Institut Mittag-Leffler is an international center for research and postdoctoral training in the mathematical sciences. It was founded in 1916 by professor Gösta Mittag-Leffler and is the oldest mathematics research institute in the world. It operates under the auspices of the Royal Swedish Academy of Sciences and is governed by a board with representatives from all Nordic countries.

The premises of the institute encompass several buildings: the main building with library, offices for the staff, and office and discussion spaces for researchers, a seminar room building, and five other buildings with housing facilities for visiting researchers.

The mission of Institut Mittag-Leffler is to support international top-level research in mathematics, with special attention to the development in the Nordic countries. The institute is a hub for the international mathematical research community and for mathematicians in the Nordic countries.

The main activities include research programs, conferences, workshops, seminars and summer schools, that all aim to conduct and develop current mathematical research. Research programs and conferences have organizing committees approved by the board. Based on the recommendations of the organizing committees, senior and junior mathematicians are invited to stay and work at the institute. Junior program participants (postdocs or advanced PhD students) are offered fellowships to finance their stays. There are yearly calls, and fellowship recipients are chosen by the organizing committee together with the director. Although senior and junior mathematicians from the Nordic countries are given some priority, the institute works actively to ensure diversity among program participants.

The institute also publishes two mathematical journals, Acta Mathematica (founded by Gösta Mittag-Leffler in 1882) and Arkiv för matematik (founded in 1903). Acta is one of a small number of exclusive world-leading international mathematics research journals and one of the highest rated journals in the mathematical world. All volumes of both journals are freely available online.
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A BRIEF REVIEW OF 2019

During 2019 the institute has continued its efforts to attract world leading mathematicians to programs and conferences, as well as the dialogue with Nordic mathematics departments, other international mathematics research institutes, the Swedish Research Council, the Wallenberg Foundations, the Research Council of Norway, and the Verg Foundation. Editorial work with Acta Mathematica and Arkiv för matematik during the year has been successfully directed towards faster processes and the creation of a suitably sized backlog. The cooperation with International Press continues.

The institute organized two research programs: Spectral Methods in Mathematical Physics and General Relativity, Geometry and Analysis: Beyond the First 100 Years after Einstein, including three workshops as well as a kick-off conference for the research program Spectral Methods in Mathematical Physics:

- Spectral theory & semiclassical analysis
- Many-body theory, effective equations & PDE’s
- Many-body theory, random operators & matrices

In addition, the institute hosted ten week-long research conferences:

- Algebro-Geometric and Homotopical Methods
- Analytic-Geometric Inequalities and Related Topics
- Numerical Methods for SPDE: 20 Successful Years and Future Challenges
- Smooth Dynamical Systems
- Modern theory of group actions and the special role of finite simple groups
- Nonlinear Dispersive Waves, Solitons, and Related Topics
- Mathematics and Physics of Knots
- New Directions in Mathematics of Coulomb Gases and Quantum Hall Effect
- Thermodynamic Formalism – Applications to Geometry, Number Theory, and Stochastics
- Proof, Computation, Complexity
Apart from these regular research activities, the institute, together with the National Centre for Mathematics Education (NCMI), organized the Klein Days – a three-day teaching workshop for high-school teachers in mathematics held three times a year (in January, June and August). These events were funded entirely by generous support from Brummer & Partners.

The institute was involved in different Nordic and international collaborations. In March, the institute participated in the yearly meeting of ERCOM, a committee of the European Mathematical Society including around 30 European research institutes in mathematics. In May, Institut Mittag-Leffler organized the annual meeting of chairmen of the major Mathematics Departments in all Nordic countries.

The institute works closely in cooperation with the Royal Academy of Sciences and Institut Mittag-Leffler is very grateful to all those who have contributed during 2019. First and foremost, to all mathematicians who choose to conduct their research at the institute and to contribute to its scientific environment, especially to our colleagues in Sweden and other Nordic countries. We also thank all organizations who has contributed to us financially: the Academy of Finland, the Acta Mathematica Foundation, the Anna-Greta and Holger Crafoord Foundation, Brummer & Partners, Chalmers/Gothenburg University, the Danish Mathematical Society, the G S Magnuson Foundation, the Icelandic Centre for Research, the Knut and Alice Wallenberg Foundation, Linköping University, Luleå University of Technology, Lund University, the Marianne and Marcus Wallenberg Foundation, the Research Council of Norway, the Royal Institute of Technology, the Simons Foundation, the Foundation in Memory of Jacob and Marcus Wallenberg, Stockholm University, the Swedish Research Council, the Verg Foundation, Uppsala University, Umeå University and Uppsala University.

We are happy to report that two of our main contributors visited the institute: in May Dick Hasselström and Marianne Lindvall from the Verg foundation and, in October, Sara Mazur, Göran Sandberg, and Peter Wallenberg Jr from the Knut and Alice Wallenberg foundation.

Finally, in December, we initiated a reorganization of the administrative side of the institute to ensure that both the institute itself and all its activities run smoothly and effectively.

Tobias Ekholm  
Director
THE BOARD OF INSTITUT MITTAG-LEFFLER

The board of Institut Mittag-Leffler consists of representatives of the Nordic countries and members appointed by the class of mathematics of the Royal Swedish Academy of Sciences.

MEMBERS OF THE BOARD 2019:

MICHAEL BENEDICKS, Royal Institute of Technology, Stockholm, Sweden
ANDERS BJÖRNER, Royal Institute of Technology, Stockholm, Sweden
ANDERS KARL CLAESSON, University of Iceland
NILS DENCKER, Lund University, Sweden
TOBIAS EKHOLM, Uppsala University, Director Institut Mittag-Leffler
LARS HESSELHOLT, University of Copenhagen, Denmark
KURT JOHANSSON, Royal Institute of Technology, Stockholm, Chair
JUHA KINNUNEN, Aalto University, Finland
ARI LAPTEV, Imperial College, London, UK
KRISTIAN RANESTAD, University of Oslo, Norway
HOLGER ROOTZÉN, Chalmers University of Technology, Gothenburg, Sweden
PER SALBERGER, Chalmers University of Technology, Gothenburg, Sweden
ANNA-KARIN TORNBERG, Royal Institute of Technology, Stockholm, Sweden
CHAIR MEETING AT INSTITUT MITTAG-LEFFLER

Institut Mittag-Leffler hosts an annual Nordic chair meeting inviting chairs of mathematical departments and mathematical associations from the Nordic countries.

Participants of the chair meeting 2019:

Joakim Arnlind, Linköping University, Sweden
Jessica Carter, University of Southern, Denmark
Geir Dahl, University of Oslo, Norway
Sandra Di Rocco, KTH Royal Institute of Technology, Sweden
Tobias Ekholm, Uppsala University, Sweden
Alexander Engström, Aalto University, Finland
Anders Heyden, Lund University, Sweden
Tuomas Hytönen, University of Helsinki, Finland
Tero Kilpeläinen, University of Jyväskylä, Finland
Hans Ringström, KTH Royal Institute of Technology, Sweden
Einar Rönquist, NTNU – Norwegian University of Science and Technology, Norway
Steen Thorbjørnsen, Aarhus University, Denmark
Warwick Tucker, Uppsala University, Sweden
Joanna Tyrcha, Stockholm University, Sweden
Peter Wall, Luleå Technical University, Sweden
Bernt Wennberg, Chalmers/University of Gothenburg, Sweden

PUBLICATIONS

Acta Mathematica
2 volumes/year (4 issues, totally around 800 pages)
The issues 220:1, 220:2, 221:1 and 221:2 were published with in total 12 articles.

EDITORIAL COMMITTEE

Editor-in-Chief:
Tobias Ekholm (Institut Mittag-Leffler, Djursholm and Uppsala University)

Technical Editor:
International Press of Boston, Inc.

Editors:
Michel Brion (CNRS, Institut Fourier, Grenoble)
Tobias Holck Colding (Massachusetts Institute of Technology, Cambridge)
Jesper Grodal (University of Copenhagen)
Helge Holden (NTNU - Norwegian University of Science and Technology, Trondheim)
Kurt Johansson (KTH Royal Institute of Technology, Stockholm)
Eero Saksman (University of Helsinki)

Arkiv för matematik
1 volume/year (2 issues, around 400 pages)
The issues 56:1 and 56:2 were published with in total 22 articles.

EDITORIAL COMMITTEE

Editor-in-Chief:
Hans Ringström (Institut Mittag-Leffler and KTH Royal Institute of Technology, Stockholm)

Editorial Assistant:
International Press of Boston Inc.

Editors:
Mats Andersson (Chalmers University of Technology, Gothenburg)
Carel Faber (Utrecht University)
Pär Kurlberg (KTH Royal Institute of Technology, Stockholm)
Volodymyr Mazorchuk (Uppsala University)
Erik Wahlén (Lund University)

FINANCIAL SUPPORT 2019

THE ACADEMY OF FINLAND
THE ACTA MATHEMATICA FOUNDATION
THE ANNA-GRETA AND HOLGER CRAFOORD FOUNDATION
BRUMMER & PARTNERS
THE DANISH MATHEMATICAL SOCIETY (INSTITUT FOR MATEMATIK/AARHUS UNIVERSITET)
THE FOUNDATION IN MEMORY OF JACOB AND MARCUS WALLENBERG
THE G S MAGNUSON FOUNDATION
GOTHENBURG UNIVERSITY/CHALMERS UNIVERSITY OF TECHNOLOGY
THE ICELANDIC CENTRE FOR RESEARCH
THE KNUT AND ALICE WALLENBERG FOUNDATION
LINKÖPING UNIVERSITY
LULEÅ UNIVERSITY OF TECHNOLOGY
LUND UNIVERSITY
THE MARIANNE AND MARCUS WALLENBERG FOUNDATION
THE RESEARCH COUNCIL OF NORWAY
THE ROYAL INSTITUTE OF TECHNOLOGY
THE SIMONS FOUNDATION
STOCKHOLM UNIVERSITY
THE SWEDISH RESEARCH COUNCIL
THE VERG FOUNDATION
UMÉÅ UNIVERSITY
UPPSALA UNIVERSITY
Mathematical physics aims at a mathematically rigorous understanding of complex phenomena in nature and is intrinsically an interdisciplinary field with many different subfields. One of the goals of our program was to bring together researchers from various subfields of mathematical physics, which typically organize their own conferences. We have also tried to reach out to other fields of mathematics, like for instance PDEs and Probability. We involved researchers from the local universities and one participant was invited to give a colloquium talk at Umeå university. A significant fraction of participants in the program were in a junior career stage and, as we will describe below in some more detail, we tried to tailor certain activities to their interests and needs.

The following activities were organized during the program:

- a kick-off workshop
- three workshops
- a satellite workshop
- six minicourses
- four weekly seminar talks
- a junior seminar

Let us describe these activities in some more detail:

The program started with a kick-off conference with a rather intense program of 49 talks in five days. The goal of the conference was to cover a broad spectrum of topics related to mathematical physics and we asked the speakers to survey their fields of research. We gratefully acknowledge additional funding through the Simons Foundation which allowed us to increase the number of participants during this conference week. The lecture room was completely full during this week.

In contrast to this kick-off conference, the three workshops were more focused and intended for reports on the latest progress in the respective research areas. They were devoted each to one of the three major topics of the conference, namely:

- Spectral Theory and Semiclassical Analysis
- Many-Body Theory, Effective Equations & PDEs
- Many-Body Theory, Random Operators & Matrices

As a satellite event an additional workshop on Mathematical Physics of Anyons and Topological States of Matter, a topic close to the theme of the program, was organized by M. Correggi, D. Lundholm and N. Rougerie at Nordita, Stockholm, and attracted several participants of the program.

During the program there were six minicourses, each one consisting of three or four hours of lectures. They were delivered by N. Anantharaman, B. Helffer, M. Lewin, D. Yafaev, C. Sogge and R. Seiringer. Since the
program was rather broad, our intention was that these lectures help junior researcher as well as researchers from different subfields to get acquainted with recent developments at the forefront of research.

In the non-workshop weeks, we organized two seminar talks on both Tuesday and Thursday afternoon. In this way all participants was given the opportunity to present their research and to introduce themselves to the other participants. In addition, on Wednesday the junior participants organized a junior seminar where they presented their results and their future research goals in an environment of peers.

Finally, we encouraged the participants of the program to submit their preprints to the Mittag-Leffler Institute, where they are available on the program’s webpage.

SEMINARS

2019-01-21
Nalini Anantharaman, University of Strasbourg,
*Mini course on topics in quantum chaos*

2019-01-22
Nalini Anantharaman, University of Strasbourg,
*Mini course on topics in quantum chaos*

2019-01-23
Nalini Anantharaman, University of Strasbourg,
*Mini course on topics in quantum chaos*

2019-01-23
Søren Mikkelsen, Aarhus University,
*Semiclassical commutator bounds*

2019-01-24
Marius Lemm, Institute for Advanced Study, IAS,
*On the averaged Green’s function of an elliptic equation with random coefficients*

2019-01-24
Christian Brennecne, University of Zurich, UZH,
*Bogoliubov theory in the Gross-Pitaevskii limit*

2019-01-28
Nicolas Popoff, Université de Bordeaux,
*Spectrum of the Robin Laplacian with singular boundary conditions*

2019-01-29
Bernard Helffer, Université de Nantes,
*Mini course on semi-classical approximation and the tunneling effect*

2019-01-29
Michael Levitin, University of Reading,
*Sharp asymptotics for Steklov eigenvalues in curvilinear polygons*

2019-01-30
Bernard Helffer, Université de Nantes,
*Mini course on semi-classical approximation and the tunneling effect*

2019-01-30
Lukas Schimmer, University of Copenhagen,
*Endpoint resolvent estimates for compact Riemannian manifolds*

2019-01-31
Bernard Helffer, Université de Nantes,
*Mini course on semi-classical approximation and the tunneling effect*

2019-01-31
Uzy Smilansky, Weizmann Institute of Science,
*Two trace formulae for Hermitian matrices*

2019-01-31
Ayman Kachmar, Lebanese University,
*A new estimate of the Ginzburg-Landau order parameter*

2019-02-05
Uzy Smilansky, Weizmann Institute of Science,
*The importance of being normal*

2019-02-06
Tobias Ried, Max Planck Institute for Mathematics in the Sciences,
*Cwikel’s bound reloaded*

2019-02-06
Yulia Meshkova, St Petersburg State University,
*On spectral theory approach to homogenization problems*
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<th>Speaker, Institution and Location</th>
<th>Title or Description</th>
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<td>Lukas Schimmer, University of Copenhagen</td>
<td>On the construction of distinguished self-adjoint extensions of operators with gaps</td>
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<td>2019-02-07</td>
<td>Yulia Meshkova, St Petersburg State University</td>
<td>On homogenization of periodic hyperbolic systems</td>
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<td>2019-02-07</td>
<td>Corentin Lena, Stockholm University</td>
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<td>Pavel Exner, Nuclear Physics Institute ASCR</td>
<td>Periodic quantum graphs: not always what a common wisdom would suggest</td>
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<td>2019-02-19</td>
<td>Victor Ivrii, University of Toronto</td>
<td>Complete spectral asymptotics for periodic and almost periodic perturbations of constant operators and Bethe-Sommerfeld conjecture in semiclassical settings</td>
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<td>2019-02-19</td>
<td>Sara Maad Sasane, Lund University</td>
<td>Perturbations of embedded eigenvalues for a magnetic Schrödinger operator on a cylinder</td>
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<td>2019-02-20</td>
<td>Martin Vogel, Université de Strasbourg, CNRS</td>
<td>Grushin problems and their applications in spectral theory</td>
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<td>2019-02-21</td>
<td>Stefan Teufel, Universität Tübingen</td>
<td>Linear response for gapped fermionic systems based on non-equilibrium almost steady states</td>
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<td>2019-02-21</td>
<td>Martin Vogel, Université de Strasbourg, CNRS</td>
<td>Spectrum of random non-self adjoint operators</td>
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<td>2019-02-26</td>
<td>Mathieu Lewin, Université Paris-Dauphine</td>
<td>Mini course on nonlinear Gibbs measures, renormalization &amp; infinite-dimensional semi classics</td>
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<tr>
<td>2019-02-26</td>
<td>Tobias Ried, Max Planck Institute for Mathematics in the Sciences</td>
<td>Cwikel’s bound reloaded</td>
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<td>2019-02-26</td>
<td>Thomas Hoffmann-Ostenhof, University of Vienna</td>
<td>On multiplicities of eigenvalues: some results and open problems</td>
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<tr>
<td>2019-02-27</td>
<td>Mathieu Lewin, Université Paris-Dauphine</td>
<td>Mini course on nonlinear Gibbs measures, renormalization &amp; infinite-dimensional semi classics</td>
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<td>2019-02-27</td>
<td>Arnaud Triay, CEREMADE</td>
<td>Semi-classical limit of large fermionic systems at positive temperature</td>
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<td>2019-02-28</td>
<td>Mathieu Lewin, Université Paris-Dauphine</td>
<td>Mini course on nonlinear Gibbs measures, renormalization &amp; infinite-dimensional semi classics</td>
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<td>2019-02-28</td>
<td>Frédéric Herau, Université de Nantes</td>
<td>A Korn-Wirtinger inequality</td>
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<td>2019-03-01</td>
<td>Mathieu Lewin, Université Paris-Dauphine</td>
<td>Mini course on nonlinear Gibbs measures, renormalization &amp; infinite-dimensional semi classics</td>
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<tr>
<td>2019-03-04</td>
<td>Dimitri Yafaev, Université de Rennes 1; St Petersburg State University</td>
<td>Mini course on spectral theory of Jacobi operators and an asymptotic behavior of orthogonal polynomials</td>
</tr>
<tr>
<td>2019-03-05</td>
<td>Dimitri Yafaev, Université de Rennes 1; St Petersburg State University</td>
<td>Mini course on spectral theory of Jacobi operators and an asymptotic behavior of orthogonal polynomials</td>
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<td>Institution</td>
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<td>Michael Loss</td>
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<td>2019-03-29</td>
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<td>IST Austria</td>
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<td>2019-04-02</td>
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<td>Université Paris-Sud</td>
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<td>2019-04-02</td>
<td>Jussi Behrndt</td>
<td>Graz University of Technology</td>
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<td>2019-04-02</td>
<td>Jean-Claude Cuenin</td>
<td>LMU Ludwig–Maximilians-Universität München</td>
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<td>2019-04-03</td>
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<td>Queen Mary University of London</td>
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<td>Semjon Wugalter</td>
<td>Karlsruhe Institute of Technology</td>
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<td>2019-04-04</td>
<td>Ioannis Anapolitanos</td>
<td>Karlsruhe Institute of Technology</td>
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<td>2019-04-04</td>
<td>Joe Viola</td>
<td>Université de Nantes</td>
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<tr>
<td>2019-04-15</td>
<td>Massimo Moscolari</td>
<td>Sapienza University of Rome</td>
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2019-04-15
Ari Laptev, Imperial College London,
Spectral inequalities and the Darboux transform

2019-04-17
Massimo Moscolari, Sapienza University of Rome,
An introduction to the localization dichotomy

2019-04-18
Alexander Elgart, Virginia Tech,
Localization for a disordered XXZ spin chain

2019-04-18
Simon Becker, University of Cambridge,
Metal-insulator transitions in discrete random Schrödinger operators

2019-04-23
Wolfgang Spitzer, Fern Universität in Hagen,
On Bose-Einstein condensation in the Luttinger-Sy model with finite interaction strength

2019-04-24
Robin Reuvers, University of Cambridge,
Aspects of fermionic entanglement

2019-04-25
Leonid Pastur, B. Verkin Institute for Low Temperature, Physics & Engineering,
Analogs of Szegö’s theorem for ergodic operators

PREPRINTS

Participants of the program were encouraged to submit preprints with results that were obtained during their visit to Institut Mittag-Leffler. Files of the preprints listed below can be found on our website www.mittag-leffler.se.

Houssam Abdul-Rahman, Christoph Fischbacher, Gunter Stolz:
Entanglement bounds in the XXZ quantum spin chain

Tadayoshi Adachi, Kyohi Itakura, Kenichi Ito, Erik Skibsted:
Spectral theory for one-body Stark operators

Tadayoshi Adachi, Kyohi Itakura, Kenichi Ito, Erik Skibsted:
Stationary scattering theory for 1-body Stark Hamiltonians

Simon Barth, Andreas Bitter, Semjon Vugalter:
Resonance interactions of multi-particle systems

Simon Barth, Andreas Bitter:
On the virtual level of two-body interactions and applications to three-body systems in higher dimensions

Rafael Benguria, Soledad Benguria:
A non-existence result for a generalized Brezis-Nirenberg problem

Vincent Bruneau, Georgi Raikov:
Threshold singularities of the spectral shift function for geometric perturbations of magnetic Hamiltonians

Raffaele Carlone, Michele Correggi, Marco Falconi, Marco Olivieri:
Microscopic derivation of time-dependent point interactions

Victor Chulaevsky, Sasha Sodin:
Anderson localization in stationary ensembles of quasiperiodic operators

Michele Correggi, Emanuela L. Giacomelli:
Effects of corners in surface superconductivity

Jean-Claude Cuenin:
Improved eigenvalue bounds for Schrödinger operators with slowly decaying potentials

Pavel Exner:
An optimization problem for finite point interaction families

Dario Feliciangeli, Robert Seiringer:
Uniqueness and non-degeneracy of minimizers of the Pekar functional on a ball

Soeren Fournais, Jan Philip Solovej:
The energy of dilute Bose gases

Rupert Frank, Simon Larson:
On the error in the two-term Weyl formula for the Dirichlet Laplacian

Bernard Helffer, Ayman Kachmar:
Thin domain limit and counterexamples to strong diamagnetism

Jan Janas, Sergey Naboko, Luis O. Silva:
Green matrix estimates of block Jacobi matrices II: Bounded gap in the essential spectrum

Yulia Meshkova:
Variations on the theme of the Trotter-Kato theorem for homogenization of periodic hyperbolic systems

Yoshihiza Miyanishi, Grigori Rozenblum:
Spectral properties of the Neumann-Poincare operator in 3D elasticity

Serguei Naboko, Sergey Simonov:
Titchmarsh-Weyl formula for the spectral density of a class of Jacobi matrices in the critical case

Dinh-Thi Nguyen:
Blow-up profile of neutron stars in the Hartree-Fock-Bogoliubov theory

Nicolas Raymond, Julien Royer:
Absence of embedded eigenvalues for translationally invariant magnetic Laplacians

Johannes Sjöstrand, Martin Vogel:
Toeplitz band matrices with small random perturbations

Johannes Sjöstrand, Martin Vogel:
General Toeplitz matrices subject to Gaussian perturbations

Alexander Sobolev, Dmitri Yafaev:
Multichannel scattering theory for Toeplitz operators with piecewise continuous symbols

Per von Soosten, Simone Warzel:
Random characteristics for Wigner matrices

Arnaud Triay:
Derivation of the time-dependent Gross-Pitaevskii equation for the dipolar gases
PARTICIPANTS

Michael Aizenman, Princeton University, Princeton, USA
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Ioannis Anapolitanos, Karlsruhe Institute of Technology, Karlsruhe, Germany
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Serena Cenatiempo, Gran Sasso Science Institute, L’Aquila, Italy
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Christopher Sogge, Johns Hopkins University, Baltimore, USA
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Arnaud Triay, CEREMADE, Paris, France
Matthias Täufer, Queen Mary University of London, London, United Kingdom

Books in the round library.

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Hanne Van Den Bosch, Universidad de Chile, Santiago de Chile, Chile
Simone Warzel, TU Munich, München, Germany
Timo Weidl, Institut für Analysis, Dynamik und Modellierung, Stuttgart, Germany
Michael Weinstein, Columbia University, New York, USA
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Thomas Østergaard Sørensen, LMU Ludwig-Maximilians-Universität München, München, Germany
The year 2015 marked the centenary of the publication by Albert Einstein of the field equations of general relativity, as well as the resulting explanation of the precession of the perihelion of Mercury. The new theory was based on differential geometric machinery developed during the nineteenth century and has played a role in the development of both mathematics and physics during the twentieth century and into the twenty-first. The importance of which can hardly be overstated. Research on the Einstein equation and general relativity proceeds at an accelerated pace both in mathematics and physics, driven to a large extent by its role in cosmology and astrophysics, and the fact that it interacts closely with many fields of mathematics, including differential geometry, PDE theory and harmonic analysis.

The objective of this program was to stimulate mathematical research on the global structure of solutions to the Einstein equation and related geometric partial differential equations and, consequently, to foster interactions between researchers within these fields of main interest in mathematics. With this in view, the program was not subdivided into thematic periods. We were happy to see that working groups among the participants were formed, some new and some old constellations. The topics discussed in these groups included geometric inequalities, including positive mass and Penrose type inequalities; black hole uniqueness and stability problems; instantons and special geometries; kinetic theory and self-gravitating systems. Areas where significant progress was made include black hole stability and the geometry of gravitational instantons. There has been spectacular progress on the black hole stability problem during the past decade, and during 2019, the first proofs of linearized stability for slowly rotating black holes were obtained. During the Mittag-Leffler program, significant steps towards solving the general black hole stability problem were taken. Concerning gravitational instantons, the problem of classification is largely open, in spite of decades of work and a number of known examples. New insights on the special geometry of known examples were obtained during the program, which may lead to new approaches to the classifying instantons.

The program gathered researchers with varying backgrounds, from all continents. We were happy to have regular participation by a number of researchers from Stockholm, and Uppsala. The post-doc participants in the program formed a close-knit and friendly group with both social and scientific activities.

The fixed weekly schedule, which was designed to leave time for research and discussions, consisted of four one-hour seminars Tuesday and Thursday mornings, and an informal afternoon seminar on Wednesdays.
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<td>Hans Lindblad, Johns Hopkins University</td>
<td>On the asymptotic behavior of Einstein’s equations close to vacuum</td>
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<td>2019-09-03 11:00</td>
<td>Maximilian Thaller, Chalmers/University of Gothenburg</td>
<td>Rotating clouds of charged particles in general relativity</td>
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<td>2019-09-05</td>
<td>Robert Wald, The University of Chicago</td>
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<td>Christopher Kauffman, Imperial College London</td>
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<td>Martin Reiris, Universidad de Montevideo</td>
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<td>Christos Mantoulidis, Massachusetts Institute of Technology, MIT</td>
<td>Capacity, fill-ins, and quasi-local mass</td>
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<td>Volker Schlue, University of Melbourne</td>
<td>On the stability of the cosmological region of Schwarzschild de Sitter spacetimes</td>
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<td>Lionel Mason, University of Oxford</td>
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<td>Paul Tod, University of Oxford</td>
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<td>Richard Schoen, University of California, Irvine</td>
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<td>Philippe G. Le Floch, Sorbonne University</td>
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<td>Igor Khavkine, Czech Academy of Sciences</td>
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<td>2019-09-26</td>
<td>Siyuan Ma, Sorbonne University</td>
<td>Linear stability for the Kerr spacetime</td>
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<td>2019-09-26</td>
<td>Stefano Borghini, Uppsala University</td>
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<td>2019-10-01</td>
<td>Gerhard Rein, Universität Bayreuth</td>
<td>Can highly relativistic, self-gravitating matter distributions be stable?</td>
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<td>2019-10-01</td>
<td>Bernardo Araneda, Universidad Nacional de Cordoba</td>
<td>Twistor theory and the Teukolsky equations</td>
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<tr>
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<td>Martin Taylor, Imperial College London</td>
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<td>2019-10-08</td>
<td>Marc Mars, University of Salamanca</td>
<td>Existence and uniqueness of rigidly rotating stars in second order perturbation theory</td>
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<tr>
<td>Date</td>
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<td>2019-10-08</td>
<td>Po-Ning Chen</td>
<td>University of California, Riverside</td>
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<tr>
<td>2019-10-10</td>
<td>Steffen Aksteiner</td>
<td>Max Planck Institute for Gravitational Physics</td>
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<td>2019-10-10</td>
<td>Jacques Smulevici</td>
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<td>2019-10-15</td>
<td>Jose Senovilla</td>
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<td>2019-10-15</td>
<td>Eric Ling</td>
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<td>2019-10-17</td>
<td>Marc Herzlich</td>
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<td>Greg Galloway</td>
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<td>Cecile Huneau</td>
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<td>Jeremie Szeftel</td>
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<td>2019-10-24</td>
<td>Jan Metzger</td>
<td>Universität Potsdam</td>
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<td>2019-10-29</td>
<td>Roland Donninger</td>
<td>University of Vienna</td>
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<td>2019-10-29</td>
<td>Anna Sakovich</td>
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<td>2019-10-30</td>
<td>Ingemar Bengtsson</td>
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<td>2019-10-31</td>
<td>Carla Cederbaum</td>
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<td>Todd Oliynyk</td>
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<td>Dejan Gajic</td>
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<td>2019-11-12</td>
<td>Olivier Biquard</td>
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<td>Håkan Andreasson</td>
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<td>Annegret Burtscher</td>
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<td>Markus Kunze</td>
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<td>Dietrich Häfner</td>
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<td>2019-11-26</td>
<td>Stefanos Aretakis</td>
<td>University of Toronto</td>
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<td>Pieter Blue</td>
<td>University of Edinburgh</td>
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<td>2019-11-27</td>
<td>Gilbert Weinstein</td>
<td>Ariel University</td>
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<tr>
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<tr>
<td>2019-11-28</td>
<td>Oscar Reula, Universidad Nacional de Cordoba</td>
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<td>2019-11-28</td>
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**PREPRINTS**

Participants of the program were encouraged to submit preprints with results that were obtained during their visit to Institut Mittag-Leffler. Files of the preprints listed below can be found on our website [www.mittag-leffler.se](http://www.mittag-leffler.se).

- **Bernardo Araneda**: Two-dimensional twistor manifolds and Teukolsky operators
- **Piotr Chrusiel, Maciej Maliborski, Nicolas Yunes**: The structure of the singular ring in Kerr-like metrics
- **Eric Ling**: Aspects of C^0 causal theory
- **Volker Schlue**: Optical functions in de Sitter

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- **Håkan Andreasson**, Chalmers/University of Gothenburg, Göteborg, Sweden
- **Bernardo Araneda**, Universidad Nacional de Cordoba, Cordoba, Argentina
- **Stefanos Aretakis**, University of Toronto, Toronto, Canada
- **Herbert Balasin**, Vienna University of Technology, Vienna, Austria
- **Ingemar Bengtsson**, Stockholm University, Stockholm, Sweden
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- **Alessandro Carlotto**, ETH Zürich, Zurich, Switzerland
- **Carla Cederbaum**, Universität Tübingen, Tübingen, Germany
- **Po-Ning Chen**, University of California, Riverside, California, United States
- **Piotr T. Chrusciel**, University of Vienna, Vienna, Austria
The workshop was suggested as a follow-up event of the successful program we were very fortunate to organize at Institut Mittag-Leffler in Spring 2017. The overall intention of the program was to initiate and further interactions between practitioners of algebraic geometry and homotopy theory, with ramifications to other parts of mathematics. A total of 32 researchers, 27 men and 5 women, from Asia, Europe, and North America registered for the workshop. In addition, several local mathematicians took part in the activities. Many new fruitful collaborations took place, and it is also notable how many participants benefit from less formal interactions with those of more distant expertise. It was pleasing to witness further interactions between practitioners of algebraic geometry and homotopy theory during the workshop.

The workshop was attended by a mix of world-leading experts and early career mathematicians. A carefully selected group of speakers talked about the very latest developments in the subjects of algebraic cycles, algebraic K-theory, (co)homology theories, A1-contractible varieties, enriched enumerative geometry, framed correspondences and spectra, motivic homotopy theory, and calculations of topological Hochschild homology. Many high-level talks were delivered, and interesting mathematical interactions took place throughout the week.

**PARTICIPANTS**

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Participants of Algebro-Geometric and Homotopical Methods.

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Georg Tamme, Universität Regensburg, Regensburg, Germany
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Maria Yakerson, Universität Duisburg-Essen, Duisburg-Essen, Germany
Paul Arne Østvaer, University of Oslo, Oslo, Norway
Various aspects of diverse inequalities of functional and geometric nature have been addressed during this workshop.

Sharp norms and constants in Sobolev type inequalities were the subject of various talks. L. Pick illustrated new rearrangement techniques for Sobolev embeddings involving general Ahlfors regular measures, that yield optimal targets for quite general families of spaces. A full characterization of the validity of Gagliardo–Nirenberg–Sobolev inequalities for fractional-order Sobolev spaces was given in P. Mironescu’s seminar. Best constants and properties of optimizers for functional inequalities involving Aharonov–Bohm magnetic potentials were discussed by M. Esteban in her contribution. D. Bucur and V. Ferone exposed, in their respective talks, various results on sharp constants and shape optimization problems for Sobolev type inequalities involving trace terms, and related boundary value problems for the Laplace operator with Robin boundary conditions.

Fine properties of Sobolev functions were discussed by some participants. They were the content of a talk by M. Korobkov, who presented sharp criteria for the validity of Luzin N–property and a description of the distortion of Hausdorff dimension in (fractional-order) Sobolev spaces. P. Koskela analyzed minimal geometric conditions on the domains of Sobolev functions for certain inequalities of Sobolev type to hold.
One focus of the workshop was on connections among convex geometry, analytic inequalities and PDEs. C. H. Jimenez presented recent functional versions of the Busemann-Petty centroid inequality and of his extensions in the $L^p$ Brunn-Minkowski theory by Lutwak, Yang, and Zhang. Such versions include log-Sobolev, Sobolev and Gagliardo-Nirenberg inequalities as well as Sobolev trace inequalities. In a similar spirit, E. Werner presented new entropy inequalities for log-concave functions which are obtained from isoperimetric inequalities for affine and $L^p$ affine surface areas of convex bodies.

P. Pivovarov presented new stochastic forms of analytic and geometric inequalities. These now include versions of the classical isoperimetric inequality, the Blaschke-Santaló inequality, the Busemann-Petty centroid inequality and of its extensions in the Orlicz Brunn-Minkowski theory. Two talks were centered on Minkowski problems and the closely related Minkowski inequalities. D. Yang presented recent results on Minkowski problems including the solution to the logarithmic Minkowski problem in the symmetric case and discussed the related PDEs of Monge-Ampère type. A. Stancu described new approaches to the conjectured logarithmic Minkowski inequality via affine curvature flows.

Important inequalities appear in studies of solutions of PDEs and minimizers in the calculus of variation. Global Schauder-type inequalities in terms of Campanate seminorms for the $p$-Laplace system were obtained by S. Schwarzacher. It was shown by J. Kristensen how Gårding inequalities help to obtain regularity of minimizers of quasiconvex integrals.

Inequalities are often deeply linked with qualitative analysis. Among most closely related topics we mention geometric function theory. S. Hencl presented results on unexpected sign of Sobolev homeomorphisms which shed new light to the famous problems of approximation by diffeomorphisms.

A. Kauranen studied branch sets of open and discrete mappings. M. Carozza proved continuity of weakly Sobolev mappings with gradient in various function spaces, particularly in Orlicz or Lorentz spaces.

PARTICIPANTS

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Numerical Methods for SPDE: 20 Successful Years and Future Challenges

MAY 20–24, 2019
Organizers: Andrea Barth, University of Stuttgart; David Cohen, Umeå University; Raphael Cohen, TU – Technische Universität Berlin; Annika Lang, Chalmers/University of Gothenburg

SCIENTIFIC REPORT

The subject of this workshop was numerical methods for stochastic partial differential equations (SPDEs) with a special emphasis to Stig Larsson’s (Chalmers & GU) contributions in terms of publications, collaborations, and support of young researchers.

The investigations presented in the workshop are in a lively phase of intensive development and impact on our understanding of core issues in computational SPDEs.

The following topics were presented and discussed: strong convergence analysis; weak convergence analysis; SPDEs with irregular coefficients; Lévy noise; Fractional noise; Monte-Carlo-type algorithms; uncertainty quantification; partial differential equations with random coefficients and/or on random domains; structure-preserving numerical methods; time-adaptivity; Machine learning and SPDEs.

All participants enjoyed the workshop very much, the scientific discussions, and the hospitality of the institute.

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Yubin Yan, University of Chester, Manchester, Manchester, Great Britain
This workshop gathered specialists from several branches within the area of smooth dynamical systems, such as: hyperbolic dynamics, integrable systems, probability and applications in number theory.

The main purpose of the workshop was to exchange ideas and methods from different areas and to present the state of the art in the field of dynamics. Several world leading experts presented their research. We outline the contents of several talks, which represents the different directions.

Raphaël Krikorian presented his new results proving generic divergence of Birkhoff normal forms of analytic symplectic diffeomorphisms. This result, which answers a long-standing question by Eliasson, provides strong dynamical consequences for the behavior of the systems.

Dmitry Dolgopyat gave a talk at the border of dynamics and probability, in which he discussed multiple Borel-Cantelli Lemma. In particular, Dolgopyat demonstrated the use of dynamical methods in probability.

Federico Rodriguez Hertz outlined in his talk a new approach to obtaining regularity for conjugacies between smooth dynamical systems through studying spaces of observables and cocycles over dynamical systems, with variable regularity. This new point of view is expected to inspire new research both in classical dynamics and in dynamics of group actions.
Livio Flaminio gave an overview of Möbius randomness conjecture in number theory and existing results from dynamics which contributed towards the conjecture, as well as his recent result on some classes of dynamical systems which satisfy the conjecture.

In the field of non-hyperbolic low dimensional dynamics, Marco Martens gave an enlightening talk in which he discussed the concept of probabilistic universality at the boundary of Chaos, Newhouse laminations and instability of renormalization.

Michael Benedicks reported on the result of his joint project with Liviana Palmisano in which they prove that for the classical Hénon family there exists a positive two-dimensional Lebesgue measure of parameters, for which the corresponding Hénon map exhibits the coexistence of any given number of attractive periodic orbits and one strange attractor.

The workshop ended with a two hours long open problem session, which led to active discussions among participants and pointed out several new directions of research.

This event was particularly useful for the local doctoral students in dynamical systems.

During this workshop the participants honoured the contribution of Michael Benedicks to mathematical research.

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The topic of the workshop was motivated by recent applications of group actions to various questions in algebra, geometry, number theory and computer science which have given rise to the development of new theoretical results as well as algorithms for computer algebra software. The theme was made accessible to young researchers, starting with the theory of permutation groups and exposing many open questions, both on the theoretical side and with regards to applications.

Three mini courses given by Niemeyer, Praeger and Roney-Dougal introduced several aspects of modern permutation group theory, addressing a variety of topics: from the foundations of permutation group theory and the theory of primitive and quasi-primitive groups to applications to graph theory and computation. Their lectures touched on current research topics as well, which was welcomed by the more advanced participants. The two spotlight lectures built on material that had been covered and introduced additional current research topics.

Roney-Dougal introduced some fundamentals of permutation group theory, including the concept of base and strong generating set, the O’Nan Scott theorem and methods for the classification of primitive permutation groups, Aschbacher’s fundamental theorem on finite classical groups and computational methods for matrix groups, and random generation of groups.
Praeger’s lectures focused on specific aspects of permutation group theory and the connection to graph theory, for example distance transitive graphs and normal graph quotients, the theory of quasiprimitive permutation groups and the connection to normal quotients of edge-transitive graphs. She went on to give an overview of simple group factorisations and their applications, especially to classify the maximal subgroups of finite symmetric groups. She spoke as well about connections between recent results on ‘growth of groups’ and the conjecture of Weiss for arc-transitive graphs.

Niemeyer’s lectures focused on computational methods and included a discussion of deterministic and randomised algorithms in group theory, proportions of elements in permutation groups and matrix groups, and spoke as well about growth of subgroups, particularly Sylow subgroups of primitive permutation groups.

Fawcett’s spotlight lecture was a survey about bases of permutation groups, and Waldecker spoke about transitive permutation groups acting with low fixity and their relevance for studying Riemann surfaces.

The participants appreciated our introductory session where each individual (organisers and speakers included) spoke for a couple of minutes about their background and interest in the summer school. They engaged actively – both as presenters and audience – in a successful poster session describing their research, and we received a lot of detailed and very positive feedback towards the end of the summer school.

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The conference gathered some of the most important specialists in the field of nonlinear dispersive equations (including among others Ioan Bejenaru, Patrick Gerard, Sebastian Herr, Herbert Koch, Felipe Linares, Kenji Nakanishi, Tohru Ozawa, Svetlana Roudenko, Daniel Tataru, Luis Vega and Monica Visan), together with researchers at an early career stage and some PhD students.

Many recent advances on important open problems were announced during the conference. Among the highlights, we mention: new results on the glonial regularity problem for the Dirac–Klein–Gordon system (Bejenaru); the first construction of an explicit representation of solutions via nonlinear Fourier transform for the Benjamin–Ono equation on the circle (Gerard); the extension to the nonlinear Schrodinger equation of randomization methods to improve on the final state problem (Nakanishii); the proof of the asymptotic stability...
for the Zakharov–Kuznetsov equation (Roudenko); an outstanding unified representation for multi-soliton solutions to the 1D cubic Schrodinger equation (Tataru); new progress on the vortex filament model of turbulence (Vega); a construction of global dynamics for the KdV on the line with white noise data (Visan). There were several discussions among the participants on the topics of the conference, and the meeting was an important occasion for a few of the younger participants to present their results to a large audience and to initiate new collaborations.

PARTICIPANTS

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Claudio Munoz, Universidad de Chile, Santiago, Spain
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Dinh-Thi Nguyen, LMU Munich, Munich, Germany
Tohru Ozawa, Waseda University, Tokyo, Japan
Svetlana Roudenko, Florida International University, Miami, USA
Daniel Tataru, University of California, Berkeley, Berkeley, USA
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Monica Visan, University of California, UCLA, Los Angeles, USA
Nicola Visciglia, University of Pisa, Pisa, USA
The aim of the workshop was to bring together mathematicians and physicists working on knot theory and related subjects.

Over the last 30 years there has been an intense interaction between physics and mathematics within the area of knot theory. This ongoing development has been driven by both fields. Beyond leading to new results about knots and low-dimensional topology it provides a mathematical environment where some of the physical ideas from gauge and string theory can be worked with. The workshop focused on some of the latest developments in the field, in particular there were talks on:

Ekholm-Shende’s recent proof of large N duality for knots and links in the 3-sphere relating gauge theory (skein invariants) and Gromov-Witten invariants of their conormals in the resolved conifold.

The knot-quiver correspondence of Sułkowski-Gukov-Kucharski and the open Gromov-Witten theory of Ekholm-Ng which indicates the workings of the topological M-theory that underlies the superpolynomial of Gukov-Rasmussen- Dunfield.

The duality interfaces in 3-dimensional theories of Aganagic and Okounkov that indicates the geometry which underlies categorifications.

The Z-hat theory of Gukov and collaborators. Here concrete progress was made. Combining the results presented in this talk with the results in another talk...
about counts of holomorphic annuli and the Alexander polynomial, a new understanding of the Z-hat theory as a certain expectation value in a Fourier transformed version of the colored HOMFLY-PT polynomial emerged. This direction is now actively and successfully researched by a large group of researchers.

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New Directions in Mathematics of Coulomb Gases and Quantum Hall Effect

JULY 1–5, 2019

Organizers: Gaëtan Borot, Max Plack Institute For Mathematics; Semyon Klevtsov, University of Cologne; Sylvia Serfaty, New York university; Paul Wiegmann, The University of Chicago

SCIENTIFIC REPORT

The workshop was devoted to the topic at the intersection of physics and mathematics: Coulomb gases and quantum Hall effect. A particular aspect of this research area is that the mathematics involved in the rigorous description of these physics systems is quite diverse, as it encompasses analytic, geometric, probabilistic as well as computational aspects. The topics prominently featured at the conference included random matrices, beta-ensembles, gaussian free fields, entanglement, Riemann surfaces, moduli spaces, theta functions, Hitchin connections, orthogonal polynomials, supergeometry, to name just a few. The goal of the conference was to bring together a diverse group of mathematicians and physicists working in this area and in related fields in order to discuss recent developments and to try to identify promising novel directions in the field. We began the conference with the ‘summer school’ style introductory lectures on Coulomb gas (Serfaty), large deviations (Guionnet), and quantum Hall effect (Gromov). In retrospect we think this was an excellent choice, as the lecturers did a great job to bring our mixed audience up to date and help them navigate more technical talks later on. The subsequent research talks can be loosely organized into four groups in their relation to various aspects of QHE/Coulomb gases: physics aspects (Gromov, Estienne, Kapustin, Can, Regnault), geometric aspects (Andersen, Kang, Ma, Zvonkine, Charles), analysis (Hedenmalm, Leble, Rougerie, Yngvasson) and probability/random matrices aspects (Hardy, Maida, Knizel, Rhodes, Wu).
One of the highlights of the conference was the special open problems session, with the short presentations by Borot, Hedenmalm, Klevtsov and Rougerie, and a short talk by Wiegmann on open questions in boundary effects in Coulomb gas.

To summarize we feel that we succeeded in our main task of bringing this group of researchers closer together. We are hopeful that this will facilitate future collaborations in novel directions, such as the questions pertaining to large N analysis and boundary behavior of the Coulomb gas, geometric and topological properties of QHE, mathematical description of higher QH states, such as Pfaffian state, etc.

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Alessandro Olgiati, CNRS, Paris, France

Quim Ortega-Cerda, Universitat de Barcelona, Barcelona, Spain

Nicolas Regnault, Sorbonne University, Paris, France

Remi Rhodes, Aix-Marseille University, Marseille, France

Nicolas Rougerie, University of Grenoble, Grenoble, France

Sylvia Serfaty, New York University, New York, USA

Paul Wiegmann, The University of Chicago, Chicago, USA

Wei Wu, University of Warwick, Coventry, Great Britain

Jakob Yngvason, University of Vienna, Wien, Austria

Ofer Zeitouni, Weizmann Institute of Science, Rehovot, Israel

Peter Zograf, St. Petersburg Department of Steklov Mathematical Institute RAS, St. Petersburg, Russia

Dimitri Zvonkine, University of Versailles Saint-Quentin-en-Yvelines, Versailles, France
SCIENTIFIC REPORT

By drawing together newcomers to the field of thermodynamic formalism and all its branches and applications, and experienced researchers who work in one of these areas or in the interim between, to speak on their decisive breakthroughs, several new collaborative partnerships formed, while others were enhanced. Indeed, one of the outcomes of the meeting will be a proceedings volume, to be published in the journal Stochastics and Dynamics, for which manuscripts are currently being prepared and submitted. Further, some of the participants joined forces and successfully applied to host a workshop in 2020 at IML.

The main focus of the research talks and discussions during the workshop included the following:

- **Dynamical methods in number theory and quasicrystals**: Thermodynamic formalism provides a link between geometry and number theory (Diophantine approximation). It plays a crucial role in the understanding of regularity of singular maps, as well as in resolving the Texan conjecture and recently in the avant-garde fields of quasicrystals and noncommutative geometry.
Random and transient dynamics: Structures which are found in nature often possess complexity and randomness on large and small scales, for instance galaxies and landscapes, aggregates and colloids, and polymers and proteins. To determine geometric characteristics of such sets (which are sometimes referred to as fractals), thermodynamic formalism is vividly used. Two burgeoning areas of research include random and transient dynamics.

Stochastics and dynamics: Every dynamical system equipped with an invariant probability measure gives rise to a wide class of stochastic processes of interest: the time series of measurements. The main tool is often the transfer operator associated with the dynamical system. The thermodynamic formalism provides a set of tools for analysing the transfer operator and has served a central role in establishing strong stochastic properties of these time series.

As a founding father of several theories which helped to shape the above framework, this event was dedicated to Manfred Denker’s 75-th birthday.

PARTICIPANTS

John Aaronson, Tel Aviv University, Tel Aviv, Israel
Demi Allen, University of Bristol, Bristol, Great Britain
José Maria Amigo, Universidad Miguel Hernández, Alicante, Spain
Jason Atnip, UNSW, Sydney, Sydney, Australia
Michael Baake, Bielefeld University, Bielefeld, Germany
Michael Benedicks, KTH Royal Institute of Technology, Stockholm, Sweden
Herold Dehling, Ruhr-Universität Bochum (RUB), Bochum, Germany
Manfred Denker, Georg-August-Universität Göttingen, Göttingen, Germany
Kenneth J. Falconer, University of St Andrews, St Andrews, Great Britain

Kurt Falk, Christian-Albrechts-Universität zu Kiel, Kiel, Germany
Ksenia Fedosova, University of Freiburg, Freiburg, Germany
Chris Good, University of Birmingham, Birmingham, Great Britain
Maik Gröger, University of Vienna, Vienna, Austria
Michael Keane, Universiteit Leiden, Leiden, Netherlands
Gerhard Keller, Universität Erlangen-Nürnberg, Erlangen, Germany
Marc Kesseböhmer, Universität Bremen, Bremen, Germany
Sabrina Kombrink, Georg-August-Universität Göttingen, Göttingen, Germany
Marco Lopez, University of North Texas, Texas, USA
Samuel Patterson, Georg-August-Universität Göttingen, Göttingen, Germany
Yakov Pesin, Penn State University, Pennsylvania, USA
Anke Pohl, Universität Bremen, Bremen, Germany
Feliks Przytyckii, IM PAN, Institute of Mathematics of the Polish Academy of Sciences, Warszaw, Poland
Tony Samuel, University of Birmingham, Birmingham, Great Britain
Omri Sarig, Weizmann Institute of Science, Rehovot, Israel
Tanja Schindler, Australian National University, Canberra, Australia
Jörg Schmeling, Lund University, Lund, Sweden
Samuel Senti, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil
Manuel Stadlbauer, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil
Inga Stolz, Europa Universität Flensburg, Flensburg, Germany
Hiroki Sumi, Kyoto University, Kyoto, Japan
Hisayoshi Toyokawa, Hokkaido University, Hokkaido, Japan
Mariusz Urbanski, University of North Texas, Texas, USA
Jamie Walton, University of Glasgow, Glasgow, Great Britain
Benjamin Weiss, Einstein Institute of Mathematics, Jerusalem, Israel
Howard Weiss, Georgia Institute of Technology, Atlanta, USA
Sanju Velani, University of York, York, Great Britain
Meng Wu, University of Oulu, Oulu, Finland
Anna Zdunik, University of Warsaw, Warszaw, Poland
Proof, Computation, Complexity

JULY 15–19, 2019

Organizers: Reinhard Kahle, Universität Tübingen; Lars Kristiansen, University of Oslo; Erik Palmgren, Stockholm University; Ralph Matthes, IRIT Toulouse Institute of Computer Science Research

scientific report

This was the 18th edition of the international workshop series: Proof, Computation, Complexity (PCC). The aim of the workshop was to stimulate research in proof theory, computation, and complexity from a mathematical perspective, focusing on issues which combine logical and computational aspects. Topics included applications of formal inference systems in mathematics and computer science, as well as new developments in proof theory motivated by mathematical and computer science demands. As in previous editions, the workshop provided a lively forum for presenting and discussing recent work. However, this edition was exceptional in being a free-standing scientific meeting of a whole work week’s length.

Without diminishing the scientific contribution of any of the other talks, we mention some examples:

• The work on proof mining employs dedicated logical meta-theorems for the effective solution of mathematical problems framed in terms of classical calculus (such as convergence in metric spaces).

• Probabilistic termination addresses quantitatively the runtime of randomized algorithms for higher-order functions, and the presented work discussed a framework of static analysis to this end.

• Gödel’s Dialectica interpretation of 1958 still inspires exciting new developments that provide new tools for proof analysis and a uniform understanding of previously unrelated methods.

The workshop was attended by 30 participants from 11 different countries; we had 25 talks, many of them by early career researchers. There was also a lot of time for discussion.
PARTICIPANTS

Bahareh Afshari, Chalmers/University of Gothenburg, Gothenburg, Sweden
Federico Aschieri, Vienna University of Technology, Vienna, Austria
Matthias Baaz, Vienna University of Technology, Vienna, Austria
Jan Bydzovsky, Vienna University of Technology, Vienna, Austria
Natalie Clarius, University of Tübingen, Tübingen, Germany
Ugo Dal Lago, University of Bologna, Bologna, Italy
Anupam Das, University of Copenhagen, Copenhagen, Denmark
Alessio Guglielmi, University of Bath, Bath, Great Britain
Andrew Lewis, Queen Mary University of London, London, Great Britain
Anders Lundstedt, Stockholm University, Stockholm, Sweden
Sonia Marin, University of Copenhagen, Copenhagen, Denmark
Ralph Matthes, IRIT Toulouse Institute of Computer Science Research, Toulouse, France
Juvenal Murawanashyaka, University of Oslo, Olso, Norway
Isabel Oitavem, Universidade Nova de Lisboa, Lisboa, Portugal
Paulo Oliva, Queen Mary University of London, London, Great Britain
Erik Palmgren, Stockholm University, Stockholm, Sweden
Luíz Pinto, Universidade Minho, Braga, Portugal
Michael Rathjen, University of Leeds, Leeds, Great Britain
Sam Sanders, University of Leeds, Leeds, Great Britain
Paulo Santos, Universidade NOVA de Lisboa, Lisboa, Portugal
Andrei Sipos, Technical University of Darmstadt, Darmstadt, Germany
Philipp Stassen, Stockholm University, Stockholm, Sweden

Books from the main library.
Klein Days

Three times a year, high school teachers of mathematics are invited to Institut Mittag-Leffler together with mathematics professors and university teachers. For three days, they inspire each other and develop tomorrow’s mathematics lessons for high school students, by combining the pedagogical expertise of high school teachers with the advanced subject knowledge of higher mathematics.

The purpose of the Klein Days is to fill the gap between the knowledge and learning within mathematics in upper secondary schools in Sweden and the university level of mathematics by giving insight into the respective mathematical approaches and teaching situations.

The Klein Days is an appreciated learning and development opportunity aiming to create lessons in mathematics with an instant impact on high school students all around Sweden.

Organizers: Mats Boij, chair of The Swedish National Committee for Mathematics and professor in mathematics at KTH Royal Institute of Technology, Stockholm

Supporting organization: Brummer & Partners

REPORT

The teacher development program Kleindagarna for high school teachers in mathematics has been arranged three times during 2019 by Svenska kommittén för matematikutbildning (KVA) together with Institut Mittag-Leffler and financed by Brummer & Partners. The program for all three instances has been based on inspirational lectures by university professors followed by work in groups in order to develop lesson plans that can be implemented in the high school teachers’ classrooms. This year we have had a more international selection of lecturers than previously. All three programs have been very well received by the participants.

I. JANUARY 10–12, 2019

Lecturers

Claus Führer, Linköping University, Linköping, Programming

Jana Madjarova, Chalmers/University of Gothenburg, Göteborg, Konst och matematik

Julie Rowlett, Chalmers/University of Gothenburg, Göteborg, Game Theory in Biology

Greg Smith, Queens University, Kingston, Pick’s Theorem
Lesson pilots

Mats Boij, KTH Royal Institute of Technology, Stockholm
Linnea Hietala, University of Gothenburg, Göteborg
Lena Leitenmaier, KTH Royal Institute of Technology, Stockholm
Lisa Nicklasson, Stockholm University, Stockholm

Participants

Catarina Arnell, Sigtuna Humanistiska Läroverket, Sigtuna
Olof Barr, Katedralskolan Lund, Lund
Mats Boij, KTH Royal Institute of Technology, Stockholm
Carina Bratt, Tibble Fristående Gymnasium, Täby
Linnea Fransson, Växjö Katedralskolan, Växjö
Ulf Hellberg, Västerås Folkhögskola, Västerås
Hiba Jameel, NTI Gymnasiet Södertälje, Södertälje
Henrik Jansson, Danderyds gymnasiu, Danderyd

Christina Killander, Forslundagymnasiet i Umeå, Umeå
Anne-Mi Liljestrand, Sundsvalls gymnasium, Sundsvall
Nicklas Lindén, Sundsgymnasiet, Vellinge
Lasse Lindholm, Bruksgymnasiet i Gimo, Gimo
Susanna Nilsson, Nyköpings gymnasium, Nyköping
Anders Sundholm, Solna gymnasium, Solna
Elena Sundkvist, Viktor Rydberg Gymnasium Odenplan, Stockholm
Conny Söderberg, Sturegymnasiet, Halmstad
Anna Vaez, ESS-Gymnasiet, Stockholm
Sten Weman, Vadsbogymnasiet, Mariestad
Linda Viklund, Sundsvalls gymnasium, Sundsvall
Petra Wikström, Kungshögskolan, Malmö
Alireza Zavareh, Jensen gymnasium Stockholm, Stockholm

The participants of the Klein Days in January, 2019.

Photo: Institut Mittag-Leffler
II. JUNE 17-19, 2019

Lecturers

Christin Borge, University of Oslo, Oslo, *Tallfølger og tallet e*

Søren Eilers, University of Copenhagen, Köpenhamn, *Berømte og berygtede tallfølger konstrueret i Lego*

Lisa Hed, Umeå University, Umeå, *Vad är nytta med numeriska beräkningar och simuleringar?*

Anders Karlsson, University of Geneva, Geneve, *Den spännande ekvationen A+B=C*

Lesson pilots

Mats Boij, KTH Royal Institute of Technology, Stockholm

Anna Gummesson, LTH Lunds Tekniska Högskola, Lund

Lena Leitenmaier, KTH Royal Institute of Technology, Stockholm

Adam Malik, Chalmers/University of Gothenburg, Göteborg

Participants

Jenny Alpsten, Södra Latins gymnasium, Stockholm

Mats Boij, KTH Royal Institute of Technology, Stockholm

Slavica Enving, Bladins gymnasium, Malmö

Henrik Geimer, Sundsgymnasiet, Vellinge

Daniel Granath, Vadsbogymnasiet, Mariestad

Johan Haglund, Rudbecksskolan, Sollentuna

Tim Hylén, Bladins gymnasium, Malmö

Jan Härstedt, NTI Handelsgymnasiet, Stockholm

Anders Johansson, Vuxenutbildningen i Falkenberg, Falkenberg

Niklas Lindberg, Viktor Rydberg Gymnasium Odenplan, Stockholm

Andreas Londos, Pauliskolan, Malmö

Martin Lübcke, Bruksgymnasiet i Gimo, Gimo

Kristian Medjed, Eductus Göteborg, Göteborg

Maria Nars, Göteborgs högre samskola, Göteborg

Anna Norberg, Tannbergsskolan, Lycksele

John Nyman, Hässleholms Tekniska Skola, Hässleholm

Narit Pidokrajt, Marks Gymnasieskola, Skene

Matthias Rezac, Viskastrandsgymnasiet, Borås

Nils Sjögren, Värmdö gymnasium, Värmdö

Ying Zhang, Sandagymnasiet, Huskvarna

Lisa Österdahl, Thoren Business School, Stockholm
III. AUGUST 15-17, 2019

Lecturers
Anne-Maria Ernvall-Hytönen, Åbo Akademi, Åbo, Krypto
Hans Ringström, KTH Royal Institute of Technology, Stockholm, Matematik för att beskriva universum
Elizabeth Wulcan, Chalmers/University of Gothenburg, Göteborg, Rationella trassel
Lars-Daniel Öhman, Umeå University, Umeå, Vad jag talar om när jag talar om de naturliga talen

Lesson pilots
Mats Boij, KTH Royal Institute of Technology, Stockholm
Anna Broms, KTH Royal Institute of Technology, Stockholm
Bashar Saleh, Stockholm University, Stockholm
Linn Öström, LTH Lunds Tekniska Högskola, Lund

Participants
Daniel Becker, Sundsta-Ålvkullegymnasiet, Karlstad
Petter Berglin, Klara teoretiska gymnasiet, Sundsvall
Malin Bergsten, Naturbruksgymnasiet, Svenljunga, Svenljunga
Joakim Cronelöv, Rudbecksskolan, Sollentuna
Sedat Delen, Fredrika Bremer gymnasiet, Stockholm
Maria Eklänge, Prins Wilhelmgymnasiet, Flen
Jonas Fallander Ågren, Sundsta-Ålvkullegymnasiet, Karlstad
Sebastian Fransson, Påhlmans Gymnasium, Stockholm
Kerstin Glimmerfors, Nacka gymnasium, Nacka
Anna Knutson Savelid, Väsby Nya Gymnasium, Upplands Väsby
Lasse Lindholm, Bruksgymnasiet i Gimo, Gimo
Magnus Lindström, Europaskolan Varese, Italien, Varese
Kazem Mobarra, Riksäpplets gymnasium, Handen
Stefanie Primetzhofer, Lundellska Skolan, Skrapan, Uppsala
Pernilla Stamming, Södra Latins gymnasium, Stockholm
Mikael Sund, NTI Gymnasiet i Karlstad, Karlstad
Ling Li Tabor, Skärgårdsgymnasiet, Åkersberga
John Terstad Örtendahl, Kalmarssunds Gymnasieförbund, Lars Kaggskolan, Kalmar
Kathleen Wireklev, Tranemo Gymnasieskola, Tranemo
Henrik Åkerstedt, Hersby gymnasium, Hersby
Currently, Wikipedia lists 13 different international scientific olympiads for young people. In the beginning of the seventies, only three of them existed: mathematics (IMO) that started in 1959, physics (IPhO) that started in 1968 and chemistry (IChO) that started in 1969. In IMO 1971, which was held in Zilina (current Slovakia), 15 teams participated, five of them from the Western Europe: Austria, France, the Netherlands, Sweden and the UK. Sweden was the first western country to participate in the IChO (1974) and Germany to participate in the IPhO (1975). (Sweden participated for the first time in the IPhO in 1976). In 2019, 80 teams participated in IChO and teams from 112 countries participated in IMO.

Most members of the Swedish IMO 1971 had met regularly throughout the years and, from 2006, members meet annually in various places in Sweden and Europe. In 2016, an international IMO 2016 reunion was arranged in Vienna, Bratislava and Zilina. One of the participants, Professor Heinz Engl, had become the president of the University of Vienna, which without doubt contributed to the success of the event. Further meetings were arranged in Dresden (2017), Groningen (2018) and in Stockholm (2019). In 2020, a meeting is scheduled in Cambridge.

During the reunion in Stockholm, visits were made at the Vasa Museum, the Nobel Prize Museum, the Drottningholm Palace and the Gröna Lund amusement park. Thanks to the hospitality of the Mittag-Leffler Institute, a guided tour and a mini-conference could be arranged at this lovely place.

During the mini-conference, lectures were held by Doctor Reinhard Wobst about decrypting the Enigma and by Professor Harald Englisch about mathematical modelling for hospital planning. Professor Ann-Marie Pendrill held a lecture at the Gröna Lund about amusement park physics. As former director for the Swedish National Resource Center for Physics Education, she used that lecture to promote the interest in physics among young people.
Participants

International Science Olympiads
- International Mathematical Olympiad, IMO, Est. 1959
- International Physics Olympiad, IPhO, Est. 1967
- International Chemistry Olympiad, IChO, Est. 1968
- International Olympiad in Informatics, IOI, Est. 1989
- International Biology Olympiad, IBO, Est. 1990
- International Philosophy Olympiad, IPO, Est. 1993
- International Astronomy Olympiad, IAO, Est. 1996
- International Geography Olympiad, iGeo, Est. 1996
- International Linguistics Olympiad, IOL, Est. 2003
- International Junior Science Olympiad, IJSO, Est. 2004
- International Earth Science Olympiad, IESO, Est. 2007
- International Olympiad on Astronomy and Astrophysics, IOAA, Est. 2007
- International Economics Olympiad, IEO, Est. 2018

Mobility Program
Departments of mathematics at several Swedish universities participate in a mobility program inviting IML program participants. A researcher from the current program gives a talk at one of the participating institutions. The institute also welcomes researchers and post-docs at the departments to participate in program activities.
Förvaltningsberättelse

Verksamheten

Allmänt om verksamheten
Makarna Mittag-Lefflers matematiska stiftelse har sitt säte i Stockholm. Stiftelsens ändamål är att inom de fyra nordiska länderna, Sverige, Danmark, Finland och Norge, och alldeles särskilt Sverige, för framtidens uppehålla och ytterligare utveckla den ställning, vilken den renia matematiken i dessa länder numera iatager, samt att härvid även bereda aktning och rättvist uppskattande utom Nordens gränser för dessa länder lambets insats inom tankelivets högsta område. Makarna Mittag-Lefflers matematiska stiftelse bedriver verksamhet bl.a., i form av tidskriftsutgivning varför alla uttag redovisas över resultsträckningen som kostnader för drift av stiftelsen.

KVA förvaltar ett kapital med ett marknadsvärde som per 2010-12-31 uppgår till 2 001 mkr via sina anknutna stiftelser. KVA och dess anknytta stiftelser kapital (exklusive Stiftelsen Anna-Greta och Holger Crafoords fond) förvaltas av Carnegie enligt av akademistyrelsen fastställda riktlinjer.

Makarna Mittag-Lefflers matematiska stiftelser andel uppgår till 11,39%.

Stiftelsen har inte haft några anställda och inga lån och ersättningar har utbetalats under året.

Främjande av ändamålet

Väsentliga händelser under räkenskapsåret
Inga väsentliga händelser finns att rapportera.

Flerårsöversikt

<table>
<thead>
<tr>
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<tr>
<td>Huvudiatäker</td>
<td>25 529 537</td>
<td>14 205 923</td>
<td>14 939 124</td>
<td>20 930 057</td>
<td>22 042 746</td>
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<tr>
<td>Årets resultat</td>
<td>16 933 114</td>
<td>-6 556 296</td>
<td>20 279 793</td>
<td>-2 585 868</td>
<td>14 827 635</td>
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<tr>
<td>Ingaende kapital</td>
<td>173 409 812</td>
<td>179 966 108</td>
<td>159 686 315</td>
<td>162 272 183</td>
<td>147 444 548</td>
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<tr>
<td>Utgående kapital</td>
<td>190 342 926</td>
<td>173 409 812</td>
<td>179 966 108</td>
<td>159 686 315</td>
<td>162 272 183</td>
</tr>
<tr>
<td>Årlig förändring i %</td>
<td>9,76%</td>
<td>-3,64%</td>
<td>12,70%</td>
<td>-1,59%</td>
<td>10,06%</td>
</tr>
</tbody>
</table>

Vad betycker stiftelss resultat och ställning i övrigt, hänvisas till efterföljande resultat- och balansräkningar med tillhörande noter.
### Resultaträkning

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Stiftelsen intäkter</strong></td>
<td></td>
<td></td>
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<tr>
<td>Bidrag</td>
<td>21 418 559</td>
<td>12 819 189</td>
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</tr>
<tr>
<td>Nettoomsättning</td>
<td>330 000</td>
<td>470 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Övriga stiftelseintäkter</td>
<td>3 760 977</td>
<td></td>
<td>116 433</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>35 589 537</td>
<td>14 285 623</td>
<td></td>
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</tr>
</tbody>
</table>

**Stiftelsen kostnader**

<table>
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<tr>
<th></th>
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</tr>
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<tbody>
<tr>
<td>Övriga externa kostnader</td>
<td>-19 836 499</td>
<td></td>
<td>-16 249 620</td>
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<tr>
<td>Av- och nedskrivningar av materiella anläggningstillgångar</td>
<td>-301 138</td>
<td>-245 080</td>
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<tr>
<td>Övriga stiftelsekostnader</td>
<td>-836 199</td>
<td>-794 896</td>
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<td><strong>Total</strong></td>
<td>-20 973 837</td>
<td>-17 284 596</td>
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### Rörelseresultat

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<th>2019-01-01 Net</th>
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<tr>
<td><strong>Total</strong></td>
<td>4 555 700</td>
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### Finansiella poster

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<th>2019-01-01 Net</th>
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<tr>
<td>Resultat från övriga finansiella anläggningstillgångar</td>
<td>12 628 741</td>
<td>3 897 991</td>
</tr>
<tr>
<td>Övriga ränteintäkter och liknande resultatposter</td>
<td>345 673</td>
<td>425 668</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12 974 414</td>
<td>4 323 659</td>
</tr>
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</table>

### Årets resultat

<table>
<thead>
<tr>
<th></th>
<th>2019-01-01 Net</th>
<th>2018-01-01 Net</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>16 933 114</td>
<td>-6 556 296</td>
</tr>
</tbody>
</table>

* Det positive rörelseresultat beror på att några projektmedel kunnat umyttjas för årets kostnader.  
** I årets resultat finns en post om 7,5 mkr avseende återförd nedskrivning vilket påverkar resultatet positivt. Föregående års siffror innehåller en motsvarande nedskrivning, se vidare not 3.
## Balansräkning

<table>
<thead>
<tr>
<th></th>
<th>2019-12-31</th>
<th>2018-12-31</th>
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<tbody>
<tr>
<td><strong>Tillgångar</strong></td>
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<tr>
<td>Anläggningstillgångar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materiella anläggningstillgångar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventarier, verktyg och installationer</td>
<td>5</td>
<td>58 327</td>
</tr>
<tr>
<td>Förbitringsutgifter på annans fastighet</td>
<td>6</td>
<td>1 843 762</td>
</tr>
<tr>
<td></td>
<td>1 877 284</td>
<td>1 808 482</td>
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<tr>
<td><strong>Finansiella anläggningstillgångar</strong></td>
<td></td>
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<tr>
<td>Andra långfristiga värdepappersinnehav</td>
<td>7</td>
<td>188 994 971</td>
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<tr>
<td></td>
<td>188 994 971</td>
<td>190 399 260</td>
</tr>
<tr>
<td><strong>Summa anläggningstillgångar</strong></td>
<td>190 871 355</td>
<td>171 207 742</td>
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<tr>
<td><strong>Tillgångar</strong></td>
<td></td>
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<tr>
<td><strong>Summa omsättningsstillgångar</strong></td>
<td>17 633 520</td>
<td>20 457 427</td>
</tr>
<tr>
<td><strong>Summa tillgångar</strong></td>
<td>208 504 875</td>
<td>197 665 169</td>
</tr>
</tbody>
</table>

### Eget kapital och skulder

#### Eget kapital

- **Bundet eget kapital**
- **Bundet eget kapital vid räkenskapsårets början** | 178 791 846 |
- **Förändringar av bundet kapital** | 8 505 464 |
- **Bundet eget kapital vid räkenskapsårets slut** | 187 297 309 |
- **Fritt eget kapital**
  - **Fritt eget kapital vid räkenskapsårets början** | 186 255 082 |
  - **Fritt eget kapital vid räkenskapsårets slut** | 178 791 846 |
  - **Årets resultat** | 5 382 034 |
  - **Lämnade och återförda anslag** | 7 483 236 |
  - **Lämnade och återförda anslag** | 6 556 296 |
  - **Fritt eget kapital vid räkenskapsårets slut** | 5 382 034 |

#### Summa Eget kapital

<table>
<thead>
<tr>
<th></th>
<th>190 342 926</th>
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</thead>
<tbody>
<tr>
<td><strong>Summa skulder</strong></td>
<td>18 161 949</td>
</tr>
<tr>
<td><strong>Summa eget kapital och skulder</strong></td>
<td>208 504 875</td>
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Not 1 - Redovisnings- och värderingsprinciper

Allmänna redovisningsprinciper
Årsredovisningen har upprättats i enlighet med Årsredovisningslagen och Bokföringsnämndens allmänna råd (BFRAR 2016:10) Årsredovisning i mindre företag.

Avskrivningsprinciper för anläggningsstillgångar
Följande avskrivningstider tillämpas

Materialiska anläggningsstillgångar
Inventarier, verktyg och installationer  3 - 5 år
Förädlingsutgifter på annans fastighet  10 - 40 år

Eget kapital
Bundet eget kapital består dels av det ursprungliga donationskapitalet, dels av resulutat som förs direkt mot bundet eget kapital. Utöver detta ingår även kapitaliseringar, årlig avsättning om 10 % på räntor och utdelningar. Fritt kapital avser den del av kapitalet som kan disponeras för utdelningar.

Not 2 - Övriga externa kostnader

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<thead>
<tr>
<th></th>
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<tbody>
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<td>Lokalkostnader</td>
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<td>IT-kostnader</td>
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<td>Personalkostnader</td>
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<tr>
<td>Övrigt</td>
<td>-2 473 253</td>
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Not 3 - Resultat från övriga finansiella anläggningsstillgångar

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<td>Ränteintäkter</td>
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<td>Realisationsresultat</td>
<td>834 782</td>
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<td>Återföring nedskrivning / Nedskrivning värdepapper</td>
<td>7 540 465</td>
<td>7 540 464</td>
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Not 4 - Övriga ränteintäkter och liknade resultatposten

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Not 5 - Inventarier, verktyg och installationer

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<tr>
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Not 6 - Förhållningssutgifter på annans fastighet

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Ackumulerade avskrivningar enligt plan

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Redovisat värde vid årets slut

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Not 7 - Andra långfristiga värdepappersinnehav

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Ackumulerade nedskrivningar

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Bokfört värde

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Marknadsvärde

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Stockholm den 28 maj 2020

Göran K Hansson
Stärdig sekreterare

Min revisionsbeslutelse har avgivits den

Magnus Prööm
Anställdad revisor