A MESSAGE FROM THE DIRECTOR

Niels Obers

Quantum science and technologies are increasingly in focus internationally, with a large presence in the Nordic region. The exciting Nobel prize in physics 2022 for quantum entanglement and pioneering quantum information science has given an extra impetus to this and further underscores the potential of future developments.

Various ambitious initiatives, from large scale experimental to theoretical collaborations, are currently being pursued in the Nordic countries. Thanks to the Wallenberg Initiative on Networks and Quantum Information (WINQ), hosted at Nordita and launched in part with our June 2022 workshops, Nordita has a great opportunity to contribute to this research field at the international frontier. WINQ also addresses the related emerging field of network science.

All this encompasses an area in which there are excellent opportunities for enhanced collaboration, utilizing synergies and creating a critical mass in the Nordic context. As a Nordic Institute, Nordita is well positioned and committed to play a central role in this, facilitating and contributing to networks that promote and support such Nordic links in research and education. I look forward to reporting in the future on the next steps in these exciting developments.

OPEN POSITIONS

Postdoctoral Fellow Positions in Dynamic Quantum Matter, Materials Informatics, and Quantum Matter for Sensing
Deadline: December 15, 2022
Application and Information

Postdoctoral Fellowship at Nordita in the Wallenberg Initiative on Networks and Quantum Information (WINQ)
Deadline: January 5, 2023
Application and Information

Postdoctoral Fellow in cosmology at Nordita: Exploring the dark sector with new microphysics in the early Universe
Deadline: December 12, 2022
Application and Information
**NEWS IN BRIEF**

**WINQ Launching workshops**

The pair of three days workshops, planned as part of the launch of the Nordita based Wallenberg Initiative on Networks and Quantum Information (WINQ), were finally held June 8–15, after a two year delay because of the covid-19 pandemic. The format consisted of various overview talks along with shorter talks. Sessions also included lively discussion (aided in part by “slido”, an app that enables to collect questions/remarks during the talks) which subsequently formed the basis for more in depth discussions and exchanges. This resulted in an interactive and open atmosphere at the workshops and in all they were considered a success. It served to highlight the exciting directions in the fields and provide exposure of WINQ to the community.

**Nordita Alumni Event**

On September 19, 2022, Nordita organized its first alumni event. Four previous researchers from Nordita, who are currently pursuing careers outside theoretical physics, presented their background and career trajectory. This included their experiences in applying for a job outside academia after the Nordita position, the process by which they were recruited/hired as well as their current position. The latter included information on the type of work they are engaged in, possibilities to develop and the relevance of their skills acquired during their physics research. The presentations were followed by a lively Q&A from Nordita researchers after which there was reception providing further opportunity to network and mingle.

**Visit of the Dutch minister of Education, Culture and Science**

Nordita had the pleasure and honor to welcome the Dutch minister of Education, Culture and Science, Robbert Dijkgraaf to Nordita on Thursday October 13. The minister was accompanied by a small delegation of the Dutch ministry as well as the Dutch embassy in Sweden. We talked about science at Nordita, including the new Wallenberg Initiative on Networks and Quantum Information (WINQ), and its relation to Swedish, Nordic and Dutch initiatives. Some of the latest developments in string theory were also discussed as well as education and career paths of young researchers.
RESEARCH HIGHLIGHTS

Exact correlation functions from integrability

Quantum Field Theory (QFT) is a notoriously difficult subject and a clear understanding of quantum fields at strong coupling is lacking to this day. Elementary quanta of a field arrange themselves, it is believed, along a one-dimensional line and behave effectively as a string when interactions become sufficiently strong. This mechanism explains quark confinement in simple terms, but its precise and detailed formulation has proven evasive so far. The best hope is the holographic duality which provides a consistent mathematical framework to explore the stringy phase of QFT. Holography has brought to light unexpected connections to quantum gravity and black holes that were obscured, or thought impossible before and uncovered a new relationship between gauge theories and integrable systems enabling an insight into genuine non-perturbative phenomena.

Researchers at Nordita and École Normale Supérieure in Paris proposed a new method to compute correlation functions using integrability with full account of wrapping effects, which was a stumbling block in the previous work. Their construction is based on splitting the string world-sheet into two (or more) hexagons which are then glued together along common edges. The gluing rules known before did not take into wrapping corrections, while the new proposal is fully consistent with the closed-string boundary conditions.

Localization enhancement by opening a quantum system

Open quantum systems, i.e. the quantum systems, coupled to reservoirs, are known to provide several intriguing phenomena in physics. One of the remarkable examples is the enhancement of the thermalization by the coupling of a quantum system to a bath, even when the isolated system was stuck and localized due to imperfections and disorder. However, recently the group of young researchers at Nordita and University of Illinois Urbana-Champaign, modeling an open quantum system by a non-Hermitian Hamiltonian, has found an opposite effect.

Indeed, the researchers have shown that adding gains and losses to the system may enhance the localization and avoid thermalization.

This counterintuitive phenomenon appears due to the competition of the dissipation and the disorder, provided by the coupling to the reservoir.

Anderson localization as a phenomenon of the localization of non-interacting particles of an isolated quantum system, subject to strong quench disorder, is described by the effects of the interference.

Non-Hermiticity mimicking the system opening to a reservoir is believed to break down the interference effects and, thus, it gives a way to the delocalization.

Unlike this, the effect of gains and loss in long-range models, that are known to be proxies of the Hilbert-space structure of an interacting version of the Anderson localization, affects a so-called non-ergodic, but delocalized phase and even bring it to the Anderson localization.

This phenomenon opens the way to the stabilization of a quantum memory in disordered quantum systems by opening them to the reservoirs.

B. Basso, A. Georgoudis, A. Klemenchuk Sueiro
"Structure constants of short operators in planar N=4 SYM theory,”
arxiv.org/abs/2207.01315

G. De Tomasi, I. M. Khaymovich
“Non-Hermitian Rosenzweig-Porter random-matrix ensemble: Obstruction to the fractal phase”
doi.org/10.1103/PhysRevB.106.094204
RECENT EVENTS

Young Researchers Integrability School 2022

After a hiatus due to the pandemic, the latest edition of the Young Researchers Integrability School took place this October at NORDITA. The school, titled “Taming the string world sheet”, saw the participation of 70 researchers and lecturers by Saskia Demulder, Sibylle Driezen, Bob Knighton, Gerben Oling, Ana Retore, Fiona Seibold, and Ziqi Yan. Their courses introduced the students to different approaches to understand the string worldsheet, including the worldsheet-CFT and “hybrid” approach, the Green-Schwarz-based integrability approach, discrete-light cone quantization, and non relativistic limits.

The school was supported by the Royal Society, Science Foundation Ireland, the GATIS+ network, the University of Padova, and NORDITA.

Organizers: Marius de Leeuw (Trinity College Dublin), Rob Klabbers (Humboldt University Berlin), Niels Obers (Nordita Stockholm), Alessandro Sfondrini (University of Padova), Roberto Volpato (University of Padova)

Current and Future Themes in Soft & Biological Active Matter

The four weeks long school on Current and Future Themes in Soft & Biological Active Matter took place at Nordita in Stockholm July 25- August 19, 2022. The focus of the school was on emerging areas in soft and active matter physics together with their growing applications in biological systems.

The summer school attracted students and early career researchers from Europe, USA, Australia, and Asia. Each week focused on one overarching theme, which allowed the participants to be exposed to the state-of-the-art advances and new directions in the field. The four main themes included: (i) Physics of living matter, (ii) Topology in Biology (iii) Interactions with complex environments, and Future perspectives in soft matter. The thematic format of the program that covered both broad picture and technical side of hot topics in soft and active matter, together with future perspectives from distinguished soft matter researchers, proved to be specifically inspiring for early career researchers in the Nordic to help identify new ideas and potential research directions for their research groups and increase their success in receiving early career grants.

Organizers: Amin Doostmohammadi (Niels Bohr Institute), Chantal Valeriani (Madrid), Gareth Alexander (Warwick), Julia Yeomans (Oxford), Miha Ravnik (Ljubljana), Tapio Ala-Nissila (Alto University).

Lecturers included Mike Cates (Cambridge), Angelo Cacciuto (Columbia), Patrick Charbonneau (Duke), Paul Dommersnes (NTNU), Jörn Dunkel (MIT), Gerhard Gompper (Julich), Mogens Høgh Jensen (Niels Bohr Institutet), Teresa Lopez-Leon (ESPCI Paris), Corinna Maass (Twente), Arnold Mathijssen (U Penn), Ignacio Pagonabarraga (EPFL), Srim Ramaswamy (Indian Institute of Science), Andela Saric (IST Austria), Anupam Sengupta (Luxembourg), Tyler Shendruk (Edinburgh), Anton Souslov (Bath), Thomas Speck (Mainz), Joakim Stenhammar (Lund), Kristian Thijsen (Cambridge), and Giovanni Volpe (Gothenburg).
Exploring the Dark Sector with New Microphysics in the Early Universe
Florian Niedermann

The success of our cosmological standard model has been threatened by differing measurements of the Universe’s expansion rate. This so-called Hubble tension has recently been claimed to have a five-sigma significance, excluding the possibility of a statistical fluke. I propose that the Hubble tension is the signature of a new eV-scale phase transition in the dark sector. It is triggered shortly before recombination and leads to the decay of an early phase of dark energy. This new microscopic scenario opens the door to a more fundamental description of the dark sector, where dark matter and different phases of dark energy could be related to the same dark sector symmetry group. To establish this idea as a novel cosmological paradigm, (a) microscopic and (b) cosmological model building must complement and inform each other. (a) will be guided by longstanding particle physics challenges, such as the origin of neutrino masses and the cosmological constant problem. (b), on the other hand, will be constrained by cosmological datasets with unique signatures in the cosmic microwave background, matter power spectrum, gravitational wave observations and particle physics experiments.

Spontaneous Dynamical Self-Organization
Antti Niemi

The aim of the project is to develop theoretical physics based paradigms to explain how autonomous rotating molecular machines operate. A rotating molecular machine is a deformable body, and deformability is pivotal for its function. The concept of symmetry breaking is combined with topological and geometrical tools to explain how geometry in the space of all possible shapes a deformable body can make fast cyclic motions such as individual atom thermal (quantum) vibrations to self-organize into a uniform rotational motion of the entire molecule: Whenever the holonomy of shape space is nontrivial, a spontaneous dynamical self-organization can occur and make a deformable body to undergo a rotational motion, even with no angular momentum.

Supernova Induced Processing of Interstellar Dust
Lars Mattsson

Enormous amounts of dust found in the high-redshift Universe make for a problematic situation, i.e., all the dust observed in galaxies cannot easily be accounted for as no low mass stars could have evolved to their dust producing phase when the Universe was only 1-2 Gyr. We will study how supernovae (SNe) interact with the surrounding dusty interstellar medium (ISM) to answer mainly two important questions: (1) are SNe net producers or net destroyers of dust? (2) Is dust over or under-abundant in newly formed cold molecular clouds? We seek to answer these questions primarily by means of advanced HPC numerical simulations which go beyond the current state of the art. We will also compute spectral energy distributions and extinction curves based on known optical properties of dust to establish links between simulations and observations. New facilities (e.g. ELT, JWST) provide a great opportunity to discriminate between possible solutions and contributing factors.
Habib Rostami
In August 2017, Habib joined Nordita as a postdoc working in the condensed matter group with Alexander Balatsky. Since January 2019, he has been a Nordita assistant professor based on a personal VR starting grant. In December, Habib will start a Lecturer (tenure-track assistant professor) position at the University of Bath in the UK. In addition to undergraduate and graduate teaching, he will develop his research group in the theoretical and computational physics division at the department of physics. His research will mainly aim to theoretically model transport and optics in quantum materials.

Woosok Moon
In September, after five years as a Nordic Assistant Professor, Woosok Moon has returned to South Korea on the permanent faculty of Pukyong National University. Following his PhD at Yale, Woosok was a Herchel-Smith fellow in the Department of Applied Mathematics and Theoretical Physics, University of Cambridge, before moving to Nordita in 2017. Here, he developed a research program in stochastic processes and their manifestations in soft condensed matter and statistical physics and climate dynamics, supervising graduate students and post docs and developing collaborations with faculty near and far. We hope to see him back in Stockholm often and wish him well in his new position.

Ivan Khaymovich
In May 2022 Dr. Ivan M. Khaymovich started a Nordita Assistant Professor position.

He works in various topics, ranged from Anderson and many-body localization and breaking of quantum thermalization to the superconductivity, Coulomb blockade and the Maxwell’s Demon paradox.

Ivan did his PhD on superconductivity in 2013 in Nizhny Novgorod, Russia. Then after 2 postdoc positions in Aalto University (Finland) and CNRS Grenoble (France), he has spent 5 years as a staff scientist in the Max Planck Institute in Dresden.
NORDITA SCIENTIFIC PROGRAMS 2023

Particle Growth in turbulence
March 20 — 31, 2023
Organizers: Axel Brandenburg, Bernhard Mehlig, Gunilla Svensson

Towards a comprehensive model of the Galactic magnetic field
April 3 — 28, 2023
Organizers: Jennifer West, Francois Boulanger, Torsten Enßlin, Frederick Gent, Marijke Haverkorn, Tess Jaffe, Jörg R. Hörandel, Anvar Shukurov

FLOW physics for climate
May 1 — 26, 2023
Organizers: Claudia Cenedese, Luca Brandt, Ekaterina Ezhova, Shervin Bagheri, Frida Bender, Geert Brethouwer

Unifying the epidemiological and evolutionary dynamics of pathogens
May 29 — June 23, 2023
Organizers: Ganna Rozhnova, Igor Rouzine, Tom Britton

Amplifying Gravity at All Scales
June 26 — July 21, 2023
Organizers: Henrik Johansson, Daniel Baumann, Zvi Bern, Alessandra Buonanno, John Joseph Carrasco, Paolo Di Vecchia, Andrea Puhm, Oliver Schlotterer

New Perspectives on Quantum Field Theory with Boundaries, Impurities, and Defects
July 31 — August 11, 2023
Organizers: Matthew Buican, Christopher Herzog, Charlotte Kristjansen, Andy O'Bannon, Konstantin Zarembo

Categorical Aspects of Symmetries
August 14 — 25, 2023
Organizers: Michele Del Zotto, Kenneth A. Intriligator, Muyang Liu, Nicolai Reshetikhin

Hydrodynamics at all scales
September 4 — 29, 2023
Organizers: Jay Armas, Cristina Marchetti, Leo Radzihovsky, Amos Yarom

Scientific Programs are an integral part of research at Nordita. The international scientific community is invited to propose future programs with a deadline in November 2023 for submitting proposals to be held in 2025.

A Nordita Scientific program is an extended workshop where a limited number of scientists work together on specific topics for a period of up to four weeks. Program topics can range beyond the traditional borders of theoretical physics and scientists in related areas of the natural sciences are encouraged to submit proposals.

For more information about Nordita events visit:
nordita.org/events/programs
A MESSAGE FROM THE BOARD

Susanne F. Viefers

A new three year period for the Nordita board started on July 1st, with a nice mix of experienced people continuing from the previous period, and some fresh members. You can check out the detailed list of board members at nordita.org/board

It was very exciting to be appointed as the new chair of the board, and I would like to take this opportunity to introduce myself and some of the work we will be doing. I am presently the Head of Department of Physics at the University of Oslo, where I am also professor of theoretical physics. My scientific background is in theoretical condensed matter physics, with focus on topological quantum phenomena.

Nordita has been an important part of my professional life ever since I was a student, and I consider myself a true “nordist”: I went to Copenhagen as a Nordita fellow right after my PhD. This was followed by postdoc positions in Jyväskylä and Göteborg, then finally a permanent position in Oslo. After Nordita’s move to Stockholm, I had the pleasure of serving on the board from 2007-2019. It was great to see Nordita reinvent itself and grow in this new environment, keeping and further developing its scientific excellence and its strong international brand.

The recent WINQ initiative will be a boost of great importance to the institute for years to come. The long-awaited move to the beautiful new building was another highlight. But while Nordita is in an excellent position in terms of science and infrastructure, there are challenges. In particular, the ever decreasing Nordic funding makes it less obvious how to preserve the Nordic nature and brand of the institute. These are issues the board will certainly be working on. Another main task for the coming year is recruiting the next director, as Niels Obers is approaching the end of his term. The search is ongoing, and several interesting candidates have already contacted, or been suggested to, the search committee. But you should still feel free to contact me if you are interested or would like to suggest a candidate!

As the new period is getting started, I would like to thank the previous chair Stellan Östlund and the board members who stepped down this summer for their excellent work on behalf of Nordita. The new board is ready to get started. Do feel free to contact your national board members or me if you have any questions or suggestions to the board!

UPCOMING WORKSHOPS & SCHOOLS

December 12—14, 2022
VASCO 2022 Workshop
nordita.org/vasco2022

January 16—27, 2023
Nordita Winter School 2023: Dynamics of Open Classical and Quantum Condensed Matter Systems
nordita.org/winterschool2023

May 08—11, 2023
Workshop on Non-relativistic Strings and Beyond
nordita.org/events/