NBIA NEWSLETTER

NEWS IN BRIEF

VILLUM GRANT

Assistant Professor Markus Ahlers has been awarded a Villum Young Investigator Grant of 7.35 MDKK for the project "Deciphering Cosmic Neutrinos with Multi-Messenger Astronomy." Markus aims at identifying the astrophysical origin of very high energy cosmic neutrinos that have recently been detected at the IceCube detector in Antarctica. The grant will allow him to hire two post-docs and a PhD-student over the next five years.

GRANT FROM INDEPENDENT RESEARCH FUND DENMARK

Associate Professor Michael Trott has received a grant of 1.7 MDKK from the Independent Research Fund Denmark to carry out a research project centered on a very precise way to detect potential deviations from the Standard Model of Particle Physics. Michael Trott will hire a two-year post-doc to help him carry out this project, which will start in 2018.

CARLSBERG FELLOWSHIP

Post-doc Mohamed Rameez has received a Carlsberg Foundation Distinguished Postdoctoral Fellowship for two years. Rameez, who joined the NBIA right after having received his PhD from the University of Geneva in 2016, seeks to explore and quantify the bulk flows in the local Universe, and their implications for high energy cosmic ray physics.

BUCHALTER PRIZE

A paper co-authored by Assistant Professor Subodh Patil entitled "Magnon Inflation: Slow Roll With Steep Potentials" has won third place in the 2017 Buchalter Cosmology Prize. The Buchalter Prize, created in 2014, aims at rewarding new ideas or discoveries that have the potential to produce a breakthrough in our understanding of the origin, structure, and evolution of the Universe.

A MESSAGE FROM THE DIRECTOR

Poul Henrik Damgaard

President J.F. Kennedy once wrote "Change is the law of life. And those who look only to the past or present are certain to miss the future." Nowhere is this more true than in the world of science! What was hot just a few years ago may be forgotten and irrelevant today. New ideas, if they are good enough, brutally turn over old ones. Thus a physics institution such as the NBIA constantly has to re-focus and be on the look-out for those new ideas that shape the future rather than continue with the ideas that defined the past. This must be a conscious strategy because renewal requires effort. Major grants to our young scientists provide one avenue through which new subjects blossom at the NBIA. Since last fall, two prestigious grants have been awarded to NBIA scientists: an ERC Starting Grant to Jacob Bourjaily and a Villum Young Investigator Grant to Markus Ahlers. Thus, also this year, now that the hiring round is finished, we feel the promise of exciting new possibilities that lie ahead of us. Six new post-docs will be joining us from all corners of the world. I look forward to describing in some detail the new research topics they will bring to Denmark in our next Newsletter!

THE VIEW FROM THE BOARD

Andrew D. Jackson

"Interdisciplinarity" in physics is fashionable. While some important problems require an interdisciplinary solution, most of the questions that we consider lie comfortably within physics and do not require expertise from other disciplines for their solution. ("Multidisciplinarity", where one individual has the ability to make significant contributions to several fields, is another story. Just think of 1905.) It is interesting to ask if one can create an atmosphere conducive to posing the important interdisciplinary questions and to finding their solutions. Clearly, the strict thematic organization of narrowly focused research groups is *not* the answer. The NBIA's response to this challenge has been to gather talented young scientists independent of their field of interest and to encourage interactions between them. "Encouragement" includes weekly NBIA N-talks as well as regular NBIA colloquia open to all. Informally, the NBIA lounge provides the setting for lively daily discussions. There is no doubt that this mix of skills and perspectives often leads to new ideas and new collaborative projects. It is also fun.

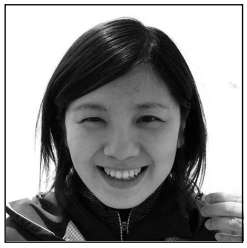
UPCOMING WORKSHOPS AND PHD SCHOOLS AT NBIA

- Simons Program: Quantum Information and Cosmology (April 9-12)
- SDC Workshop on Particle, Astroparticle, and Astrophysics (April 18-20)
- Simons Program: QMath Masterclass on Tensors: Geometry and Quantum Information (June 18-22)
- Emergent Symmetries in Particle Physics, Cosmology, and Condensed Matter Systems (June 20-22)
- NBIA & DARK Summer School: Multi-Messengers from Compact Sources (July 2-6)
- Current Themes in High Energy Physics and Cosmology (August 13-17)

NEW NBIA MEMBERS AND VISITORS

This Spring, NBIA welcomes a number of new postdoctoral members and visitors working in a wide range of fields within Physics as described below. We welcome our new NBIA assistant professor Paolo Benincasa. You can find more about his work in the Research Highlight of this Newsletter. We also give a warm welcome to our new PhD student Laurie Walk, as well as our new MSc student Taus Munk Hansen.

Charles Bennett from IBM Research at Yorktown Heights is Simons Visiting Professor at the NBIA this spring. He is one of the founders of the fields of quantum computation and quantum encryption, and is currently also interested in the overlap of these subjects with new developments in high energy physics.



Jane Lixin Dai is a new Assistant Professor at the NBIA and DARK. Her research area is high-energy astrophysics, with focus on studying accretion and jet physics through general relativistic numerical simulations as well as the physics of astrophysical transients.

RESEARCH HIGHLIGHT on Particle Physics

Paolo Benincasa

Our description of the fundamental forces of Nature at accessible high energies relies on the language of quantum field theory. One of its striking features is to be the only way to manifestly reconcile the principle of quantum mechanics with the ones of special relativity. The price to pay is that quantum fields carry unphysical degrees of freedom, which need to be eliminated by introducing gauge redundancies, with the further consequence of making the computation of physical observables, such as scattering amplitudes, overly complicated. In the last years it became clear that a new perspective can be fruitfully adopted, by constructing the theory directly in terms of the observables themselves. In this direction, a big deal of progress has been made by NBIA researchers. For example, we learnt that scattering amplitudes can be described in terms of processes involving on-shell states only (thus without the need of introducing unphysical particles) which are generated by suitably gluing together three-particle amplitudes which are fixed by Poincaré symmetry. Despite the fact that most of the progress has been made for a very specific theory, this approach promises to be much more general, with some concrete steps made for non-maximally supersymmetric gauge theories. Scattering amplitudes, however, are crucial observables as long as we are concerned with asymptotically flat space-time. In the presence of a non-vanishing cosmological constant, it is no longer true and there are other quantities we need to care about. In cosmology, for example, what we have is an experiment that happened in the past and which we can observe the remnants of. So, we care about the late-time correlators or the so-called wavefunction of the universe, from which one tries to reconstruct a cosmological time evolution. Our understanding of such quantities is incredibly small, especially compared to the flat-space counterpart. In a recent work an important step forward has been made by arguing that it is possible to reconstruct these observables in terms of "boundary" data without making any reference to an actual time evolution: for a concrete toy model, the wavefunction at arbitrarily high point and for arbitrary high loop correction (at integrand level) can be generated recursively, in an ideally similar fashion of scattering amplitudes! Furthermore, there is a geometrical picture - in terms of a new class of polytopes - which allows to compute it and read off its properties. This opens up new exiting times, with the NBIA at the forefront for reformulating perturbation theory.

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.

Online registration will soon be open at http://www.fukbh.dk.

1. The magnetized cosmic plasma (Alexander Schekochihin, 22/10)
2. The big rip, the ultimate fate of the universe? (Subodh Patil, 29/10)
3. Controlling quantum nanosystems (Mark Rudner, 5/11)
4. IceCube: the South Pole neutrino detector (Jason Koskinen, 12/11)
5. String theory & the black-hole information paradox (David McGady, 19/11)

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