INSTITUT
MITTAG-LEFFLER
THE ROYAL SWEDISH ACADEMY OF SCIENCES

Annual Report 2019

Institut Mittag-Leffler

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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Institut Mittag-Leffler

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Annual Report 2019

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.

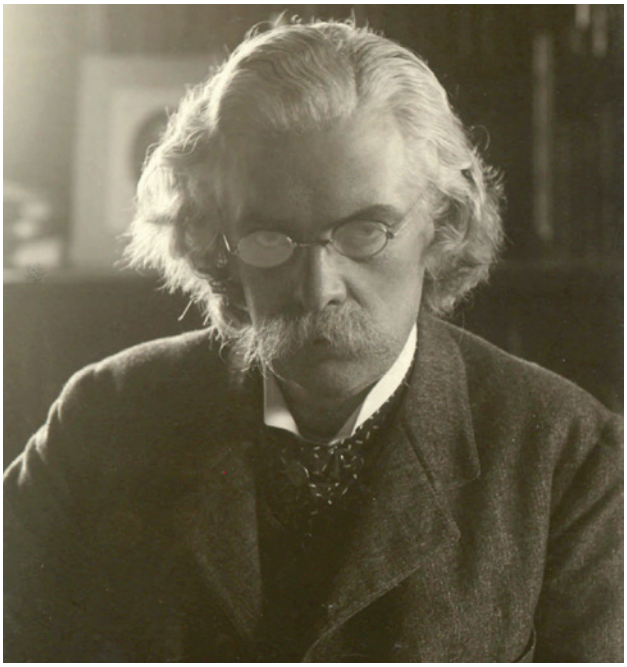


Photo: Arkiv Institut Mittag-Leffler

Gösta Mittag-Leffler.

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 (NCM), 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.

Photo: Institut Mittag-Leffler

Director **Tobias Ekholm.**

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

Photo: Institut Mittag-Leffler

The board of Institut Mittag-Leffler 2019.

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 Universitet)

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

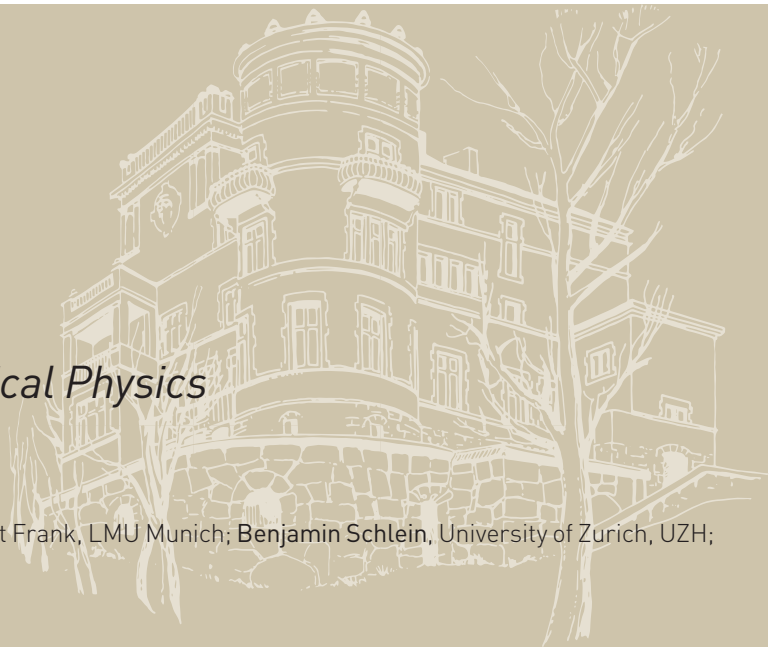
STOCKHOLM UNIVERSITY

THE SWEDISH RESEARCH COUNCIL

THE VERG FOUNDATION

UMEÅ UNIVERSITY

UPPSALA UNIVERSITY



Programs

Spectral Methods in Mathematical Physics

JANUARY 14–APRIL 26, 2019

Organizers: Søren Fournais, Aarhus University; Rupert Frank, LMU Munich; Benjamin Schlein, University of Zurich, UZH; Simone Warzel, TU Munich

SCIENTIFIC REPORT

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 Brennecke, 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

2019-02-07
Lukas Schimmer, University of Copenhagen,
On the construction of distinguished self-adjoint extensions of operators with gaps

2019-02-07
Yulia Meshkova, St Petersburg State University,
On homogenization of periodic hyperbolic systems

2019-02-07
Corentin Lena, Stockholm University,
Optimization of eigenvalues for the magnetic Laplacian

2019-02-08
Pavel Exner, Nuclear Physics Institute ASCR,
Periodic quantum graphs: not always what a common wisdom would suggest

2019-02-19
Victor Ivrii, University of Toronto,
Complete spectral asymptotics for periodic and almost periodic perturbations of constant operators and Bethe-Sommerfeld conjecture in semiclassical settings

2019-02-19
Sara Maad Sasane, Lund University,
Perturbations of embedded eigenvalues for a magnetic Schrödinger operator on a cylinder

2019-02-20
Martin Vogel, Université de Strasbourg, CNRS,
Grushin problems and their applications in spectral theory

2019-02-21
Stefan Teufel, Universität Tübingen,
Linear response for gapped fermionic systems based on non-equilibrium almost steady states

2019-02-21
Martin Vogel, Université de Strasbourg, CNRS,
Spectrum of random non-self adjoint operators

2019-02-26
Mathieu Lewin, Université Paris-Dauphine,
Mini course on nonlinear Gibbs measures, renormalization & infinite-dimensional semi classics

2019-02-26
Tobias Ried, Max Planck Institute for Mathematics in the Sciences,
Cwikel's bound reloaded

2019-02-26
Thomas Hoffmann-Ostenhof, University of Vienna,
On multiplicities of eigenvalues: some results and open problems

2019-02-27
Mathieu Lewin, Université Paris-Dauphine,
Mini course on nonlinear Gibbs measures, renormalization & infinite-dimensional semi classics

2019-02-27
Arnaud Triay, CEREMADE,
Semi-classical limit of large fermionic systems at positive temperature

2019-02-28
Mathieu Lewin, Université Paris-Dauphine,
Mini course on nonlinear Gibbs measures, renormalization & infinite-dimensional semi classics

2019-02-28
Frédéric Herau, Université de Nantes,
A Korn-Wirtinger inequality

2019-03-01
Mathieu Lewin, Université Paris-Dauphine,
Mini course on nonlinear Gibbs measures, renormalization & infinite-dimensional semi classics

2019-03-04
Dimitri Yafaev, Université de Rennes 1; St Petersburg State University,
Mini course on spectral theory of Jacobi operators and an asymptotic behavior of orthogonal polynomials

2019-03-05
Dimitri Yafaev, Université de Rennes 1; St Petersburg State University,
Mini course on spectral theory of Jacobi operators and an asymptotic behavior of orthogonal polynomials

2019-03-05
Michael Loss, Georgia Institute of Technology,
Some results for functionals of Aharanov-Bohm type

2019-03-06
Dimitri Yafaev, Université de Rennes 1; St Petersburg State University,
Mini course on spectral theory of Jacobi operators and an asymptotic behavior of orthogonal polynomials

2019-03-06
Lukas Emmert, LMU Munich,
On the liquid drop model

2019-03-07
Annemarie Luger, Stockholm University,
Herglotz-Nevanlinna functions and generalizations

2019-03-14
Volker Bach, TU Braunschweig,
On the ultraviolet limit of the Pauli-Fierz Hamiltonian in the Lieb-Loss model

2019-03-14
Wilhelm Schlag, Yale University,
On the Bourgain-Dyatlov fractal uncertainty principle

2019-03-22
Christopher Sogge, Johns Hopkins University,
Mini course: Introduction – Resolvent and quasimode estimates on Riemannian manifolds

2019-03-25
Christopher Sogge, Johns Hopkins University,
Mini course on Eigenfunction and quasimode estimates

2019-03-26
Robert Seiringer, IST Austria,
Mini course: The polaron at strong coupling

2019-03-27
Robert Seiringer, IST Austria,
Mini course: The polaron at strong coupling

2019-03-27
Dario Feliciangeli, IST Austria,
Uniqueness and Non-degeneracy of minimizers of the Pekar functional on a ball

2019-03-28
Robert Seiringer, IST Austria,
Mini course: The polaron at strong coupling

2019-03-28
Michael Aizenman, Princeton University,
Disorder effects on phase transitions in low dimensions

2019-03-29
Robert Seiringer, IST Austria,
Mini course: The polaron at strong coupling

2019-04-02
Nicolas Burq, Université Paris-Sud,
Almost sure global existence and scattering for the one-dimensional Schrödinger equation

2019-04-02
Jussi Behrndt, Graz University of Technology,
The Landau Hamiltonian with δ-potential supported on a curve

2019-04-02
Jean-Claude Cuenin, LMU Ludwig-Maximilians-Universität München,
Eigenvalue estimates for bilayer graphene

2019-04-03
Matthias Täufer, Queen Mary University of London,
Floquet theory and eigenfunctions on periodic graphs

2019-04-04
Semjon Wugalter, Karlsruhe Institute of Technology,
Van der Waals Force in pseudo-relativistic molecules

2019-04-04
Ioannis Anapolitanos, Karlsruhe Institute of Technology,
Compactness of molecular reaction paths in quantum mechanics

2019-04-04
Joe Viola, Université de Nantes,
Dirac brushes

2019-04-15
Massimo Moscolari, Sapienza University of Rome,
Beyond diophantine Wannier diagrams: gap labelling for Bloch-Landau Hamiltonians

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, Kyohei Itakura, Kenichi Ito, Erik Skibsted: *Spectral theory for one-body Stark operators*

Tadayoshi Adachi, Kyohei 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*

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The main library of Institut Mittag-Leffler.

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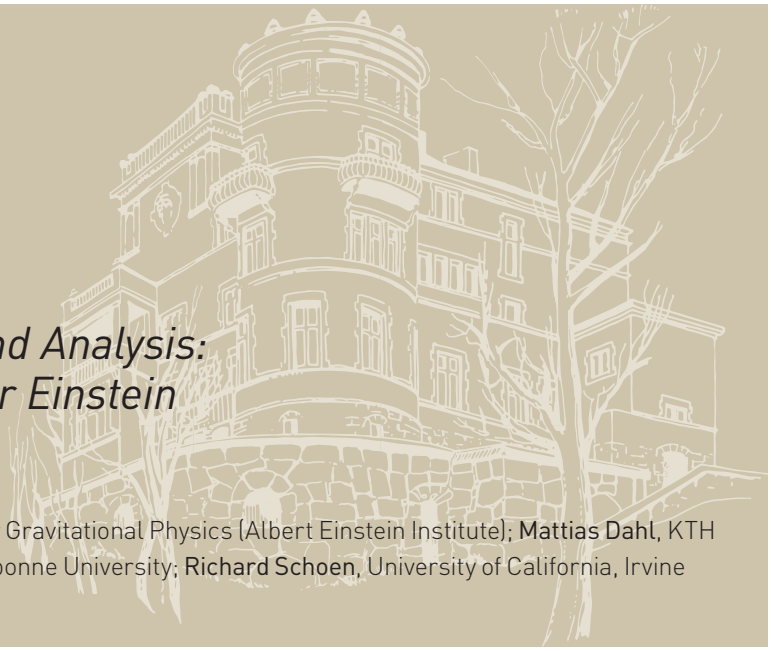


Programs

General Relativity, Geometry and Analysis: Beyond the First 100 Years after Einstein

SEPTEMBER 2–DECEMBER 13, 2019

Organizers: : Lars Andersson, Max Planck Institute for Gravitational Physics (Albert Einstein Institute); Mattias Dahl, KTH Royal Institute of Technology; Philippe G. LeFloch, Sorbonne University; Richard Schoen, University of California, Irvine

SCIENTIFIC REPORT

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.

SEMINARS

2019-09-03
Hans Lindblad, Johns Hopkins University,
On the asymptotic behavior of Einstein's equations close to vacuum

2019-09-03 11:00
Maximilian Thaller, Chalmers/University of Gothenburg,
Rotating clouds of charged particles in general relativity

2019-09-05
Robert Wald, The University of Chicago,
The memory effect in spacetimes of dimension $d \geq 4$

2019-09-05
Christopher Kauffman, Imperial College London,
Global stability for the charge-scalar field on a curved background

2019-09-10
Martín Reiris, Universidad de Montevideo,
The problem of existence of static and electrostatic solutions of the Einstein equations in arbitrary topology

2019-09-10
Christos Mantoulidis, Massachusetts Institute of Technology, MIT,
Capacity, fill-ins, and quasi-local mass

2019-09-12
Volker Schlue, University of Melbourne,
On the stability of the cosmological region of Schwarzschild de Sitter spacetimes

2019-09-12
Klaus Kröncke, Universität Hamburg,
Stability of ALE Ricci-flat manifolds under Ricci flow

2019-09-17
Lionel Mason, University of Oxford,
From null geodesic to gravitational scattering [An alternative route from BMS to soft theorems via ambitwistors and strings]

2019-09-17
Paul Tod, University of Oxford,
Asymptotically $AdS_2\times S^2$ metrics satisfying the null energy condition

2019-09-19
Richard Schoen, University of California, Irvine,
Scalar curvature and minimal hypersurface singularities

2019-09-19
Alessandro Carlotto, ETH Zürich,
Constrained deformations of positive scalar curvature metrics

2019-09-24
Philippe G. Le Floch, Sorbonne University,
On the global nonlinear stability of self-gravitating matter

2019-09-24
Igor Khavkine, Czech Academy of Sciences,
Conformal killing initial data

2019-09-26
Siyuan Ma, Sorbonne University,
Linear stability for the Kerr spacetime

2019-09-26
Stefano Borghini, Uppsala University,
Static vacuum spacetimes with positive cosmological constant

2019-10-01
Gerhard Rein, Universität Bayreuth,
Can highly relativistic, self-gravitating matter distributions be stable?

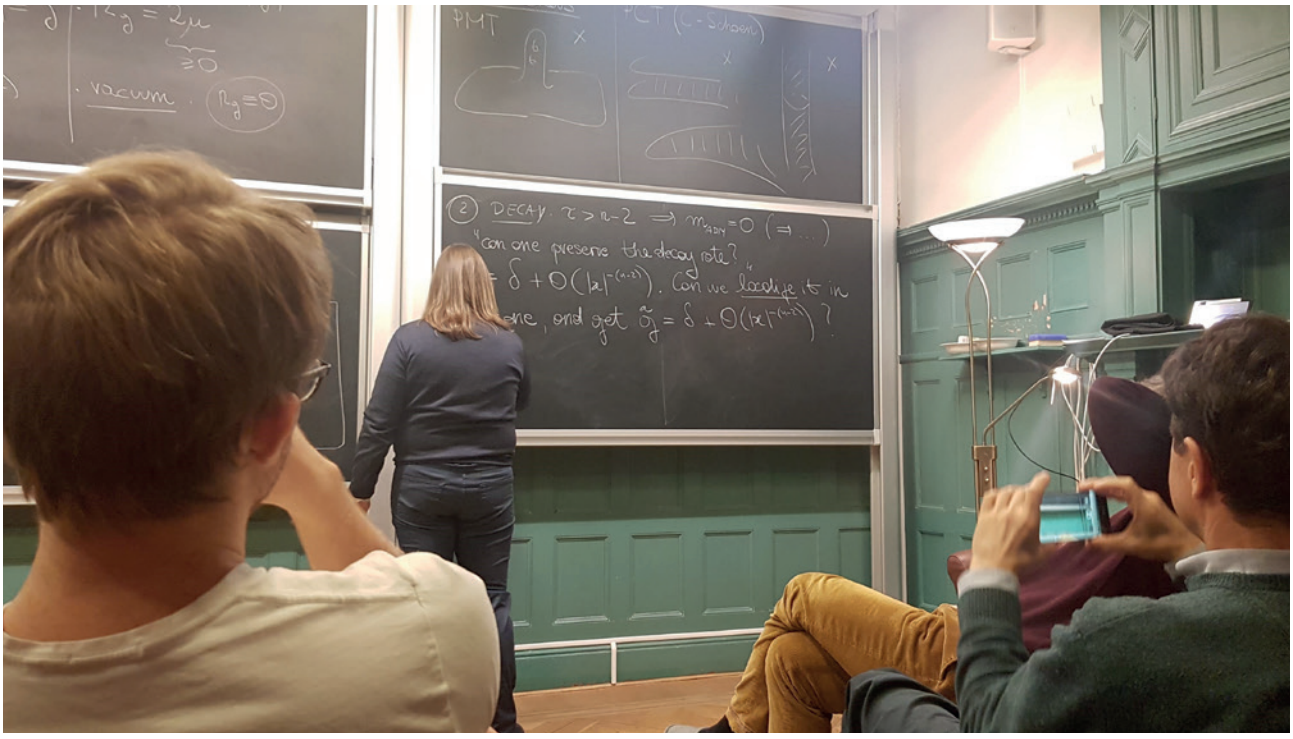
2019-10-01
Bernardo Araneda, Universidad Nacional de Cordoba,
Twistor theory and the Teukolsky equations

2019-10-03
Martin Taylor, Imperial College London,
The nonlinear stability of the Schwarzschild family of black holes

2019-10-03
Thomas Bäckdahl, Chalmers/University of Gothenburg,
Spinor techniques for black hole stability

2019-10-08
Marc Mars, University of Salamanca,
Existence and uniqueness of rigidly rotating stars in second order perturbation theory

Photo: Stephen McCormick



Informal seminar in *General Relativity, Geometry and Analysis*.

2019-10-08
Po-Ning Chen, University of California, *Riverside*
Quasi-local mass and Penrose inequality

2019-10-10
Steffen Aksteiner, Max Planck Institute for Gravitational Physics (Albert Einstein Institute),
All local gauge invariants for black hole perturbation theory

2019-10-10
Jacques Smulevici, Sorbonne University,
On the initial boundary value problem for the Einstein equations in the maximal gauge

2019-10-15
Jose Senovilla, University of the Basque Country,
Characterizing the existence of gravitational radiation at null infinity in asymptotically de Sitter (and flat) spacetimes

2019-10-15
Eric Ling, KTH Royal Institute of Technology,
Spacetime extensions of the Big Bang

2019-10-17
Marc Herzlich, Université de Montpellier,
"Universal" positive mass theorems

2019-10-17
Greg Galloway, University of Miami,
Existence of CMC Cauchy surfaces and spacetime splitting

2019-10-22
Cecile Huneau, École Polytechnique,
High frequency limit for Einstein equations with a U(1) symmetry

2019-10-22
Tom Dutilleul, Université Paris 13,
Chaotic dynamics of spatially homogeneous spacetimes

2019-10-23
Mihai Tohaneanu, University of Kentucky,
Local energy estimates on black hole backgrounds

2019-10-24
Jeremie Szeftel, Sorbonne University,
The nonlinear stability of Schwarzschild

2019-10-24
Jan Metzger, Universität Potsdam,
Variational Problems related to the Hawking mass

2019-10-29
Roland Donninger, University of Vienna,
Strichartz estimates for the one-dimensional wave equation

2019-10-29
Anna Sakovich, Uppsala University,
On the spacetime intrinsic flat convergence

2019-10-30
Ingemar Bengtsson, Stockholm University,
The Null Shell Penrose Inequality in Anti-de Sitter

2019-10-31
Carla Cederbaum, Universität Tübingen,
On special hypersurfaces of the Schwarzschild spacetime and related uniqueness theorems

2019-10-31
Todd Oliynyk, Monash University,
The Fuchsian approach to global existence for hyper bolic equations

2019-11-05
Andras Vasy, Stanford University,
Outgoing Fredholm theory and the limiting absorption principle for asymptotically conic spaces

2019-11-05
Dejan Gajic, King's College, Cambridge,
Quasinormal modes on asymptotically flat black holes

2019-11-07
David Fajman, University of Vienna,
Stability of the Milne model with matter

2019-11-07
Marcus Khuri, Stony Brook University,
Geometric Inequalities for Quasi-Local Masses

2019-11-12
Olivier Biquard, Ecole normale supérieure of Paris,
Renormalized volume for ALE Ricci-flat 4-manifolds

2019-11-12
Jacek Jezierski, University of Warsaw,
Geometry of null hypersurfaces

2019-11-13
Claudio Paganini, Monash University,
Kerr uniqueness and what's trapping got to do with it

2019-11-14
Håkan Andreasson, Chalmers/University of Gothenburg,
On the existence and structure of stationary solutions of the Einstein-Vlasov system

2019-11-14
Annegret Burtscher, Radboud University,
Spacetime convergence for warped products

2019-11-19
Oliver Lindblad Petersen, Universität Hamburg,
Compact Cauchy horizons in vacuum spacetimes

2019-11-19
Thomas Johnson, Imperial College London,
The linear stability of the Schwarzschild solution in a generalized wave gauge

2019-11-20
Jacek Jezierski, University of Warsaw,
Simple description of electromagnetic and gravitational hopfions

2019-11-21
Markus Kunze, University of Cologne,
Higher regularity of the 'tangential' fields in the relativistic Vlasov-Maxwell system

2019-11-21
Dietrich Häfner, Université Grenoble Alpes,
Linear stability of slowly rotating Kerr spacetimes

2019-11-26
Stefanos Aretakis, University of Toronto,
Observational signatures for extremal black holes

2019-11-26
Pieter Blue, University of Edinburgh,
On the stability of higher dimensions

2019-11-27
Gilbert Weinstein, Ariel University,
Harmonic Maps and applications to higher dimensional black holes

2019-11-28
Oscar Reula, Universidad Nacional de Cordoba,
On necessary and sufficient conditions for strong hyperbolicity, work in collaboration with Fernando Abalos

2019-11-28
Stephen McCormick, Uppsala University,
Gluing collars to manifolds; how and why

2019-12-03
Chao Liu, Peking University,
Stability of FLRW metric for polytropic (Makino) fluids

2019-12-03
Lorenzo Mazzieri, University of Trento,
Monotonicity formulas in potential theory and applications

2019-12-04
Alessandro Carlotto, ETH Zürich,
Some open problems on initial data sets for the Einstein field equations

2019-12-05
Istvan Racz, Wigner Research Center for Physics,
On construction of Riemannian three-spaces with smooth generalized inverse mean curvature flows

2019-12-05
Andrzej Rostworowski, Jagiellonian University,
A new perspective on metric gravitational perturbations of spherically symmetric spacetimes

2019-12-10
Jerzy Lewandowski, University of Warsaw,
Isolated horizons, near horizon geometries and the Petrov type D equation

2019-12-10
Rita Teixeira da Costa, University of Cambridge,
Mode stability for the Teukolsky equation on extremal Kerr black hole spacetimes

2019-12-12
Justin Corvino, Lafayette College,
Deformation and asymptotics for the constraint equations

2019-12-12
Christian Bär, University of Potsdam,
Index theory on Lorentzian manifolds

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.

Bernardo Araneda: *Two-dimensional twistor manifolds and Teukolsky operators*

Piotr Chrusciel, 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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Conferences

Algebro-Geometric and Homotopical Methods

MAY 6–10, 2019

Organizers: Eric M. Friedlander, University of Southern California; Lars Hesselholt, University of Copenhagen and Nagoya University; Paul Arne Østvær, University of Oslo

SCIENTIFIC REPORT

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.

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Alice Petronella Hedenlund, University of Oslo, Oslo, Norway

Photo: Institut Mittag-Leffler

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Georg Tamme, Universität Regensburg, Regensburg, Germany

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Kirsten Wickelgren, Georgia Institute of Technology, Atlanta, USA

Ben Williams, University of British Columbia, Vancouver, Canada

Glen Wilson, NTNU - Norwegian University of Science and Technology, Trondheim, Norway

Maria Yakerson, Universität Duisburg-Essen, Duiburg-Essen, Germany

Paul Arne Østvaer, University of Oslo, Oslo, Norway

Photo: Institut Mittag-Leffler

Participants of *Analytic-Geometric Inequalities and Related Topics*.

Analytic-Geometric Inequalities and Related Topics

MAY 13–17, 2019

Organizers: Monika Ludwig, Vienna University of Technology; Andrea Cianchi, University of Florence; Jan Maly, Charles University in Prague; Vladimir Mazýa, Linköping University

SCIENTIFIC REPORT

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 Lp 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 Lp 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

Dorin Bucur, Université Savoie Mont Blanc, Chambéry, France

Menita Carozza, University of Sannio, Benevento, Italy

Andrea Cianchi, University of Florence, Florence, Italy

Maria J. Esteban, Université Paris-Dauphine, Paris, France

Vincenzo Ferone, Università degli studi di Napoli Federico II, Napoli, Italy

Piotr Hajlasz, University of Pittsburgh, Pittsburgh, USA

Stanislav Hencl, Charles University in Prague, Prague, Czech

Carlos Hugo Jimenez, PUC, California, USA

Aapo Kauranen, Universitat Autònoma de Barcelona, Barcelona, Barcelona, Spain

Bernard Kawohl, University of Cologne, Cologne, Germany

Bernd Kircheim, Universität Leipzig, Leipzig, Germany

Tobias Koenig, LMU Ludwig-Maximilians-Universität München, Munich, Germany

Mikhail Korobkov, Novosibirsk State University, Novosibirsk, Germany

Pekka Koskela, University of Jyväskylä, Jyväskylä, Finland

Jan Kristensen, University of Oxford, Oxford, Great Britain

Ari Laptev, Imperial College London, London, Great Britain

Monika Ludwig, Vienna University of Technology, Vienna, Austria

Jan Maly, Charles University in Prague, Prague, Czech

Vladimir Maz'ya, Linköping University, Linköping, Sweden

Petru Mironescu, Université Lyon 1, Lyon, France

Lubos Pick, Charles University in Prague, Prague, Czech

Peter Pivovarov, University of Missouri, Columbia, USA

Sebastian Schwarzacher, Charles University in Prague, Prague, Czech

Alina Stancu, Concordia University, Sir George William Campus, Montréal, Canada

Jean Van Schaftingen, Université Catholique de Louvain, Louvain, Belgium

Igor Verbitsky, University of Missouri, Columbia, USA

Elisabeth Werner, Case Western Reserve University, Cleveland, USA

Tobias Weth, Goethe University Frankfurt am Main, Frankfurt, Germany

Deane Yang, New York University, New York, USA

Photo: Institut Mittag-Leffler

Participants of *Numerical Methods for SPDE: 20 Successful Years and Future Challenges*.

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.

PARTICIPANTS

Lubomir Banas, Bielefeld University, Bielefeld, Germany
Andrea Barth, University of Stuttgart, Stuttgart, Germany
André Berg, Umeå University, Umeå, Sweden
Charles-Edouard Bréhier, Université Lyon 1, Lyon, Lyon, France
David Cohen, Umeå University, Umeå, Sweden
Anne de Bouard, Ecole Polytechnique CNRS, Paris, Paris, France

Photo: Institut Mittag-Leffler

The upper round library of Institut Mittag-Leffler.

Arnaud Debussche, ENS Rennes, Bruz, France

Monika Eisenmann, Technische Universität Berlin, Berlin, Germany

Fred Espen Benth, University of Oslo, Oslo, Norway

István Gyöngy, University of Edinburgh, Edinburgh, Great Britain

Erika Hausenblas, Montana university Leoben, Leoben, Austria

Kristin Kirchner, ETH Zürich, Zürich, Zürich, Switzerland

Mihály Kovács, Pázmány Péter Catholic university, Budapest, Budapest , Hungary

Raphael Kruse, TU - Technische Universität Berlin, Berlin, Germany

Annika Lang, Chalmers/University of Gothenburg, Gothenburg, Sweden

Stig Larsson, Chalmers/University of Gothenburg, Gothenburg, Sweden

Gabriel Lord, Heriot Watt University, Edinburgh, Great Britain

Annie Millet, Université Paris 1 Panthéon-Sorbonne, Paris, France

Andreas Petersson, Chalmers/University of Gothenburg, Gothenburg, France

Tony Shardlow, University of Bath, Bath, Great Britain

David Siska, University of Edinburgh, Edinburgh, Great Britain

Andreas Stein, University of Stuttgart, Stuttgart, Germany

Raul Tempone, KAUST, King Abdullah University of Science and Technology, Saudi Arabia, Saudi Arabia

Xiaojie Wang, Central South University, Changsha, Changsha, China

Timo Welti, ETH Zürich, Zürich, Switzerland

Yubin Yan, University of Chester, Manchester, Manchester, Great Britain

Photo: Institut Mittag-Leffler

Participants of *Smooth Dynamical Systems*.

Smooth Dynamical Systems

MAY 27–30, 2019

Organizers: Kristian Bjerklöv, KTH Royal Institute of Technology; Danijela Damjanovic, KTH Royal Institute of Technology; Maria Saprykina, KTH Royal Institute of Technology

SCIENTIFIC REPORT

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.

PARTICIPANTS

Martin Andersson, Uppsala University, Uppsala, Sweden

Michael Benedicks, KTH Royal Institute of Technology, Stockholm, Sweden

Kristian Bjerklöv, KTH Royal Institute of Technology, Stockholm, Sweden

Michael Björklund, Chalmers/University of Gothenburg, Gothenburg, Sweden

Alexander Bufetov, Steklov Mathematical Institute, Moscow, Moscow, Russia

Mats Bylund, Lund University, Lund, Sweden

Danijela Damjanovic, KTH Royal Institute of Technology, Stockholm, Sweden

Dmitry Dolgopyat, University of Maryland, Maryland, USA

Håkan Eliasson, Université Paris Diderot, Paris 7, Paris, France

Gerard Farré, KTH Royal Institute of Technology, Stockholm, Sweden

Jordi-Lluis Figueras, Uppsala University, Uppsala, Sweden

David Fisher, Indiana University Bloomington, Bloomington, USA

Livio Flaminio, Université des sciences et Technologies de Lille, Lille, France

Denis Gaidashev, Uppsala University, Uppsala, Sweden

Boris Kalinin, Pennsylvania State University, Pennsylvania, USA

Anders Karlsson, University of Geneva, Geneva, Switzerland

Alejandro Kocsard, Universidad Federal Fluminense, Rio De Janeiro, Brazil

Raphael Krikorian, The University of Cergy-Pontoise, Cergy-Pontoise Cedex, Cergy, France

Victor Linroth, Uppsala University, Uppsala, Sweden

Stefano Marmi, Scuola Normale Superiore, Pisa , Italy

Marco Martens, Stony Brook University, Stony Brook, USA

Thomas Ohlson Thimoudas, KTH Royal Institute of Technology, Stockholm, Sweden

Liviana Palmisano, Uppsala University, Uppsala, Sweden

Tomas Persson, Lund University, Lund, Sweden

Boris Petkovic, KTH Royal Institute of Technology, Stockholm, Sweden

Fredrico Rodriguez-Hertz, Pennsylvania State University, Pennsylvania, USA

Victoria Sadovskaya, Pennsylvania State University, Pennsylvania, USA

Maria Saprykina, KTH Royal Institute of Technology, Stockholm, Sweden

Jörg Schmeling, Lund University, Lund, Sweden

Warwick Tucker, Uppsala University, Uppsala, Sweden

Björn Winckler, Imperial College London, London, London, Great Britain

Photo: Institut Mittag-Leffler

Participants of *Modern Theory of Group Actions and the Special Role of Finite Simple Groups*.

Modern Theory of Group Actions and the Special Role of Finite Simple Groups

JUNE 3–7, 2019

Organizers: Cheryl E. Praeger, The University of Western Australia; Donna Testerman, Ecole Polytechnique Fédérale de Lausanne; Rebecca Waldecker, Martin Luther University Halle-Wittenberg

SCIENTIFIC REPORT

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.

PARTICIPANTS

Stefanos Aivazidis, Unknown (affiliation)

Dominik Bernhardt, RWTH Aachen University, Aachen, Germany

Mark Butler, University of Birmingham, Birmingham, Great Britain

Mun See Chang, University of St Andrews, St Andrews, Great Britain

Darius Dramburg, RWTH Aachen University, Aachen, Tyskland

Justine Falque, Université Paris-Sud, Paris, France

Joanna Fawcett, Imperial College London, London, Great Britain

Saul Freedman, University of St Andrews, St Andrews, Great Britain

Daniele Garzoni, University of Padova, Padova, Italy

Jonathan Gruber, École Polytechnique Fédérale de Lausanne, EPFL, Lausanne, Switzerland

Paula Haehndel, Martin Luther University Halle-Wittenberg, Halle, Germany

Scott Harper, University of Bristol, Bristol, Great Britain

Scott Hudson, University of South Wales, TreforestWales, Great Britain

Henrik Jansson, Unknown (affiliation)

Julian Kapsczyk, University of Aberdeen, Aberdeen, Great Britain

Veronica Kelsey, University of St Andrews, St Andrews, Great Britain

Mikko Korhonen, University of Manchester, Manchester, Great Britain

Marvin Krings, RWTH Aachen University, Aachen, Germany

Melissa Lee, Imperial College London, London, Great Britain

Bianca Loda, University of South Wales, Treforest, Wales, Great Britain

Eilidh McKemmie, University of Southern California, California, USA

Mariapia Moscatiello, University of Padova, Padova, Italy

Alice Niemeyer, RWTH Aachen University, Aachen, Germany

Cheryl E. Praeger, The University of Western Australia, Perth, Australia

Alejandra Ramos Rivera, University of Primorska, Koper - Capodistria, Slovenia

Ana Retegan, École Polytechnique Fédérale de Lausanne, EPFL, Lausanne, Switzerland

Colva Roney-Dougal, University of St Andrews, St Andrews, Great Britain

Kyle Rosa, The University of Western Australia, Perth, Australia

Patrick Salfeld, Martin Luther University Halle-Wittenberg, Halle, Germany

Jack Saunders, University of Birmingham, Birmingham, Great Britain

Patrick Serwene, City University London, London, Great Britain

Mima Stanojkovski, Bielefeld University, Bielefeld, Great Britain

Ben Stratford, University of Warwick, Coventry, Great Britain

Donna Testerman, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

Lauren Thornton, University of the Sunshine Coast, Sunshine, Coast, Queensland, Australia

Imke Torborg, Martin Luther University Halle-Wittenberg, Halle, Germany

Rebecca Waldecker, Martin Luther University Halle-Wittenberg, Halle, Germany

Martin van Beek, University of Birmingham, Birminghamn, Great Britain

Photo: Institut Mittag-Leffler

Participants of *New Directions in Mathematics of Coulomb Gases and Quantum Hall Effect*.

Nonlinear Dispersive Waves, Solitons, and Related Topics

JUNE 10–14, 2019

Organizers: Piero D'Ancona, Roma Tre University; Luca Fanelli, Roma Tre University

SCIENTIFIC REPORT

The main topic of the conference was the study of the large time structure of global solutions for several classes of evolutive and dispersive nonlinear differential equations. The soliton resolution conjecture claims that, asymptotically, solutions decompose in a combination of coherent structures, each evolving with its own dynamic, plus remainder terms which behave like linear waves. The main conjecture is very ambitious and presently out of reach. However, in several special cases, important partial results have already been obtained. For many equations the program has already been carried out in part; the asymptotic behaviour of the linearized equation is known for most of the important models, and soliton dynamics has been investigated in detail at least for someone dimensional problems (KdV and its variants). These advances require a combination of tools, and a collaboration of mathematicians, from the most diverse areas, including nonlinear Fourier analysis, geometry, spectral theory and nonlinear elliptic PDEs.

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 glonal 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 (Nakanishi); the proof of the asymptotic stability

Entrance to the upper gallery of the library.

Bust of Anne Charlotte Leffler.

Photos: Institut Mittag-Leffler

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

Ioan Bejenaru, University of California, San Diego, San Diego, USA

Jean-Marc Bouclet, Toulouse University, Toulouse, France

Lucrezia Cossetti, Karlsruhe Institute of Technology, Karlsruhe, Germany

Piero D`Ancona, Roma Tre University, Rome, Italy

Arnaud Eychenne, University of Bergen, Bergen, Norway

Luca Fanelli, Roma Tre University, Rome, Italy

Luigi Forcella, Ecole polytechnique fédérale de Lausanne, EPFL, Lausanne, Switzerland

Patrick Gérard, Université Paris-Sud, Paris, France

Sebastian Herr, Bielefeld University, Bielefeld, Germany

Mihaela Ifrim, University of Wisconsin-Madison, Madison, USA

Oana Ivanovici, Université de Nice - Sophia Antipolis, Nice, France

Herbert Koch, University of Bonn, Bonn, Germany

Felipe Linares, IMPA, Rio De Janeiro, Brasil

Renato Luca, Basque Center for Applied Mathematics (BCAM), Bilbao, Spain

Eugenia Martinez, Universidad de Chile, Santiago, Chile

Jeremy Louis Marzuola, The University of North Carolina at Chapel Hill, North Carolina, USA

Claudio Munoz, Universidad de Chile, Santiago, Spain

Kenji Nakanishi, Graduate School of Information Science and Technology, Orsaka, Orsaka, Japan

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

Luis Vega, Basque Center for Applied Mathematics (BCAM), Bilbao, Spain

Monica Visan, University of California, UCLA, Los Angeles, USA

Nicola Visciglia, University of Pisa, Pisa, USA

Photo: Institut Mittag-Leffler

Participants of *Mathematics and Physics of Knots*.

Mathematics and Physics of Knots

JUNE 24–28, 2019

Organizers: Sergei Gukov, California Institute of Technology Caltech; Shamil Shakirov, Uppsala University; Maxime Zabzine, Uppsala University

SCIENTIFIC REPORT

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 Sulkowski-Gukov-Kucharski and the open Gromov-Witten theory of Ekholm-Ng which indicates the workings of the topological M-theory that underlies the super-polynomial of Gukov-Rasmussen- Dunfield.

The duality interfaces in 3-dimensional theories of Aganagic and Okuonkov 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.

PARTICIPANTS

Mina Aganagic, University of California, Berkeley, Berkeley, USA

Aleksandra Anokhina, Institute for Theoretical and Experimental Physics, Moscow, Russia

Johan Asplund, Uppsala University, Uppsala, Sweden

Anna Beliakova, University of Zurich, UZH, Zürich, Switzerland

Julio Candanedo, Uppsala University, Uppsala, Sweden

Magnus Carlsson, KTH Royal Institute of Technology, Stockholm, Sweden

Luca Cassia, Uppsala University, Uppsala, Sweden

Miranda Cheng, University of Amsterdam, Amsterdam, The Netherlands

Georgios Dimitroglou Rizell, University of Cambridge, Cambridge, USA

Francesca Ferrari, University of Amsterdam, Amsterdam, Amsterdam, Netherlands

Agnes Gadbled, Uppsala University, Uppsala, Sweden

Sergei Gukov, California Institute of Technology, Caltech, California, USA

Sarah Harrison, McGill University, Montreal, Canada

Yang Huang, Aarhus University, Aarhus, Denmark

Rinat Kashaev, University of Geneva, Geneva, Switzerland

Piotr Kucharski, California Institute of Technology, Caltech, California, USA

Thang Le, Georgia Institute of Technology, Atlanta, USA

Wanmin Liu, Uppsala University, Uppsala, Sweden

Rebecca Lodin, Uppsala University, Uppsala, Sweden

Kishore Marathe, Brooklyn College of CUNY, Brooklyn, USA

Maksim Maydanskiy, Institut Mathematiques de Jussieu, Paris, France

Andrei Mironov, Institute for Theoretical and Experimental, PhysicsMoscow, Russia

Alexei Morozov, Institute for Theoretical and Experimental Physics, Moscow, Russia

Satoshi Nawata, Fudan University, Shanghai, China

Photo: Institut Mittag-Leffler

Books written by Anne Charlotte Leffler.

Lenhard Ng, Duke University, Durham, USA

Du Pei, California Institute of Technology, Caltech, California, USA

Alexander Popolitov, Uppsala University, Uppsala, Sweden

Sebastian Pöder, Uppsala University, Uppsala, Sweden

Jian Qui, Uppsala University, Uppsala, Sweden

Jacob Rasmussen, University of Cambridge, Cambridge, Great Britain

Daniel Roggenkamp, University of Mannheim, Mannheim, Germany

Ryszard Rubinsztein, Uppsala University, Uppsala, Sweden

Matteo Sacchi, University of Milan, Milano, Milano, Italy

Shamil Shakirov, Uppsala University, Uppsala, Uppsala, Sweden

Vivek Shende, University of California, Berkeley, Berkeley, USA

Marcus Stalhammar, Stockholm University, Stockholm, Sweden

Piotr Sulkowski, California Institute of Technology, Caltech, California, USA

Alex Takeda, University of California, Berkeley, Berkeley, USA

Arkady Vaintrob, University of Oregon, Oregon, USA

Paul Wedrich, Australian National University, Canberra, Canberra, Australia

Maxim Zabzine, Uppsala University, Uppsala, Sweden

Photo: Institut Mittag-Leffler

Participants of *New Directions in Mathematics of Coulomb Gases and Quantum Hall Effect*.

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.

PARTICIPANTS

Eddy Ardonne, KTH Royal Institute of Technology, Stockholm, Sweden

Alexander Bogatskiy, The University of Chicago, Chicago, USA

Gaëtan Borot, Max Planck Institute for Mathematics, Bonn, Germany

Jeanne Boursier, New York University, New York, USA

Tankut Can, The City College of New York, New York, USA

Gabriel Cardoso, Stony Brook University Mathematics Department, New York, USA

Laurent Charles, Institut de Mathématiques de Jussieu – Paris, Rive Gauche, Paris, France

Jörgen Ellegaard Andersen, Aarhus University, Aarhus, Denmark

Benoit Estienne, LPTHE Le Laboratoire de Physique Théorique et Hautes Énergies, Paris, France

Andrey Gromov, The University of Chicago, Chicago , USA

Alice Guionnet, ENS de Lyon, Lyon, France

Adrien Hardy, Université de Lille 1, Lille, France

Håkan Hedenmalm, KTH Royal Institute of Technology, Stockholm, Sweden

Maria Hermanns, Stockholm University, Stockholm, Sweden

Nam-Gyu Kang, KIAS, Korea Institute for Advanced Study, Seoul, South Korea

Semyon Klevtsov, University of Cologne, Köln, Germany

Alisa Knizel, Columbia University, New York, USA

Gaultier Lambert, University of Zurich, UZH, Zürich, Switzerland

Thomas Leble, New York University, New York, USA

Xiaonan Ma, Université Paris Diderot, Paris 7, Paris, France

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Staircase to the upper library.

Mylene Maida, Université de Lille 1, Lille, France

Nikita Nemkov, University of Cologne, Köln, Germany

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

Photo: Institut Mittag-Leffler

Participants of *Thermodynamic Formalism – Applications to Geometry, Number Theory, and Stochastics*.

Thermodynamic Formalism – Applications to Geometry, Number Theory, and Stochastics

JULY 8–12, 2019

Organizers: Sabrina Kombrink, Georg-August-Universität Göttingen; Tony Samuel, University of Birmingham; Marc Kesseböhmer, Universität Bremen; Jörg Schmeling, Lund University; Yakov Pesin, Penn State University

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 Przytycki, IM PAN, Institute of Mathematics of the Polish Academy of Sciences, Warzaw, 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, Universidad Federal do Rio de Janeiro, Rio De Janeiro, Brasil

Manuel Stadlbauer, Universidad 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, Warzaw, Poland

Photo: Institut Mittag-Leffler

Participants of *Proof, Computation, Complexity*.

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.

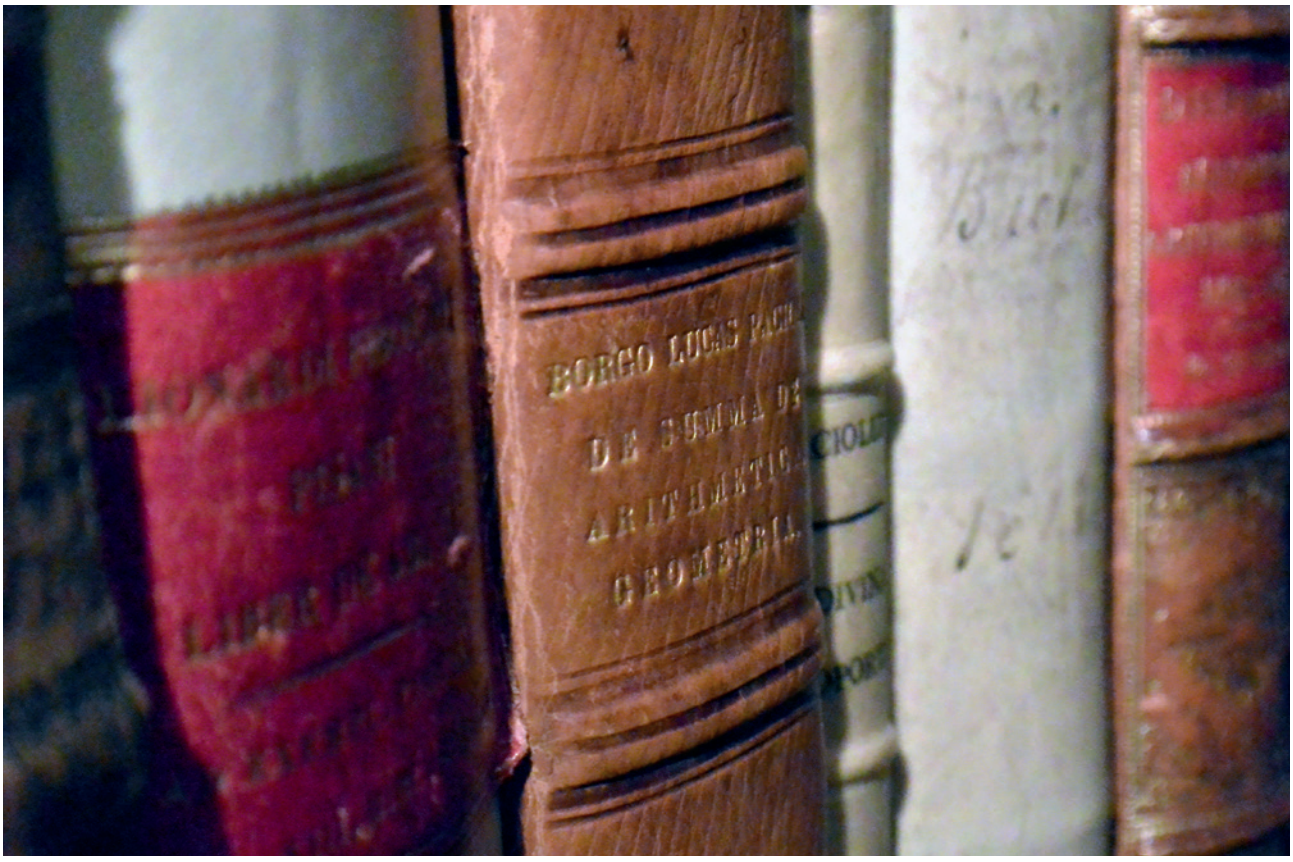

Photo: Institut Mittag-Leffler

Books from the main library.

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

Mattias Granberg Olsson, Göteborgs Universitet, Gothenburg, Sweden

Alessio Guglielmi, University of Bath, Bath, Great Britain

Hugo Herbelin, Inria, Paris, France

Gerhard Jäger, University of Bern, Bern, Switzerland

Reinhard Kahle, Universität Tübingen, Lisboa, Portugal

Annika Kanckos University of Helsinki, Helsinki, Finland

Ulrich Kohlenbach, Technical University of Darmstadt, Darmstadt, Germany

Lars Kristiansen, University of Oslo, Oslo, Norway

Graham Leigh, Chalmers/University of Gothenburg, Gothenburg, Sweden

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

Luis 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

Other Activities

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, *Programmering*

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*

Photo: Institut Mittag-Leffler

The participants of the Klein Days in January, 2019.

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 gymnasium, 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, Kungsshögskolan, Malmö

Alireza Zavareh, Jensen gymnasium Stockholm, Stockholm

Photo: Institut Mittag-Leffler

The participants of the Klein Days in June, 2019.

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 talfølger konstrueret i Lego*

Lisa Hed, Umeå University, Umeå, *Vad är nyttan 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 Gummeson, 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

Photo: Institut Mittag-Leffler

The participants of the Klein Days in August, 2019.

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-Älvkullegymnasiet, Karlstad

Petter Berglin, Klara teoretiska gymnasium, Sundsvall

Malin Bergsten, Naturbruksgymnasiet, Svenljunga, Svenljunga

Joakim Cronelöv, Rudbecksskolan, Sollentuna

Sedat Delen, Fredrika Bremer gymnasiet, Stockholm

Maria Eklånge, Prins Wilhelmgymnasiet, Flen

Jonas Fallander Ågren, Sundsta-Älvkullegymnasiet, 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, Kalmarsunds Gymnasieförbund, Lars Kaggskolan, Kalmar

Kathleen Wireklev, Tranemo Gymnasieskola, Tranemo

Henrik Åkerstedt, Hersby gymnasium, Hersby

Photo: Jan Francu and Reinhard Wobst

Participants of *International Mathematics Olympiad 1971 – Reunion in Stockholm May 17*, 2019.

International Mathematics Olympiad 1971 – Reunion in Stockholm

MAY 17, 2019

Organizer: **Hans Alberg**

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 paricipate 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.

Photo: Institut Mittag-Leffler

Winter at Institut Mittag-Leffler.

Participants

Anneli Aitta, Per-Göran Andermo, Wivika Sollergren-Andermo, Steven Dijk, Darja Dobsikova, Harald Englisch, Jan Francu, Chris Hills, Irene Hills, Ellen van der Kaaij, Nick Manton, Arnulf Möbius, Renate Möbius, Ann-Marie Pendrill, Leslie Pendrill, Gudrun Pielenz, Colin Vout, Janet Vout, Reinhard Wobst.

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.

Financial Report

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 framtiden uppehålla och ytterligare utveckla den ställning, vilken den rena matematiken i dessa länder numera intager, samt att härvid även bereda aktning och rättvist uppskattande utom Nordens gränser för dessa länders insats inom tankelivets högsta område. Makarna Mittag-Lefflers matematiska stiftelse bedriver verksamhet bl.a., i form av tidskriftsutgivning varför alla uttag redovisas över resultaträkningen som kostnader för drift av stiftelsen.

KVA förvaltar ett kapital med ett marknadsvärde som per 2019-12-31 uppgår till 2 091 mkr via sina anknutna stiftelser. KVA och dess anknutna stiftelsers kapital (exklusive Stiftelsen Anna-Greta och Holger Crafoords fond) förvaltas av Carnegie enligt av akademistyrelsen fastställda riktlinjer.

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

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

Främjande av ändamålet

Resultatet från stiftelsens verksamhet exklusive de finansiella posterna uppgår till 4 555 700 kr som därmed återförs till fonden. Det positiva resultatet är en följd av att gamla projektmedel kunnat utnyttjas för årets kostnader. Stiftelsen driver Institut Mittag-Leffler och utger tidskrifterna Acta Mathematica och Arkiv för Matematik. Eftersom Makarna Mittag-Lefflers matematiska stiftelse bedriver verksamhet, och därmed är klassad som närings-drivande, redovisas alla uttag som kostnader för drift av stiftelsen.

Väsentliga händelser under räkenskapsåret

Inga väsentliga händelser finns att rapportera.

Flerårsöversikt

	2019	2018	2017	2016	2015
Huvudintäkter	25 529 537	14 205 623	14 939 124	20 930 057	22 042 746
Årets resultat	16 933 114	-6 556 296	20 279 793	-2 585 868	14 827 635
Ingående kapital	173 409 812	179 966 108	159 686 315	162 272 183	147 444 548
Utgående kapital	190 342 926	173 409 812	179 966 108	159 686 315	162 272 183
Årlig förändring i %	9,76%	-3,64%	12,70%	-1,59%	10,06%

Vad beträffar stiftelsens resultat och ställning i övrigt, hänvisas till efterföljande resultat- och balans-räkningar med tillhörande noter.

>>

RESULTATRÄKNING	Not	2019-01-01 2019-12-31	2018-01-01- 2018-12-31
Stiftelsen intäkter			
Bidrag		21 418 559	12 819 189
Nettoomsättning		350 000	470 000
Övriga stiftelseintäkter		3 760 977	916 433
		25 529 537	14 205 623
Stiftelsen kostnader			
Övriga externa kostnader	2	-19 836 499	-16 249 620
Av- och nedskrivningar av materiella anläggningstillgångar		-301 138	-245 080
Övriga stiftelsekostnader		-836 199	-794 896
		-20 973 837	-17 289 596
Rörelseresultat		**4 555 700** *	**-3 083 973**
Finansiella poster			
Resultat från övriga finansiella anläggningstillgångar	3	12 028 741	-3 897 991
Övriga ränteintäkter och liknande resultatposter	4	348 673	425 668
		12 377 414	-3 472 323
Årets resultat		**16 933 114** **	**-6 556 296**

* det positiva rörelseresultatet beror på att gamla projektmedel kunnat utnyttjas för årets kostnader.
** I årets resultat finns en post om 7,5 mkr avseende återförda nedskrivningar vilket påverkar resultatet positivt. Föregående års siffra innefattar en motsvarande nedskrivning, se vidare not 3.

BALANSRÄKNING		2019-12-31	2018-12-31
Tillgångar			
Anläggningstillgångar			
Materiella anläggningstillgångar			
Inventarier, verktyg och installationer	5	33 522	58 527
Förbättringsutgifter på annans fastighet	6	1 843 762	1 749 955
		1 877 284	1 808 482
Finansiella anläggningstillgångar			
Andra långfristiga värdepappersinnehav	7	188 994 071	169 399 260
		188 994 071	169 399 260
Summa anläggningstillgångar		**190 871 355**	**171 207 742**
Omsättningstillgångar			
Kortfristiga fordringar			
Övriga fordringar		16 272 763	19 754 242
Förutbet. kostnader och uppl. intäkter		751 946	1 207 273
		17 024 709	20 961 515
Kassa och bank		608 811	5 495 912
Summa omsättningstillgångar		**17 633 520**	**26 457 427**
Summa tillgångar		**208 504 875**	**197 665 169**
Eget kapital och skulder			
Eget kapital			
Bundet eget kapital			
Bundet eget kapital vid räkenskapsårets början		178 791 846	186 255 082
Förändringar av bundet kapital		8 505 464	-7 463 236
Bundet eget kapital vid räkenskapsårets slut		187 297 309	178 791 846
Fritt eget kapital			
Fritt eget kapital vid räkenskapsårets början		-5 382 034	-6 288 974
Överfört till och från bundet eget kapital		-8 505 464	7 463 236
Lämnade och återförda anslag			
Årets resultat		16 933 114	-6 556 296
Fritt eget kapital vid räkenskapsårets slut		3 045 617	-5 382 034
Summa Eget kapital		**190 342 926**	**173 409 812**
Kortfristiga skulder			
Leverantörsskulder		128 638	1 065 099
Övriga skulder		-	-
Uppl. kostnader och förutbet. intäkter		18 033 311	23 190 259
		18 161 949	24 255 357
Summa skulder		**18 161 949**	**24 255 357**
Summa eget kapital och skulder		**208 504 875**	**197 665 169**

>>

Not 1 - Redovisnings- och värderingsprinciper

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

Avskrivningsprinciper för anläggningstillgångar
Följande avskrivningstider tillämpas

Materiella anläggningstillgångar	
Inventarier, verktyg och installationer	3 - 5 år
Förbättringsutgifter på annans fastighet	10 - 40 år

Eget kapital
Bundet eget kapital består dels av det ursprungliga donationskapitalet, dels av rearesultat 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	**2019-12-31**	**2018-12-31**
Lokalkostnader	-3 552 259	-3 066 839
Projektkostnader	-7 828 483	-6 158 276
IT-kostnader	-1 148 761	-1 000 844
Personalkostnader	-4 833 743	-3 430 948
Övrigt	-2 473 253	-2 592 713
	-19 836 499	-16 249 620

Not 3 - Resultat från övriga finansiella anläggningstillgångar	**2019-12-31**	**2018-12-31**
Utdelningar	3 664 144	3 484 239
Ränteintäkter	289 350	524 442
Realisationsresultat	534 782	-366 207
Återföring nedskrivning / Nedskrivning värdepapper	7 540 465	-7 540 464
	12 028 741	-3 897 991

Not 4 - Övriga ränteintäkter och liknade resultatposter	**2019-12-31**	**2018-12-31**
Fondrabatter	348 673	425 668
	348 673	425 668

Not 5 - Inventarier, verktyg och installationer	**2019-12-31**	**2018-12-31**
Ackumulerade anskaffningsvärden		
Vid årets början	1 429 985	1 386 260
Nyanskaffningar	-	43 725
Vid årets slut	1 429 985	1 429 985
Netto anskaffningsvärde	1 429 985	1 429 985
Ackumulerade avskrivningar enligt plan		
Vid årets början	-1 371 458	-1 347 331
Årets avskrivning på anskaffningsvärden	-25 005	-24 127
Vid årets slut	-1 396 463	-1 371 458
Redovisat värde vid årets slut	**33 522**	**58 527**

Not 6 - Förbättringsutgifter på annans fastighet	**2019-12-31**	**2018-12-31**
Ackumulerade anskaffningsvärden		
Vid årets början	4 161 956	3 547 937
Nyanskaffningar	369 940	614 019
Vid årets slut	4 531 896	4 161 956
Netto anskaffningsvärde	4 531 896	4 161 956
Ackumulerade avskrivningar enligt plan		
Vid årets början	-2 412 001	-2 191 048
Årets avskrivning på anskaffningsvärden	-276 133	-220 953
Vid årets slut	-2 688 134	-2 412 001
Redovisat värde vid årets slut	**1 843 762**	**1 749 955**

Not 7 - Andra långfristiga värdepappersinnehav		
	2019-12-31	**2018-12-31**
Ackumulerade anskaffningsvärden		
Vid årets början	176 939 724	174 768 075
Köp	39 205 904	41 026 346
Försäljning	-27 151 557	-38 854 697
Utgående anskaffningsvärden	188 994 071	176 939 724
Ackumulerade nedskrivningar		
Vid årets början	-7 540 464	-
Årets nedskrivning	-	-7 540 464
Återförda nedskrivningar	7 540 464	-
	0	-7 540 464
Bokfört värde	188 994 071	169 399 260
Marknadsvärde	217 213 021	169 399 260

Stockholm den 28 maj 2020

Göran K Hansson
Ständig sekreterare

Min revisionsberättelse har avgivits den

Magnus Prööm
Auktoriserad revisor

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