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Contents

Mathematical Physics at Matematisk Institut, Aarhus Universitet, 1954–2004 3
The Dannie Heineman Prize 11
IUPAP Conference Sponsorship 13
News from the IAMP Executive Committee 13
Contact coordinates for this issue 16

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News Bulletin (International Association of Mathematical Physics)
Mathematical Physics at Matematisk Institut, Aarhus Universitet, 1954–2004

by SØREN FOURNAIS, ARNE JENSEN, and JACOB SCHACH MØLLER

Introduction

The Mathematics Institute, Aarhus University, Denmark, has played a significant role in developing mathematical physics, both in Denmark, and in a wider international context.

We will describe some of the activities and people in mathematical physics at Aarhus University during the period 1954 to 2004. Aarhus University was established in 1928. Mathematics was established in 1954 by the hiring of Professor Svend Bundgaard. He was hired not for his contributions to research but with an expectation that he could develop an internationally focused teaching and research institute in mathematics.

It was a good time to establish a new science department, since the Danish government in the early 1950’s put increased emphasis on science education. This initiative should be seen in an international context. The USA had begun emphasizing science education right after the end of the war, and many Western countries did the same. This should also be seen in the context of the Cold War. Thus when Prof. Bundgaard in collaboration with some other professors in science proposed substantially increased funding for chemistry, mathematics, and physics, it was positively received.

The Chemistry and Physics Departments were established much earlier, but had not had many students in science. Prof. Bundgaard was the driving force behind the expansion. Teaching at the Mathematics Institute started in September 1956, with two students enrolled.

In 1960 the number of students in chemistry, mathematics, and physics was more than 200, a number that by 1970 had increased to almost 1000. This growth required a substantial increase in the number of assistants and professors. The policy for filling new positions in mathematics was very different from the other two departments. New positions in chemistry and physics were filled as they became available. Prof. Bundgaard had a different approach. Some professor positions in mathematics were converted to long-term visiting positions, and other positions were filled on a temporary basis.

We list a few of the early long term visiting professors, in areas related to mathematical physics.

- Monroe Donsker 1959–60 (1 year)
- Konrad Jørgens 1962–63 (9 months)
Mathematical Physics at Matematisk Institut, Aarhus Universitet, 1954–2004

- Irving E. Segal 1965–66 (6 months)
- Richard V. Kadison 1965–66 (1 year)
- Kiyosi Itô 1967–69 (2 years)
- Ralph Phillips 1968 (1 year)
- André Unterberger 1974–75 (1 year)
- Shige Toshi Kuroda 1976 (9 months)

The visiting professors gave graduate courses and were advisors to Master degree students, besides carrying out research. We mention that in the academic year 1965–66 Richard V. Kadison organized seminars on operator algebras, and in this connection brought several of his PhD students and collaborators to Aarhus. Since then research in operator algebras has had a strong position at the universities in Aarhus, Copenhagen, and Odense.

In some cases the lectures given by the visiting professors were published in the Institute Lecture Notes series, see [9, 6, 7, 13, 14, 15].

In 1968 the Institute moved to its present location at Ny Munkegade. The new building had facilities for housing short term and long term visitors. There were 8 guest rooms and 4 apartments. There was also a large cafeteria in the building. These facilities made it much easier to attract visitors.

The study programs offered were of two kinds. One corresponded to a Masters degree, typically combining two subjects, e.g., mathematics and physics. The other was in one subject only, and
had the goal of preparing for a career as researcher. Soon the distinction between the two degrees disappeared, at least in mathematics.

Higher degrees than the MSc existed in the university regulations, both one corresponding to the PhD and one corresponding to Habilitation, but they were not used at the Mathematics Institute until late 1970’s and early 1980’s. In the early days research education was a combination of advanced courses and seminars, given primarily by visiting professors, and education of the young talents at foreign universities, primarily in the USA. Study at foreign universities was supported by stipends from Aarhus University. Two early examples will be mentioned.

Erik Balslev started his studies in mathematics as one of the first students at the new institute. He received his Masters degree in 1961, then went to University of California, Berkeley, where he received his PhD in 1963 under the direction of Prof. Tosio Kato. Dissertation: Perturbation of Differential Operators.

Gerd Grubb started her studies at University of Copenhagen, but after finishing the equivalent of a BSc she continued her studies at Aarhus University in 1959, where she received her MSc (equivalent) degree in 1963. She then went to Stanford University and received her PhD under the direction of Prof. Ralph Phillips in 1966. Dissertation: A Characterization of the Non-Local Boundary Value Problems Associated With an Elliptic Operator.

Research in Mathematical Physics

Research in mathematical physics started early at the Institute. In 1956 Ebbe Thue Poulsen was hired as assistant professor (equivalent) in mathematics, and in 1957 Povl Kristensen was hired as professor in theoretical physics. Both had an interest in the interplay of mathematics and physics and initiated a long term collaboration. They were later joined by another assistant professor in mathematics, Lars C. Mejilbo. Together they developed a framework of tempered distributions in infinitely many variables with the goal of studying quantum field theory rigorously, [10, 11, 12].

In this connection it should be mentioned that Povl Kristensen was one of the founding editors of Communications in Mathematical Physics (founded by Rudolf Haag).

After his PhD Erik Balslev spent time at UCLA, IHES, and CNRS, Marseille. He worked on various aspects of differential operators and also field-theoretic questions; see [2]. The stay in Marseille led to collaboration with J. M. Combes on many-body Schrödinger operators with dilatation-analytic interactions [1]. Erik Balslev returned to Aarhus University as professor in 1974 and continued to work on spectral and scattering theory for Schrödinger operators until approximately 1995. At that time his interests turned to spectral theory for the Laplacian on hyperbolic manifolds.

1974–85

During this period the activities in mathematical physics were centered around Erik Balslev. During Spring 1976 Shige Toshi Kuroda gave a series of lectures on stationary scattering theory [13], which inspired much subsequent research in the mathematical physics group. Arne Jensen received his MSc with Erik Balslev as advisor in January 1976 (thesis on resonances and poles of the scattering matrix). He continued as a PhD student with Erik Balslev as the
formal advisor. The PhD studies were carried out at University of California, Berkeley, with Tosio Kato as the actual advisor and collaborator. He received his PhD in January, 1979, from Aarhus University.

Erik Balslev lectured regularly on various aspects of Schrödinger operators and had a number of MSc students 1980-85. One of them was Erik Skibsted. He received his MSc in 1985 and his PhD in 1986, both with Erik Balslev as advisor.

1985–97

During this period there was increased activity in mathematical physics. Arne Jensen became associate professor in 1985. After his PhD Erik Skibsted had a 3 year postdoc position at Aarhus University. In 1990 he became associate professor at the Institute.

Besides pursuing research in mathematical physics, mainly spectral and scattering theory for Schrödinger operators, a number of workshops were organized and a substantial number of short-term visitors were hosted by the mathematical physics group. As an early example we mention the meeting in 1985 [3].

In 1988 the Nordic Summer School in Mathematics was dedicated to Schrödinger operators. It was organized by Helge Holden (Trondheim) and Arne Jensen. It was held August 1–12 at the Aarhus University conference facility Sandbjerg Slot, located in southern Denmark. Several series of lectures were given and a few shorter talks were also given. As examples we mention some of the lecture series; see [8].

- B. Helffer and J. Sjöstrand, The Schrödinger equation with magnetic field, and the Harper equation.
- W. Hunziker, Asymptotic perturbation theory for Schrödinger eigenvalue problems.
- Tosio Kato, Nonlinear Schrödinger equations.
- Werner Kirsch, Random Schrödinger operators.
- Elliott H. Lieb, Kinetic energy bounds and their application to the stability of matter.
- I. M. Sigal, Many-body scattering problem.

The summer school was attended by approximately 40 PhD students and recent graduates. It was a remarkable gathering of talent, viewed with hindsight. Among the participants we mention Volker Bach, Gian-Michele Graf, Frédéric Klopp, Izabella Łaba, Shu Nakamura, Erik Skibsted, Jan Philip Solovej, and Horng-Tzer Yau.

A long workshop was held May 15 to August 1, 1991. Several of the participants stayed for one or two months, including Israel M. Sigal and Jan Dereziński. The focus was the quantum mechanical many-body problem. During this period Jan Dereziński solved the asymptotic completeness problem for $N$-body Schrödinger operator with long range potentials, [5]. Some of the contributions to the program are in the Proceedings [4].

Jan Philip Solovej joined the mathematical physics group as research professor in June 1995. He moved to Copenhagen in August 1997. His addition to the group substantially expanded the research areas covered. He advised two PhD students during the time at Aarhus,
Søren Fournais and Thomas Østergaard Sørensen. They both spent time at University of Copenhagen 1997–98, completing their studies. Thomas Østergaard Sørensen received his PhD in 1998, dissertation: *Towards a relativistic Scott correction*, and Søren Fournais in 1999, dissertation: *Semiclassics of Quantum Current in Weak and Strong Magnetic Fields*. Both degrees were obtained from Aarhus University.

1998–2004

Søren Fournais was a postdoc in Aarhus in 2000, and then moved to Austria and France. He returned to Aarhus in 2006.

Jacob Schach Møller received his PhD in 1998 with Erik Skibsted as his advisor, dissertation: *Two applications of positive commutator estimates in spectral and scattering theory*. He had positions in France and Germany until 2004, when he returned to Aarhus.

In April 1998 the Centre for Mathematical Physics and Stochastics (MaPhySto) started its activities. The director was Ole Barndorff-Nielsen (professor in theoretical statistics). MaPhySto had approximately 20 principal investigators from the universities in Aarhus, Aalborg, Copenhagen, and Odense. It was funded by the Danish National Research Foundation. The substantial funding led to increased activities in mathematical physics at the Institute in Aarhus, in particular, but also in Aalborg and Copenhagen. A large part of the activities were in stochastics, with activities at Aarhus, Aalborg, and Copenhagen.

The activities in mathematical physics included workshops and advanced series of lectures, besides a large number of short term visitors. We give a few examples of activities in Aarhus:


- August 1999: Advanced course on second-quantized Hamiltonians. Lectures by Jan Dereziński.

- August 2000: Summer School on Quantum Field Theory - from a Hamiltonian point of view. Held at Sandbjerg Slot. Lecture series by Volker Bach (Spectral analysis of nonrelativistic quantum electrodynamics), Jan Dereziński (Spectral analysis of simple models of quantum field theory), Gian-Michele Graf (Stability of (ultraviolet cutoff) non-relativistic QED), Jens Hoppe (Membranes and matrix models), Michael Loss (Self-energy of electrons in nonrelativistic QED), and Herbert Spohn (Dynamics of classical charges and their radiation field).

The first funding period ended in March 2003. The second funding period was from April 2003 to December 2004. The name was changed to the Danish National Research Foundation Network in Mathematical Physics and Stochastics, with Arne Jensen as the director.

During this funding period the emphasis in Aarhus was mainly having short and long term visitors and a large number of seminar talks.
One large interdisciplinary workshop was organized: Aspects of Large Quantum Systems Related to Bose-Einstein Condensation, April 15–17, 2004. Speakers included

- François Bardou, IPCMS 23, France (Can one cool faster?)
- Jean Dalibard, Laboratoire Kastler Brossel, France (Fast rotation of an atomic Bose-Einstein condensate)
- Tony Dorlas, Dublin Institute for Advanced Studies, Dublin, Ireland (Bosons on a lattice)
- Tilman Esslinger, ETH, Zürich, Switzerland (Looking at a one-dimensional atomic gas)
- Christian Gérard, Université de Paris Sud Orsay, France (Spectral and scattering theory of non-relativistic QFT models)
- Stefano Giorgini, BEC-INFM, Italy (Degenerate gases in quasi-1D harmonic traps)
- Philippe-André Martin, Institut de Physique Théorique - EPFL, Lausanne, Suisse (The Bose gas beyond mean field)
- Maxim Olshanii, Department of Physics & Astronomy, University of Southern California, USA (Zero-range potentials, contact problems, UV divergencies, and all that)
- Lev Petrovich Pitaevski, BEC-INFM, Italy (Superfluidity of 1D Bose gas)
- Gora V. Shlyapnikov, CNRS, Université Paris-Sud, France (Correlation properties of one-dimensional trapped Bose-gases)
- Daniel Ueltschi, Mathematics Department, University of Arizona, USA (The Mott insulating phase of the Bose-Hubbard model)
- André Verbeure, Institute for Theoretical Physics, Katholieke Universiteit Leuven, Belgium (Josephson currents: A microscopic model)
- Jakob Yngvason, Erwin Schrödinger International Institute for Mathematical Physics, Austria (Bose Einstein condensation as a quantum phase transition in an optical lattice model).

During the years 1998–2004 a number of postdocs were employed, and funding was also used to attract new researchers. We mention Horia Cornean who was partially funded by MaPhySto 2000–04, at Aalborg University.

After 2004

We will not go into detail with developments after 2004. When Søren Fournais and Jacob Schach Møller returned to Aarhus, they had a number of large individual grants which have funded a substantial number of PhD students and postdocs.

A new research area was initiated during the MaPhySto funding period by Jørgen Ellegaard Andersen in problems in geometry and algebraic topology arising from quantum field theory.
This activity attracted large external funding from the Danish National Research Foundation, supporting the Centre for the Quantum Geometry of Moduli Spaces (QGM), and a 5 year Niels Bohr visiting professorship for Nicolai Reshetikhin (UC Berkeley).

**Concluding remark**

It is remarkable to look back over the 50 years 1954–2004 and see the extent to which the visions of the founder of the Institute, Svend Bundgaard, have been realized: An internationally recognized Institute with extensive visitor programs and a substantial number of workshops, summer schools, and conferences, covering several areas of the mathematical sciences.

**References**


The Dannie Heineman Prize

Nominations for the next Dannie Heineman Prize for Mathematical Physics will be due on June 1, 2020. Instructions for preparing and submitting nomination packages are available at:

https://www.aps.org/programs/honors/prizes/heineman.cfm

As reported in the previous News Bulletin, the 2019 winner was Svetlana Jitomirskaya of the University of California, Irvine. We are pleased to reprint here an article that appeared about her and the work that led to this honor.4

UCI Distinguished Professor wins Dannie Heineman Prize for Mathematical Physics

Svetlana Jitomirskaya, Distinguished Professor of Mathematics at the University of California, Irvine, has been named the 2020 winner of the Dannie Heineman Prize for Mathematical Physics. She is only the second woman to receive the annual prize – and the first to receive it alone, not jointly.

The citation says Jitomirskaya was recognized “for work on the spectral theory of almost-periodic Schrödinger operators and related questions in dynamical systems. In particular, for her role in the solution of the Ten Martini problem, concerning the Cantor set nature of the spectrum of all almost Mathieu operators, and in the development of the fundamental mathematical aspects of the localization and metal-insulator transition phenomena.”

Established in 1959 by the Heineman Foundation for Research, Educational, Charitable and Scientific Purposes Inc., the prize is administered jointly by the American Physical Society and the American Institute of Physics. It was first awarded to Murray Gell-Mann, and other recipients include Stephen Hawking (1976), Edward Witten (1998) and Giorgio Parisi (2005).

“To say I am honored and humbled to receive this prize – to now be on the same list with so many of my absolute heroes – is a huge understatement,” Jitomirskaya said. “The prize is relatively rarely given to pure mathematicians like me; I see it as an indication of the physics community’s growing interest in the questions I’ve been working on – and perhaps math in general.”

The Journal of Mathematical Physics defines the field as “the application of mathematics to problems in physics and the development of mathematical methods suitable for such applications and for the formulation of physical theories.” An early example would be Sir Isaac Newton’s invention of calculus in order to solve physics problems, such as explaining Kepler’s laws of planetary motion. Some of the most significant modern advances have been in classical mechanics, quantum theory, special and general relativity, and statistical mechanics.

Jitomirskaya’s main accomplishments involve quasiperiodic operators. She is best known for creating the first nonperturbative methods of studying small denominators, influencing ongoing developments in this field. She has also solved – individually and collaboratively – several long-standing problems related to almost Mathieu operators.

4Reprinted with permission from University of California, Irvine, original publication date October 22, 2019.

IAMP News Bulletin, January 2020

11
“The work I do that this prize recognizes is in a rather narrow area, so it hasn’t had a fraction of the impact the work of some of my predecessors has had,” she said. “However, it did have a considerable impact in that area, and the field itself is getting more and more attention because of its relationship to the science of quantum materials.”

Jitomirskaya attended Russia’s Moscow State University, earning an undergraduate degree in 1987 and a Ph.D. in 1991, both in mathematics. She became a part-time lecturer at UCI in 1991 and has been professionally affiliated with the university ever since – her most extended leave being about half a year in 1996 when she was a visiting assistant professor at the California Institute of Technology with Barry Simon, 2018 winner of the Dannie Heineman Prize.

She is a member of the International Association of Mathematical Physics, serving as vice president in 2012-14, and was inducted into the American Academy of Arts and Sciences in 2018. Jitomirskaya is a recipient of fellowships from the Alfred P. Sloan Foundation and the Simons Foundation and was awarded the American Mathematical Society’s Ruth Lyttle Satter Prize in 2005. She has also held an Aisenstadt Chair at Montreal’s Centre de Recherches Mathematiques and received a Distinguished Mid-Career Faculty Award for Research from UCI and a UCI Chancellor’s Fellowship.

“Congratulations to Professor Jitomirskaya on this outstanding accomplishment,” said Enrique Lavernia, UCI provost and executive vice chancellor. “Being awarded the Dannie Heineman Prize for Mathematical Physics is indeed an exceptional honor and a recognition of her outstanding work in the field.”
IUPAP Conference Sponsorship Applications
Deadline: June 1, 2020

The due date for the submission of IUPAP sponsorship application forms for conferences that will be held anytime in 2021 (i.e. anytime between 1 January and 31 December, 2021) is June 1, 2020. The conference sponsorship rules and guidelines are accessible on the IUPAP weblink http://iupap.org/sponsored-conferences/conference-policies/.

News from the IAMP Executive Committee

New individual members

IAMP welcomes the following new members

1. **MR. ALEK BEDROYA**, Harvard University, USA.
2. **PROF. DR. MIKAELA IACOBELLI**, ETH Zurich, Switzerland.
3. **PROF. ALEKSEY KOSTENKO**, University of Ljubljana, Slovenia.
4. **DR. KOMAL SINGLA**, Chandigarh University, India

Recent conference announcements

**Gran Sasso Quantum Meeting: From Equilibrium Phenomena Towards Open Quantum Systems**
March 30-April 3, 2020. GSSI L’ Aquila (Italy)
https://indico.gssi.it/event/103/

**123rd Statistical Mechanics Conference**
May 10-12, 2020, Rutgers University, Busch Campus, New Brunswick, NJ, USA.
Baylor Analysis Fest: “From Operator Theory to Orthogonal Polynomials, Combinatorics, and Number Theory”
May 18-22, 2020. Baylor University, Waco, TX, USA.
https://www.baylor.edu/math/index.php?id=963972

Mathematical aspects of physics with non-self-adjoint operators: 10 years after
This conference is partially supported by IAMP.
https://conferences.cirm-math.fr/2153.html

IST Summer School in Analysis and PDEs
https://summerschool-analysis.ist.ac.at/

PIMS-CRM 2020. Summer school in probability
This conference is partially supported by IAMP.
http://www.math.ubc.ca/Links/ssprob20/

Contemporary analysis and its applications
Satellite conference to the 8-th European Congress of Mathematics.
July 1-5, 2020. Portoroz (Slovenia).
This conference is partially supported by IAMP.
http://www.caia2020.com/

The mathematics of conformal field theory II
July 6-10, 2020. The Australian National University, Canberra.
This conference is partially supported by IAMP.

Quantum information in many-body physics: a mathematical invitation
This conference is partially supported by IAMP.
https://wiki.tum.de/display/qimp20
Open positions

2 PhD Positions in Theoretical Quantum Physics at LMU Munich

We are seeking two highly motivated PhD students to join our research group in theoretical quantum physics at the LMU Munich. The candidates are expected to have strong analytic skills, ideally with a background in fermionic quantum systems and reduced density matrices. Mathematical physicists are encouraged to apply as well. Our projects are concerned with the interface of quantum information theory and quantum many-body physics. We resort to analytic approaches partly complemented/guided by computational studies to gain universal insights into interacting quantum many-body systems. A particular emphasis lies on the concept of reduced density matrices and the ground state problem. For more details see our website

https://www.theorie.physik.uni-muenchen.de/lsschollwoeck/schilling_group/index.html.

Required documents: Cover letter, CV including a list of publications and contact details of two referees, (link to) Bachelor/Master thesis, academic transcript.

Applications as a single pdf to (please state "PhD" in the subject line): c.schilling@physik.uni-muenchen.de. Review of applications on a rolling basis; final deadline: 10 April 2020.

For more information on these positions and for an updated list of academic job announcements in mathematical physics and related fields visit


Benjamin Schlein (IAMP Secretary)