using internal biochemical processes. In addition to their important biological roles, these intrinsically multiscale systems provide novel ideas for fundamental theories of non-equilibrium statistical physics and biomimetic inspiration for synthetic micro-machines capable of locomotion and self-organization. To tackle these diverse subjects, NBIA has recently launched an exciting new initiative to expand into soft matter physics and in particular the hot topic of active, self-organizing matter. Specifically, the research is focused on several fundamentally important areas in biophysics:

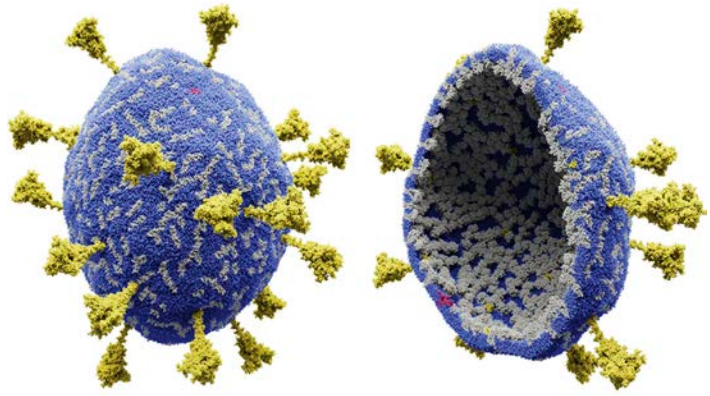
Bioinspired, Self-Organizing Active Matter: A material that organizes itself Odd as this might sound, nature has found ways to make it happen: bacterial colonies, cellular tissues, and filaments inside living cells, all work as engines converting the chemical energy of their environment into motion, and are classified as “active materials”. The unifying feature of active materials is the continuous conversion of chemical energy to motion by individual particles, and the ability to create motion on scales that are significantly larger than the size of an individual. This swarm-like behavior is termed collective motion: simple building blocks organize into moving structures that are often complex and chaotic.

Under the right conditions, active systems are capable of self-organization from chaotic flows into coherent flows: groups of active particles move together as a unit in a directed manner, forming a self-pumping fluid. However, the exact nature of these ‘right conditions’ is currently the focus of intense study as many biological processes - including subcellular flows, formation of bacterial biofilms, morphogenesis, and collective tumor invasion – demonstrate active coherent flows. An outstanding question is how the activity of particles at the individual particle level is translated into self-sustained coherent flows.

The core idea is to design a novel class of Living Matter, comprised of a viscoelastic and adaptive phase freely embedded within spontaneously flowing biofluids. Funded by a Villum Young Investigator Award and Novo Nordisk’s New Exploratory Research and Discovery (NERD) programme together with two Marie-Curie Fellowships awarded to Active & Intelligent Matter research group members, we have launched the development of a state-of-the-art modeling framework that combines artificial intelligence, with physical modelling of active matter, and mathematical modeling of complaint materials, to study the interaction of active matter with adaptable and responsive environments.

Mechanostransduction: How Mechanics Guides Biochemical Signaling. There is growing evidence that mechanical forces can activate biochemical signaling for tissue regeneration, stem cell differentiation, and morphogenesis. Importantly disruption of this effect by changes in the microenvironment leads to pathological responses including tissue fibrosis and cancer. The con-





nection between mechanical forces and cell response is the process of mechanotransduction: mechanical forces activate biochemical signals by changing the concentration of mechanosensing proteins inside the cells. For example, putting cells under excessive tension localizes proteins that control cell division inside cell nuclei, leading to hyper-proliferation. Diffusion of chemical signals is too slow to be able to convey the mechanical information across the tissue. On the contrary, the force transmission between the cells provides a fast and long-range mechanism for propagation of mechanical cues over large spatial scales. Therefore, it is essential to understand the mechanism of mechanotransduction in the context of multicellular aggregates.

Starting in September 2022 and funded by an ERC Starting Grant, the Active & Intelligent Matter research group combines multiscale modeling – discrete and continuum simulations of cell mechanics with in-house experiments to reveal the impact of mechanical forces from multicellular motion on signaling and the mechanical feedback from the activation of biochemical signaling.

Thermodynamics in Biology: Currently, one main research interest in the group is on how thermodynamics puts constraints on biological processes. More specifically, the focus is on questions such as to what extend are biological processes, such as DNA replication, optimised, which role does thermodynamics play in biological evolution, and what are the thermodynamic constraints necessary to create non-equilibrium phenomena, such as chemical oscillations and motility-induced phase-separation. We also study the stochastic thermodynamics of synthetic biological circuits. Over the last two decades synthetic biology has lead to important applications such as dru g delivery and biosensors. By creating a consistent framework for the thermodynamics of these circuits, our objective is to propose new optimisation schemes and design principles for future applications.

Computational Microscopy: We develop and use computational microscopes to understand fundamental biological processes at the cellular level. For instance, how cells repair their membranes after injury or how toxic particles hijack cellular machinery for their entry. These mechanisms include many exciting physical phenomena such as fluctuations induced forces, phase transition, phase coexistence, and molecular condensations. Our latest works include obtaining the molecular architecture of SARS-CoV-2 virion envelope through integrative modeling techniques and FreeDTS, a software package to simulate a biological membranes at the mesoscale. Our current focus is to understand how biomolecules come together and form the architecture of the cellular powerhouse

Finally, links with experiments are important in conducting this research. We have launched exciting collaborations with international experimental groups in France (University Paris Diderot and Curie Institute) and Japan (Osaka University), as well as with the Novo Nordisk Foundation Center for Stem Cell Medicine and Novo Nordisk Foundation Center for Protein Research to profile NBIA as one of the leading institutions in these rapidly growing areas of research.

NBIA Staff

Faculty

Niels Emil J. Bjerrum-Bohr completed his Ph.D. in Copenhagen in 2004. He was a postdoc in Swansea from 2004 to 2006 and was a member of the Institute for Advanced Study in Princeton from 2006 to 2009. Emil was appointed Knud Højgaard Assistant Professor at the NBIA in 2010 and awarded a Steno grant from the Danish Science Research Council. He was appointed Associate Professor in 2016. Emil's research focuses on amplitudes in Yang-Mills theory and quantum gravity, and he currently works on computing classical observables in Einstein's gravity from scattering amplitudes supported by a grant from the Independent Research Fund Denmark.

Vitor Cardoso did his PhD in Técnico Lisbon in 2003. Professor of Physics at Técnico since 2016, he was a Fellow at Amsterdam, Belém do Pará, CERN, Perimeter Institute, Rome, Waseda at the Yukawa Institute. He joined NBIA in 2022, as a Villum Foundation Investigator and a DNRF Chair and leader of the Strong team. His research interests are mainly focused on strong-gravity problems, with implications for gravitational-wave and black-hole physics, high-energy and particle physics. He is the co-author of one book and of over 200 scientific papers. He is a member of the Lisbon Academy of Sciences and an IST Distinguished Professor. His researchv was recognized by the European Research Council, with three prestigious ERC Grants. He was awarded the "Ordem de Sant'Iago da Espada" presidential title, for contributions to science and is an "Honourable Citizen" of Póvoa de Varzim.

Poul Henrik Damgaard did his undergraduate studies at the University of Copenhagen and then went to Cornell University, where he received his PhD in 1982. He has held post-doctoral positions at Nordita, CERN, and the Niels Bohr Institute, and has for a period of six years been Scientific Associate at the Theory Group of CERN. In 1995 he took up a position as Senior Lecturer at Uppsala University and that same year moved to the Niels Bohr Institute on a similar position. He has been Professor of Theoretical Physics since 2010 and Director of Niels Bohr International Academy since its beginning in 2007. His current research interests include modern techniques for amplitude computations, non-perturbative studies of supersymmetric theories on a space-time lattice, and constraints on electroweak baryogenesis from the Large Hadron Collider (LHC).

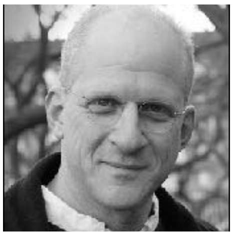
Amin Doostmohammadi is a Novo Nordisk Foundation Associate Professor at NBIA. He also has a cross-appointment as Specially Appointed Assistant Professor at Bioengineering in Osaka University, Japan. He received his PhD at University of Notre Dame and held a prestigious Royal 1851 Research Fellowship at Oxford before joining NBIA. Amin leads the Active Intelligent Matter research group working at the interface between physics and biology, modeling active materials. Their recent finding of the correlation between topological defects in tissues and the sites for cell death is a page-turner for the field of tissue biology, challenging the consensus, and bring physics of liquid crystals into studying diverse biological problems. Currently, Amin's group is generously supported by the Novo Nordisk and Villum Foundations and an ERC Starting Grant.

Faculty

Troels Harmark is Associate Professor at NBIA. He received his PhD from NBI in 2001 and became postdoc at Harvard University with Andrew Strominger. He received grants from DFF and Carlsberg to work as researcher at NBI and subsequently an assistant professorship at Nordita in 2009. Since 2012 he has been at NBI, becoming permanent in 2015. From 2017 he held the large project grant from DFF (together with N. Obers). He has led the Theoretical High Energy, Astroparticle and Gravitational Physics section since 2018. His current research includes astrophysical applications of general relativity, such as magnetospheres of black holes and tidal forces on binary systems, as well as non-relativistic limits of the holographic principle and string theory.

Tobias Heinemann joined NBIA as an Associate Professor after postdoctoral appointments at the IAS in Princeton, at the University of California at UC Berkeley, and at the Kavli Institute for Theoretical Physics in Santa Barbara. His research interests span a wide spectrum of problems in astrophysical fluid dynamics and magnetohydrodynamics. In recent years his research has focused increasingly on the intersection between stellar dynamics and kinetic plasma theory, two fields that share much in terms of formalism and mathematical machinery, which makes an exchange of ideas particularly fruitful. Together with Chris Hamilton (IAS) he has recently demonstrated that the linear response of a stellar system is free of divergences as the system becomes unstable. Such divergences have previously been invoked to explain various physical phenomena.

Charlotte Fløe Kristjansen got her PhD from NBI and afterwards held postdoc positions at IPhT Saclay, Nordita and NBI where she became Associate Prof. in 2006 and Professor in 2011. She had long term visiting positions at Tokyo Institute of Technology and at the MPI for gravitational physics in Potsdam. Charlotte's research interests are centered around exact solutions to problems in quantum field theory and string theory. She is currently working on defect conformal field theories with holographic duals. Other key interests are integrability in the AdS/CFT correspondence, spin chains and graphene. Earlier she has worked on discrete models of quantum gravity and on random matrices. She has been a member of the national research council for six years.



Charles Marcus was an undergraduate at Stanford University (1980-84). He received his Ph.D. at Harvard in 1990 and was an IBM postdoc at Harvard 1990-92. He was on the faculty in Physics at Stanford University from 1992-2000 and Harvard University from 2000 to 2011. In 2012, Marcus was appointed Villum Kann Rasmussen Professor at the Niels Bohr Institute and serves as the director of the Center for Quantum Devices, a Center of Excellence of the Danish National Research Foundation, and director of Microsoft StationQ – Copenhagen. He is an affiliate of the Niels Bohr International Academy — and acting Chair of the International Advisory Board starting in 2021. Marcus' research interests involve fabrication and low-temperature measurement of quantum coherent electronics in semiconductors and superconductors, including nanowires, quantum dots, quantum Hall systems, and Josephson devices.

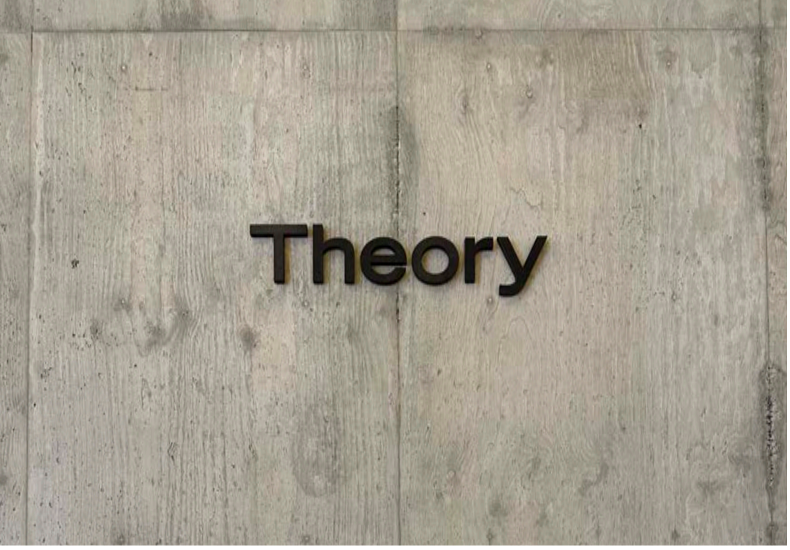
Faculty

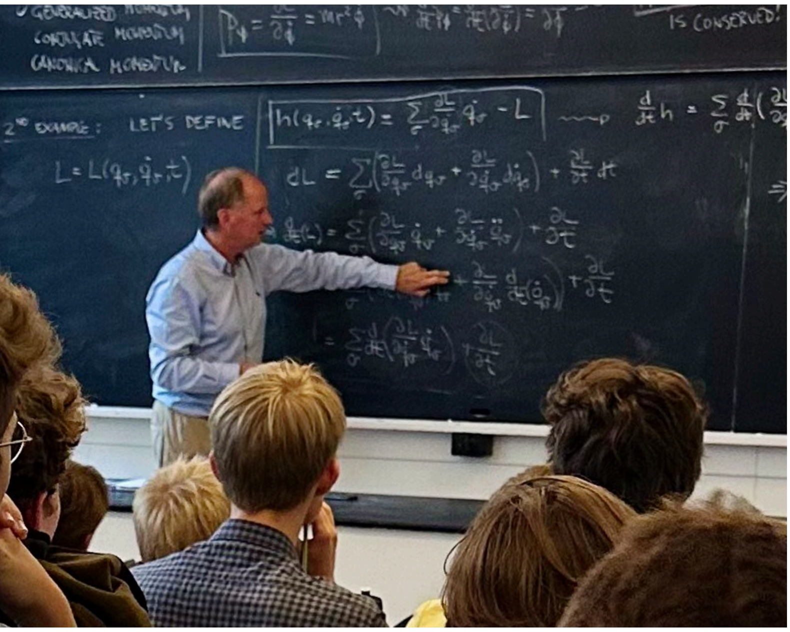
Pavel Naselsky did his undergraduate studies at the Southern Federal University of Russia and received his PhD in 1979 at Tartu University. In 1989 he got Doctor Habilitation at Moscow State University, Russia, working with theoretical astrophysics group of Zeldovich. In 2000 Pavel Naselsky took up a position as Associate Professor at the Theoretical Astrophysics Center (Copenhagen, Denmark) and in 2003 he was appointed as Lecturer at the Niels Bohr Institute. He has been Professor of Theoretical Physics since 2015 and group leader of the Theoretical Particle Physics and Cosmology group at the Niels Bohr Institute. His current research interests include modern cosmology, theory of the primordial black holes formation, physics of dark energy and dark matter, physics of the CMB etc. Since 2000 Pavel Naselsky has been working on the Planck project.

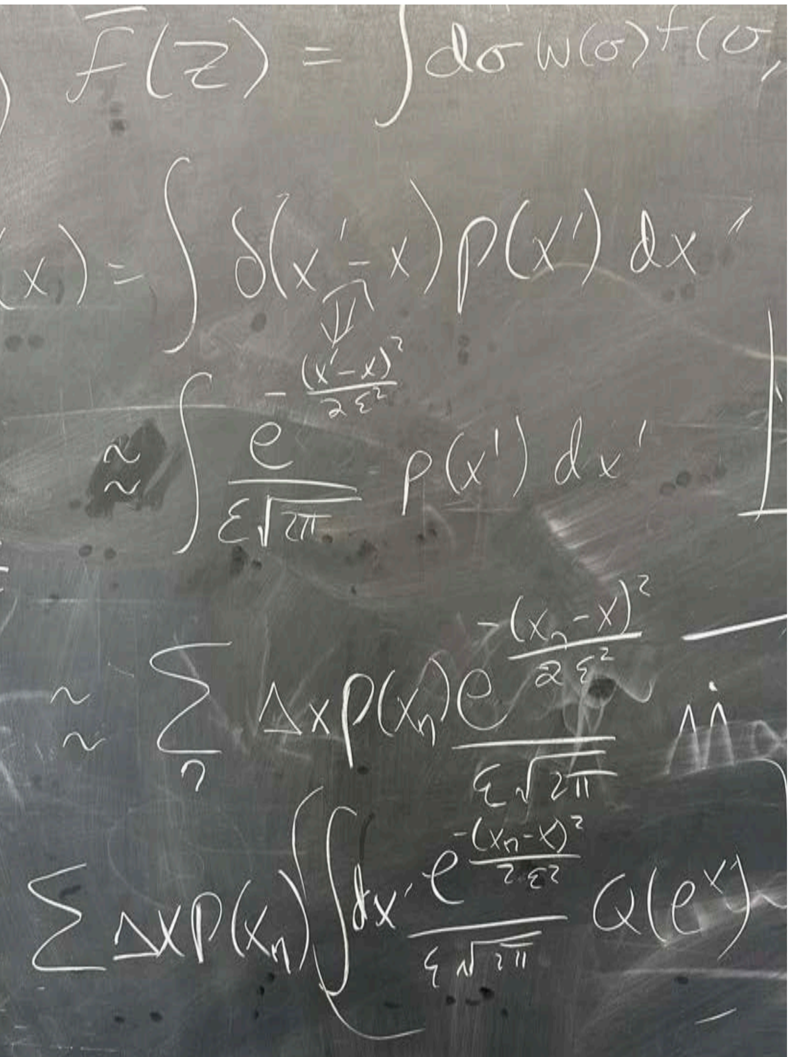
Niels Obers is Professor at NBIA. He did is undergraduate studies at Nijmegen University and received his PhD degree from the University of California, Berkeley in 1991. He subsequently held postdoctoral positions at Bonn, Ecole Polytechnique, CERN and Nordita. During 2000-2002 he was an assistant professor at Utrecht University and moved in 2002 to NBI for an associate professor position, becoming full professor in 2012. From 2012-2018 he was deputy head of departement as well as acting head of department for a period in 2017. He has done research on conformal field theory, non-perturbative string dualiies and the dynamics of higher-dimensional black holes and branes. Recently he has been developing non-relativistic gravity, string theory, and holography using non-Lorentzian geometries.

Martin Pessah obtained his first degree in Astronomy in 2000 from the University of La Plata, Argentina and received his PhD in Theoretical Astrophysics from the University of Arizona in 2007. He was a Member at the Institute for Advanced Study in Princeton until 2010 and later moved to Copenhagen as a Knud Højgaard Assistant Professor to break ground for the new Theoretical Astrophysics Group at NBIA. Martin became Associate Professor in 2013, Professor MSO in 2015, and was appointed Professor of Theoretical Astrophysics in 2023. He has been Deputy Director at NBIA since 2016. Martin's research interests span a broad range of subjects in astrophysical dynamics, fluid dynamics, and magnetohydrodynamics.

Christopher Pethick is Professor at NBIA. He did his undergraduate and graduate studies at Oxford, and received his D. Phil degree in 1965. After a period as a postdoc at the University of Illinois, he joined the teaching faculty there, be-coming full professor in 1973. In that year he also became a professor at Nordita. In 2008 he received the Lars Onsager Prize of the American Physical Society for his work on quantum liquids and cold atomic gases, and in 2011 the Society's Hans Bethe Prize for his work in nuclear physics and astrophysics. His research focuses on condensed matter in the laboratory and in the cosmos. Current interests include neutron stars (especially the properties of their outer layers) and ultracold atomic gases.


Theory


GENERALIZED MOMENTUM
CONJUGATE MOMENTUM
CANONICAL MOMENTUM
IS CONSERVED!
2nd EXAMPLE: LET'S DEFINE



Faculty

Irene Tamborra is Professor and leader of the AstroNu group. Irene obtained her PhD at the University of Bari in 2011. Before joining the Niels Bohr Institute in January 2016, Irene has held research appointments at the Max Planck for Physics in Munich, as the Alexander von Humboldt Fellow, and at GRAPPA, Center of Excellence of the University of Amsterdam. Irene's research activity is in the area of theoretical particle astrophysics and astrophysics. In particular, Irene is interested in exploring the role of weakly interacting particles, such as the neutrino, in astrophysics and cosmology. Within a multi-messenger framework, she also aims at unveiling what can be learnt by adopting neutrinos as probes of extreme astrophysical sites not otherwise accessible.

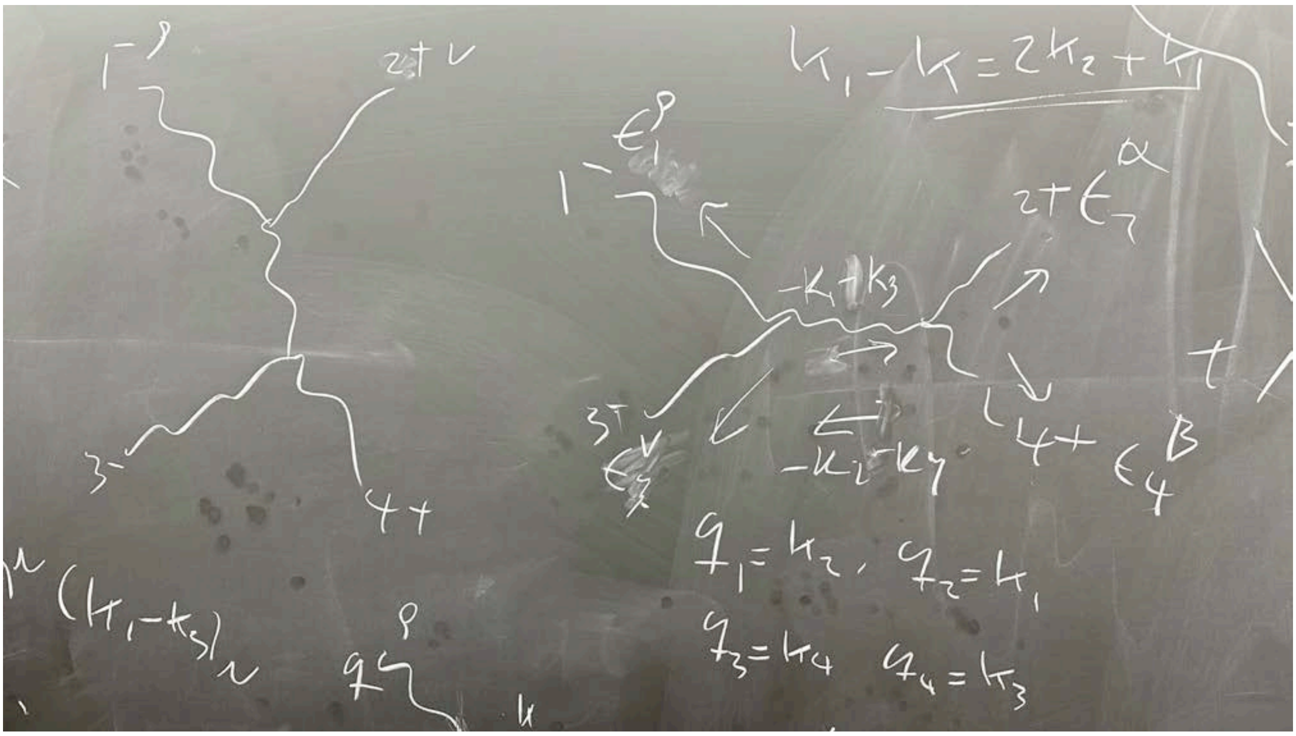
Matthias Wilhelm received his PhD from Humboldt University Berlin before joining NBIA in 2015. His research interests lie within the field of quantum field theory and high-energy theory, with a focus on gauge theories, the gauge-gravity duality and exact methods. He works on the number theory behind scattering amplitudes, on form factors and on thermodynamics as well as on the effects of introducing defects.

Konstantin Zarembo received his PhD from the Steklov Mathematical Institute in Moscow in 1997. After that he worked at UBC in Vancouver, Uppsala University and École Normale Supérieure in Paris. He became a Nordita Professor in 2010 and holds a joint appointment between NBI and Nordita since 2019. Konstantin's field of research is theoretical high-energy physics, with main interests in quantum field theory, string theory and integrable systems. He pioneered the use of integrability and the Bethe ansatz in the AdS/CFT correspondence, which gave rise to new nonperturbative methods in quantum field theory. He has also worked on various aspects of string theory, statistical mechanics, and mathematical physics.

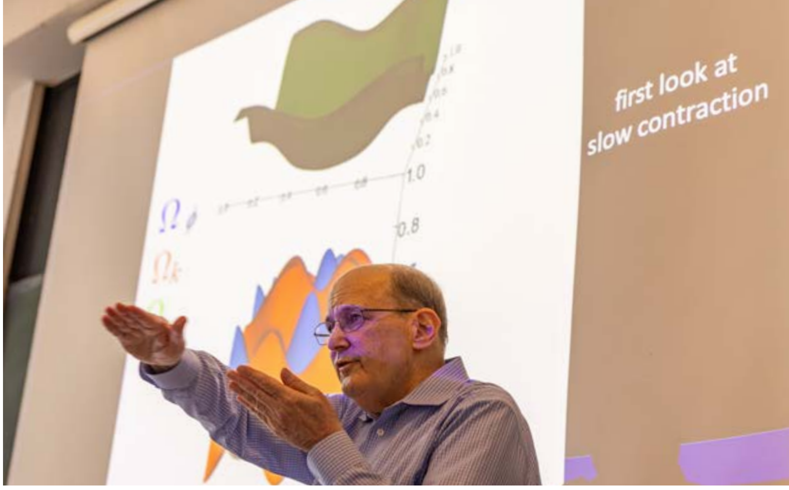
Associate Faculty

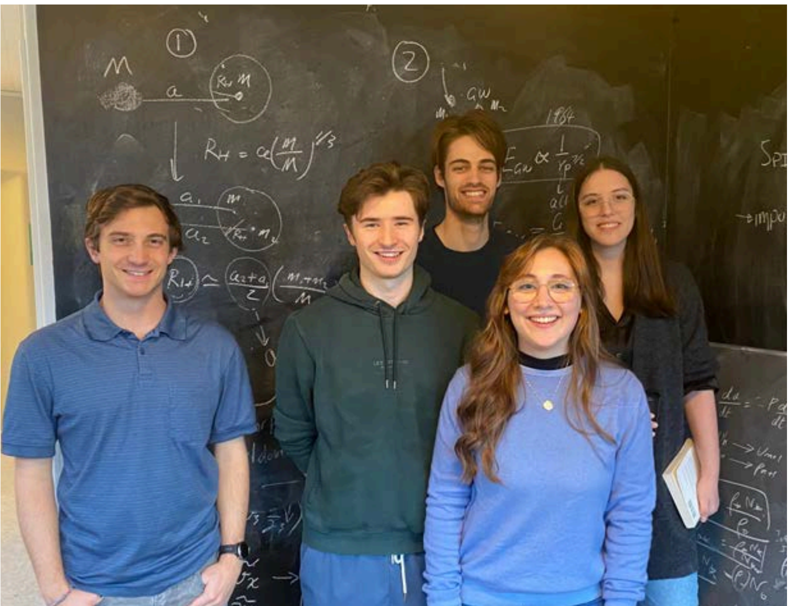
Jácome (Jay) Armas completed his Ph.D. at the Niels Bohr Bohr Institute in 2012. He was postdoctoral researcher at the University of Bern 2013-2014 and Université Libre de Bruxelles 2015-2017. He joined the University of Amsterdam in 2018 as tenured Assistant Professor and became coordinator of the Dutch Institute for Emergent Phenomena. His research is now focused on hydrodynamics and symmetries with applications to astrophysics, quantum matter, soft and active matter as well as high-energy physics. He is PI of the interdisciplinary program Foundations and Applications of Emergence as well as Emergent Phenomena in Society: Polarisation, Segregation and Inequality where he works on applying quantum methods to complex systems with applications to living systems and social/economic problems. In addition he is founder and main organizer of the internationally renowned and award-winning Science & Cocktails event series. He is also Associated Professor at NBIA and a member of the Institute for Advanced Study in Amsterdam since 2022.

Marta Orselli joined the Strong Gravity group at NBIA in 2023. She is an Associate Professor at the University of Perugia and Affiliate Associate Professor at the Niels Bohr Institute. After obtaining her PhD from Parma University, Marta held postdoc positions at NORDITA and at the Niels Bohr Institute, receiving grants from the Carlsberg Foundation, the European Community (ERG) and from the Danish Natural Science Research Council. Marta's research interests include the study of systems in a s strong gravity regime, gravitational-wave physics, black-hole physics and high-energy physics.




CAPRA


first look at
slow contraction



Junior Faculty

Markus Ahlers received his Ph.D. in Theoretical Particle Physics from the University of Hamburg (DESY) in 2007. He has been a Postdoc in Oxford and Stony Brook before becoming a John Bahcall Fellow for Neutrino Astronomy at the University of Wisconsin-Madison. He joined NBIA in 2017 as an Assistant Professor. Markus research focus is centered on astroparticle physics. He studies the origin and transport of cosmic rays, the associated emission in gamma rays and neutrinos as well as beyond-the-SM probes by cosmic messengers. He has been a member of the IceCube Collaboration since 2007.

Berislav Buca has joined NBIA in November 2022 as an Assistant Professor on a Villum Young Investigator grant. His field of research is theoretical physics of non-equilibrium quantum many-body systems. Berislav obtained his PhD (2015) at the University of Ljubljana discovering ‘weak’ and ‘strong’ symmetries in open quantum systems. During his postdoc (2017-2022) at Oxford University he discovered a novel algebraic principle determining the dynamics of quantum many-body-systems out-of-equilibrium. He lectured for Keble College Oxford and remains a visitor at Oxford. At NBIA Berislav will study exact solutions of dynamics in quantum many-body systems. This will enable discovery of novel kinds of phases of quantum matter out-of-equilibrium, which have not been theoretically accessible before.

Michele Burrello joined NBIA in 2016 and is Associate Professor in condensed matter theory. He completed his Ph.D. in statistical physics at SISSA (Trieste) in 2011, and worked as a postdoc in Leiden and at the Max Planck Institute for Quantum Optics. Since 2019 he has been leading the NBIA research group on topological phases of matter thanks to the generous support of the Villum Foundation. Michele's research focuses on the study of topological phenomena in many-body systems. He aims at applying their emergent and exotic properties to novel quantum technologies and platforms for quantum computation. Michele works on different low-temperature setups, including ultracold atoms and superconducting devices, and he is interested in the common theoretical frameworks underlying such diverse systems.

Mauricio Bustamante is an Assistant Professor at NBIA. He completed his PhD at the University of Würzburg and DESY in 2014. He later became a postdoc at the Center for Cosmology and AstroParticle Physics (CCAPP) of The Ohio State University before joining the Niels Bohr Institute in 2017. His research is in the field of astroparticle physics, with a focus on high-energy astrophysical neutrinos and ultra-high-energy cosmic rays. He is interested in two open issues with far-reaching implications: what are the sources of high-energy cosmic rays, neutrinos, light, and gravitational waves, and how are these connected, and what can we learn about fundamental particle physics from astrophysical messengers with energies far above those achievable in the lab.

Gang Chen completed his PhD. in Nanjing University and worked junior faculty in there. Then he moved to Uppsala, Queen Mary University as postdoc. From 2022, he joint in NBI and employed as assistant professor from 2023. Now he works on scattering amplitude, gravitational wave and high spin field theory. He is currently focus on the kinematic algebra and double copy in various theories, and applies them to gravitational-wave and black hole physics.

Daniel D'Orazio is a DFF Sapere Aude Research Leader and Assistant Professor at NBIA. After a Fulbright Fellowship at the University of Zürich, Daniel completed his PhD in 2016 as an NSF Graduate Research Fellow at Columbia University. Before joining the NBIA in 2020 he was a NASA Einstein Fellow and an Institute for Theory and Computation Fellow at Harvard University. Daniel's research lies at the interface of theory and observation and spans a wide range of topics in high energy astrophysics. His primary interests lie in harnessing tools of the burgeoning era of multimessenger astronomy for uncovering the origin of compact-object-binary sources of gravitational radiation, spanning the mass scale from neutron stars up to supermassive black hole binaries.

Jose M. Ezquiaga joined NBIA as an Assistant Professor in 2022. Previously, he was a NASA Einstein Fellow at the University of Chicago. He obtained his PhD from Universidad Autonoma de Madrid in 2019. Jose exploits gravitational-wave data to explore uncharted regions of 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. Jose is a Villum Young Investigator and PI of the Niels Bohr Institute LIGO group. He is also a member of LISA and Cosmic Explorer.

Natascha Leijnse is an experimental biophysicist working in the Active Intelligent Matter Research group. After she obtained her PhD at University of Copenhagen she worked as a postdoc at Stanford University and returned to Copenhagen. She is studying cell properties and mechanotransduction processes in living cells using optical tweezers combined with fluorescent imaging. Her latest work uncovered an active mechanism that filopodia, "cellular fingers", use to exert forces during embryonic- but also cancer development.

Junior Faculty

Zhengwen Liu received his Doctorate from the Université catholique de Louvain in 2019. Before joining the NBIA as an assistant professor in the fall of 2022, Zhengwen was a postdoctoral fellow at the DESY in Hamburg. He is interested in understanding the fundamental interactions in nature, with a particular focus on scattering amplitudes and Feynman integrals in quantum field theory, ranging from their mathematical structures to their applications to collider physics and gravitational-wave observations. He currently works on developing novel computational methods to solve the gravitational two-body problem by importing cutting-edge techniques from high energy physics and mathematics, including effective field theory and iterated integrals.

Andres Luna completed his education in Mexico City and then earned his PhD at the University of Glasgow in 2018. He held a postdoctoral position in the Mani L. Bhaumik Institute for Theoretical Physics at UCLA before joining the NBIA as an assistant professor in 2021. His research interests lie at the interface between gravitation and scattering amplitudes in Quantum Field Theory. He is currently working on the generalization of the double copy to black holes and other interesting classical solutions in General Relativity, as well as in the application of these, and other modern scattering amplitudes techniques to the description of the dynamics of binary black holes and its application to the burgeoning field of gravitational-wave physics.

Martin Cramer Pedersen is an Assistant Professor working in the field of soft matter and biophysics. He is particularly interested in using methods from computational and applied differential geometry and topology to characterize and understand the emergence of order, disorder, and self-assembled geometries in e.g. colloidal and polymer systems, cellular and other active materials, crystals and quasicrystals, or reticular chemical systems. Furthermore, Martin works on extracting and quantifying shape and order from a variety of experimental data and simulations of such systems; and consequently development and curation of data scientific methods, efficient simulation methods, and high-performance computing are central aspects of his research as well.

Weria Pezeshkian is a biophysicist. He received his PhD from the University of Southern Denmark. Before joining NBIA he was a postdoctoral fellow at the University of Groningen. He develops and uses computational microscopes to understand fundamental biological processes at the cellular level. For instance, how cells repair their membranes after injury or how toxic particles hijack cellular machinery for their entry. These mechanisms include many exciting physical phenomena such as fluctuations induced forces, phase transition, phase coexistence, and molecular condensations. His latest works include the first simulation of mitochondrial membranes with realistic size and SARS-CoV-2 virion envelope with a near-atomistic resolution. His current focus is to understand the p molecular mechanisms that control the form of subcellular factories.

Junior Faculty

Karel Proesmans joined the NBIA as an assistant professor in October 2021. After obtaining his PhD in 2017 at Hasselt University in Belgium, he worked as a post-doctoral researcher in Canada and Luxembourg. During this time, he worked on non-equilibrium statistical mechanics, with particular focus on the development of a general framework, known as stochastic thermodynamics, to study the thermodynamics of mesoscopic systems. Currently, his main research interest is on how thermodynamics puts constraints on biological processes. More specifically, his focus is on questions such as to what extend are biological processes, such as DNA replication, and what are the thermodynamic constraints necessary to create non-equilibrium phenomena motility-induced phase-separation.

Johan Samsing joined the NBIA as a Louis-Hansen Assistant Professor and Marie Curie Fellow in 2019. In 2020 he received a Villum Young Investigator Grant to establish a group at the NBIA dedicated to gravitational-wave astrophysics. In 2022, Johan also received an ERC Starting Grant from the European Union for the project "Gravitational Wave Astrophysics and Dynamical Formation of Black Hole Mergers". Johan received his PhD from the Niels Bohr Institute (DARK) in 2014, after which he moved to Princeton University, first as an Einstein Fellow and then as a Spitzer Fellow. He currently works on the astrophysical formation of gravitational-wave sources and the origin of black hole mergers.

Apoorv Tiwari joins NBIA as an assistant professor. He is interested in applying concepts related to generalized symmetries, anomalies and topological aspects of quantum field theories and quantum lattice models to the study of phase diagrams of quantum matter. He is also interested in the discovery of novel properties of quantum matter that is far from equilibrium realized for example in driven, open or monitored quantum systems. He recently received the Villum Young Investigator grant.

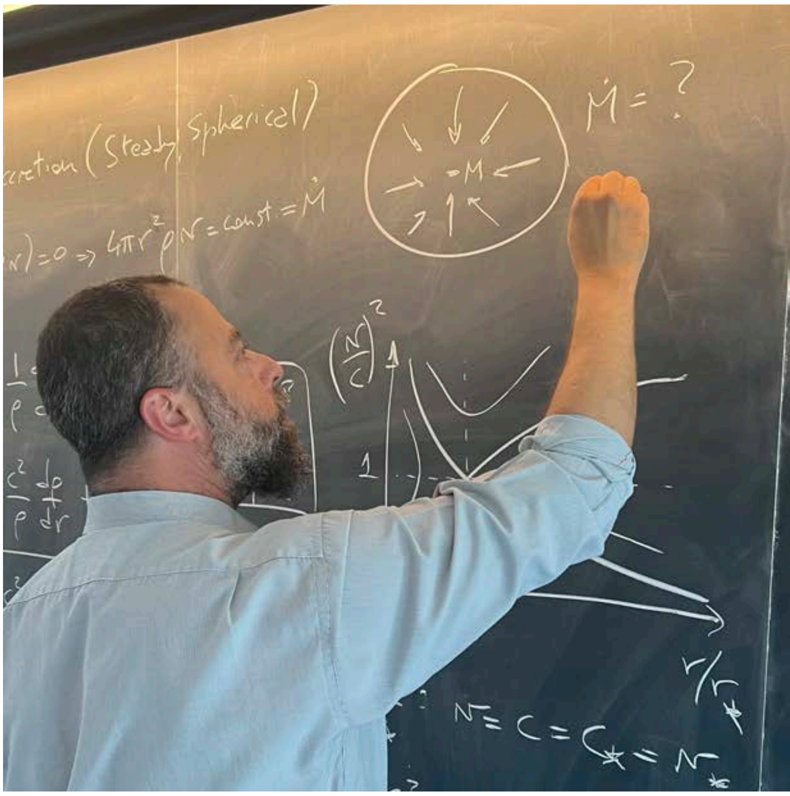
Maarten Van de Meent joined the NBIA in 2022 as an assistant professor in the "Strong Gravity'' group. After obtaining his PhD from Utrecht University under supervision of Gerard 't Hooft, Maarten held an NWO Rubicon Fellowship at the University of Southampton, and a Marie Skłodowska–Curie Fellowship at the Max Planck Institute for Gravitational Physics in Potsdam. He is interested in the relativistic 2-body problem describing the inspiral and merger of black hole binaries. In particular, he is an expert on the gravitational self-force formalism, which solves the 2-body problem as a perturbative expansion in the ratio of the masses. He leverages this knowledge to develop and improve waveform models for gravitational wave observations.

Junior Faculty

Cristian Vergu graduated from Ecole Normale Superieure (Paris, France) and obtained his PhD in Theoretical Physics from Paris VI University and IPhT Saclay. He held postdoctoral positions at Brown University, USA, ETH Zü-rich, Switzerland and King's College London, UK. He is interested in twistor theory, AdS/CFT, integrability and scattering amplitudes in N=4 super-Yang-Mills theory.

Matt von Hippel received his PhD from Stony Brook. He was a postdoctoral fellow at the Perimeter Institute, before joining NBIA first as a postdoctoral fellow and now as an assistant professor. He researches scattering amplitudes in gauge and gravity theories. In particular, he has developed new methods to calculate multi-loop scattering amplitudes in N=4 super Yang-Mills based on the properties of polylogarithmic functions. Currently, he is interested in extending these techniques, both to more general theories and to elliptic integrals.

Mary Wood has a background in surface chemistry and obtained her PhD at the University of Cambridge in 2016 studying adsorption phenomena at metal/liquid interfaces. She held postdoctoral positions in Cambridge and Birmingham, studying corrosion and lipid bilayers respectively, before moving to EPFL in Switzerland to take up a Human Frontiers Science Programme cross-disciplinary fellowship. Her interests lie in bioelectronic interfaces, particularly photosynthetic membranes supported on electrode surfaces, with broader applications in the fields of renewable energies and green treatment of polluting waste.


cretion (Steady, Spherical)
Ṁ = ?
M
4πr²ρv = const = Ṁ
r/r★
v = c = c★ = v★

Postdoctoral Fellows

Aleksandra Ardaševa received her PhD from the Mathematical Institute at the University of Oxford. Her doctoral work focused on studying evolutionary adaptation strategies of cancer cells in dynamic environments using analytical and numerical techniques. She currently studies physico-chemical coupling in active biological matter by utilising phase-field modelling approach and continuum theory of liquid crystals.

Thomas Berlok is a Marie Skłodowska-Curie fellow working on the physics of the intracluster medium found in galaxy clusters, plasma physics and astrophysical fluid dynamics. All current cosmological simulations of turbulence in the intracluster medium have assumed that the plasma is fully collisional. At NBIA, Thomas intends to improve on this by producing the first cosmological galaxy cluster simulations that move beyond the collisional assumption, enabling predictions for future X-ray observations.

Jonas Berx is a post-doctoral researcher in non-equilibrium statistical mechanics. He has worked on topics ranging from active matter and surface growth to knot theory. He did his PhD at the University of Leuven and worked as a post-doctoral researcher at the Max Planck Institute for Dynamics and Self-Organisation and at the University of Leiden. He joined NBIA as a Marie Curie fellow to investigate the thermodynamics of replication processes at the molecular scale.

Clément Bonnerot joined the NBIA as a Marie Curie fellow in 2021. He obtained his PhD from Leiden Observatory in 2017 and then was a postdoc at the California Institute of Technology. His research concerns tidal disruption events as well as other transient and high-energy phenomena, which he studies theoretically in order to characterize their observational signatures. Starting in February 2023, Clément is working as an Assistant Professor at the University of Birmingham in the UK.

Gregorio Carullo is a Marie Skłodowska Curie Interactions Fellow in the newly formed Strong gravity group. Before, he received his PhD from the University of Pisa and was a Della Riccia Fellow at the University of Jena. His research focuses on extracting fundamental physics implications from gravitational waves observations and testing the black hole paradigm, mainly using spectroscopy techniques. He is also interested in dynamical captures and measuring black hole horizon effects using LISA.

Postdoctoral Fellows

Adam Chalabi is a postdoc working in theoretical high-energy physics. He joined NBI in 2022 after completing his PhD at the University of Southampton. His research interests include conformal field theory, gauge theory, and supersymmetry. Adam's current work investigates the role of boundaries and defects in conformal field theory, with some inspiration drawn from string theory and condensed matter physics. Boundaries and defects encode crucial information about quantum systems, and they are necessary to describe many realistic physical phenomena.

Jayeeta Chattopadhyay is a postdoctoral researcher interested in active matter. Her research focuses on studying non-equilibrium properties of active nematics at the continuum level through computer simulation. She is also interested in understanding fundamental properties in tissue mechanics, including cell death, cell integration, collective cell motions, etc., which are governed by activating biochemical signals through mechanical stress generation.

Yifan Chen obtained his PhD from Sorbonne Universite in 2019. Before joining NBIA as a postdoc, he worked at Institute of Theoretical Physics, Chinese Academy of Science. His research is in the intersection of particle physics, strong gravity, string theory and quantum sensor. Recently, he focuses on detection of ultralight bosons, such as axions and dark photons, by exploiting Event Horizon Telescope observations on supermassive black holes, or a network of sensors like cavities and magnetometers.

Damiano Fiorillo obtained his PhD in late 2021 from the University of Naples and joined the group of Mauricio Bustamante at NBIA in early 2022. His research interests encompass many facets of high-energy multi-messenger astrophysics: he has worked on various topics in dark matter, axions, gamma rays, and high-energy neutrinos. At NBIA, his focus is on how cosmic neutrinos can test both high-energy particle physics and astrophysics, both using present-day observations and forecasting future opportunities with upcoming detectors.

Hjalte Frellesvig received his PhD from the NBI, and has done postdocs in Greece, Germany, and Italy. His main field of research is scattering amplitudes in particle physics, with a focus on Feynman integrals and their mathematical properties. This includes work on the use of the mathematical disciplines of intersection theory and "symbol" algebra for simplifying and systematizing the manipulation and evaluation of Feynman integrals and associated special functions. He also works on particle scattering phenomenology including problems related to the production of the Higgs boson and electro-weak corrections to the production of the Z and W bosons.

Postdoctoral Fellows

Emil Have received his PhD in 2023 from the University of Edinburgh. After a brief postdoctoral position at the same institution, he joined the NBI in the autumn of 2023 working on holographic dualities in quantum gravity and string theory. His research currently focuses on the application of non-Lorentzian geometry in the contexts of holography, string theory, gravity and fluids.

Asta Heinesen is a postdoctoral researcher working on questions within cosmology and general relativity. Her research is in the interface between theoretical and observational cosmology, and focuses on developing model - independent methods for analysing, for instance, standard candles, standard sirens, and the ages and distribution of galaxies in the Universe.

Shilpa Kastha is a postdoctoral researcher in the Strong group at NBIA. She finished her Ph.D. from the Institute of Mathematical Sciences, India in 2019. Before joining NBIA, she was a junior scientist at the Albert Einstein Institute. She has explored the physics of gravitational waves with cutting - edge analytical and numerical tools. Her present interests encompass post-Newtonian modeling of compact binaries, black hole spectroscopy, astrophysical implication of gravitational wave detections, and parameter estimation. She is also interested in the formulation of various tests of general relativity, and studying black hole horizon dynamics using marginally outer trapped surfaces within numerical relativity.

Takuya Katagiri joined NBIA in April 2023. He completed his PhD at Rikkyo University in Japan in March 2022 and was then a postdoc at Tohoku University in Japan for a year. He is currently interested in interactions of black holes with astrophysical environments or particles beyond the standard model, the underlying symmetric structure of phenomena in strong gravity within General Relativity, and fundamental understandings of gravity towards a test of theories of gravity with gravitational waves.

Sameer Kumar is a post-doctoral researcher, currently investigating time evolutions and pattern formation in active matter by writting the equations of motion for the density and orientation of living objects of anisotropic shape, coupled to an incompressible fluid. The Naviar-Stokes equation to describe the motion of the flow field (fluid velocity). Numerical solutions to these coupled equations are obtained using the Lattice-Boltzmann method, allowing the study of different patterns formed in the system under various input conditions.

Postdoctoral Fellows

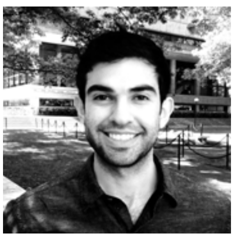
Bin Liu received his PhD in China in 2016 and held postdoctoral positions at Shanghai Astronomical Observatory and Cornell University. He joined NBIA in 2020 as an INTERACTIONS fellow and now is a Marie-Curie Fellow. Bin is interested in a wide range of dynamical problems, including exoplanetary systems, dynamical formation of binary black holes, and dynamics and merger of compact objects near super-massive black holes in the disks of active galactic nuclei.

Rico (Ka Lok) Lo joined NBIA in August 2023, after completing his PhD at the Caltech. At the Strong group, he works on both data-analysis and theoretical aspects of gravitational waves. His current research focuses on gravitational lensing of gravitational waves and its implications to cosmology and tests of general relativity. He is also a member of the LIGO Scientific Collaboration contributing to many of its lensing and testing general relativity analyses.

Lorenzo Maffi received his PhD in 2020 from the University of Florence. The topic of his research has been the edge dynamics of topological states of matter by means of conformal field theory approaches. He focused on the quantum Hall states and topological insulators in 3D. Currently he is working on low temperature phases in nanowire-leads systems, and, in particular, on stability of topological Kondo effect.

Rodrigo Panosso Macedo joined the NBIA as a senior post-doctoral fellow in March 2023. Before the NBI, Rodrigo has worked in Brazil (USP), Germany (Max Planck Institute-Potsdam and University of Jena) and the UK (Queen Mary University of London and University of Southampton), with regular visits to CENTRA (Lisbon, Portugal) and the University of Bourgogne (Dijon, France). He develops a novel framework for gravitational wave and black-hole physics by applying Penrose's conformal treatment of infinity to perturbation theory.

Pablo Martínez-Miravé obtained his PhD at the University of Valencia (Spain) and he joined NBIA in October 2023 as part of the AstroNu group. His work focuses on particle astrophysics. He is interested in exploring standard and non-standard neutrino properties relying on terrestrial experiments, the Sun, the early Universe, as well as core-collapse supernovae and binary neutron star mergers.



Siavash Monfared received his PhD at MIT followed by a postdoc position at Caltech. His research is at the interface of granular physics, statistical mechanics and active matter. He is interested in understanding the link between the physics of force transmission and collective self-organization in biological systems through developing theoretical models and high performance computational tools.

Postdoctoral Fellows

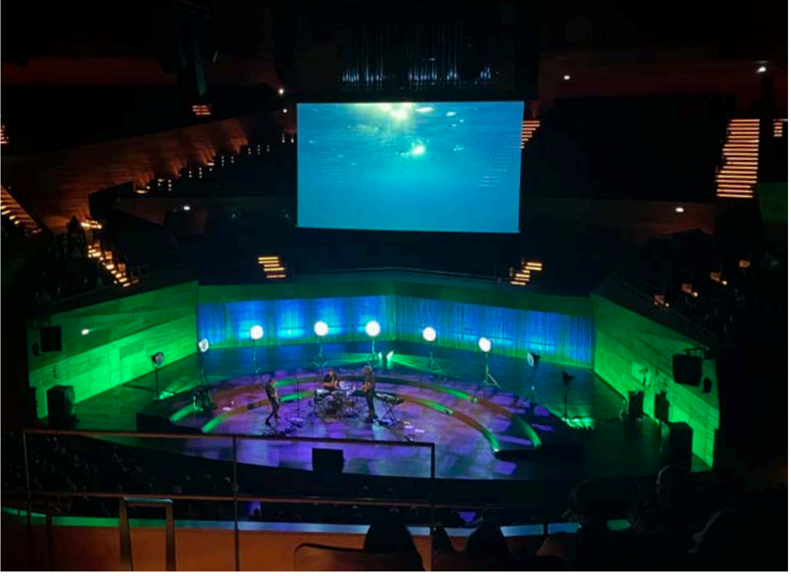
David Pereñiguez obtained his PhD from the Institute of Theoretical Physics, in the Autonomous University of Madrid. He joined NBI in October 2022. His research focuses on black hole physics. At NBI, he works on theoretical aspects of gravitational wave propagation in black hole spacetimes, and studies how these encode information about the black hole structure, with special emphasis on signatures of new physics.

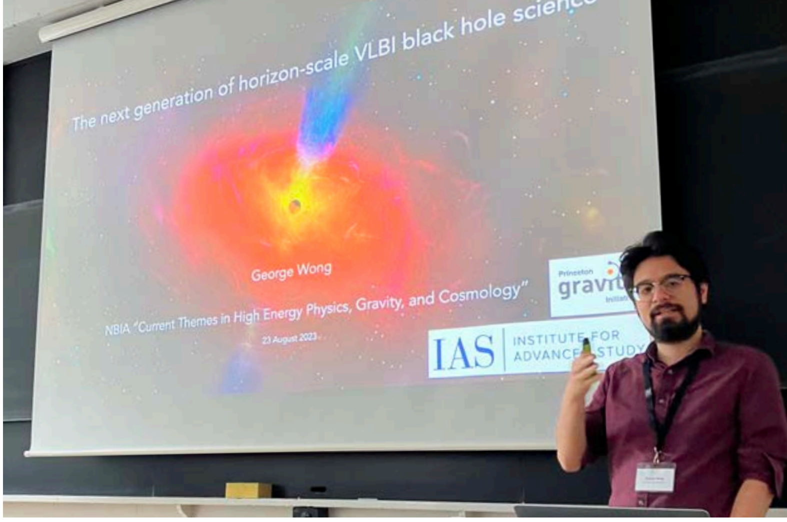
Enrico Peretti obtained his PhD in Astroparticle Physics at the Gran Sasso Science Institute (L'Aquila, Italy) in July 2020 and he joined the Niels Bohr Institute in September 2020. His research interests are in astroparticle physics and focus on the transport of high energy particles and its multimessenger implications in extreme astrophysical environments, most notably starburst galaxies. He is also interested in non-thermal phenomena in relativistic jets such as gamma-ray bursts.

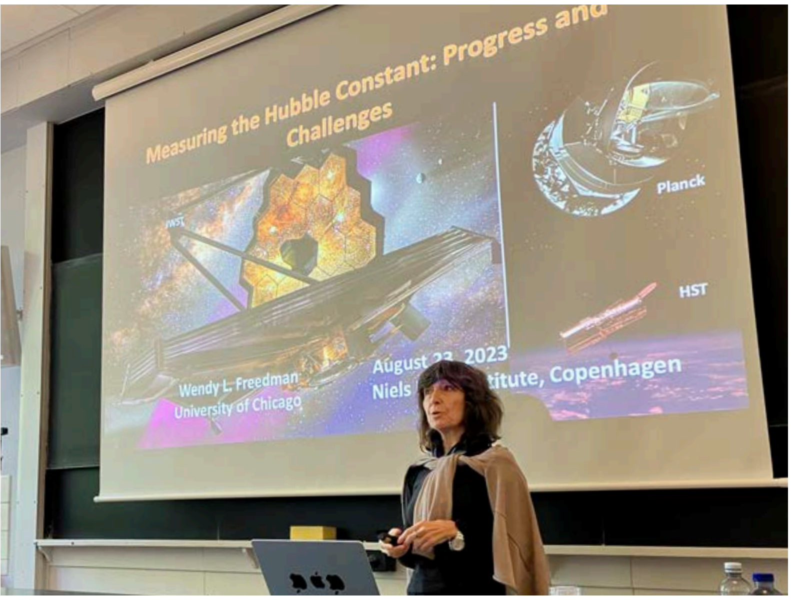
Neda Rahmani was a postdoc in the Computational Material Group at Southern Denmark University. Her research focused on finding new functional materials, specifically multiferroic and half-metallic double perovskites, for photovoltaics and spintronics through density functional theory calculations. Now, as a postdoc at NBIA, she is exploring biomaterials and biological processes using multiscale computer simulation techniques. Currently, Neda is focusing on the design of a nanoscale force sensor to measure interactions between membrane proteins.

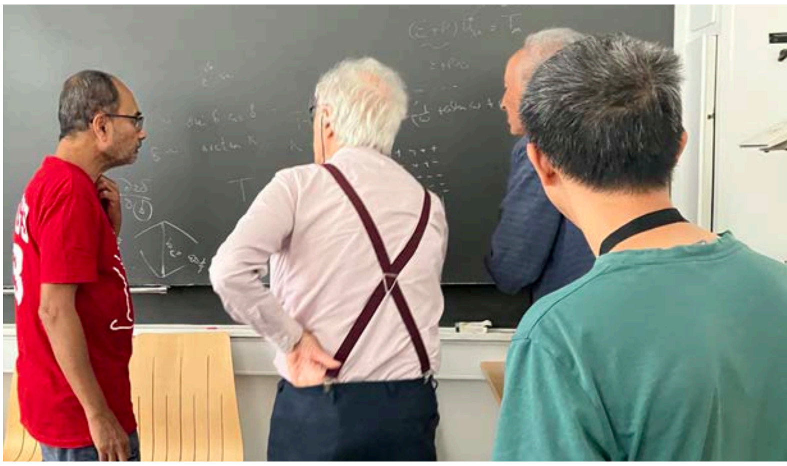
Annika Rudolph obtained her PhD in Mai 2022 from Humboldt University Berlin/DESY and joined the AstroNu group in September 2022. Her work focuses on non-thermal high-energy astrophysical phenomena like Gamma-Ray Bursts an Active Galactic Nuclei. Within these environments she studies the interplay between photons, neutrinos and charged nuclei (called cosmic rays) though numerical modeling, aiming at making multi-messenger predictions testable through observations.

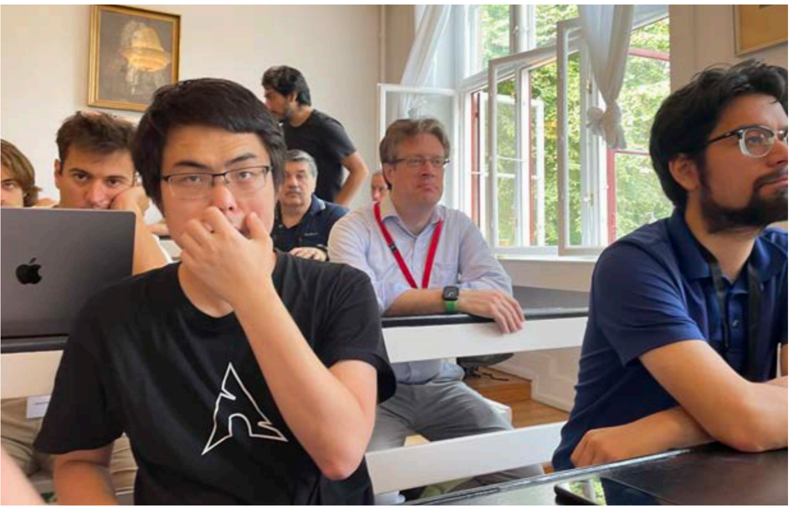
Fabian Schuhmann did his PhD at the Carl-von-Ossietzky University in Oldenburg, Germany. His research focused on tailored tools to analyze single protein dynamics and their conformational changes. For instance, he developed the Python package SiMBols, which makes similarity measures easily accessible for biological systems and the comparison of spatio-temporal data. As a postdoc at NBIA, he is building on the computational foundation to transfer and find new ways to analyze and simulate protein clusters and systems, including membranes in coarse-grained and all-atom settings.

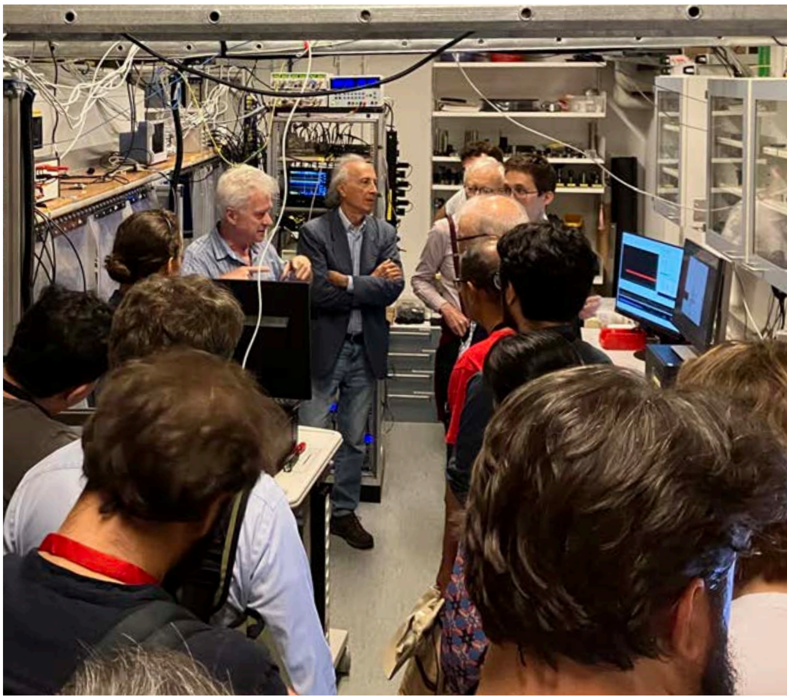



The next generation of horizon-scale VLBI black hole scien
George Wong
NBIA "Current Themes in High Energy Physics, Gravity, and Cosmology"
23 August 2023
IAS


Measuring the Hubble Constant: Progress and Challenges
Planck
HST
Wendy L. Freedman
University of Chicago







Postdoctoral Fellows

Shashank Shalgar received his PhD from Northwestern University in 2013. He later became a postdoctoral fellow at the University of New Mexico and Los Alamos National Laboratory. His research is focused on neutrino physics in extreme astrophysical environments and the early Universe. He is especially interested in the non-linear evolution of the neutrino flavor that occurs in these astrophysical environments.

Prashant Singh is a postdoctoral researcher at NBIA working with Prof. Karel Proesmans. He obtained his PhD from the ICTS in Bangalore, India in November 2022. The general theme of his research has been non-equilibrium statistical mechanics. More precisely, he has worked on Brownian motion and random walks, active particles, stochastic resetting, extreme-value statistics, single-file motion and functional statistics. At NBIA, he is exploring the field of stochastic thermodynamics with a primary focus on its applications in biological settings.

Anne Spiering received her PhD from Trinity College Dublin. Her research focusses on the interplay between infinite-dimensional symmetries at the core of physical models and their manifestation at the level of the model's observables. This includes the research on how the existence, and absence, of quantum integrability constrains the physical data of superconformal field theories, and in particular the mathematical structure of scattering amplitudes.

Kristian Thijssen is a computational soft matter physicist interested in the dynamics of emergent collective phenomena and how those systems (e.g., bacteria colonies and cellular tissues) interact with reconfigurable surroundings. He obtained his MSc at the Eindhoven University of Technology, after which he did a PhD in physics under the tutelage of Julia Yeomans in Oxford. After holding a postdoctoral position under Robert Jack in Cambridge, he joined the NBI Copenhagen with a Marie-Curie fellowship.

Christopher Tiede received his PhD from New York University in May, 2022 before joining the NBIA as a postdoc in the Fall. His research is in the development and application of high-performance hydrodynamics simulations to astrophysical systems. Chris's primary focus is in the study of gas dynamics around binary black holes and how such accretion phases both alter the life cycles of these binaries and enable their multi-messenger observational prospects.

Postdoctoral Fellows

Inar Timiryasov received his PhD from Moscow State University in 2016. He was a postdoc at EPFL in Lausanne until 2021 when he joined NBI. In 2022 he joined NBIA as an INTERACTION Senior Fellow. Inar's research focuses on the physics of the early Universe (gravity, inflation, dark matter, baryogenesis) and particle physics. He also explores the potential of artificial intelligence as a tool for discoveries in physics and cosmology and the transfer of ideas between deep learning and theoretical physics.

Alessandro Alberto Trani joined the NBIA as an INTERACTIONS Senior Fellow. He received his PhD from SISSA in 2017, before moving to The University of Tokyo as a JSPS Postdoctoral Fellow. His main research focus is the study of collisional self-gravitating systems, which include star clusters, galactic nuclei, binary stars, and planetary systems. With the advent of gravitational wave astronomy, he is leveraging the few-body problem to unveil the astrophysical origin of gravitational wave events. In 2023 Alessandro received a MCSA Fellowship at NBIA.

Matteo Wauters is interested in a variety of non-equilibrium phenomena in quantum physics, ranging from topological transport properties to reinforcement learning techniques for quantum control and quantum computation. At the moment he focuses on the modeling and numerical analysis of topological Kondo effect in nanowire systems, aiming to a qualitative comparison with experimental results.

Chi Zhang received his PhD in 2020 from the Institute of Theoretical Physics, Chinese Academy of Sciences. He works on scattering amplitudes in gauge theories and string theory. He is interested in studying the underlying mathematical structures of scattering amplitudes as well as developing new techniques for computing amplitudes.

Lorenz Zwick joined NBIA as a postdoctoral fellow in 2023 to study the variety of perturbations that astrophysical backgrounds imprint on gravitational waves. Due to the multidisciplinary nature of this endeavor, Lorenz 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.

PhD Students

Benjamin Halager Andersen joined the Active Intelligent Matter (AIM) group at NBIA in November as a PhD fellow, where he will be using a combination of numerical and analytical methods to study systems of active matter. Prior to this, Benjamin obtained both his master's and bachelor's degrees from NBI, the former on the topic of complex systems physics and the phenomenon of fully developed turbulence in 2D as well as 3D.

Robin Bölsterli is pursuing a PhD in the Active Intelligent Matter group under the supervision of Professor Amin Doostmohammadi. After obtaining his MSc in Interdisciplinary Sciences at ETH Zurich, he started his PhD in August 2023. In his research, he is modelling and theoretically studying the critical phenomena occurring in Collective Mechanotransduction and Active Matter. To this end, he also collaborates with experimentalists.

Lasse Bonn obtained his MSc and one year of research experience working as a research assistant at NBIA in the Active Intelligent Matter group working on the properties of topological defects in fluctuating active nematics under the supervision of Amin Doostmohammadi. He has now started as a PhD student in the same group and will be looking at turbulent flows in active systems using continuum fluid dynamics simulations.

Adrian Vidal Bravo is a PhD student at NBIA working in the Computational Microscopy group under the supervision of Weria Pezheskian. He obtained his Master's degree at Aarhus University with a thesis on the dynamic and thermodynamic properties of a system of interacting autonomous thermal motors. Now, his main focus is studying biological membranes' passive and active fluctuations using numerical simulations.

Chun Lung Chan (Juno) obtained his MSc degree in Physics from the Chinese University of Hong Kong with a thesis on detecting strongly lensed gravitational waves and the asteroseismology of magnetars. He is now working in the Strong group under the supervision of Jose Maria Ezquiaga and Vitor Cardoso. His research at NBIA focuses on numerical simulations of magnetars and detecting lensed gravitational wave signals.

PhD Students

Marina De Amicis is a PhD candidate at Strong under the supervision of Vitor Cardoso. Originally from Rome, she obtained her MSc degree at La Sapienza University, where she investigated how black holes evolve due to quantum effects. In her PhD, she is exploring the interaction between gravitational waves and astrophysical systems, with a particular interest on stochastic backgrounds. Her primary interest is studying the signal generated during the coalescence of black holes, with specific emphasis on the post-merger phase known as the "ringdown".

Pedro Dedin is a Ph.D. candidate at the University of Campinas, Brazil, working on neutrino flavor conversion in supernovae. During his one-year exchange period at NBIA, he worked in the Astronu group under the supervision of Prof. Irene Tamborra on the topic of flavor instabilities in a self-interacting neutrino gas. In collaboration with Dr. Shashank Shalgar, they have explored the overlooked role of vacuum mixing on flavor instabilities driven by the angular distribution of flavor lepton number.

Conor Dyson is a PhD student in the Strong Gravity at the Niels Bohr International Academy working under the supervision of Maarten van de Meent and Vitor Cardoso. His research is in the field of black hole perturbation theory, with a specific focus on applying the self-force formalism (a type of singular perturbation theory) to model post-adiabatic and environmental effects in black hole binaries.

Roger Morales Espasa joined the NBIA in April 2022 as a PhD student under the supervision of Matthias Wilhelm after obtaining his MSc degree from NBIA too. In his master's thesis, he studied the coalescence of a black hole binary system through the post-Newtonian effective field theory of gravity. Now, his PhD project is devoted to the study of scattering amplitudes and the special mathematical functions that occur in Feynman integrals, focusing on elliptic and higher-dimensional geometries.

Evelyn-Andreea Ester is a member of the Strong Gravity group and works on quantum field theory in curved spacetimes. She completed a Mathematics BSc and a Physics MSc at Royal Holloway, University of London, focusing on Hawking radiation - specifically on the information paradox and on analyzing the production of dark matter by decaying primordial black holes. Her research continues to highlight quantum effects in the strong gravity regime by investigating the backreaction of quantum processes on classical black hole geometries.

PhD Students

Gaia Fabj obtained her MSc degree at the University of Heidelberg in 2021. She is currently a PhD student in the gravitational astrophysics group at NBIA. She is working under the supervision of Johan Samsing on the formation and evolution of black-hole binaries in Active Galactic Nuclei (AGN) accretion disks in order to investigate the AGN channel for gravitational-wave detection.

Manuel Goimil García received his MSc degree at the Niels Bohr Institute working on high-energy cosmic ray transport and neutrino production in tidal disruption events. He started his PhD in particle astrophysics in fall 2023 under the supervision of Irene Tamborra. His PhD work aims to explore how collective phenomena affect neutrino flavor conversion in dense astrophysical environments, such as supernovae and binary neutron star mergers.

Marcela Grcic received her Master's degree in physics from the University of Copenhagen in 2022 with a thesis on eccentric circumbinary disks. In October 2022, Marcela started working on her PhD with the NBI Astrophysics group. She works under the supervision of Daniel J. D'Orazio and Martin Pessah. Marcela's research at NBIA includes theoretical analysis of the interaction of astrophysical binary systems and surrounding accretion disks, with a focus on the resulting disk eccentricity evolution.

Kathrine Mørch Groth obtained her MSc degree at the NBIA in 2021 working on multi-messenger emission of ultra-high energy cosmic rays. Since October 2021 she has been a PhD student in the astroparticle group under the supervision of Markus Ahlers. Her project aims to clarify the origin of the high-energy cosmic neutrino flux through studies of candidate neutrino sources in the context of multi-messenger observations.

Valeriia Grudtsyna completed her biomedical engineering degree at Lund University and gained research experience as a part of Vinay Swaminathan's group, Laboratory of Cell and Molecular Mechanobiology, at Lund University. Currently, she is pursuing her PhD under Amin Doostmohammadi at the Active Intelligent Matter Research Group. Her focus is on experimental investigations of the underlying physics of collective mechanotransduction in epithelial cells.

PhD Students

Ersilia Guarini is a PhD student working under the supervision of Irene Tamborra. She joined NBI in January 2021, after obtaining her MSc degree from Bari University (Italy) with a thesis on axion-like particles production in photon conversions in large-scale coherent magnetic fields. She is currently working on multi-messenger astrophysics. In particular, her project aims to investigate non-thermal neutrino production in astrophysical transients.

Shanzhong Han obtained his Master's degree in Theoretical Physics from Beijing Normal University in 2019. He is currently pursuing his PhD in Theoretical High Energy, Astroparticle, and Gravitational Physics under the supervision of Professor Niels Obers. His research focuses on the double copy, with a particular emphasis on the Weyl double copy. He is exploring the connection between gravity theory and gauge theory, as well as investigating the applications of double copy on gravitational wave astronomy and astrophysics.

Marie Cornelius Hansen received her MSc degree at the Niels Bohr Institute with a thesis on probing the properties of axion-like dark matter using astrophysical high-energy neutrinos observed in IceCube. She started her PhD in November 2022 under the supervision of Irene Tamborra. Marie's work is within the field of particle astrophysics. Specifically, her PhD project focuses on numerical simulations of the flavor evolution of neutrinos in dense astrophysical environments, such as core-collapse supernovae and neutron star mergers.

Kai Hendriks joined the NBIA as a PhD student in November 2022, to work on the astrophysical formation channels of black hole binaries and imprints on their gravitational wave signals with Johan Samsing. Kai obtained his BSc and MSc at Maastricht University and Radboud University respectively, with research on neutron star binaries with numerical relativity as well as models of electromagnetic counterparts to gravitational wave sources.

PhD Students

Dana Taylor Kemp obtained her MSc degree at NBI in 2021 contributing to the soliton theory of nerve signalling by combining numerical, theoretical and experimental work. Her PhD-work focuses on theoretical frameworks for non-equilibrium circuits with biological perspectives under the supervision of Karel Proesmans.

Ida E. Nielsen is a PhD student with Prof. Michele Burrello in the Condensed Matter Theory group since October 2019. She works on models of parafermionic modes and proposes experimental realization and verification of these. Parafermionic modes can potentially be exploited to build platforms for error-protected quantum computation.

David O'Neill began his masters in physics at the university of Copenhagen in 2020, before joining the Astrophysics group for his thesis in black hole binary formation. Further pursuing this work, he began his PhD in September 2022 interested in supermassive black hole binaries. His projects aim to investigate the environments and dynamics of the most massive objects in the universe and to explore possible observational signatures they may exhibit.

Daniele Pica is a PhD student both at NBIA and University of Perugia, working in the Strong Group under the supervision of Troels Harmark and Marta Orselli. He obtained his Master's Degree at University of Perugia with a thesis on charged black hole binary merger. He is now working on three body systems, specifically on black holes triple systems, trying to understand analytically how the presence of a supermassive black hole affects the dynamics of a binary system.

Tetyana Pitik started as a PhD student at NBIA under the supervision of Irene Tamborra after obtaining her MSc degree in Theoretical Physics from University of Perugia (Italy). The PhD project of Tetyana focused on modeling the high-energy neutrino and electromagnetic emission from gamma-ray bursts and superluminous supernovae to guide multi-messenger observations. Tetyana has successfully defended her PhD thesis on November 3, 2023. She moves on as postdoctoral fellow sponsored by NSF at U. of California, Berkeley and Penn State.

PhD Students

Andrea Placidi obtained a Master's degree in Physics at the University of Perugia in Italy. After this, he started a double degree PhD program between the latter university and the University of Copenhagen. A the moment he is also a research fellow at the Galileo Galilei Institute for Theoretical Physics, in Florence. His work mainly focuses on the theoretical aspects of gravitational wave physics, with particular reference to effective one-body models for coalescing compact binaries.

Xin Qian did his bachelor in Lanzhou, China, followed by a gap year for self-study. He then decided to continue his career in Copenhagen, where there are a number of researchers with similar research interests. Xin joined Prof. Charlotte Kristjansen's group for his master thesis, mainly to work on the field theory side of AdS/CFT correspondence by using the integrability technique. Xin is now a PhD. student supervised by Charlotte Kristjansen's, working on extending the study he carried out in his MSc thesis to ABJM superconformal field theory.

Martin Seltmann's research aims to employ algebraic methods in the field of many-body physics to investigate non-equilibrium phenomena in open and closed quantum systems to gain new structural insights into the complex dynamics of those systems. Questions to be addressed include dynamical symmetries and the uniqueness of steady states for open systems. A primary focus is the relaxation behavior of systems with local observable algebras; the first milestone is to show the impossibility of optical bistability.

Thomas Spieksma is a PhD student working in the group of Vitor Cardoso since September 2022. He obtained his MSc degree at the University of Amsterdam, where he mainly worked on the dynamics of fundamental fields around black holes. He continues to do so in a broader setup, studying both black holes in binary systems and the ringing down of a black hole after it has undergone merger. This work uses tools from black hole perturbation theory as well as numerical relativity.

Chenliang Su is a PhD student working with Charlotte Kristjansen. He is mainly working in AdS/CFT correspondence, integrability and defect CFTs. He is currently investigating the one-point function in ABJM theory with a domain wall. The intriguing problems include extending the overlap formula between Bethe eigenstates and integrable boundary states, which determines the form of one-point functions, to general values of the bond dimension and to the higher loop orders.

PhD Students

Bernanda Telalovic received her MSc degree in Mathematical Physics from the University of Tübingen in late 2021, with a thesis on the Littlewood-Richardson rule, which has applications in QCD calculations. She joined NBIA as a PhD student in early 2022, under the supervision of Mauricio Bustamante. The work of Bernanda is within particle astrophysics. Her PhD project is on looking for signs of new physics in the distribution of the incoming directions of high-energy neutrinos, and related subjects.

Victor Valera worked as a PhD student under the supervision of Mauricio Bustamante. He completed the Postgraduate Diploma Programme in High Energy Physics at the International Centre for Theoretical Physics (Italy). During his PhD, Victor's research focused on the study of ultra-high energy neutrinos and their potential to probe neutrino astrophysics and fundamental physics using current and future neutrino telescopes. Victor has successfully defended his PhD thesis on November 2023 and has since transitioned into a software development position.

Varun Venkatesh began his masters in physics at the university of Copenhagen in 2020. He joined the Active Intelligent matter group for his thesis in 2021 about the jamming and unjamming of active flexible filaments. Continuing in the same group under the supervision of Amin Doostmohammadi, he began his PhD in February of 2023 on topographical active matter. His project looks at the interplay of substrate wrinkle deformations with cell motility and collective self-organization.

Luka Vujeva is a PhD student in the Strong Group at NBIA working with Jose Maria Ezquiaga and Vitor Cardoso. His previous work ranged from studying the Interstellar Medium in the local Universe to designing survey strategies that employ strong gravitational lenses as discovery tools to find the highest redshift galaxies in the Universe. He is currently studying the effects of gravitational lensing of gravitational waves, and trying to pair these with electromagnetic observations to learn about cosmology.

Jaime Redondo-Yuste is a PhD student in the Strong group under the supervision of Vitor Cardoso. He obtained his MSc degree at the Perimeter Institute (Canada) with a thesis on the duality between the dynamics of black hole horizons and Carrollian fluids. He combines analytical and numerical techniques in his research to understand the consequences of the non-linear nature of Einstein's equations. This modifies the emission and propagation of gravitational waves, opening a unique window to test General Relativity.

MSc Students

Simon Guldager Andersen — Biophysics

Jonah Tobias Baerman — Particle Physics

Stavros Bakandreas — Astroparticle Physics

Adam Brcek — Astroparticle Physics

Antonio Capanema — Particle Physics

Thomas Cope — Theoretical Astrophysics

Julie Cabrera Cortada — Biophysics

Patrizio C. di Sant'Orsala — Particle Physics

Valentin De Lia — Astroparticle Physics

Julie Kiel Holm — Astroparticle Physics

Yoshiaki Horiike — Biophysics

Philip J.Ø. Kirkeberg — Theoretical Astrophysics

Oddyseas Lazaridis — Biophysics

Yuchan Miao — Particle Physics

Gowtham Rishi Mukkamala —Particle Physics

Idris Nurlu — Biophysics

Marcos Skowronek Santos — Particle Physics

Henri Schmidt — Biophysics

Toni Teschke - Particle Physics

Adjunct Faculty

Oliver Gressel — Theoretical Astrophysics (AIP, Potsdam, Germany)

Åke Nordlund — Computational Astrophysics (NBI and Rosseland Center, Oslo, Norway)

Igor Novikov — Theoretical Astrophysics (Lebedev Physics Institute, Moscow, Russia)

Jørgen Rasmussen — Mathematical Physics (University of Queensland, Australia)

Meng Ru Wu — Particle Astrophysics (Institute of Physic, Academia Sinica, Taipei, Taiwan)

Visiting Professors

Jens Oluf Anderson — Norwegian Univ. of Science and Technology, Trondheim, 07.08.23 — 31.12.23

Can Kozcas — Bogazici University, Istanbul, 24.01.23 —10.05.23

Dingfang Zeng — Beijing University of Technology, 17.12.22 — 16.12.23

Visitors

The NBIA maintains a vigorous visitor program, which usually attracts more than 100 scientists every year. These visitors actively engage in daily activities at the NBIA and the Niels Bohr Institute. The list of visitors for the calendar year 2023 follows below.

Name	Affiliation	Arrival	Departure
Jan Ambjørn	Radboud University	20.12.23	21.12.23
Gwenaeil Ferrando	Tel Aviv University	06.12.23	08.12.23
Paolo Cremonese	Universitat de les Illes Balears	05.12.23	13.12.23
Anson Chen	Queen Mary University of London	04.12.23	13.12.23
Ralph Engel	Karlsruhe Institue of Technology	31.10.23	02.11.23
Erik Panzer	University of Oxford	29.11.23	01.12.23
Alejandro Vigna Gomez	MPA Garching, De	28.11.23	01.12.23
Ruggero Valli	MPA Garching, De	28.11.23	01.12.23
Lance Dixon	SLAC National Accelerator Laboratory	27.11.23	27.11.23
Lisa J. Schumacher	Technische Universität München	26.11.23	30.11.23
Tim Adamo	University of Edinburgh	23.11.23	25.11.23
Jay Armas	University of Amsterdam	14.11.23	17.11.23
Sebastian Pögel	JGU Mainz	13.11.23	17.11.23
Maria Charisi	Vanderbilt University	13.11.23	15.11.23
Alessia Platania	Perimeter Institute	08.11.23	10.11.23
Andrew Mcleod	University of Edinburgh	02.11.23	07.11.23
Tjonnie Li	KU Leuven	02.11.23	02.11.23
Enrico Cannizzaro	University of Roma	01.11.23	01.12.23
Anna Nelles	FAU	01.11.23	01.11.23
Ankul Bardoloi	Universtity of Delft	01.11.23	30.11.23
Zhao-He Watse	University of Iceland	31.10.23	01.11.23

Roman Rafikov	University of Cambridge	30.10.23	02.11.23
Alejandro Ruiperez	University of Roma	29.10.23	03.11.23
Charlotte Sleight	Durham/Naples University	25.10.23	27.10.23
Konstantin Zarembo	NORDITA	09.10.23	20.10.23
Yuri Makeenko	Emeritus	09.10.23	13.10.23
Paolo de Vecchia	NORDITA	07.11.23	16.11.23
Isabelle John	Stockholm Univ	02.10.23	03.10.23
Ludovic Plante	Altarea EnR	02.10.23	04.10.23
Zihan Zhou	Princeton	02.10.23	07.10.23
Sera Markoff	University of Amsterdam	16.10.23	17.10.23
Josu Aurrekoetxea	University of Oxford	16.10.23	18.10.23
Luca Buoninfante	Stockholms Universitet	10.10.23	14.10.23
David Mateos	University of Barcelona	27.09.23	29.09.23
Astrid Eichhorn	SDU, Odense	21.09.23	21.09.23
Paolo Di Vecchia	NORDITA	19.09.23	06.10.23
Miquel Miravet-Tenes	Universtity of Valencia	18.09.23	18.12.23
Tim Dietrich	Max Planck Institute for Gravitational Physics	10.09.23	12.09.23
Eli Waxman	Weizmann Institute of Science	07.09.23	08.09.23
Masaru Shibata	Albert Einstein Inst., Potsdam	06.09.23	07.09.23
Adam Brček	Lund Univ	04.09.23	04.09.24
Alejandro Vigna Gomez	Max Planck Institute for Astrophysics	04.09.23	06.09.23
Heidar Moradi	Univ of Kent	04.09.23	30.09.23
Qinrui Liu	Queen's Univ, canada	02.09.23	30.09.23
Paolo Di Vecchia	NORDITA	01.09.23	08.09.23
S. Datta	AEI	28.08.23	02.09.23
D. Gross	Univ. of California, Santa Barbara	22.08.23	25.08.23
G. Wong	Princeton Univ.	21.08.23	31.08.23

P. Steinhardt	Princeton Univ.	21.08.23	25.08.23
A. Nagar	Institut des Hautes Études Scientifiques	21.08.23	25.08.23
M. Nødtvedt	Norwegian Univ. Science and Technology	14.08.23	18.08.23
Q. Yang	ITP, CAS	12.08.23	26.08.23
J.O. Andersen	NTNU	07.08.23	31.12.23
D. Nelson	Harvard Univ.	07.08.23	09.08.23
R. Philips	Caltech Univ.	07.08.23	09.08.23
S. Gasparotto	IFAE	05.08.23	xx.08.23
H. Elvang	Michigan Univ.	01.08.23	01.08.23
F. Teng	Penn State Univ.	30.07.23	06.08.23
S. Hannestad	Aarhus Univ.	18.07.23	21.07.23
B. Kol	Hebrew Univ.	18.07.23	18.07.23
G. Barenboim	Univ. of Valencia	17.07.23	21.07.23
W. Winther	DESY Zeuthen	17.07.23	21.07.23
L. Zhou	NOAA	09.07.23	23.07.23
K. Bering	Masarykova Univ.	07.07.23	24.07.23
K. Zoubos	Univ. of Pretoria	03.07.23	05.07.23
E. Pomoni	DESY	03.07.23	05.07.23
J. Andrews	Univ. of Florida	03.07.23	05.07.23
A. Ashtekhar	Penn State Univ.	23.06.23	13.07.23
S. Prabhu	TIFR, Mumbai	21.06.23	23.06.23
H. Johansson	Uppsala Univ.	21.06.23	22.06.23
C. Keeler	Arizona State Univ.	20.06.23	25.06.23
I. Antoniadis	CNRS Paris	20.06.23	24.06.23
F. Capel	Max Planck Institute for Physics	18.06.23	20.06.23
M. Pedersen	Univ. of Copenhagen	16.06.23	16.06.23
M. Riva	DESY, Hamburg	14.06.23	17.06.23

J. S. Williams	King's College London	14.06.23	16.06.23
T. Islam	Univ. of Massachusetts	12.06.23	25.07.23
M. Lagos	Columbia Univ.	12.06.23	15.06.23
M. Zumalacarregui	Albert Einstein Institute	12.06.23	14.06.23
W. Ahmed	California State Univ.	07.06.23	13.06.23
I. Mahadewan	Harvard Univ.	07.06.23	08.06.23
J. Distler	Univ. of Texas	07.06.23	07.06.23
A. Heinesen	Univ. of Conpenhagen	06.06.23	16.06.23
A. del Rio Vega	Univ. of Valencia	04.06.23	24.06.23
P. di Vecchia	Univ. of Copenhagen	01.06.23	15.06.23
C. Fiory	Univ. of São Paolo	30.05.23	02.06.23
D. O'Connell	Univ. of Edinburgh	29.05.23	01.06.23
P. Orland	Baruch College	26.05.23	15.08.23
N. Moynihan	Univ. of Edinburgh	24.05.23	26.05.23
V. Varma	Albert Einstein Institute	22.05.23	24.05.23
S. Hughes	MIT	21.05.23	28.05.23
A. Sever	Tel Aviv Univ.	21.05.23	23.05.23
Z. Haiman	Columbia Univ.	15.05.23	17.05.23
L. Gualtieri	Univ. of Pisa	14.05.23	22.05.23
X. Chen	LPENS, CNRS	14.05.23	16.05.23
N. Sherrill	Univ. of Sussex	10.05.23	12.05.23
A. Chen	Queen Mary Univ. of London	08.05.23	16.06.23
A. Foschi	Instituto Superior Tecnico	07.05.23	13.05.23
G. Baym	Univ. of Illinois	05.05.23	05.06.23
Z. Zhong	Instituto Superior Tecnico	01.05.23	31.05.23
A. Heinesen	École Normale Supériure de Lyon	01.05.23	14.05.23
Y. Genolini	Annecy, LAPTH	01.05.23	05.05.23


S BOHR INSTITUT
1920


WOLVES RIDGE


HST

A.L. Varri	Univ. of Edinburgh	01.05.23	03.05.23
Z. Ahmed	Univ. of Stavanger	30.04.23	21.05.23
J. de Boer	Univ. of Virginia	26.04.23	28.04.23
A. Placidi	Perugia Univ.	24.04.23	28.04.23
G. Grignani	Perugia Univ.	23.04.23	26.04.23
P. Jetzer	Univ. of Zürich	23.04.23	26.04.23
G. Faye	Institut d'Astrophysique de Paris, CNRS	23.04.23	26.04.23
A. Nagar	Institut des Hautes Études Scientifiques	23.04.23	26.04.23
M. Lemoine	Institut d'Astrophysique de Paris, CNRS	21.04.23	25.04.23
A. Tivari	KTH Stockholm	20.04.23	21.04.23
K. Zarembo	Stockholm Univ.	17.04.23	28.04.23
A. Pound	Southampton Univ.	16.04.23	19.04.23
R. Emparan	ICREA & Univ. de Barcelona	12.04.23	14.04.23
J.O. Andersen	NTNU	12.04.23	14.04.23
M. Wood	Univ. of Cambridge	11.04.23	12.04.23
A. McLeod	CERN	05.04.23	12.04.23
R. Mbarek	Univ. of Maryland	03.04.23	07.03.23
P. Kornecki	The Observatoire de Paris Meudon	30.03.23	31.03.23
M. Trepanier	King's College London	29.03.23	31.03.23
C. Evoli	Gran Sasso Science Institute	27.03.23	29.03.23
A. Christofoli	Univ. of Edinburgh	22.03.23	24.03.23
S. Schroder	Institute for Advanced Study	20.03.23	28.03.23
A. Ray	UC, Berkeley	20.03.23	24.03.23
R. Marzucca	Zurich Univ.	14.03.23	19.03.23
A. Vigna Gomez	Max Planck Institute for Astrophysics	14.03.23	17.03.23
J. Jeomans	Oxford Univ.	14.03.23	17.03.23
D. Jafferis	Harvard Univ.	11.03.23	16.03.23

A. Retore	Durham Univ.	08.03.23	10.03.23
V. Gennari	Univ. of Pisa	07.03.23	01.06.23
D. Gangardt	Birmingham Univ.	07.03.23	19.03.23
K. Clough	Queen Mary Univ. of London	06.03.23	08.03.23
M. Cates	Cambridge Univ.	06.03.23	08.03.23
Z. Zhang	SISSA, Trieste	01.03.23	04.03.23
E. Pomoni	DESY, Hamburgh	22.02.23	24.02.23
Z. Yang	Pittsburgh Univ.	15.02.23	18.02.23
P. di Vecchia	Copenhagen Univ.	14.02.23	26.02.23
A. Galvão	Univ. do Rio de Janeiro	13.02.23	30.01.24
A. Heinesen	École Normale Supériure de Lyon	13.02.23	03.03.23
Y. Suto	Tokyo Univ.	13.02.23	17.02.23
W. Winter	DESY Zeuthen	12.02.23	15.02.23
D. Figueruelo	Univ. de Salamanca	11.02.23	11.03.23
J. Costa	Instituto Universitário de Lisboa	06.02.23	28.02.23
R. Mbarek	Univ. Maryland	06.02.23	10.02.23
M. Casals	Leipzig Univ.	06.02.23	08.02.23
I. Nurlu	Universite de Montpellier	01.02.23	07.07.23
A. Ambrosone	Univ. di Napoli	01.02.23	30.04.23
F. Brown	Oxford Univ.	29.01.23	02.02.23
F. Testagrossa	Univ. of Padova	28.02.23	28.02.23
C. Kozcaz	Bogazici Univ.	24.01.23	10.05.23
R. Vicente	IFAE, Barcelona	18.01.23	02.02.23
F. Duque	Instituto Superior Technico, Lisbon	18.01.23	02.02.23
B. Page	CERN	16.01.23	20.01.23
F. Camilloni	Perugia Univ.	14.01.23	21.01.23
G. Grignani	Perugia Univ.	14.01.23	21.01.23

N. Engelhardt	MIT	10.01.23	13.01.23
A. Heinesen	École Normale Supériure de Lyon	09.01.23	23.01.23
M. Çaliskan	Johns Hopkins Univ.	09.01.23	30.01.23
T. Baumgarte	Bowdoin College	09.01.23	15.01.23
M. Bianco	Lund Univ.	09.01.23	13.01.23

Administrative Staff

Gosia Dekempe is the NBIA administrator. She is responsible for onboarding new employees, coordination of guests and visitors, NBIA office overview and organization of events, workshops, and seminars. She handles HR matters and budget allocation. She holds a master's degree in economics from the Main School of Economics in Warsaw, Poland.

Zofia Merie Kohring is the section secretary for the Theoretical High Energy, Astroparticle and Gravitational Physics section. She is responsible for the daily running of the section, event and workshop coordination, budget, HR, guest handling, onboarding of new employees, and censorship. She is a business language correspondent in English and German from Slagelse Business School.

Iryna Kopachynska is a new part-time Administrative Assistant at NBIA. She assists in all practical matters at NBIA, assists the NBIA Director and Deputy Director, and has duties overlapping with the student assistants. Iryna is a forced migrant from Ukraine, where she was educated as an economist and a lawyer and held administrative positions in State Tax Service of Ukraine. She is currently following intensive courses in Danish outside her working hours at NBIA.

Julie de Molade is the Research Coordinator for the Strong Group at NBIA and PA to Prof. Vitor Cardoso. She is responsible for the daily running of the Strong Group, event coordination, communication, reporting, budget, HR, and general grant administration (DNRF Chair and Villum Foundation). She holds a Master of Arts in English and French from Roskilde University.

Financial Officers: During 2023, NBIA members received assistance in all matters related to budgets in applications and grants by Aida Coric, Ljiljana Markovic, and Mina Martinez-Diaz in the finance team at the Niels Bohr Institute.

Student Assistants: During 2023, students Marta Bloch Christiansen and Marcos Skowronek Santos assisted the NBIA administrative officers run daily NBIA activities.

NBIA Activities

NBIA Colloquia

NBIA Colloquia consist of talks on a wide variety of subjects aimed at scientists who are not necessarily experts on the subject matter. Topics are not limited to physics but can cover any subject of interest to the wide spectrum of researchers and students at NBIA. In the past year we have had talks on such varied topics as the geological-scale time history of the carbon cycle, the many-world interpretation of quantum mechanics, ecological diversity on mountains, and behavior patterns behind economic inequality. The list of talks and speakers follows below.

Christian J. Bjerrum (Dept. of Geosciences, KU) — 27.10.2023
"Deep time aerosols and long term carbon cycle"

Jørgen Christensen_Dalsgaard (Stellar Astrophysics Center, Aarhus University) — 22.09.2023
"Probing Red Giant Stars with the Kepler Mission"

Eli Waxman (Weismann Institute of Science) — 08.09.2023
"ULTRASAT: Revolutionizing our understanding of the hot transient Universe"

Peter Ditlevsen (NBI, Copenhagen University) — 01.09.2023
"Collapse of the Gulf Stream"

Thibault Damour (IHES, Paris) — 25.08.2023
"Einstein's Mouse, Bohr's Coat of Arms, and Everett's unsuccessful visit to Copenhagen"

David Gross (KITP, Santa Barbara) — 25.08.2023
"Fifty Years of Quantum Chromodynamics"

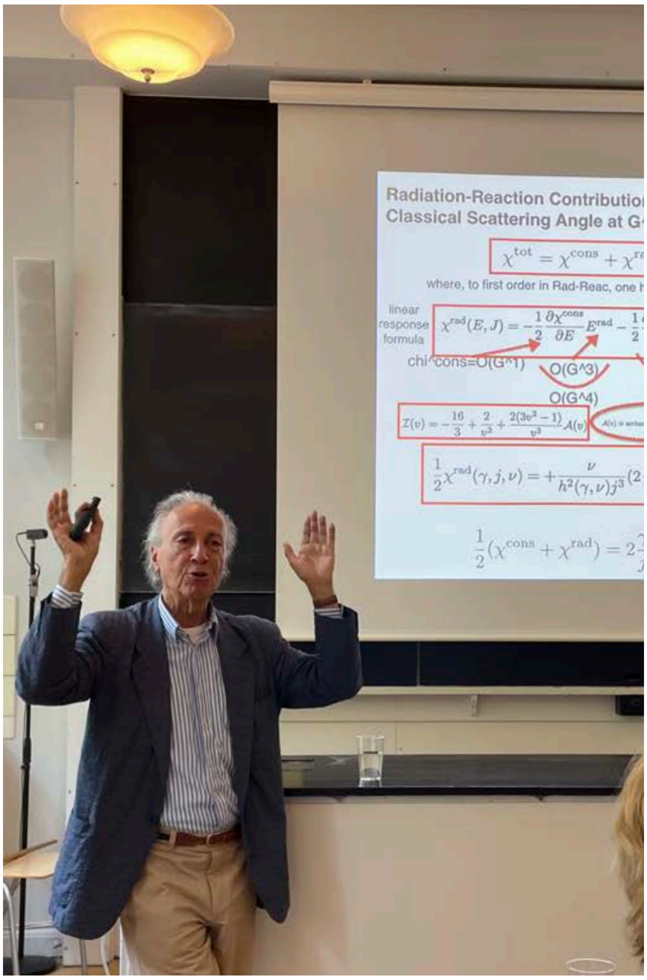
Abhay Ashtekar (Penn State University) — 30.06.2023
"Illustrations of Paradigm Shifts in Science: Black Holes, Big Bang and Gravitational Waves"

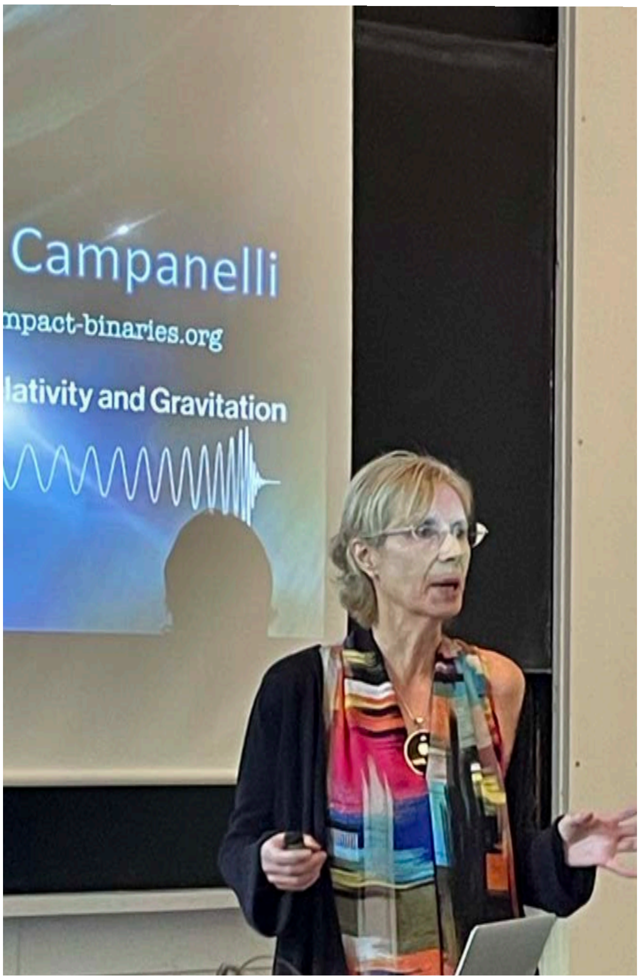
Scott Hughes (MIT) — 26.05.2023
"Precision: The next frontier in binary gravitational-wave modeling"

Francois Renard (University of Oslo) — 28.04.2023
"The 2023 earthquake sequence in Turkey and Syria, and why it is not possible to predict earthquakes"

Carsten Rahbek (GLOBE Institute, Copenhagen University) — 14.04.2023
"Why is Earth so biologically diverse? Mountains hold the answer"

Martin Greiter (Faculty of Physics and Astronomy, Julius-Maximilians-Universität, Würzburg) — 31.03.2023
"Interlinking and the Emergence of Classical Physics in Quantum Theory: Schrödinger's cat and EPR resolve"


Radiation-Reaction Contributio
Classical Scattering Angle at G
where, to first order in Rad-Reac, one h
linear
response
formula
chi^cons=O(G^1)
O(G^3)
O(G^4)

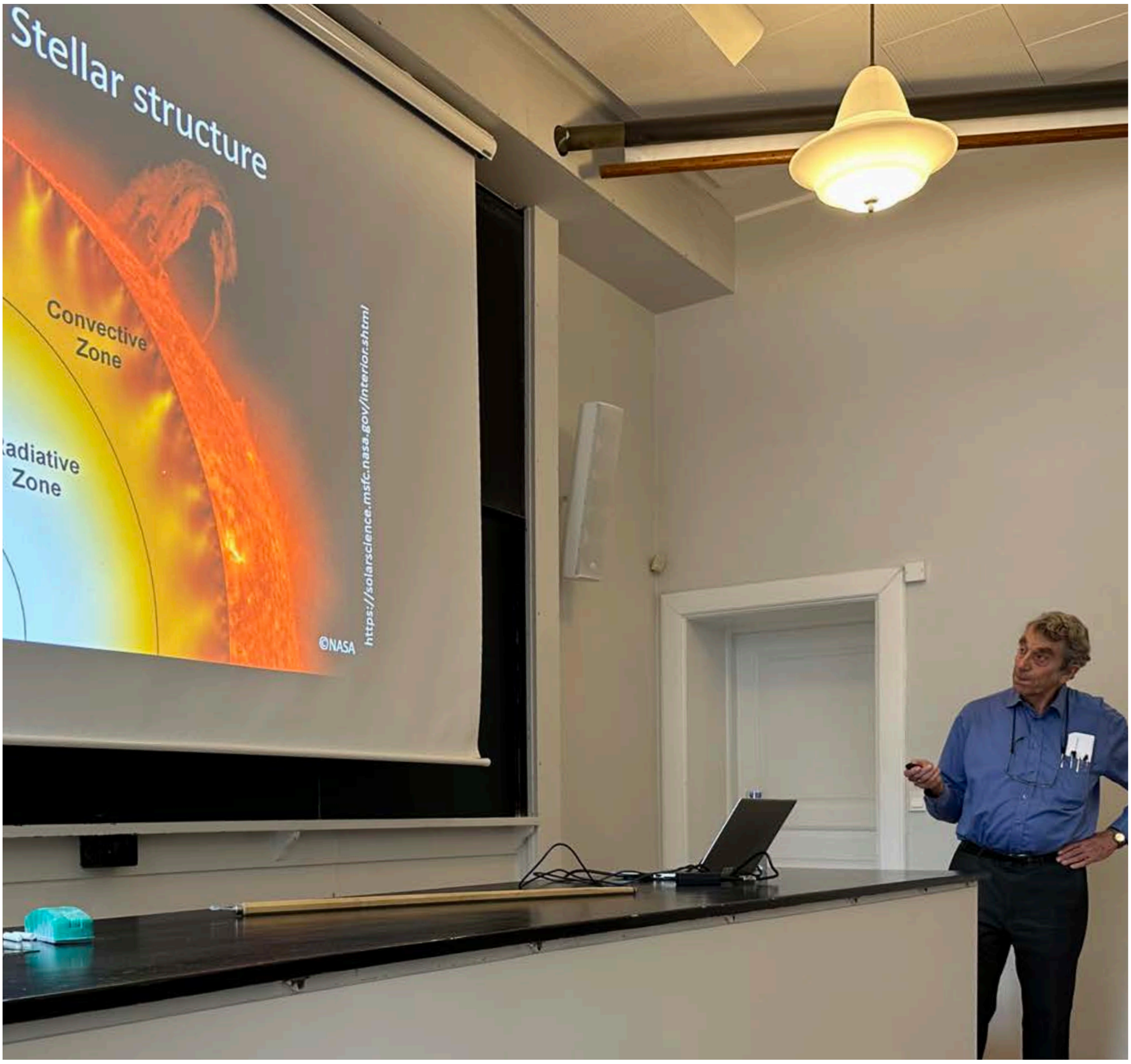

Campanelli
mpact-binaries.org
lativity and Gravitation

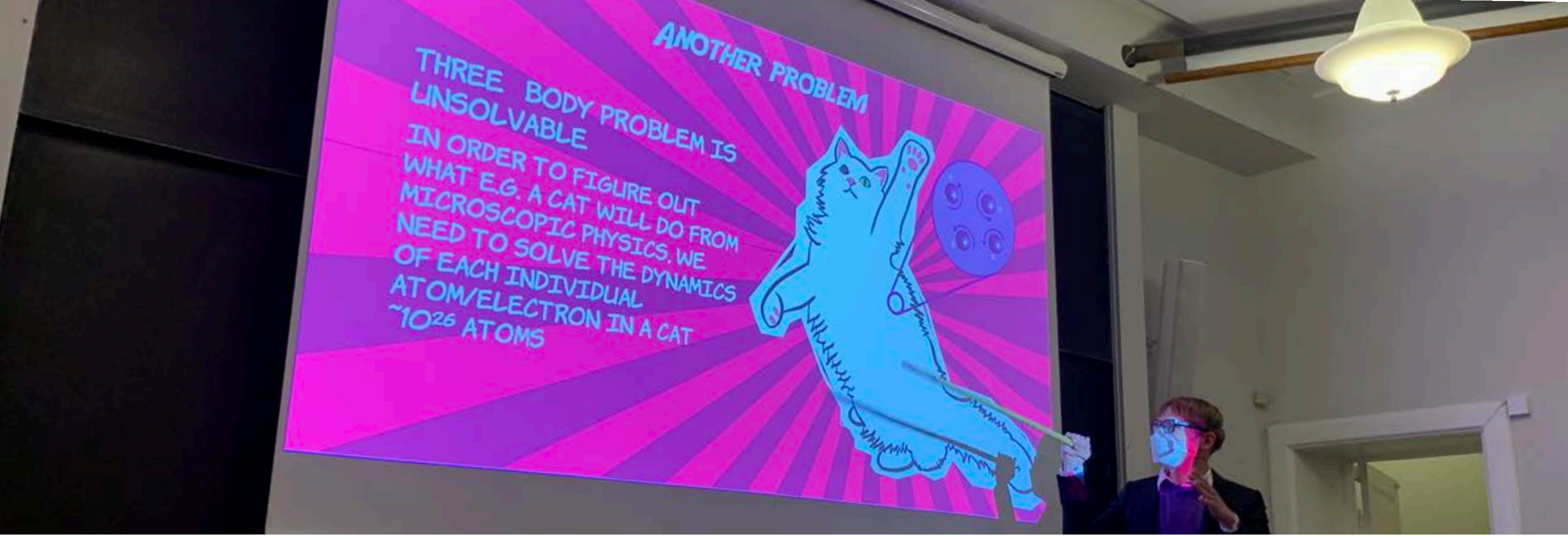
NBIA Colloquia

Julia Yeomans (Oxford University) — 17.03.2023
“Topology in Biology”

Jill Miwa (Aarhus University) — 17.02.2023
“Photoemission spectroscopy of advanced materials”

Claus Thustrup Kreiner (Dept. of Economics, Univ. of Copenhagen) — 20.01.2023
“Role of Behavior for Inequality”




ANOTHER PROBLEM
THREE BODY PROBLEM IS UNSOLVABLE
IN ORDER TO FIGURE OUT WHAT E.G. A CAT WILL DO FROM MICROSCOPIC PHYSICS, WE NEED TO SOLVE THE DYNAMICS OF EACH INDIVIDUAL ATOM/ELECTRON IN A CAT
~10²⁶ ATOMS

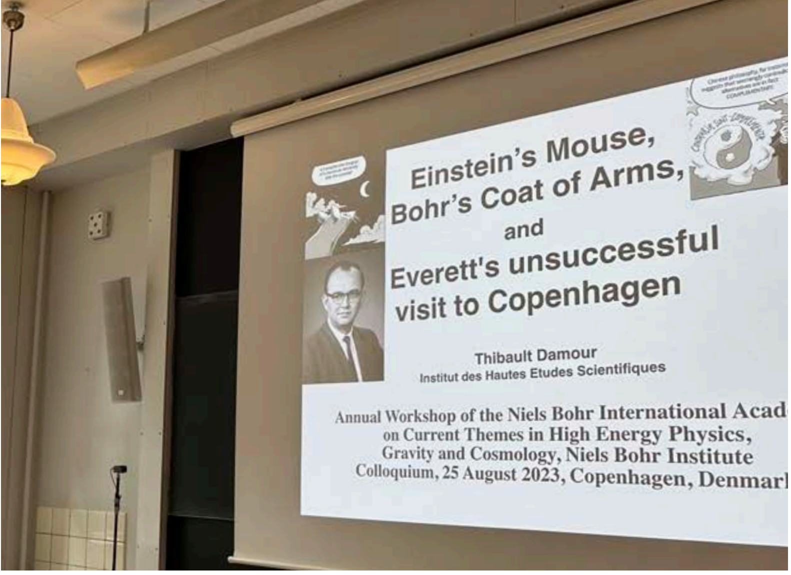

loso (Niels Bohr Institute)

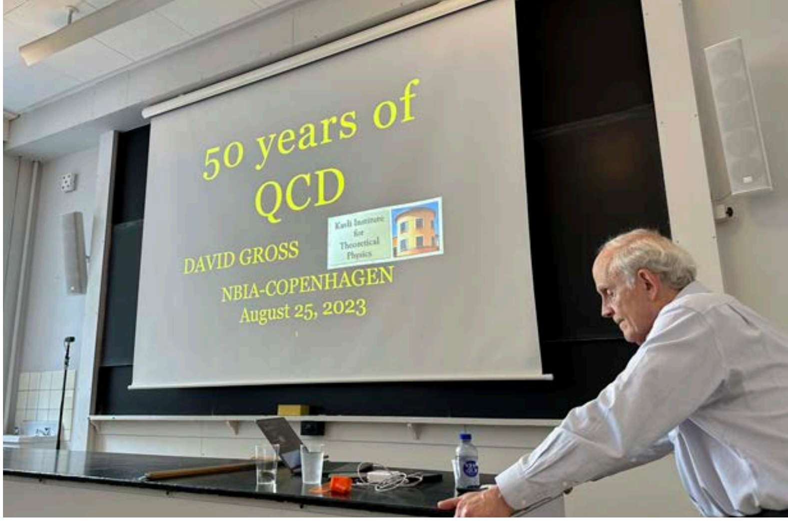

Fundamental Physics
from the Work Package Perspective

NBIA Seminars & Talks

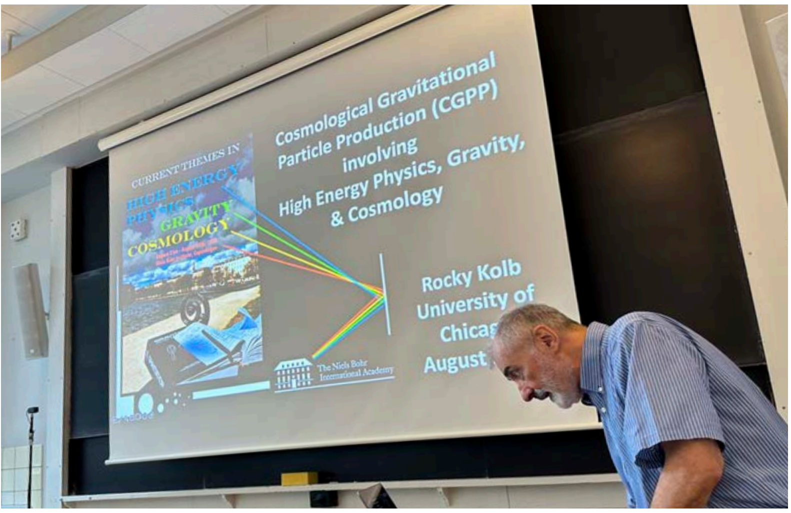
Apart from the weekly series of NBIA Colloquia, members of the NBIA organize or co-organize numerous more specialized seminars and lectures. Members of the particle theory group at the NBIA co-organize up to two specialized seminars every week, held by visitors to the group. In condensed matter physics there is a flurry of activities and seminars organized through the QDev Center of Excellence, to which NBIA's condensed matter physics group belongs. In astrophysics the talks co-hosted by members of the NBIA are often held together with the Center for Star and Planet Formation. Astroparticle physics talks are customarily held on Mondays, often partially overlapping in topics with both astrophysics and particle physics. On any given week, it will be rare to find a day in which not at least one scientific event is being organized or co-organized by NBIA members. Topics range from gravitational waves emitted from black holes merging to the intricate mathematical structures behind quantum field theory amplitudes at high orders in perturbation theory.

A special opportunity for attracting scientific visitors and thus creating a flow of seminar and colloquium speakers is the NBIA programs for Visiting Professors, which typically open up for the opportunity to focus on a particularly hot subject in an area of interest to the Visiting Professor. The group working on biological physics at the NBIA has its own program of talks and lectures, also in conjunction with the new Novo Nordisk Foundation Visiting Professor program.


Einstein's Mouse,
Bohr's Coat of Arms,
and
Everett's unsuccessful
visit to Copenhagen
Thibault Damour
Institut des Hautes Etudes Scientifiques
Annual Workshop of the Niels Bohr International Acad
on Current Themes in High Energy Physics,
Gravity and Cosmology, Niels Bohr Institute
Colloquium, 25 August 2023, Copenhagen, Denmark


50 years of
QCD
DAVID GROSS
Kavli Institute for Theoretical Physics
NBIA-COPENHAGEN
August 25, 2023


Suggested Tensions in the Standard Model:
Are There Effects at Greater than 2 to 3 sigma?


CURRENT THEMES IN
HIGH ENERGY
PHYSICS
GRAVITY
COSMOLOGY
Cosmological Gravitational
Particle Production (CGPP)
involving
High Energy Physics, Gravity,
& Cosmology
Rocky Kolb
University of
Chica
August
The Niels Bohr
International Academy

NBIA Workshops & PhD Schools

Building on Niels Bohr's vision, NBIA members engage in several activities aimed at promoting and enhancing the traditions of internationalism, interdisciplinarity and excellence in physics. The NBIA is instrumental in running approximately ten high-profile, international events every year to the benefit of the wider Institute community. The following events were organized by NBIA members during 2023:

"Nordic Winter School on Gravitational Astrophysics" — 29.01 / 03.02.2023.

"26th Capra Meeting on Radiation Reaction in General Relativity" — 03.07 / 07.07.2023

NBIA Summer School: "Neutrinos: Here, There & Everywhere" — 17.07 / 21.07.2023

"Crossing the Disciplinary Boundaries of Physics - Bohr-100 Centennial Celebrations" — 07.08 / 11.08.2023

"Current Themes in High Energy Physics, Gravity, and Cosmology" — 21.08 / 25.08.2023

"QFT at the Computational Frontier" — 25.09 / 27.09.2023

"RESCEU-NBIA Workshop on Gravitational Wave Sources" — 07.12 / 15.12.2023

NBIA MSc Day 2023

October 11, 2023
Niels Bohr Institute
Europe/Copenhagen timezone

Enter your search term

Contact
markus.ahlers@nbi.ku.dk
mbustamante@nbi.ku.dk

NBIA MSc Day 2023

The Niels Bohr International Academy (NBIA) invites prospective MSc students to an informal event "MSc Projects @ NBIA" on **Wednesday, October 11, 9am-1:30pm**. Join us on that day to learn more about the diverse research program at NBIA. You will have the chance to chat with scientists about their research and the possibilities to carry out your MSc project at NBIA.

The Niels Bohr International Academy (NBIA) is a center of excellence for theoretical physics and neighboring disciplines at the Niels Bohr Institute. Our mission is to attract the best and the brightest to Denmark and provide the environment to enable breakthrough research in theoretical particle physics, gravitational physics and astrophysics, theoretical astrophysics, biophysics and active matter, particle astrophysics, and condensed matter theory.

You can find more information on our NBIA website and brochure.

The NBIA staff includes several Professors, including a Villum Kann Rasmussen Professor and a DNRF Chair. A significant number of NBIA Assistant Professors and Associate Professors have started new research groups in their disciplines by attracting prestigious national and European grants. The NBIA hosts a large number of post-docs, PhD-students, and MSc-students. We have a steady stream of international visitors, who are invited to give seminars or collaborate with NBIA members.

The NBIA hosts around ten workshops, symposia and PhD-schools every year. We also reach out to the public with a number of activities, including an annual series of public lectures in collaboration with the Danish Open University. All in all the NBIA offers an incredible stimulating environment for students!

Starts Oct 11, 2023, 9:00 AM
Ends Oct 11, 2023, 1:30 PM
Europe/Copenhagen

Niels Bohr Institute
Auditorium A

Blegdamsvej 17
DK-2100 Copenhagen

Markus Ahlers
Martin Pessah
Mauricio Bustamante
N. E. J Bjerrum-Bohr
Shashank Shalgar

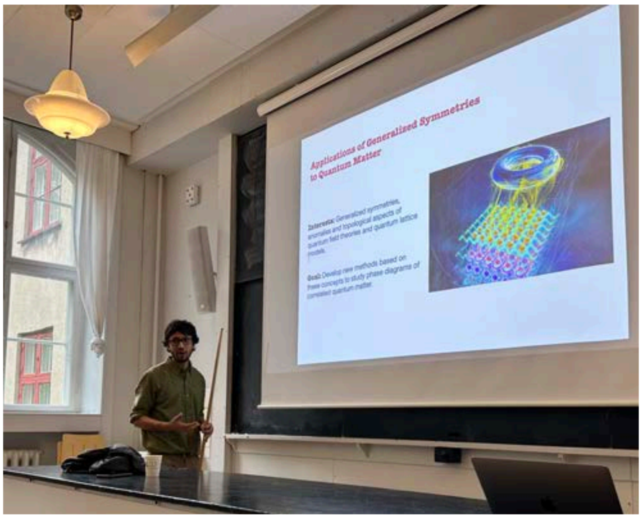
nbia-brochure-2023.pdf

Registration
You are registered for this event.

See details ›

NBIA MSc Day 2023

Starting in 2018, scientists at NBIA began organizing an annual gathering for MSc students for them to learn more about the diversity of research opportunities at NBIA. During this one-day event, the students have the opportunity to attend a series of talks and meet with postdocs and young faculty member in order to discuss their research interests and the possibilities of carrying out Masters projects at NBIA.




Origin of Highly Eccentric Mergers

NBIA Public Lectures & Outreach

Since 2011 NBIA has organized an annual series of public lectures on physics in collaboration with the Danish Open University “Folkeuniversitetet”. All lectures take place at the historic Auditorium A. The idea was from the start to let the public benefit from the presence of young and enthusiastic scientists at the NBIA, each of them speaking about a topic very close to their actual on-going research, but at a level appropriate for an audience with no background in science. By design, these lectures will then cover a wide range of topics in modern theoretical physics, giving a glimpse of the questions, ideas and approaches that are now at the scientific forefront. This formula turned out to be a success, and although the subjects covered are at the forefront of present-day research, the there is always good attendance. This year’s lectures included:

Jose María Ezquiaga (NBI) — 10.10.2023
“Unveiling the Dark Universe with Gravitational Waves”

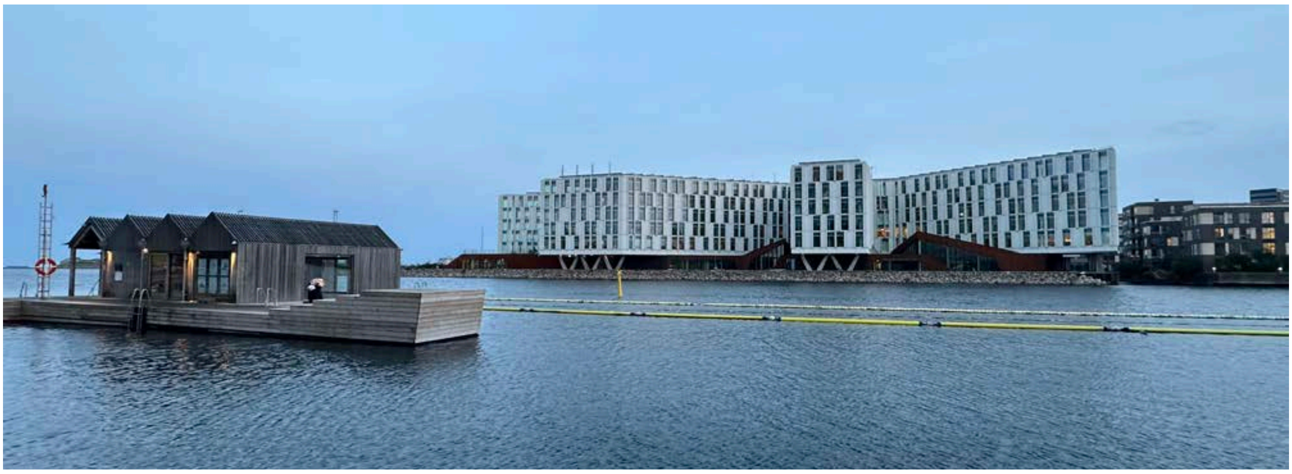
Christian J. Bjerrum (KU) — 24.10.2023
“The evolution of multicellular life did not happen as we though - or did it?”

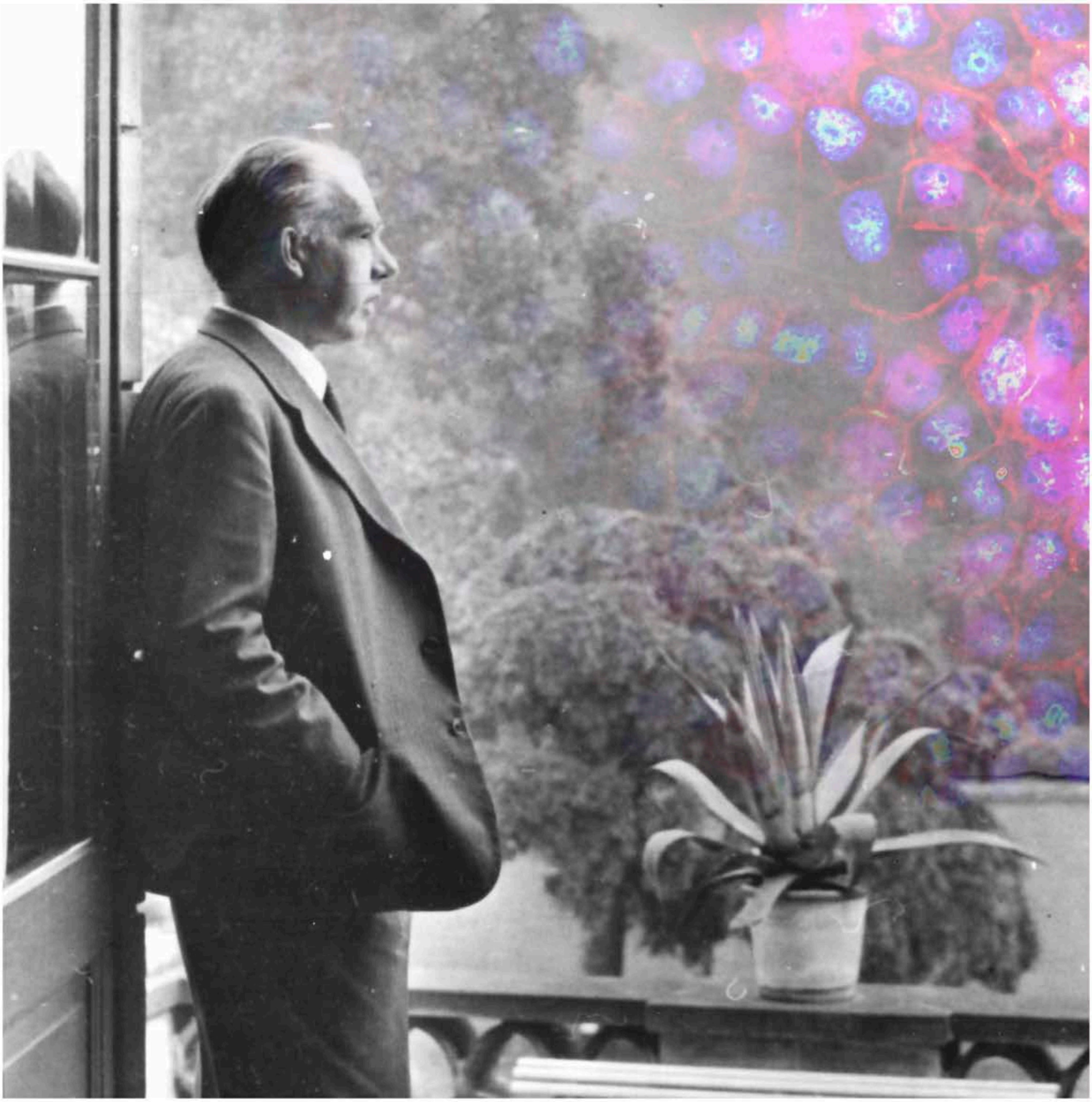
Jens Hesselbjerg Christensen (NBI) — 07.11.2023
“The melting platform: Are climate extremes man-made?”

Berislav Buca (NBI) — 07.11.2023
“Reductionism strikes back”

Weria Pezekshian (NBI) — 14.11.2023.
“Computational Microscopy of Cells”

Outreach is not limited to this series of lectures. Scientists at the NBIA who speak Danish are often called upon for interviews in radio or TV, and some write in newspapers and Danish popular science journals on a regular basis. Likewise, popular talks are often given outside of the Copenhagen area, at public libraries or through local cultural organizations.





CROSSING THE DISCIPLINARY BOUNDARIES OF PHYSICS

2023 Centennial Conference

7–11 August 2023
Copenhagen

UNIVERSITY OF COPENHAGEN
NIELS BOHR INSTITUTE

NIELS BOHR ARCHIVE

The Niels Bohr International Academy

novo nordisk fonden

Niels Bohr Institute Centennial

Crossing the Disciplinary Boundaries of Physics (Bohr-100 Centennial Celebration)

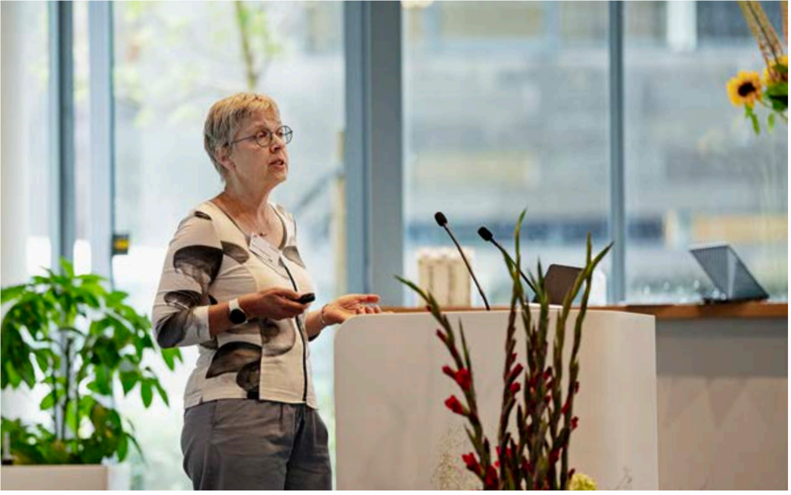
August 7-11, 2023, we co-organized a conference at the Novo Nordisk Foundation in celebration of the 100-year anniversary of the Niels Bohr Institute. The meeting was divided into two parts, with the first two days dedicated to history of science and the last three days dedicated to the borderlines between physics and biology and to addressing cross-disciplinary opportunities in physics and bordering subjects in life sciences. The meeting included with an afternoon in public celebration of 2022 Nobel Prize Laureate Morten Meldal in a program that was opened by Crown Prince Frederik of Denmark.

The meeting celebrated the same ideas that lie behind our NBIA grant from the Novo Nordisk Foundation: bringing together the seemingly disparate fields of biology and physics in order to achieve completely new understanding of phenomena in the life sciences. This is a tradition that was initiated by Niels Bohr himself, already in the 1930's reaching out biologists and seeking at first to explore if the newly discovered laws of quantum mechanics could have implications for biology and life. Later, Niels Bohr also turned toward classical problems in biology that could be analyzed from a new viewpoint by the tools traditionally employed by physicists.

A number of frontier topics on the borderlines between physics, biology, mathematics, chemistry, and computer science were discussed. Speakers included key players in currently most promising new research directions and, in the spirit of the meeting, brought together scientists working in a wide array of different topics that one way or another are linked to physics.

As an important part of the Centennial Celebration, prominent scientist from various disciplines were invited to give talks. The list of speakers included:

- Andreas Bausch, *TU Munich*
- Ewine van Dishoeck, *Leiden*
- Nikta Fakhri, *MIT*
- Morten Meldal, *U. Copenhagen*
- David Nelson, *Harvard*
- Rob Phillips, *Caltech*
- Manu Prakash, *Stanford*
- Leonie Ringrose, *Humboldt University Berlin*
- David Weitz, *Harvard*
- Julia Yeomans, *Oxford*

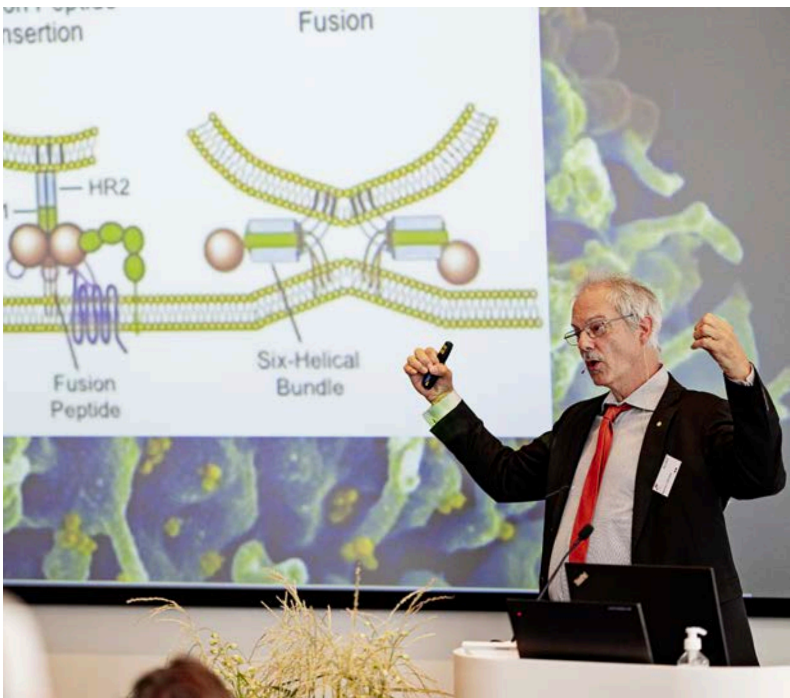


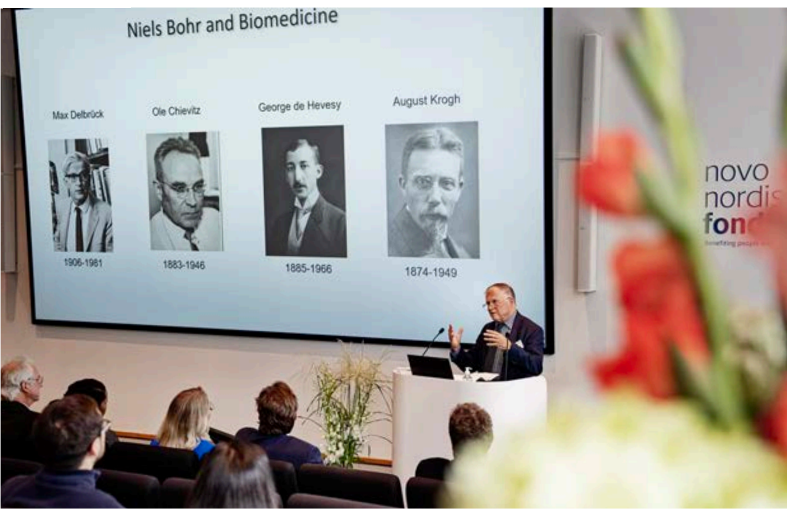

novo
nordisk
fonden
Benefiting people and society


CROSSING THE DISCIPLINARY
BOUNDARIES OF PHYSICS
2023 Centennial Conference
7–11 August 2023
Copenhagen


novo
holdings


årsdag. April 1947. Fra højre, Margrethe, Niels,
Bohr, Hanne Bohr, Ellen Bohr (døtre af Harald og Ulla)
og Erling Følner gift med Ellen Bohr.


insertion
Fusion
HR2
Fusion
Peptide
Six-Helical
Bundle


Niels Bohr and Biomedicine
Max Delbrück
1906-1981
Ole Chievitz
1883-1946
George de Hevesy
1885-1966
August Krogh
1874-1949


GENE GENIE
CUTTING THROUGH THE NOISE
Error mitigation empowers quantum processor to probe physics that classical methods can't reach
Call of the wild
Tracking natural behaviour in animals to decode the brain
Soda stream
Phosphates found in ice ejected from ocean on Enceladus
Sowing the seeds
Ancient DNA reveals how farming came to northwest Africa
The international journal of science / 29 June 2023
nature
SHINING EXAMPLE
Fluorescent mimic sheds light on DNA's 3D folding capabilities
outlook
Malaria
DRIVING FORCE
STAR SYSTEM
Gene patterns
The international journal of science / 5 October 2023
nature
OUTSHINING THE STARS
How artificial satellites could change the night sky and challenge astronomy
A STAR IS BORN
JWST reveals molecular nature of jet expelled by nascent star
GROWTH FACTOR
How warmer waters helped guide the evolution of small, fast-growing coral-reef fishes
The international journal of science / 23 February 2023
nature
BRAVE NEW WORLDS
JWST offers unprecedented insights into exoplanets
Fighting back
Smart decision
Climate crisis
BENDING THE RULES
nature
SHAPE SHIFTERS
Origami template powers DNA folding into multiple reversible structures

NBIA Publications

Refereed Papers

1. **Precision-dissipation trade-off for driven stochastic systems**
Proesmans, Karel, 2023, Communications Physics, 6, 226 - ArXiv: 2203.00428

2. **Thermodynamics of interacting systems: The role of the topology and collective effects**
Mamede, Iago N., Proesmans, Karel, Fiore, Carlos E. et al., 2023, Physical Review Research, 5, 043278 - ArXiv: 2308.02255

3. **Uniform sky glow observed through the throat of a wormhole**
Bugaev, M. A., Samorodskaya, P. S., Novikov, I. D. et al., 2023, Phys. Rev. D, 108, 124059 - ArXiv: 2305.18041

4. **Astrophysics with the Laser Interferometer Space Antenna**
Amaro-Seoane, Pau, Andrews, Jeff, Arca Sedda, Manuel et al., 2023, Living Reviews in Relativity, 26, 2 - ArXiv: 2203.06016

5. **Constraining the Binarity of Black Hole Candidates: A Proof-of-concept Study of Gaia BH1 and Gaia BH2**
Hayashi, Toshinori, Suto, Yasushi, Trani, Aless et al., 2023, ApJ, 958, 26 - ArXiv: 2307.01793

6. **Bounds on tidal charges from gravitational-wave ringdown observations**
Mishra, Akash K., Carullo, Gregorio, Chakraborty, Sumanta et al., 2023, preprint - ArXiv: 2311.03556

7. **Parametrized multipolar gravitational waveform for testing general relativity: Amplitude corrections upto 2PN order**
Mahapatra, Parthapratim, Kastha, Shilpa, 2023, preprint - ArXiv: 2311.04672

8. **TESLA-X: An effective method to search for sub-threshold lensed gravitational waves with a targeted population model**
Li, Alvin K. Y., Chan, Juno C. L., Fong, Heather et al., 2023, preprint - ArXiv: 2311.06416

9. **A frequency-domain perspective on GW150914 ringdown overtone**
Wang, Yi-Fan, Capano, Collin D., Abedi, Jahed et al., 2023, preprint - ArXiv: 2310.19645

10. **Two-detector flavor sensitivity to ultra-high-energy cosmic neutrinos**
Testagrossa, Federico, Fiorillo, Damiano F. G., Bustamante, Mauricio et al., 2023, preprint - ArXiv: 2310.12215

11. **Flavor Anisotropy in the High-Energy Astrophysical Neutrino Sky**
Telalovic, Bern, a, Bustamante, Mauricio et al., 2023, preprint - ArXiv: 2310.15224

12. **Linear Quivers at Large-N**
Nunez, Carlos, Santilli, Leonardo, Zarembo, Konstantin et al., 2023, preprint - ArXiv: 2311.00024

13. **Kinematic Hopf algebra for amplitudes from higher-derivative operators**
Chen, Gang, Rodina, Laurentiu, Wen, Congkao et al., 2023, preprint - ArXiv: 2310.11943

14. **Late-time tails in nonlinear evolutions of merging black hole binaries**
Carullo, Gregorio, De Amicis, Marina, 2023, preprint - ArXiv: 2310.12968

15. **Binary mergers in strong gravity background of Kerr black hole**
Camilloni, Filippo, Grignani, Gianluca, Harmark, Troels et al., 2023, preprint - ArXiv: 2310.06894

16. **Resummed spinning waveforms from five-point amplitudes**
Br, huber, Andreas, Brown, Graham R. et al., 2023, preprint - ArXiv: 2310.04405

17. **On R-matrix formulation of qq-characters**
Bayindirli Mehmet Batu, Demirtaş, Dilan Nur, Kozçaz, Can et al., 2023, preprint - ArXiv: 2310.02587

18. **Compact object mergers: exploring uncertainties from stellar and binary evolution with SEVN**
Iorio, Giuliano, Mapelli, Michela, Costa, Guglielmo et al., 2023, MNRAS, 524, 426-470 - ArXiv: 2211.11774

19. **Longitudinal Galilean and Carrollian limits of non-relativistic strings**
Bidussi, Leo, Harmark, Troels, Hartong, Jelle et al., 2023, preprint - ArXiv: 2309.14467

20. **Problems of the Origin of the Universe**
Novikov, I. D., 2023, Astronomy Reports, 67, 759-763

21. **Quantifying the Impact of the Dust Torque on the Migration of Low-mass Planets**
Guilera, Octavio M., Benitez-Llambay, Pablo, Miller Bertolami, Marcelo M. et al., 2023, ApJ, 953, 97 - ArXiv: 2305.02140

22. **Growing black holes through successive mergers in galactic nuclei - I. Methods and first results**
Atallah, Dany, Trani, Alessandro A. et al., 2023, MNRAS, 523, 4227-4250 - ArXiv: 2211.09670

23. **The NANOGrav 15 yr Data Set: Constraints on Supermassive Black Hole Binaries from the Gravitational-wave Background**
Agazie, Gabriella, Anumarlapudi, Akash, Archibald, Anne M. et al., 2023, ApJ, 952, L37 - ArXiv: 2306.16220

24. **Joint measurement of the ultra-high-energy neutrino spectrum and cross section**
Valera, Victor B., Bustamante, Mauricio, Mena, Olga et al., 2023, preprint - ArXiv: 2308.07709

25. **Spin dependence of black hole ringdown nonlinearities**
Redondo-Yuste, Jaime, Carullo, Gregorio, Ripley, Justin L. et al., 2023, preprint - ArXiv: 2308.14796

26. **A coupling prescription for post-Newtonian corrections in Quantum Mechanics**
Hartong, Jelle, Have, Emil, Obers, Niels A. et al., 2023, preprint - ArXiv: 2308.07373

27. **Black Holes as Neutrino Factories**
Chen, Yifan, Xue, Xiao, Cardoso, Vitor et al., 2023, preprint - ArXiv: 2308.00741

28. **Unified Theory of Local Quantum Many-Body Dynamics: Eigenoperator Thermalization Theorems**
Buca, Berislav, 2023, Phys. Rev. X, 13, 031013 - ArXiv: 2205.13007

29. **Carrollian fluids and spontaneous breaking of boost symmetry**
Armas, Jay, Have, Emil, 2023, preprint - ArXiv: 2308.10594

30. **Lieb-Schultz-Mattis anomalies and web of dualities induced by gauging in quantum spin chains**
Aksoy, Omer M., Mudry, Christopher, Furusaki, Akira et al., 2023, preprint - ArXiv: 2308.00743

31. **Probing wave-optics effects and dark-matter subhalos with lensing of gravitational waves from massive black holes**
Çalişkan, Mesut, Anil Kumar, Neha, Ji, Lingyuan et al., 2023, preprint - ArXiv: 2307.06990

32. **Aligning Retrograde Nuclear Cluster Orbits with an Active Galactic Nucleus Accretion Disc**
Nasim, Syeda S., Fabj, Gaia, Caban, Freddy et al., 2023, MNRAS, 522, 5393-5401 - ArXiv: 2207.09540

33. **Active topological defect absorption by a curvature singularity**
Vafa, Farzan, Nelson, David R, Doostmohammadi, Amin et al., 2023, Journal of Physics: Condensed Matter, 35, 425101

34. **Do Neutrinos Become Flavor Unstable Due to Collisions with Matter in the Supernova Decoupling Region?**
Shalgar, Shashank, Tamborra, Irene, 2023, preprint - ArXiv: 2307.10366

35. **Symmetry fractionalization, mixed-anomalies and dualities in quantum spin models with generalized symmetries**
Moradi, Heidar, Aksoy, Omer M., Bardarson, Jens H. et al., 2023, preprint - ArXiv: 2307.01266

36. **Supernova Emission of Secretly Interacting Neutrino Fluid: Theoretical Foundations**
Fiorillo, Damiano F. G., Raffelt, Georg, Vitagliano, Edoardo et al., 2023, preprint - ArXiv: 2307.15122

37. **Large Neutrino Secret Interactions, Small Impact on Supernovae**
Fiorillo, Damiano F. G., Raffelt, Georg G., Vitagliano, Edoardo et al., 2023, preprint - ArXiv: 2307.15115

38. **Hunting for bumps in the diffuse high-energy neutrino flux**
Fiorillo, Damiano F. G., Bustamante, Mauricio, 2023, preprint - ArXiv: 2307.09170

39. **The gravitational eikonal: from particle, string and brane collisions to black-hole encounters**
Di Vecchia, Paolo, Heissenberg, Carlo, Russo, Rodolfo et al., 2023, preprint - ArXiv: 2306.16488

40. **Symmetry-restoring crossover from defect-free to defect-laden turbulence in polar active matter**
Andersen, Benjamin H., Renaud, Julian, Rønning, Jonas et al., 2023, Physical Review Fluids, 8

41. **Editorial: Active and Intelligent Living Matter: from Fundamentals to Applications**
Amin Doostmohammadi, Mazza, Marco G., Shendruk, Tyler N. et al., 2023, Frontiers in Physics, 11

42. **Galactic Diffuse Neutrino Emission from Sources beyond the Discovery Horizon**
Ambrosone, Antonio, Groth, Kathrine Morch, Peretti, Enrico et al., 2023, preprint - ArXiv: 2306.17285

43. **Dynamics of intermediate mass black holes in globular clusters. Wander radius and anisotropy profiles**
Di Cintio, Pierfrancesco, Pasquato, Mario, Barbieri, Luca et al., 2023, A&A, 673, A8 - ArXiv: 2302.05542

44. **Across atoms to crossing continents: Application of similarity measures to biological location data**
Schuhmann, Fabian AND Ryvkin, Leonie AND McLaren, James D. AND Gerhards, Luca AND Solov'yov, Ilia A., 2023, PLOS ONE, 18, 1-18

45. **Search for dark photons with synchronized quantum sensor network**
Jiang, Min, Hong, Taizhou, Hu, Dongdong et al., 2023, preprint - ArXiv: 2305.00890

46. **Multimessenger Constraints on Radiatively Decaying Axions from GW170817**
Diamond, Melissa, Fiorillo, Damiano F. G., Marques-Tavares, Gustavo et al., 2023, preprint - ArXiv: 2305.10327

47. **The Gravitational Wave Universe Toolbox. III. Simulating joint observations of gravitational waves and gamma-ray bursts**
Hendriks, Kai, Yi, Shu-Xu, Nelemans, Gijs et al., 2023, A&A, 672, A74 - ArXiv: 2208.14156

48. **Mechanical basis and topological routes to cell elimination**
Siavash Monfared, Guruswami Ravich, ran et al., 2023, eLife, 12

49. **A Binary Origin for the First Isolated Stellar-mass Black Hole Detected with Astrometric Microlensing**
Vigna-Gómez, Alejandro, Ramirez-Ruiz, Enrico et al., 2023, ApJ, 946, L2 - ArXiv: 2203.08478

50. **Chaos in the vicinity of a singularity in the Three-Body Problem: The equilateral triangle experiment in the zero angular momentum limit**
Parischewsky, Hugo D., Trani, Alessandro A. et al., 2023, SciPost Physics Core, 6, 016 - ArXiv: 2108.06335

51. **Unusual Hard X-Ray Flares Caught in NICER Monitoring of the Binary Supermassive Black Hole Candidate AT2019cuk/Tick Tock/SDSS J1430+2303**
Masterson, Megan, Kara, Erin, Pasham, Dheeraj R. et al., 2023, ApJ, 945, L34 - ArXiv: 2302.12847

52. **Collective rotational motion of freely expanding T84 epithelial cell colonies**
Flora Ascione, Sergio Caserta, Speranza Esposito et al., 2023, Journal of the Royal Society Interface, 20

53. **Lensing or luck? False alarm probabilities for gravitational lensing of gravitational waves**
Çalişkan, Mesut, Ezquiaga, Jose Maria, Hannuksela, Otto A. et al., 2023, Phys. Rev. D, 107, 063023 - ArXiv: 2201.04619

54. **Design and analysis of tweet-based election models for the 2021 Mexican legislative election**
Vigna-Gómez, Alejandro, Murillo, Javier et al., 2023, arXiv e-prints, arXiv:2301.00626 - ArXiv: 2301.00626

55. **Lagrange versus Lyapunov Stability of Hierarchical Triple Systems: Dependence on the Mutual Inclination between Inner and Outer Orbits**
Hayashi, Toshinori, Trani, Alessandro A. et al., 2023, ApJ, 943, 58 - ArXiv: 2209.08487

56. **B-type anomaly coefficients for the D3-D5 domain wall**
de Leeuw, Marius, Kristjansen, Charlotte, Linardopoulos, Georgios et al., 2023, Phys. Lett. B, 846, 138235 - ArXiv: 2307.10946

57. **Carroll stories**
de Boer, Jan, Hartong, Jelle, Obers, Niels A. et al., 2023, JHEP, 09, 148 - ArXiv: 2307.06827

58. **Instability of ultracompact horizonless spacetimes**
Zhong, Zhen, Cardoso, Vitor, Maggio, Elisa et al., 2023, Phys. Rev. D, 107, 044035 - ArXiv: 2211.16526

59. **Piercing of a solitonic boson star by a black hole**
Zhong, Zhen, Cardoso, Vitor, Ikeda, Taishi et al., 2023, Phys. Rev. D, 108, 084051 - ArXiv: 2307.02548

60. **Gravity induced spontaneous radiation**
Zeng, Ding-fang, 2023, Nucl. Phys. B, 990, 116171 - ArXiv: 2207.05158

61. **Mesoscale simulation of biomembranes with FreeDTS**
Weria Pezeshkian, John H. Ipsen, 2023, bioRxiv - ArXiv: https://www.biorxiv.org/content/early/2023/08/26/2023.05.05.539540.full.pdf

62. **Molecular architecture and dynamics of SARS-CoV-2 envelope by integrative modeling**
Weria Pezeshkian, Fabian Grünewald, Oleks et al., 2023, Structure, 31, 492-503.e7

63. **Standing accretion shock instability in the collapse of a rotating stellar core**
Walk, Laurie, Foglizzo, Thierry, Tamborra, Irene et al., 2023, Phys. Rev. D, 107, 063014 - ArXiv: 2212.07467

64. **Near-future discovery of the diffuse flux of ultrahigh-energy cosmic neutrinos**
Valera, Victor Branco, Bustamante, Mauricio, Glaser, Christian et al., 2023, Phys. Rev. D, 107, 043019 - ArXiv: 2210.03756

65. **Probing Neutrino Decay Using the First Steady-State Source of High-Energy Astrophysical Neutrinos, NGC 1068**
Valera, Victor B., Fiorillo, Damiano, Esteban, Ivan et al., 2023, PoS, ICRC2023, 1066

66. **Comprehensive Measurement Forecasts of the EeV Neutrino-Nucleon Cross Section with Cosmic Neutrinos at IceCube-Gen2**
Valera, Victor B., Bustamante, Mauricio, Glaser, Christian et al., 2023, PoS, ICRC2023, 1063 - ArXiv: 2307.11050

67. **Discovery Forecasts of the Diffuse Ultra-High-Energy Neutrino Flux with IceCube-Gen2**
Valera, Victor B., Bustamante, Mauricio, Glaser, Christian et al., 2023, PoS, ICRC2023, 1065 - ArXiv: 2307.11055

68. **Dynamical friction in gravitational atoms**
Tomaselli, Giovanni Maria, Spieksma, Thomas F. M., Bertone, Gianfranco et al., 2023, JCAP, 07, 070 - ArXiv: 2305.15460

69. **Combining effective-one-body accuracy and reduced-order-quadrature speed for binary neutron star merger parameter estimation with machine learning**
Tissino, Jacopo, Carullo, Gregorio, Breschi, Matteo et al., 2023, Phys. Rev. D, 107, 084037 - ArXiv: 2210.15684

70. **Where intermediate-mass black holes could hide in the Galactic Centre - A full parameter study with the S2 orbit**
Straub, O. et al., 2023, Chinese Astron. Astrophys., 672, A63 - ArXiv: 2303.04067

71. **Superradiance: Axionic couplings and plasma effects**
Spieksma, Thomas F. M., Cannizzaro, Enrico, Ikeda, Taishi et al., 2023, Phys. Rev. D, 108, 063013 - ArXiv: 2306.16447

72. **Flavor-dependent long-range neutrino interactions in DUNE and T2HK: alone they constrain, together they discover**
Singh, Masoom, Bustamante, Mauricio, Agarwalla, Sanjib Kumar et al., 2023, JHEP, 08, 101 - ArXiv: 2305.05184

73. **Do we have enough evidence to invalidate the mean-field approximation adopted to model collective neutrino oscillations?**
Shalgar, Shashank, Tamborra, Irene, 2023, Phys. Rev. D, 107, 123004 - ArXiv: 2304.13050

74. **Neutrino flavor conversion, advection, and collisions: Toward the full solution**
Shalgar, Shashank, Tamborra, Irene, 2023, Phys. Rev. D, 107, 063025 - ArXiv: 2207.04058

75. **Neutrino decoupling is altered by flavor conversion**
Shalgar, Shashank, Tamborra, Irene, 2023, Phys. Rev. D, 108, 043006 - ArXiv: 2206.00676

76. **Defining eccentricity for gravitational wave astronomy**
Shaikh, Md Arif, Varma, Vijay, Pfeiffer, Harald P. et al., 2023, Phys. Rev. D, 108, 104007 - ArXiv: 2302.11257

77. **Gamma rays and neutrinos from supernovae of type Ib and Ic with late time emission**
Sarmah, Prantik, Chakraborty, Sovan, Tamborra, Irene et al., 2023, Phys. Rev. D, 108, 103033 - ArXiv: 2303.13576

78. **Electromagnetic radiation reaction and energy extraction from black holes: The tail term cannot be ignored**
Santos, Joao S., Cardoso, Vitor, Natario, Jose et al., 2023, Phys. Rev. D, 107, 064046 - ArXiv: 2303.03411

79. **Spontaneous flows and dynamics of full-integer topological defects in polar active matter**
Rønning, Jonas, Renaud, Julian, Doostmohammadi, Amin et al., 2023,, 19, 7513–7527

80. **Close, but not too close: a mesoscopic description of (a)symmetry and membrane shaping mechanisms**
Ruhoff, Victoria Thusgaard, Bendix, Poul Martin, Pezeshkian, Weria et al., 2023, Emerging Topics in Life Sciences, 7, 81-93 - ArXiv: https://portlandpress.com/emergtoplifesci/article-pdf/7/1/81/947985/etls-2022-0078c.pdf

81. **Subphotospheric emission from short gamma-ray bursts: Protons mold the multi-messenger signals**
Rudolph, Annika, Tamborra, Irene, Gottlieb, Ore et al., 2023, Astrophys. J. Lett. (2023, in press) - ArXiv: 2309.08667

82. **Multi-messenger Model for the Prompt Emission from GRB 221009A**
Rudolph, Annika, Petropoulou, Maria, Winter, Walter et al., 2023, Astrophys. J. Lett., 944, L34 - ArXiv: 2212.00766

83. **Multicollision Internal Shock Lepto-hadronic Models for Energetic Gamma-Ray Bursts (GRBs)**
Rudolph, Annika, Petropoulou, Maria, Bošnjak, Željka et al., 2023, Astrophys. J., 950, 28 - ArXiv: 2212.00765

84. **Non-linear black hole dynamics and Carrollian fluids**
Redondo-Yuste, Jaime, Lehner, Luis, 2023, JHEP, 02, 240 - ArXiv: 2212.06175

85. **Eternal binaries**
Redondo-Yuste, Jaime, Cardoso, Vitor, Macedo, Caio F. B. et al., 2023, Phys. Rev. D, 107, 124025 - ArXiv: 2304.02039

86. **2.5PN accurate waveform information for generic-planar-orbit binaries in effective one-body models**
Placidi, Andrea, Grignani, Gianluca, Harmark, Troels et al., 2023, Phys. Rev. D, 108, 024068 - ArXiv: 2305.14440

87. **Optically informed searches of high-energy neutrinos from interaction-powered supernovae**
Pitik, Tetyana, Tamborra, Irene, Lincetto, Massimiliano et al., 2023, Mon. Not. Roy. Astron. Soc., 524, 3366--3384 - ArXiv: 2306.01833

88. **Black hole perturbations and electric-magnetic duality**
Pereniguez, David, 2023, Phys. Rev. D, 108, 084046 - ArXiv: 2302.10942

89. **Hyperboloidal approach for static spherically symmetric spacetimes: a didactical introduction and applications in black-hole physics**
Panosso Macedo, Rodrigo, 2023, Phil. Trans. of the Royal Society A - ArXiv: 2307.15735

90. **4-OGC: Catalog of Gravitational Waves from Compact Binary Mergers**
Nitz, Alex, er H., Kumar, Sumit et al., 2023, Astrophys. J., 946, 59 - ArXiv: 2112.06878

91. **Bootstrapping Elliptic Feynman Integrals Using Schubert Analysis**
Morales, Roger, Spiering, Anne, Wilhelm, Matthias et al., 2023, Phys. Rev. Lett., 131, 041601 - ArXiv: 2212.09762

92. **Curvature-induced lipid sorting beyond the critical packing parameter**
Melanie Konig, Reinier de Vries, Fabian Grunewald et al., 2023, bioRxiv - ArXiv: https://www.biorxiv.org/content/early/2023/12/15/2023.12.15.571845.full.pdf

93. **An infinite family of elliptic ladder integrals**
McLeod, Andrew, Morales, Roger, von Hippel, Matt et al., 2023, JHEP, 05, 236 - ArXiv: 2301.07965

94. **A new multimessenger study of Starburst galaxies: a closer look to expecting neutrinos**
Marinelli, Antonio, Ambrosone, Antonio, Chianese, Marco et al., 2023, J. Phys. Conf. Ser., 2429, 012032

95. **A new multi-messenger description of starburst galaxies emission: perspectives for neutrino and gamma-ray observations**
Marinelli, Antonio, Ambrosone, Antonio, Chianese, Marco et al., 2023, Astron. Nachr., 344, e220137

96. **Bayesian statistical framework for identifying strongly lensed gravitational-wave signals**
Lo, Rico K. L., Magana Hern, ez, Ignacio et al., 2023, Phys. Rev. D, 107, 123015 - ArXiv: 2104.09339

97. **Targeted subthreshold search for strongly lensed gravitational-wave events**
Li, Alvin K. Y., Lo, Rico K. L., Sachdev, Surabhi et al., 2023, Phys. Rev. D, 107, 123014 - ArXiv: 1904.06020

98. **TESLA-X: An effective method to search for sub-threshold lensed gravitational waves with a targeted population model**
Li, Alvin K. Y., Chan, Juno C. L., Fong, Heather et al., 2023, preprint - ArXiv: 2311.06416

99. **From the EFT of spinning gravitating objects to Poincare and gauge invariance at the 4.5PN precision frontier**
Levi, Michele, Morales, Roger, Yin, Zhewei et al., 2023, JHEP, 09, 090 - ArXiv: 2210.17538

100. **'t Hooft loops and integrability**
Kristjansen, Charlotte, Zarembo, Konstantin, 2023, JHEP, 08, 184 - ArXiv: 2305.03649

101. **Stability of relativistic tidal response against small potential modification**
Katagiri, Takuya, Nakano, Hiroyuki, Omukai, Kazuyuki et al., 2023, Phys. Rev. D, 108, 084049 - ArXiv: 2304.04551

102. **Vanishing Love numbers of black holes in general relativity: From spacetime conformal symmetry of a two-dimensional reduced geometry**
Katagiri, Takuya, Kimura, Masashi, Nakano, Hiroyuki et al., 2023, Phys. Rev. D, 107, 124030 - ArXiv: 2209.10469

103. **Key Science Goals for the Next-Generation Event Horizon Telescope**
Johnson, Michael D. et al., 2023, Galaxies, 11, 61 - ArXiv: 2304.11188

104. **Follow-up Analyses to the O3 LIGO-Virgo-KAGRA Lensing Searches**
Janquart, Justin et al., 2023, preprint - ArXiv: 2306.03827

105. **Introducing the Automated Ligand Searcher**
Jacobsen, Luise, Hungerl, , Jonathan et al., 2023, Journal of Chemical Information and Modeling, 63, 7518-7528 - ArXiv: https://doi.org/10.1021/acs.jcim.3c01317

106. **Reconciling a decelerating Universe with cosmological observations**
Heinesen, Asta, 2023, Phys. Rev. D, 107, L101301 - ArXiv: 2212.05568

107. **Bulk flows in the local Universe and the importance of relativistic effects**
Heinesen, Asta, 2023, Phys. Rev. D, 108, 103530 - ArXiv: 2305.16084

108. **Hairy black holes in AdS with Robin boundary conditions**
Harada, Tomohiro, Ishii, Takaaki, Katagiri, Takuya et al., 2023, JHEP, 06, 106 - ArXiv: 2304.02267

109. Transients stemming from collapsing massive stars: The missing pieces to advance joint observations of photons and high-energy neutrinos
Guarini, Ersilia, Tamborra, Irene, Margutti, Raffaella et al., 2023, Phys. Rev. D, 108, 083035 - ArXiv: 2308.03840

110. State-of-the-art collapsar jet simulations imply undetectable subphotospheric neutrinos
Guarini, Ersilia, Tamborra, Irene, Gottlieb, Ore et al., 2023, Phys. Rev. D, 107, 023001 - ArXiv: 2210.03757

111. Probing gamma-ray bursts observed at very high energies through their afterglow
Guarini, Ersilia, Tamborra, Irene, Begue, Damien et al., 2023, Mon. Not. Roy. Astron. Soc., 253, 149--162 - ArXiv: 2301.10256

112. Carrollian motion in magnetized black hole horizons
Gray, Finnian, Kubiznak, David, Perche, T. Rick et al., 2023, Phys. Rev. D, 107, 064009 - ArXiv: 2211.13695

113. Probing lens-induced gravitational-wave birefringence as a test of general relativity
Goyal, Srashti, Vijaykumar, Aditya, Ezquiaga, Jose Maria et al., 2023, Phys. Rev. D, 108, 024052 - ArXiv: 2301.04826

114. A rapid method for preliminary identification of subthreshold strongly lensed counterparts to superthreshold gravitational-wave events
Goyal, Srashti, Kapadia, Shasvath, Cudell, Jean-Rene et al., 2023, preprint - ArXiv: 2306.04397

115. Numerical-relativity-informed effective-one-body model for black-hole — neutron-star mergers with higher modes and spin precession
Gonzalez, Alejandra, Gamba, Rossella et al., 2023, Phys. Rev. D, 107, 084026 - ArXiv: 2212.03909

116. The Hitchhiker's Guide to the Galaxy Catalog Approach for Dark Siren Gravitational-wave Cosmology
Gair, Jonathan R. et al., 2023, Astron. J., 166, 22 - ArXiv: 2212.08694

117. On $\bar{\epsilon}$-factorised bases and pure Feynman integrals
Frellesvig, Hjalte, Weinzierl, Stefan, 2023, preprint - ArXiv: 2301.02264

118. Using the motion of S2 to constrain scalar clouds around Sgr A*
Foschi, A. et al., 2023, Mon. Not. Roy. Astron. Soc., 524, 1075--1086 - ArXiv: 2306.17215

119. Near-future discovery of point sources of ultra-high-energy neutrinos
Fiorillo, Damiano, Bustamante, Mauricio, Valera, Victor et al., 2023, PoS, ICRC2023, 1000

120. Searches for dark matter decay with ultrahigh-energy neutrinos endure backgrounds
Fiorillo, Damiano F. G., Valera, Victor B., Bustamante, Mauricio et al., 2023, Phys. Rev. D, 108, 103012 - ArXiv: 2307.02538

121. Strong Supernova 1987A Constraints on Bosons Decaying to Neutrinos
Fiorillo, Damiano F. G., Raffelt, Georg G., Vitagliano, Edoardo et al., 2023, Phys. Rev. Lett., 131, 021001 - ArXiv: 2209.11773

122. Flavor solitons in dense neutrino gases
Fiorillo, Damiano F. G., Raffelt, Georg G., 2023, Phys. Rev. D, 107, 123024 - ArXiv: 2303.12143

123. Slow and fast collective neutrino oscillations: Invariants and reciprocity
Fiorillo, Damiano F. G., Raffelt, Georg G., 2023, Phys. Rev. D, 107, 043024 - ArXiv: 2301.09650

124. **Supernova simulations confront SN 1987A neutrinos**
Fiorillo, Damiano F. G., Heinlein, Malte, Janka, Hans-Thomas et al., 2023, Phys. Rev. D, 108, 083040 - ArXiv: 2308.01403

125. **Near-future discovery of point sources of ultra-high-energy neutrinos**
Fiorillo, Damiano F. G., Bustamante, Mauricio, Valera, Victor B. et al., 2023, JCAP, 03, 026 - ArXiv: 2205.15985

126. **Bump hunting in the diffuse flux of high-energy cosmic neutrinos**
Fiorillo, Damiano F. G., Bustamante, Mauricio, 2023, Phys. Rev. D, 107, 083008 - ArXiv: 2301.00024

127. **Black holes surrounded by generic dark matter profiles: Appearance and gravitational-wave emission**
Figueiredo, Enzo, Maselli, Andrea, Cardoso, Vitor et al., 2023, Phys. Rev. D, 107, 104033 - ArXiv: 2303.08183

128. **Normal modes of Proca fields in AdS spacetime**
Fernandes, Tiago V., Hilditch, David et al., 2023, Gen. Rel. Grav., 55, 5 - ArXiv: 2301.10248

129. **Shielding a charged black hole**
Feng, Justin C., Chakraborty, Sumanta, Cardoso, Vitor et al., 2023, Phys. Rev. D, 107, 044050 - ArXiv: 2211.05261

130. **Things That Might Go Bump in the Night: Assessing Structure in the Binary Black Hole Mass Spectrum**
Farah, Amanda, Edelman, Bruce et al., 2023, Astrophys. J., 955, 107 - ArXiv: 2301.00834

131. **Identifying strongly lensed gravitational waves through their phase consistency**
Ezquiaga, Jose Maria, Hu, Wayne, Lo, Rico K. L. et al., 2023, Phys. Rev. D, 108, 103520 - ArXiv: 2308.06616

132. **Massive Galaxy Clusters Like El Gordo Hint at Primordial Quantum Diffusion**
Ezquiaga, Jose Maria, Garcioa-Bellido, Juan, Vennin, Vincent et al., 2023, Phys. Rev. Lett., 130, 121003 - ArXiv: 2207.06317

133. **Fast Neutrino Flavor Conversions Can Help and Hinder Neutrino-Driven Explosions**
Ehring, Jakob, Abbar, Sajad, Janka, Hans-Thomas et al., 2023, Phys. Rev. Lett., 131, 061401 - ArXiv: 2305.11207

134. **Fast neutrino flavor conversion in core-collapse supernovae: A parametric study in 1D models**
Ehring, Jakob, Abbar, Sajad, Janka, Hans-Thomas et al., 2023, Phys. Rev. D, 107, 103034 - ArXiv: 2301.11938

135. **Kerr-fully diving into the abyss: analytic solutions to plunging geodesics in Kerr**
Dyson, Conor, van de Meent, Maarten, 2023, Class. Quant. Grav., 40, 195026 - ArXiv: 2302.03704

136. **Magnetic black holes: From Thomson dipoles to the Penrose process and cosmic censorship**
Dyson, Conor, Pereniguez, David, 2023, Phys. Rev. D, 108, 084064 - ArXiv: 2306.15751

137. **Mesoscale simulations: An indispensable approach to understand biomembranes**
Duncan, Anna, Pezeshkian, Weria, 2023, Emerging Topics in Life Sciences, 122, 1883-1889

138. **Multimessenger observations of core-collapse supernovae: Exploiting the standing accretion shock instability**
Drago, Marco, Andresen, Haakon, Di Palma, Irene et al., 2023, Phys. Rev. D, 108, 103036 - ArXiv: 2305.07688

139. **Axion-sourced fireballs from supernovae**
Diamond, Melissa, Fiorillo, Damiano F. G., Marques-Tavares, Gustavo et al., 2023, Phys. Rev. D, 107, 103029 - ArXiv: 2303.11395

140. **Classical gravitational observables from the Eikonal operator**
Di Vecchia, Paolo, Heissenberg, Carlo, Russo, Rodolfo et al., 2023, Phys. Lett. B, 843, 138049 - ArXiv: 2210.12118

141. **String Theory**
Di Vecchia, Paolo, 2023, Springer Proc. Phys., 287, 239--254

142. **The quadrupole in the local Hubble parameter: first constraints using Type Ia supernova data and forecasts for future surveys**
Dhawan, Suhail, Borderies, Antonin, Macpherson, Hayley J. et al., 2023, Mon. Not. Roy. Astron. Soc., 519, 4841--4855 - ArXiv: 2205.12692

143. **Higher categorical symmetries and gauging in two-dimensional spin systems**
Delcamp, Clement, Tiwari, Apoorv, 2023, preprint - ArXiv: 2301.01259

144. **Classical observables from the exponential representation of the gravitational S-matrix**
Damgaard, Poul H., Hansen, Elias Roos, Plante, Ludovic et al., 2023, JHEP, 09, 183 - ArXiv: 2307.04746

145. **The relation between KMOC and worldline formalisms for classical gravity**
Damgaard, Poul H., Hansen, Elias Roos, Plante, Ludovic et al., 2023, JHEP, 09, 059 - ArXiv: 2306.11454

146. **What is the Fate of Hawking Evaporation in Gravity Theories with Higher Curvature Terms?**
Corelli, Fabrizio, De Amicis, Marina, Ikeda, Taishi et al., 2023, Phys. Rev. Lett., 130, 091501 - ArXiv: 2205.13006

147. **Nonperturbative gedanken experiments in Einstein-dilaton-Gauss-Bonnet gravity: Nonlinear transitions and tests of the cosmic censorship beyond general relativity**
Corelli, Fabrizio, De Amicis, Marina, Ikeda, Taishi et al., 2023, Phys. Rev. D, 107, 044061 - ArXiv: 2205.13007

148. **Distinguishing environmental effects on binary black hole gravitational waveforms**
Cole, Philippa S., Bertone, Gianfranco, Coogan, Adam et al., 2023, Nature Astron., 7, 943--950 - ArXiv: 2211.01362

149. **Nonlinear Effects in Black Hole Ringdown**
Cheung, Mark Ho-Yeuk et al., 2023, Phys. Rev. Lett., 130, 081401 - ArXiv: 2208.07374

150. **Intersection numbers from higher-order partial differential equations**
Chestnov, Vsevolod, Frellesvig, Hjalte, Gasparotto, Federico et al., 2023, JHEP, 06, 131 - ArXiv: 2209.01997

151. **Photon Ring Astrometry for Superradiant Clouds**
Chen, Yifan, Xue, Xiao, Brito, Richard et al., 2023, Phys. Rev. Lett., 130, 111401 - ArXiv: 2211.03794

152. **Earth shielding and daily modulation from electrophilic boosted dark particles**
Chen, Yifan, Fornal, Bartosz, S et al., 2023, Phys. Rev. D, 107, 033006 - ArXiv: 2110.09685

153. **Boundaries in free higher derivative conformal field theories**
Chalabi, Adam, Herzog, Christopher P., Ray, Krishnendu et al., 2023, JHEP, 04, 098 - ArXiv: 2211.14335

154. **Reply to Comment on "Analysis of Ringdown Overtones in GW150914"**
Carullo, Gregorio, Cotesta, Roberto, Berti, Emanuele et al., 2023, Phys. Rev. Lett., 131, 169002 - ArXiv: 2310.20625

155. **Energy Extraction from Q-balls and Other Fundamental Solitons**
Cardoso, Vitor, Vicente, Rodrigo, Zhong, Zhen et al., 2023, Phys. Rev. Lett., 131, 111602 - ArXiv: 2307.13734

156. **Curvature and dynamical spacetimes: can we peer into the quantum regime?**
Cardoso, Vitor, Hilditch, David, Marouda, Krinio et al., 2023, Class. Quant. Grav., 40, 065008 - ArXiv: 2209.12589

157. **Constraints on massive gravity from dipolar mode excitations**
Cardoso, Vitor, Duque, Francisco, Maselli, Andrea et al., 2023, Phys. Rev. D, 108, 124003 - ArXiv: 2304.01252

158. **Energy extraction from bouncing geometries**
Cardoso, Vitor, Costa, Joao L., Natario, Jose et al., 2023, Phys. Rev. D, 108, 024071 - ArXiv: 2304.08520

159. **Multimode Quasinormal Spectrum from a Perturbed Black Hole**
Capano, Collin D., Cabero, Miriam, Westerweck, Julian et al., 2023, Phys. Rev. Lett., 131, 221402 - ArXiv: 2105.05238

160. **Tidal deformations of a binary system induced by an external Kerr black hole**
Camilloni, Filippo, Grignani, Gianluca, Harmark, Troels et al., 2023, Phys. Rev. D, 107, 084011 - ArXiv: 2301.04879

161. **The Milky Way shines in high-energy neutrinos**
Bustamante, Mauricio, 2023, Nat. Rev. Phys.

162. **Spinning black holes with axion hair**
Burrage, Clare, Fern, es, Pedro G. S. et al., 2023, Class. Quant. Grav., 40, 205021 - ArXiv: 2306.03662

163. **The averaging problem on the past null cone in inhomogeneous dust cosmologies**
Buchert, Thomas, van Elst, Henk, Heinesen, Asta et al., 2023, Gen. Rel. Grav., 55, 7 - ArXiv: 2202.10798

164. **One-loop gravitational bremsstrahlung and waveforms from a heavy-mass effective field theory**
Br, huber, Andreas, Brown, Graham R. et al., 2023, JHEP, 06, 048 - ArXiv: 2303.06111

165. **Pseudospectrum of horizonless compact objects: A bootstrap instability mechanism**
Boyanov, Valentin, Destounis, Kyriakos, Panosso Macedo, Rodrigo et al., 2023, Phys. Rev. D, 107, 064012 - ArXiv: 2209.12950

166. **Next-to-leading-order QCD corrections to Higgs production in association with a jet**
Bonciani, Roberto, Del Duca, Vittorio, Frellesvig, Hjalte et al., 2023, Phys. Lett. B, 843, 137995 - ArXiv: 2206.10490

167. **Classical spin gravitational Compton scattering**
Bjerrum-Bohr, N. E. J., Chen, Gang, Skowronek, Marcos et al., 2023, JHEP, 06, 170 - ArXiv: 2302.00498

168. **Unifying constructions of non-invertible symmetries**
Bhardwaj, Lakshya, Schafer-Nameki, Sakura, Tiwari, Apoorv et al., 2023, SciPost Phys., 15, 122 - ArXiv: 2212.06159

169. **Non-invertible symmetry webs**
Bhardwaj, Lakshya, Bottini, Lea E., Schafer-Nameki, Sakura et al., 2023, SciPost Phys., 15, 160 - ArXiv: 2212.06842

170. **Neutrino self-interactions: A white paper**
Berryman, Jeffrey M. et al., 2023, Phys. Dark Univ., 42, 101267 - ArXiv: 2203.01955

171. **The Panorama of Spin Matrix theory**
Baiguera, Stefano, Harmark, Troels, Lei, Yang et al., 2023, JHEP, 04, 075 - ArXiv: 2211.16519

172. **Agnostic black hole spectroscopy: Quasinormal mode content of numerical relativity waveforms and limits of validity of linear perturbation theory**
Baibhav, Vishal, Cheung, Mark Ho-Yeuk, Berti, Emanuele et al., 2023, Phys. Rev. D, 108, 104020 - ArXiv: 2302.03050

173. **Cosmology with the Laser Interferometer Space Antenna**
Auclair, Pierre et al., 2023, Living Rev. Rel., 26, 5 - ArXiv: 2204.05434

174. **Energy-dependent flavor ratios of High-energy Astrophysical Neutrinos**
Arguelles, Carlos A., Bustamante, Mauricio, Fiorillo, Damiano F. G. et al., 2023, PoS, ICRC2023, 1182

175. **Snowmass white paper: beyond the standard model effects on neutrino flavor: Submitted to the proceedings of the US community study on the future of particle physics (Snowmass 2021)**
Arguelles, C. A. et al., 2023, Eur. Phys. J. C, 83, 15 - ArXiv: 2203.10811

176. **Building post-Newtonian neutron stars**
Andersson, Nils, Gittins, Fabian, Yin, Shanshan et al., 2023, Class. Quant. Grav., 40, 025016 - ArXiv: 2209.05871

177. **Starburst Galactic Nuclei as Light Dark Matter Laboratories**
Ambrosone, Antonio, Chianese, Marco, Fiorillo, Damiano F. G. et al., 2023, Phys. Rev. Lett., 131, 111003 - ArXiv: 2210.05685

178. **Faithful effective-one-body waveform of small-mass-ratio coalescing black hole binaries: The eccentric, nonspinning case**
Albanesi, Simone, Bernuzzi, Sebastiano, Damour, Thibault et al., 2023, Phys. Rev. D, 108, 084037 - ArXiv: 2305.19336

179. **Inferring mechanical properties of the SARS-CoV-2 virus particle with nano-indentation tests and numerical simulations**
Aida Nonn, Bálint Kiss, Weria Pezeshkian et al., 2023, Journal of the Mechanical Behavior of Biomedical Materials, 148, 106153

180. **Present and future constraints on flavor-dependent long-range interactions of high-energy astrophysical neutrinos**
Agarwalla, Sanjib Kumar, Bustamante, Mauricio, Das, Sudipta et al., 2023, JHEP, 08, 113 - ArXiv: 2305.03675

181. **Frequency-Dependent Squeezed Vacuum Source for the Advanced Virgo Gravitational-Wave Detector**
Acernese, F. et al., 2023, Phys. Rev. Lett., 131, 041403

182. **Advanced Virgo Plus: Future Perspectives**
Acernese, F. et al., 2023, J. Phys. Conf. Ser., 2429, 012040

183. Polarimetry and astrometry of NIR flares as event horizon scale, dynamical probes for the mass of Sgr A*
Abuter, R. et al., 2023, Chinese Astron. Astrophys., 677, L10 - ArXiv: 2307.11821

184. Spectroscopy for asymmetric binary black hole mergers
Abedi, Jahed, Capano, Collin D., Kastha, Shilpa et al., 2023, Phys. Rev. D, 108, 104009 - ArXiv: 2309.03121

185. GWTC-3: Compact Binary Coalescences Observed by LIGO and Virgo during the Second Part of the Third Observing Run
Abbott, R. et al., 2023, Phys. Rev. X, 13, 041039 - ArXiv: 2111.03606

186. Open Data from the Third Observing Run of LIGO, Virgo, KAGRA, and GEO
Abbott, R. et al., 2023, Astrophys. J. Suppl., 267, 29 - ArXiv: 2302.03676

The Niels Bohr International Academy
Blegdamsvej 17
DK – 2100 Copenhagen Ø
www.nbia.dk