NBIA NEWSLETTER

NEWS IN BRIEF

STEPHEN HAWKING AT NBIA

Stephen Hawking joined the NBIA Simons Program participating in the workshop 'Current Themes in High Energy Physics and Cosmology.' Hawking and Mukhanov, NBIA's first Simons Visiting Professor, shared this year's BBVA Foundation Frontiers of Knowledge Award.

CAMBRIDGE MONOGRAPH

Jacob Bourjaily, NBIA Assistant Professor, publishes the monograph Grassmannian Geometry of Scattering Amplitudes with Cambridge University Press. The book outlines a new formulation of perturbative quantum field theory.

BEST STUDENT AWARDS

Mohamed Rameez won the 2016 CHIPP prize awarded by the Swiss Institute of Particle Physics to the best PhD student in Switzerland. Pablo Benítez-Llambay received the Varsavsky prize to the best Argentinian PhD thesis in Astrophysics 2015/2016, awarded by the Asociación Argentina de Astronomía and the Varsavsky Foundation.

NATURE COMMUNICATIONS

NBIA post-doc, Ben Brown, developed the first error-correction algorithm for a new code design, the gauge color code, which is of interest due to its scalable quantum computation properties. His paper has been published in Nature Communications. The gauge color code is a promising candidate for the architecture for the first large-scale fault tolerant quantum computers.

A MESSAGE FROM THE DIRECTOR

Poul Henrik Damgaard

The first Simons Program at the NBIA is well under way. Launched with a workshop this past summer on the recently discovered gravitational waves and other aspects of high-energy astrophysics, it continued with a high-profile two-week workshop on cosmology and high energy physics. Highlights from the meeting included the settling of a 16-year old bet regarding the possible discovery of supersymmetry at CERN's Large Hadron Collider, and the participation of legendary Stephen Hawking in the meeting. A popular lecture by Stephen Hawking was sold out in just 19 minutes, with more than 20,000 people on the waiting list. Black-market prices for tickets sky-rocketed, and a last-minute arrangement involving a number of movie theaters around Denmark eventually allowed more than 8,000 people to watch Hawking's lecture live. Generous support from the Carlsberg Foundation allowed us to handle this unusual event. The public interest in science is evident and at the NBIA we are following up on this event this fall with a new series of public lectures on "News from the Niels Bohr International Academy." You can learn more about these lectures and how to sign up for them on the next page.

THE VIEW FROM THE BOARD

Andrew D. Jackson

"Can you hear me?" The Copenhagen audience greeted Stephen Hawking's famous opening line with a roar of approval. Audiences always do. Stephen's visit has given us an excellent opportunity to follow the advice of both the Advisory Board and the Director's Council to bring the NBIA and its goals to the attention of a broader, non-scientific audience. The visit itself received massive coverage by Danish newspapers, radio, and television. I think that the message has gotten through that the NBIA is the only institution in Denmark that could have made it possible. We have also started a YouTube channel. Presently, there are fascinating lectures by Alexander Polyakov and Nima Arkani-Hamed as well as coverage of the famous supersymmetry wager, and more will be added. You can subscribe to the Niels Bohr International Academy Youtube channel here. Given the continuing popularity of the NBIA public lectures described elsewhere in this newsletter, I think it is safe to say: "Yes, they can hear us!"

UPCOMING EVENTS AT NBIA

Workshops & PhD Schools

- Higgs Effective Field Theory workshop (October 26-28, 2016)
- Nordic Winter School on Cosmology and Particle Physics (January 2-7, 2017)
- Simons Program on Condensed Matter Physics (May - June, 2017)

Niels Bohr International Academy
Niels Bohr Institute
Blegdamsvej 17, DK-2100 CPH
Coordinator: Anette Luff Studsgård
+45 3533 7870 - studsgaard@nbi.dk

The Niels Bohr International Academy

RESEARCH HIGHLIGHT on Particle Physics

Jacob Bourjaily

The traditional framework of quantum field theory—described in all textbooks—is no longer the one used by experts for practical computations. Feynman diagrams, however intuitive, depend on too many unobservable degrees of freedom, rendering all but the simplest scattering amplitudes (those involving the fewest states at the lowest orders of perturbation) computationally intractable or theoretically inscrutable. A new language for fundamental physics is under rapid development, with many important discoveries being made by NBIA researchers. Among the most important insights is that perturbative amplitudes should first be determined at integrand level—postponing the complications of loop integration until later. This is because, prior to integration, amplitudes are always rational functions, completely determined by their residues. These residues are always determined by lower-order amplitudes, without any reference to unphysical data. Interestingly, at least for theories such as the Standard Model, only a finite number of distinct residues ever exist—independent of loop-order! An infinity of loop amplitudes can be determined from a finite list of functions. This surprising fact was proven through the correspondence between these residues and Grassmannian geometry. These new developments have led to many important insights and powerful new technology. One application, for example, was the recent determination of a particular scattering amplitude to 10 loops (!)—setting the record for the highest order reached for any 4 dimensional theory. This record has been continuously held (and twice broken) by Bourjaily since 2011.

NEWS FROM THE NIELS BOHR INTERNATIONAL ACADEMY

These public lectures are organized jointly with Folkeuniversitetet and will be held at the Niels Bohr Institute in the historic Auditorium A, from 5:00pm to 7.00pm. The talks on various topics in modern theoretical physics will be given in English by NBIA members on two different dates. They will give you a glimpse of the questions, ideas and approaches that are right now at the scientific forefront. Sign up for courses 1052-1053 at http://www.fukbh.dk

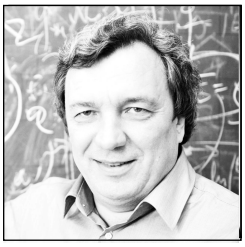
1. The Pauli Principle
   (Jan-Philip Solovej, 24-25/10)
2. Inflation and Modern Cosmology
   (Slava Mukhanov, 31/10-1/11)
3. What is Dark Matter?
   (Will Shepherd, 7-8/11)
4. Supernova Explosions and Neutrinos
   (Irene Tamborra, 14-15/11)
5. Towards Quantum Computing
   (Charles Marcus, 21-22/11)

NEW NBIA MEMBERS AND VISITORS

Below you will learn about the newcomers at the NBIA this fall (before Oct. 1st). In addition, because of the new Simons Program on Cosmology and Particle Physics and because of the increased activity in astroparticle physics, we are having a steady stream of visitors and seminar speakers within astroparticle physics and cosmology. In addition, Roger Penrose will visit NBIA and give a talk related to his new book. Many more activities can be found on our webpage at www.nbia.dk.

Ajit Coimbatore Balram is a new postdoc at NBIA. His research interests are in the field of theoretical condensed matter with an emphasis on the physics of the fractional quantum Hall effect and topological insulators.

Peter Denton is a new NBIA postdoc with varied interests, focusing on astroparticle and neutrino physics. He is interested in determining the sources of high energy particles and probing particle physics in extreme astrophysical environments.



Viatcheslav Mukhanov is the Simons Visiting Professor this semester from the University of Munich. He is a cosmologist known for the theory of the Quantum Origin of the Universe Structure. He predicted the spectrum of inhomogeneities from initial quantum fluctuations.

Jens Oluf Andersen is a visiting professor from Trondheim. His research interests are QCD in extreme conditions, i.e. high temperature, high density and strong magnetic fields and its applications.

Mohamed Rameez is a new NBIA postdoc. Rameez has worked on Dark Matter indirect detection and point source searches with the IceCube detector. While at NBIA, he hopes to better understand Cosmology and local universe anisotropies.

Meng-Ru Wu joins the NBIA as a postdoc working on theoretical particle- and nuclear- astrophysics with particular focuses on neutrinos, core-collapse supernovae, neutron star mergers, and the formation of elements in the Universe.