NBIA NEWSLETTER

NEWS IN BRIEF

VILLUM YIP GRANT

Assistant Professor Matthias Wilhelm has been awarded a Villum Young Investigator Grant for the development of new theoretical methods to understand the thermodynamics of strongly coupled quantum field theories in general, and the quark-gluon plasma and its transition to ordinary matter in particular. The grant will allow him to hire two postdocs and one PhD student during the course of the next five years.

SHAKTI P. DUGGAL AWARD

Knud Højgaard Associate Professor Irene Tamborra has been awarded the 2019 Shakti P. Duggal Award for her "pioneering work in advancing our understanding of neutrinos in cosmic accelerators." The award has been presented during the opening ceremony of the 36th International Cosmic Ray Conference (ICRC) in Madison (USA) this summer.

EU MARIE CURIE FELLOWSHIP

Assistant Professor Johan Samsing has received a two-year EU Marie Skłodowska-Curie Fellowship to join the NBIA in December 2019. His project will provide new insight into fundamental questions of theoretical astrophysics, such as how and where black holes form and what helps them to get close enough to merge on an observable timescale. Johan will develop a new numerical Monte-Carlo framework for evolving dense stellar systems.

MICIUS QUANTUM PRIZE

Simons Visiting Professor Charles H. Bennett has been awarded the Micius Quantum Prize 2019 together with Gilles Brassard for their inventions of quantum key distribution, quantum teleportation, and entanglement purification. The Micius Quantum Prize recognizes scientists who have made outstanding contributions in the field of quantum communications, quantum simulation, quantum computation, and quantum metrology. Each awardee receives a Prize of one million Chinese Yuans (approximately $150,000).

A MESSAGE FROM THE DIRECTOR

Poul Henrik Damgaard

Four new Assistant Professors are joining the NBIA this fall, expanding our research directions into four new areas. Amin Doostmohammadi, who joins us from Oxford University, is our first Novo Nordisk Foundation Assistant Professor. Amin works on biological physics and the new area that goes under the name 'active matter', aiming to understand the physical mechanisms that underlie motion at the cellular level in living organisms. Michele Levi is newly appointed Assistant Professor in the burgeoning area of analytical computations needed to describe the merger of two black holes and the gravitational waves emitted in the process. Michele Levi joins us from the IPhT of CEA Saclay, Paris. Johan Samsing, who will arrive later this fall from Princeton University, will be appointed as Louis-Hansen Assistant Professor. Johan Samsing works on the astrophysical understanding of black hole mergers and the associated gravitational waves that spectacularly have now been observed on Earth. Finally, towards the end of the year, Evert van Nieuwenburg joins us from Caltech on another Louis-Hansen Assistant Professorship. Evert van Nieuwenburg works on the forefront of using machine learning to discover phenomena in quantum systems. It's a tremendously exciting palette of burning-hot new subjects in theoretical physics these four scientists bring to the NBIA. There is much to look forward to in the coming years!

OUTREACH EVENTS AT NBIA

The Niels Bohr International Academy continues the public lecture series "News from the NBIA." These lectures are organized jointly with Folkeuniversitetet and will be held at the Niels Bohr Institute in the historic Auditorium A, from 5.15pm to 7.00pm. The talks on various topics in modern theoretical physics will be given in English by NBIA members. They will give you a glimpse of the questions, ideas and approaches right now at the scientific forefront. Registration is open at: www.fukbh.dk

THE VIEW FROM THE BOARD

Andrew D. Jackson

Too much specialization is rarely good for physicists, and we all know the unfortunate limit of the process of learning more and more about less and less. The NBIA recruits broadly in theoretical physics, and we remain convinced that talented scientists of any age benefit good people working in completely different areas. Previously, NBIA members have been invited to present their own work in a regular series of short informal talks with the aim of catalyzing such interactions. Although these talks have long been supplemented by a broad spectrum of ad hoc NBIA colloquia, this semester has seen the initiation of a series of regular weekly colloquia delivered by excellent scientists. Many of the presentations, such as Paul Ho's marvelous talk on the first direct image of a Black Hole, deal with mainstream physics. But topics at our colloquia have ranged widely from the cultural significance of ancient textiles to the appearance of stochastic Turing patterns in the biosphere. So far, attendance has been good, and interest has been high. With a little luck, we can all hope to learn more and more about more and more!

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The Niels Bohr International Academy

NEW NBIA MEMBERS & VISITORS

This Fall, the NBIA welcomes a number of long-term visitors, Assistant Professors, and postdocs. You can find a brief description of their work below and a research highlight by one of our new Assistant Professors, Michèle Levi. We also give a warm welcome to our new Ph.D. students, Ian Padilla-Gay, Alexander Kristensson, Tetyana Pitik and David Dam Ribers, and our new M.Sc. students, Alexandra Zisimopolou, Daniel Lozano Gomez, Emil Kozuch and Mariana Vieira.

Charles Bennett from IBM Research at Yorktown Heights is Simons Visiting Professor at the NBIA this fall and he is also joint Visiting Professor with the QMATH Villum Center of Excellence at the Department of Mathematics. He is one of the founders of the fields of quantum computation and encryption.

Rasmus S. L. Hansen is a new postdoc working on neutrino astrophysics. He studies non-linear neutrino oscillations in the presence of extremely high neutrino densities, as in the early Universe or supernovae. These situations can be studied via stability analyses as well as detailed numerical simulations.

Visiting Professor Jens Oluf Andersen studies QCD under extreme conditions. He has calculated the thermodynamic properties of the quark-gluon plasma using advanced resummation techniques in hard-thermal-loop perturbation theory, and pion condensation using chiral perturbation theory for two and three flavors.

Jim Talbert is a new postdoc working in particle phenomenology and effective field theory. He has contributed precision calculations for high-energy colliders and neutrino observatories, and also explores problems in particle physics, *e.g.*, the origin of flavor, CP violation, and new fundamental symmetries.

Johan Samsing is Louis-Hansen Foundation Assistant Professor working on the formation of black hole mergers, and how features in their gravitational wave signal can probe their origin. He has recently developed novel analytical and numerical methods to model black hole mergers in dense stellar clusters.

Yoann Genolini is a new postdoc in astroparticle physics, studying cosmic-ray propagation and phenomenology using analytical and semi-analytical methods. He is also interested in dark matter phenomenology and its indirect probe by astrophysical observables, notably those related to properties of compact objects.

Amin Doostmohammadi is the first Novo Nordisk Foundation Assistant Professor at NBIA with a special cross-appointment as an Assistant Professor in Bioengineering at Osaka University, Japan. Amin works at the interface between physics and biology, modeling active materials, like cellular tissues.

RESEARCH HIGHLIGHT on High Energy and Gravity Theory

Michèle Levi

Our understanding of gravity is lacking at the quantum regime, and even at the classical one. With the cosmological constant problem and the dark matter puzzle we need to ameliorate our knowledge of gravity theory at all scales from the smallest to the largest, where the problems with gravity in the UV and the IR sides may well be tied together. Amazingly and fortunately, a new era of high precision gravity has been launched with the recent and long-awaited detection of gravitational waves from black hole binary mergers. The influx of improved gravitational wave data has been constantly increasing, and more and more accurate theoretical waveform templates are required to study the signal, which probes gravity even at strong field. The ongoing advances in gravitational wave measurements dramatically enhance our ability to pin down the ultimate viable theory of gravity. My research is interdisciplinary and is very much driven by experiment and by realizing the potential of invoking high precision computation and various concepts and ideas from the realm of high energy physics and quantum field theory to study gravity at all scales. Indeed, in recent years we have made a remarkable progress in our ability to study the gravitational wave signal - to a high order of precision - in an analytic manner, which uniquely allows to tackle crucial portions of the signal. This progress has been achieved so far mainly thanks to evoking the effective field theory framework, and the bigger quantum field theory toolbox. More recently, there have also been developments in the endeavor to harness the powerful lore and modern advances in the field of scattering amplitudes - including intriguing duality and correspondence relations among gauge and gravity theories - to study gravity and gravitational waves. At the Niels Bohr International Academy, which has carried out world leading studies in scattering amplitudes for years, we have now an exciting opportunity to step up and lead this formidable mission with world-class research.

UPCOMING WORKSHOPS

- Simons Program: Toward a Mathematical Home for our Classical Phenomenon (October 28 - November 1)