



NBIA NEWSLETTER

NEWS IN BRIEF

GRANT FROM INDEPENDENT RESEARCH FUND DENMARK

NBIA Professor MSO Martin Pessah has received a grant of 2.6 MDKK from the Independent Research Fund Denmark | Natural Sciences to carry out a research project on the subject of gaps carved by forming planets in protoplanetary disks. The grant will be devoted to hiring a postdoctoral researcher in the coming year.

EU INNOVATIVE TRAINING NETWORK GRANT

Emil Bjerrum-Bohr, Jacob Bourjaily, Poul Henrik Damgaard and Michael Trott have received 4.4 MDKK from the EU as part of the Innovative Training Network "Scattering Amplitudes: from Geometry to Experiment." The grant will allow the group to hire two PhD-students who will work on modern developments towards a highly efficient computation of scattering amplitudes.

EU MARIE CURIE FELLOWSHIPS

NBIA post-docs Matt von Hippel and George Mamatsashvili have been awarded two-year EU Marie Curie Fellowships. Matt's project entitled "Amplitudes Bootstrap" aims to vastly extend bootstrapping techniques for scattering amplitude calculations. He aims to extend these ideas to the broader class of functions that are needed to describe amplitudes in general. George and collaborators have developed new tools to investigate non-linear dynamics in shear flows where the energy cascade is strongly anisotropic. In his project, entitled "Turbulence in Accretion Disks – New Perspectives," George will further develop these ideas in order to provide new insights into the fundamental problem of sustenance of magnetohydrodynamic turbulence and angular momentum transport in differentially rotating disks.

A MESSAGE FROM THE DIRECTOR

Poul Henrik Damgaard

This year we have welcomed two new members to the NBIA Boards. Barry Simon (Caltech) has joined the NBIA's International Science Advisory Board, and Kirsten Smedegaard Andersen has joined the Director's Advisory Council. These two advisory boards play an incredibly important role for us, and we are very much indebted to all members for their support, help, suggestions and advice. Many of the important developments over the past few years would not have been possible without that support. While NBIA scientists do extremely well in terms of receiving individual research funding, the NBIA itself needs to be able to strike out in brand-new directions by offering young scientists in burgeoning areas the chance to establish new research groups at the NBIA. In this Newsletter, I am happy to report that the Danish Aage and Johanne Louis-Hansen Foundation has granted the NBIA the possibility to offer up to four fixed-term junior appointments for the next five years. We expect to be able to use this unique opportunity to expand into several new research areas, always in the light of our general strategy which is that sheer scientific excellence will trump any strategic decisions. It will be exciting to see which new research areas may appear as a result of this large expansion. Our search will take place over the coming months so that I should be able to report on the result in the Spring Newsletter.

THE VIEW FROM THE BOARD

Andrew D. Jackson

We all appreciate the generosity of the Aage and Johanne Louis-Hansen Foundation and the confidence it has shown in the mission of the NBIA and the prospects for its success. But such gifts do not "just happen." They require hard work. The Director's Advisory Council has been a continuing source of suggestions and — as its name implies — good advice. Its chairman, Lars Kann Rasmussen, has worked with us in literally every step of the process. We thank them all! This grant means far more than money. It signals the start of a new era in which the NBIA will be able to initiate new ventures on the basis of their scientific interest without the necessity of first securing external funding. This era will also present new challenges. It will be necessary for us to craft new strategies to find the right fields, to identify the right people, and to convince them to join us in Copenhagen. The challenge lies in the fact that many of these new ventures will be in fields where there is likely to be little or no resident expertise at the Niels Bohr Institute. Fortunately, we will be able to call upon the knowledge and experience of the members of the NBIA International Science Advisory Board. In short, there is every reason to feel confident that we will "get by with a little help from our friends."

UPCOMING WORKSHOPS AND PHD SCHOOLS

- Nordic Winter School on Cosmology and Particle Physics 2019 (January 1-7)
- Simons Program: Large-N field theory, string theory and hadrons (February 25-March 1)
- Simons Program: Amplitudes in string theory and field theory (March 18-22)
- Conference: Zooming in on Star Formation (June 10-14)
- Current Themes in High Energy Physics and Cosmology (August 19-23)
- Workshop: Neutrino Quantum Kinetics in Dense Environments (August 26-30)

NEW NBIA MEMBERS

This Fall, NBIA welcomes a number of new postdoctoral members working in a wide range of fields within Physics as described below. We also give a warm welcome to our new PhD students, **Kays Haddad** and **Anna Suliga**, and our new MSc students, **Peter Daly**, **Gregory Gold**, **Lea Halser**, **Henrik Jessen Munch**, **Charlotte Rosenstrøm** and **Johannes M. Sørensen**.



Tyler Corbett has worked on particle phenomenology during his PhD and currently focuses on Effective Field Theories and their application to Higgs physics. He has also recently branched out into some studies of Baryogenesis and Z primes as a solution to the observed anomalies in B decays.



Humberto Gomez Zuniga develops methods and extensions of the so-called CHY approach or Ambitwistor string. He has studied the underlying mathematical structures encoded in the scattering equations as well as developed techniques to make analytic computations.



George Mamatsashvili works on astrophysical fluid dynamics, with focus on the stability, dynamics and evolution of accretion disks, jets and shear flows. He studies the mechanisms of onset and sustenance of turbulence and its transport properties in these flows via computer simulations.



Shashank Shalgar is primarily 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.



Christian Vergu works on scattering amplitudes in N=4 supersymmetric Yang-Mills theory and connected areas. He is also interested in mathematical aspects of loop integrals, such as symbols and motives, cluster algebras, and their interplay with the projective geometry of dual twistor space.

RESEARCH HIGHLIGHT on Cosmology

Subodh Patil

Cosmology is the study of the Universe at the largest conceivable scales. Particle physics is the study of the Universe at the smallest possible scales. So what could the two subjects possibly have to do with each other? Quite a lot, as it turns out. The current state of the Universe and its future evolution are dictated by a set of initial conditions at the big bang, when densities and temperatures were so high that physics at energies far higher than what we can achieve in terrestrial particle accelerators was operative. My research broadly focuses on understanding more about very high energy physics through a range of astrophysical and cosmological observations. The techniques I primarily use are those of a particle physicist — Effective Field Theory (EFT) — but applied towards looking for signatures of new physics in observations of the cosmic microwave background (CMB), the distribution of large scale structure in the Universe, and more recently, gravitational waves. Here at the NBIA, we have assembled leading expertise in applying EFT to looking for signatures of physics beyond the Standard Model of particle physics in collider experiments. I am actively involved with taking these techniques and adapting them towards the analysis of cosmological observations to try and understand the particle physics origins of the initial conditions at the big bang. Together with collaborators at the NBIA, we have recently developed a technique to map non-trivial scale dependence that might be present in correlation functions of the anisotropies in the CMB into parameters of the effective theory of inflation, the hypothesized epoch that preceded the big bang and set up its initial conditions, offering a window into the particle physics origins of inflation. I've also recently been involved in calculating quantum corrections to cosmological observables involving primordial gravitational waves, the detection of which would allow us to detect the presence of fields that are completely hidden from the Standard Model. More recently, I have also worked on using constraints from the CMB and other tracers of small scale structure such as pulsar timing arrays to test the idea that the black holes that the LIGO gravitational wave observations have purportedly detected could have been primordial (rather than astrophysical) in origin. However the real work is just beginning. In the near future, cosmologists will be confronted with a windfall of data from surveys of the large scale structure of the universe and improving gravitational wave observations that will allow us to ask more accurate questions about the origins of the big bang, with efforts at the NBIA leading the charge.



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. www.fukbh.dk

1. Turbulent plasma: from fusion power plants to intergalactic space and back (Alexander Schekochihin, 22/10)
2. String theory, black holes & information (David McGady, 29/10)
3. Controlling quantum nanosystems (Mark Rudner, 5/11)
4. IceCube: the South Pole neutrino detector (Jason Koskinen, 12/11)
5. The big rip, the ultimate fate of the universe? (Subodh Patil, 19/11)

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