INSTITUT
MITTAG-LEFFLER
THE ROYAL SWEDISH ACADEMY OF SCIENCES

Annual Report 2024

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, a dining hall, 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 IML 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 is a yearly call for applications, 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 Mathematica* 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 these journals are freely available online.

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Content

Annual Report 2024

Photo: Institut Mittag-Leffler

The Director of Institut Mittag-Leffler,

A Brief Review of 2024

During 2024, the institute has continued its efforts to attract world leading mathematicians to programs, as well as the dialogue with Nordic mathematics departments, other international mathematics research institutes, the Swedish Research Council, the Wallenberg Foundations, and the Verg Foundation. Editorial work with *Acta Mathematica* and *Arkiv för Matematik* during the year has been successful; both journals perform well and continue to attract very good submissions in cooperation with International Press continues.

The institute organized two research programs: *Two Dimensional Maps* and *Geometric and Order and Randomness in Partial Differential Equations* and nine conferences. Both programs and conferences have been very well attended and have run efficiently in cooperation with the organizers.

During 2024 we started the renovation of the interior of the main building with the walls of the former seminar room and the furniture in the flower room.

The institute works in close cooperation with *The Royal Swedish Academy of Sciences* and is 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 Edinburgh.

Institut Mittag-Leffler is very grateful to all those who have contributed during 2024: 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 Knut and Alice Wallenberg Foundation, Linköping University, Luleå University of Technology, Lund University, the Research Council of Norway, KTH Royal Institute of Technology, Jacob and Marcus Wallenberg's memorial foundation, Stockholm University, The Swedish Research Council, The Verg Foundation, Umeå University and Uppsala University.

Tobias Ekholm, *Director*

Photo: Institut Mittag-Leffler

Members of the Scientific Board 2024.

Scientific Board Meeting

May 9, 2024

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 SCIENTIFIC BOARD AT INSTITUT MITTAG-LEFFLER 2024:

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KTH Royal Institute of Technology, Stockholm, Sweden

Photo: Institut Mittag-Leffler

Participants of the Nordic Department Chair Meeting 2024.

Nordic Department Chair Meeting at Institut Mittag-Leffler

May 13-14, 2024

Institut Mittag-Leffler hosts a Nordic chair meeting yearly, inviting the heads of mathematical departments and chairs of mathematical associations from the Nordic countries.

JOHAN BJÖRKLUND
University of Gävle

ÅKE BRÄNNSTRÖM
Umeå University

TOBIAS EKHOLM
Institut Mittag-Leffler/ Uppsala University

BIRGIR HRAFNKELSSON
University of Iceland

JANI LUKKARINEN
University of Helsinki

ADRIAN MUNTEAN
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University of Bergen

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Aarhus University

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Uppsala University

INAR RØNQUIST
Norwegian University of Science and Technology

MOGENS STEFFENSEN
University of Copenhagen

PETER WALL
Luleå University of Technology

BERNT WENNBERG
Chalmers University of Technology/University of Gothenburg

PUBLICATIONS

Acta Mathematica

Two volumes including four issues are published annually (around 800 pages).
Published issues 240:1, 240:2, 241:1 and 241:2 including 9 articles in total.

EDITORIAL COMMITTEE

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

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International Press of Boston, Inc.

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Jesper Grodal
University of Copenhagen

Helge Holden
NTNU – Norwegian University of Science and Technology, Trondheim

Tuomas Hytönen
Aalto University

Kurt Johansson
KTH Royal Institute of Technology, Stockholm

Arkiv för matematik

Arkiv för matematik was founded in 1903 by The Royal Swedish Academy of Sciences. One volume including two issues are published annually (around 400 pages)
Published issues, 62:1 and 62:2, including 15 articles in total.

EDITORIAL COMMITTEE

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

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International Press of Boston Inc.

EDITORS:

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Chalmers University of Technology, Gothenburg

Fredrik Viklund
KTH Royal Institute of Technology, Stockholm

Erik Wahlén
Lund University

Genkai Zhang
Chalmers University of Technology, Gothenburg

Financial Support 2024

The Academy of Finland

Acta Mathematica Foundation

Anna-Greta and Holger Crafoord Foundation

Brummer & Partners

Gothenburg University/Chalmers University of Technology

The Danish Mathematical Society (Institut for Matematik/Aarhus Universitet)

G S Magnuson Foundation

Knut and Alice Wallenberg Foundation

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Luleå University of Technology

Lund University

Jacob and Marcus Wallenberg Foundation

Stockholm University

The Research Council of Norway

KTH Royal Institute of Technology

The Swedish Research Council

The Verg Foundation

Umeå University

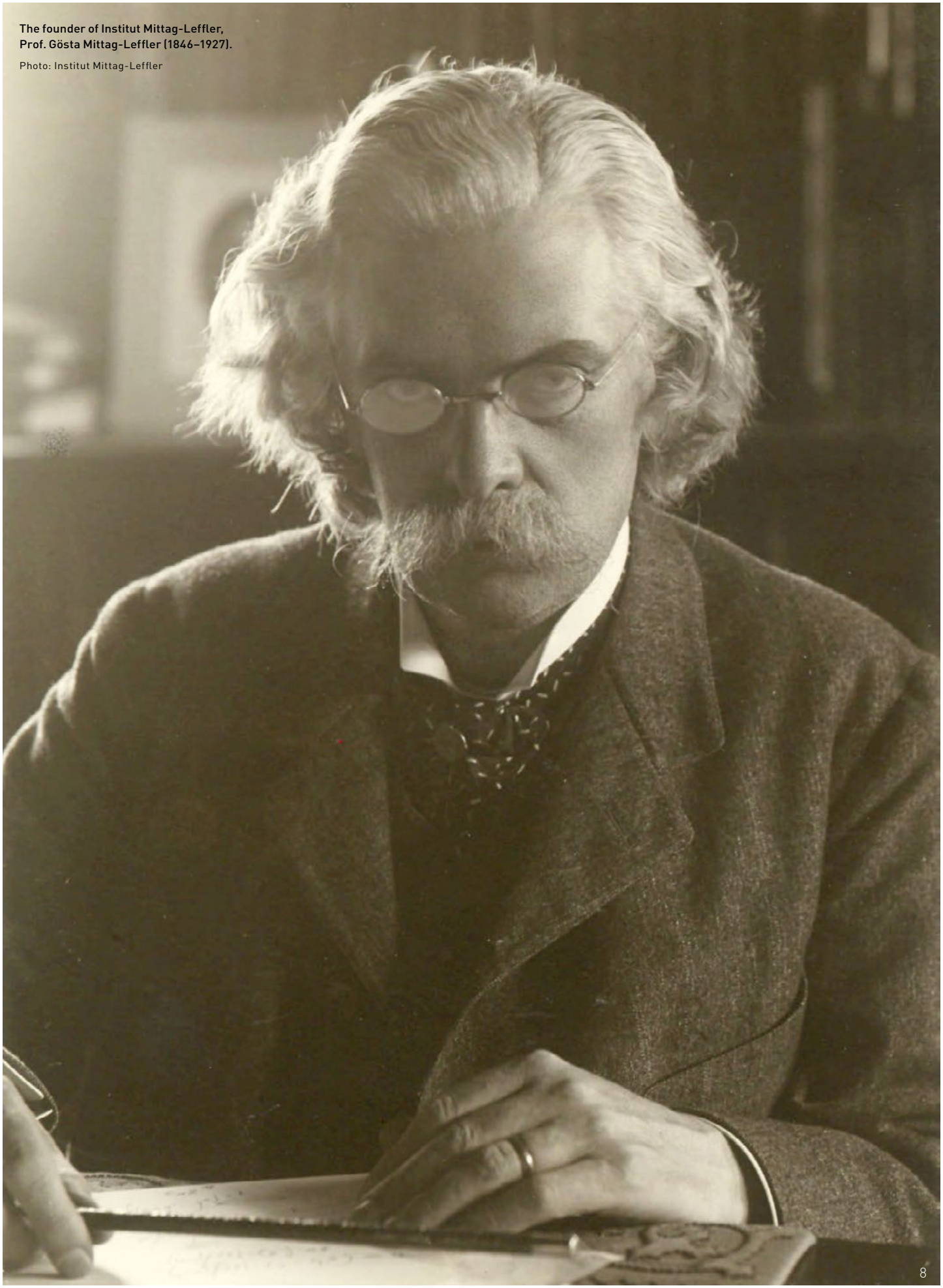
Uppsala University


Photo:Britt-Marie Stocke

Lennart Bondesson
(1944–2024)

Professor Lennart Bondesson passed away in June 2024 at the age of 80. Lennart Bondesson was a very prominent researcher who made significant contributions to both theoretical and applied mathematical statistics.

He will be missed by family, friends and previous colleagues. Professor Bondesson made a substantial donation to Institut Mittag-Leffler. The institute wants to express its sincere gratitude and appreciation of his generosity.



The founder of Institut Mittag-Leffler, Prof. Gösta Mittag-Leffler (1846–1927).

Photo: Institut Mittag-Leffler

Research Program

Analytic Number Theory

January 17–April 26, 2024

Organizers:
Pär Kurlberg
KTH Royal Institute of Technology
Morten Risager
University of Copenhagen
Anders Södergren
Chalmers/University of Gothenburg

SCIENTIFIC REPORT

The program focused on several aspects of modern analytic number theory, including spectacular recent results on progressions in the primes and prime gaps both large and small. Apart from prime number theory, the program also focused on multiplicative number theory where several recent breakthroughs on multiplicative functions in short intervals, e.g. relating to the Erdős Discrepancy problem, served as inspiration. Another major theme was automorphic L-functions and their applications in geometry, arithmetic, and quantum chaos. Moreover, various counting problems in arithmetic groups and on arithmetic surfaces were actively investigated both in low and high rank situations.

The program was highly successful and led to a large number of new results and papers. Here is a small sample: *Statistics of characteristic polynomials and determinants of rational matrices* (by M. Afifurrahman, V. Kuperberg, A. Ostafe and I. E. Shparlinski), *Artin's conjecture on average and short character sums* (O. Klurman, I. Shparlinski, and J. Teräväinen), *Rational approximation with chosen prime numerators* (by M. Hauke and E. Kowalski), *Low-lying zeros in families of Maass form L-functions* (by M. Cech, L. Devin, D. Fiorilli, K. Matomäki and A. Södergren), *Estimates for smooth Weyl sums on major arcs* (by J. Bruedern and T. D. Wooley), *Rational curves on complete intersections and the circle method* (by T. Browning, P. Vishe and S. Yamagishi), *Random Chowla's conjecture for Rademacher multiplicative functions* (by J. Chinis and B. Shala), *The third moment of the logarithm of zeta and a twisted pair correlation conjecture* (by A. Fazzari and M. Gerspach), Mixed moments of GL(2) *Symmetric square L-functions* (by B. Huang and L. Li), *Proving the Duffin-Schaeffer conjecture without GCD graphs* (by M. Hauke, S. V. Saez, and A. Walker), *Simple Barban-Davenport-Halberstam type asymptotics for general sequences* (by A. J. Harper), *Fourier asymptotics and equidistribution* (by S. Datta and S. Jana), *On the real zeroes of half-integral weight Hecke cusp forms* (by J. Jääsaari) and *Mittag-Leffler type theorems for Helson zeta-functions* (by J. Andersson).

The program saw developments in several new directions. Examples include progress on effective equidistribution results for unipotent orbits in homogeneous spaces using the delta method in the form developed by Heath-Brown (by A. Strömbergsson, A. Södergren and P. Vishe), new techniques leading to improvements on the longstanding error-estimate in the hyperbolic circle problem (by D. Chatzakos, G. Cherubini, S. Lester, and M. Risager), quantitative asymptotics for polynomial patterns in the primes (by Matthiesen, Teräväinen, and Wang), new development on the dimension growth conjecture for thin sets of Type II (L. Pierce and collaborators).

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The program usually hosted two talks on Wednesday afternoon and two talks on Friday morning, where program participants presented new ideas and recent work. Most sessions included talks by a junior participant and a more senior participant. All talks were streamed online for people not able to attend in person. Besides the above, the junior participants had a weekly learning seminar on e.g. ergodic theory.

Besides the regular seminars the program hosted a week-long workshop in January. Particular highlights were talks given by Valentin Blomer, Bryce Kerr, Stephen Lester, Vivian Kuperberg, Maksym Radziwill and Alex Walker. A second weeklong workshop was hosted in March, where particular highlights were talks by Roger Heath-Brown, Bingrong Huang, Lillian Pierce, Abishek Saha, Oleksiy Klurman, Caroline Turnage-Butterbaugh and Trevor Wooley. A one day mini-workshop was hosted at the end of April to conclude the program.

The list of special invited participants included world-renowned experts like Tim Browning, Adam Harper, Roger Heath-Brown, Emmanuel Kowalski, Kaisa Matomäki, Philippe Michel, Paul Nelson, Lillian Pierce, Maksym Radziwill, Per Salberger, Kristian Seip, Igor Shparlinski, Joni Teräväinen and Trevor Wooley.

SEMINARS

(W) WORKSHOP

JANUARY 18, 2024
Maksym Radziwil
University of Texas at Austin
Recent progress in multiplicative number theory

JANUARY 22, 2024 (W)
Igor Shparlinski
University of New South Wales
Ranks of matrices with polynomial entries

JANUARY 22, 2024 (W)
Alex Walker
University College London
Autocorrelation of Hurwitz Class Numbers

JANUARY 22, 2024 (W)
Paolo Minelli
KTH Royal Institute of Technology
Bias in the running time of the Euclidean algorithm and applications to Dedekind sums

JANUARY 22, 2024 (W)
Maksym Radziwill
University of Texas at Austin
The sixth moment of Dirichlet L-functions

JANUARY 23, 2024 (W)
Valentin Blomer
University of Bonn
Hyperbolic lattice point counting in unbounded rank

JANUARY 23, 2024 (W)
Gergely Harcos
Alfréd Rényi Institute of Mathematics
The prime geodesic theorem in arithmetic progressions

JANUARY 23, 2024 (W)
Emmanuel Kowalski
ETH Zurich
Toroidal averages with Dirichlet characters

JANUARY 23, 2024 (W)
Subhajit Jana
Queen Mary University of London
On the local L2-bound of the Eisenstein series and application

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Photo: Markus Marcetic

Institut Mittag-Leffler,
built and extended during 1890–1906.

JANUARY 24, 2024
Steven Lester
King's College London
Mass equidistribution for Siegel modular forms

JANUARY 24, 2024
Vivian Kuperberg
ETH Zurich
Sums of odd-ly many fractions and the distribution of primes

JANUARY 24, 2024
Aled Walker
King's College London
Correlations of multiplicative functions along Beatty sequences

JANUARY 25, 2024
Alina Ostafe
University of New South Wales
On some arithmetic statistics for integer matrices

JANUARY 25, 2024
Asbjørn Nordentoft
Université Paris 13
Non-vanishing of twists of L-functions by characters of fixed order

JANUARY 25, 2024
Lilian Matthiesen
KTH Royal Institute of Technology
Distributional properties of smooth numbers: Smooth numbers are orthogonal to nilsequences

JANUARY 25, 2024
Matthew de Courcy-Ireland
Stockholm University
Six-dimensional sphere packing and linear programming

JANUARY 26, 2024
Petru Constantinescu
École Polytechnique Fédérale de Lausanne
On the distribution of closed geodesic cycle integrals and non-vanishing of central values of L-functions

JANUARY 26, 2024
Alessandro Fazzari
Université de Montréal
Weighted statistics of families of L-functions

JANUARY 26, 2024
Bryce Kerr
University of New South Wales
Cubic weyl sums with smooth denominator

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JANUARY 26, 2024
Joni Teräväinen
University of Turku
Detecting primes in multiplicatively structured sequences

JANUARY 31, 2024
Johan Andersson
Örebro University
Aspects of universality

JANUARY 31, 2024
Kaisa Matomäki
University of Turku
Mollifying Dirichlet L-functions and their derivatives

FEBRUARY 2, 2024
Sun Kai Leung
Université de Montréal
Joint distribution of primes in multiple short intervals

FEBRUARY 7, 2024
Yoonbok Lee
Incheon National University
Discrepancy bounds for the distribution of L-functions near the critical line

FEBRUARY 7, 2024
Giacomo Cherubini
Istituto Nazionale di Alta Matematica
Coprime-universal quadratic forms

FEBRUARY 9, 2024
Manuel Hauke
University of York
The Duffin-Schaeffer conjecture and beyond

FEBRUARY 9, 2024
Sumit Kumar
Alfréd Rényi Institute of Mathematics
Delta method and its application to the Rankin-Selberg problem

FEBRUARY 14, 2024
Dimitrios Chatzakos
University of Patras
Mean values and quantum variance for degenerate Eisenstein series of higher rank

FEBRUARY 14, 2024
Min Lee
University of Bristol
Murmurations of holomorphic modular forms in the weight aspect

FEBRUARY 16, 2024
Athanasios Sourmelidis
Graz University of Technology
Discrete Omega results for the Riemann zeta function

FEBRUARY 16, 2024
Oleksiy Klurman
University of Bristol
Counting sign changes

FEBRUARY 21, 2024
Sebastián Herrero
ETH Zürich and University of Santiago de Chile
Special values of Green's functions on hyperbolic 3-space

FEBRUARY 21, 2024
Ilaria Viglino
École Polytechnique Fédérale de Lausanne
Almost sure convergence of least common multiple of ideals for polynomials over a number field

FEBRUARY 23, 2024
Prahlad Sharma
Max Planck Institute for Mathematics, Bonn
Bilinear sums with (GL(2)) coefficients and the exponent of distribution of (d_3)

FEBRUARY 23, 2024
Andrii Bondarenko
Norwegian University of Science and Technology
Fourier interpolation from zeros of the Riemann zeta function

FEBRUARY 28, 2024
Robert Tichy
Graz University of Technology
Equidistribution and Pseudorandomness

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Photo: Markus Marcetic

The seminar building at Institut Mittag-Leffler.

FEBRUARY 28, 2024
Danylo Radchenko
Centre national de la recherche scientifique
Convolution identities for sums of even powers of divisors

MARCH 1, 2024
Neea Palojärvi
University of Helsinki
Conditional estimates for logarithms and logarithmic derivatives in the Selberg class

MARCH 1, 2024
Jesse Jääsaari
University of Turku
On Signs of Fourier Coefficients of Hecke-Maass Cusp Forms on GL(3)

MARCH 6, 2024
Fabien Pazuki
University of Copenhagen
Isogeny volcanoes: an ordinary inverse problem

MARCH 6, 2024
Daniel Fiorilli
Université Paris-Saclay
Extending the unconditional support in an Iwaniec-Luo-Sarnak family

MARCH 8, 2024
Sary Drappeau
Aix Marseille Université
q-Pochhammer symbols and modularity

MARCH 8, 2024
Winston Heap
The Norwegian University of Science and Technology
Simultaneous extreme values of zeta and L-functions

MARCH 11, 2024 (W)
Adam Harper
University of Warwick
Lower bounds for low moments of character sums

MARCH 11, 2024 (W)
Maxim Gerspach
KTH Royal Institute of Technology
Heuristics for quadratic character sums over function fields on average

MARCH 11, 2024 (W)
Lucile Devin
Université du Littoral Côte d'Opale
Distribution of Gaussian primes and zeros of L-functions

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Photo: Markus Marcetic

The ground floor of the main building at Institute Mittag-Leffler.

MARCH 11, 2024 (W)
Yiannis Petridis
University College London
Counting and equidistribution

MARCH 12, 2024 (W)
Abishek Saha
Queen Mary University of London
Simple supercuspidals for GSp(4) and large values of paramodular newforms

MARCH 12, 2024 (W)
Caroline Turnage-Butterbaugh
Carleton College
Moments of Dirichlet L-functions

MARCH 12, 2024 (W)
Lillian Pierce
Duke University
Number-theoretic methods to produce counterexamples for questions motivated by PDE's

MARCH 12, 2024 (W)
Barnabás Szabó
University of Warwick
A lower bound on high moments of character sums

MARCH 13, 2024 (W)
Anna-Maria Ernvall-Hytönen
University of Helsinki
Explicit estimate for Laguerre polynomial (joint work with Tapani Matala-aho)

MARCH 13, 2024 (W)
Alia Hamieh
University of Northern British Columbia
Mean Values of Long Dirichlet Polynomials with Divisor Coefficients

MARCH 14, 2024 (W)
Bingrong Huang
Shandong University
Value distribution of Hecke eigenforms

>>

MARCH 14, 2024
Roger Heath-Brown
University of Oxford
Manin's Conjecture for Del Pezzo Surfaces of Degree 5 with a Conic Fibration

MARCH 14, 2024
Joni Teräväinen
University of Turku
Multiple ergodic averages with Möbius weight

MARCH 14, 2024
Claire Burrin
University of Zürich
Rational points on the sphere

MARCH 15, 2024
Keshav Aggarwal
University of Copenhagen
Short second moment bound and subconvexity for GL(3) L-functions

MARCH 15, 2024
Oleksiy Klurman
University of Bristol
Partition regularity of Pythagorean pairs

MARCH 15, 2024
Trevor Wooley
Purdue University
Representations by sums of powers

MARCH 20, 2024
Julia Brandes
University of Gothenburg
A minimalist approach to the circle method and Diophantine problems over thin sets

MARCH 20, 2024
Tim Browning
Institute of Science and Technology Austria
100% of quadratic twists have no integral points

MARCH 22, 2024
Nuno Arala Santos
University of Warwick
Singular intersections of quadrics and cusp forms

MARCH 22, 2024
Julia Stadlmann
University of Oxford
Primes in arithmetic progressions to smooth moduli

MARCH 27, 2024
Mengdi Wang
University of Turku
Local Fourier uniformity of divisor functions

MARCH 27, 2024
Per Salberger
Chalmers University
On the global determinant method

APRIL 3, 2024
Pankaj Vishe
Durham University
A two dimensional delta method and applications to quadratic forms

APRIL 3, 2024
Régis de la Bretèche
Institut de Mathématiques de Jussieu-Paris Rive Gauche, Université Paris Cité
Mean value of Erdos–Hooley Delta-function

APRIL 3, 2024
Igor Wigman
KCL King's College London
Around Gauss circle problem: Hardy's conjecture and the distribution of lattice points near circles

APRIL 5, 2024
Matteo Bordignon
KTH Royal Institute of Technology
Weyl sums with multiplicative coefficients and joint equidistribution

APRIL 5, 2024
Niclas Technau
Max Plank Institute for Mathematics, Bonn
Counting Rational Points Near Manifolds

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Photo: Institut Mittag-Leffler

Organizers of the research program *Analytic Number Theory*, 2024.

APRIL 10, 2024
Efthymios Sofos
University of Glasgow
Multiplicative functions and applications

APRIL 10, 2024
Shreyasi Datta
Uppsala University
Inhomogeneous Diophantine approximation on manifolds

APRIL 10, 2024
Philippe Michel
École Polytechnique Fédérale de Lausanne
The unipotent mixing conjecture

APRIL 12, 2024
András Biró
Alfréd Rényi Institute of Mathematics
Local square mean in the hyperbolic circle problem

APRIL 12, 2024
Paul Nelson
Aarhus University
Microlocal analysis and analytic theory of automorphic forms

APRIL 16, 2024
Ramunas Garunkstis
Vilnis University
On the zeros of the Riemann zeta-function

APRIL 16, 2024
Chung-Hang (Kevin) Kwan
University College London
Moments and Periods

APRIL 16, 2024
Stelios Sachpazis
University of Turku
Primes in arithmetic progressions and exceptional characters

APRIL 19, 2024
Andrei Shubin
Vienna University of Technology
Prime number theorem for sums of digits in several bases

APRIL 19, 2024
Aled Walker
King's College London
An argument without quality: a short(er) proof of the Duffin–Schaeffer conjecture

APRIL 23, 2024
Florent Jouve
Institut de Mathématiques de Bordeaux
Moments in the Chebotarev density Theorem

APRIL 23, 2024
Ian Petrow
University College London
Counting characters on algebraic tori according to their Langlands L-functions

APRIL 25, 2024
Soumendra Ganguly
Aarhus University
Subconvexity for twisted L-functions on GL(3) x GL(2) and GL(3)

APRIL 25, 2024
Martin Raum
Chalmers University of Technology
Decomposition of an L2 space associated with a non-reductive group

APRIL 25, 2024
Marios Voskou
University College London
Hyperbolic Counting Problems

APRIL 25, 2024
Brad Rodgers
Queens University
Best approximation by restricted divisor sums and random matrix integrals

APRIL 25, 2024
Martin Čech
University of Turku
Moments of real Dirichlet L-functions and multiple Dirichlet series

APRIL 25, 2024
Junxian Li
University of California, Davis
Non-vanishing of twists of L-functions

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Valentin Blomer
University of Bonn, Germany

Andrii Bondarenko
Norwegian University of Science and Technology, Norway

Matteo Bordignon
KTH Royal Institute of Technology, Sweden

Julia Brandes
Chalmers/University of Gothenburg, Sweden

Timothy Browning
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Chalmers/University of Gothenburg, Sweden

Martin Cech
University of Turku, Finland

Dimitrios Chatzakos
University of Patras , Greece

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Winston Heap
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Oleksiy Klurman
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ETH Zürich, Switzerland

Sumit Kumar
Alfréd Rényi Institute of Mathematics, Hungary

Vinay Kumaraswamy
KTH Royal Institute of Technology, Sweden

Vivian Kuperberg
ETH Zurich, Switzerland

Pär Kurlberg *(Organizer)*
KTH Royal Institute of Technology, Sweden

Chung-Hang Kwan
University College London, United Kingdom

Min Lee
University of Bristol, United Kingdom

Yoonbok Lee
Incheon National University, Korea

Steve Lester
King's College London, United Kingdom

Sun Kai Leung
University of Montreal, Canada

Junxian Li
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University of Turku, Finland

Lilian Matthiesen
KTH Royal Institute of Technology, Sweden

Philippe Michel
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Paolo Minelli
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Alina Ostafe
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Lillian Pierce
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Danylo Radchenko
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Maksym Radziwill
University of Texas at Austin, United States

Martin Raum
Chalmers University of Technology, Sweden

Morten Risager *(Organizer)*
University of Copenhagen, Denmark

Brad Rodgers
Queens University, Canada

Stelios Sachpazis
University of Turku, Finland

Research Program

Random Matrices and Scaling Limits

August 28–December 13, 2024

Organizers:
Maurice Duits
KTH Royal Institute of Technology
Kurt Johansson
KTH Royal Institute of Technology
Gaultier Lambert
KTH Royal Institute of Technology
Kevin Schnelli
KTH Royal Institute of Technology

SCIENTIFIC REPORT

The program focused on four different research directions in the general area of random matrix theory: universality of eigenvalue statistics, KPZ-universality for random growth models, random tilings and related models, as well as characteristic polynomials and Gaussian multiplicative chaos. The main goal of the program was to report on the recent progress in these areas and to bring them together to foster new research directions. Particular emphasis was placed on inviting younger or mid-career participants.

We describe some topics that were discussed during talks many of which were also active research topics during the program.

Horng-Tzer Yau gave a seminar on optimal rigidity for the eigenvalues of d-regular random graphs, which leads to edge universality for this model, and the fact that approximately 69% of large d-regular graphs are Ramanujan. Ofer Zeitouni (Weizmann Institute) talked about the log-correlated structure of characteristic polynomials and eigenvectors in some matrix models. Other highlights were talks by Paul Bourgade on non-Hermitian dynamics for the Ginibre eigenvalues, and of Alice Guionnet on partition functions for ß-ensembles on curves in the plane with complex potentials. Problems on random matrix ensembles and Coulomb gases in the plane were also discussed by Yacin Ameur, Klara Courteaut, Kurt Johansson and Fredrik Viklund, Gernot Akemann, as well as by Joakim Cronvall.

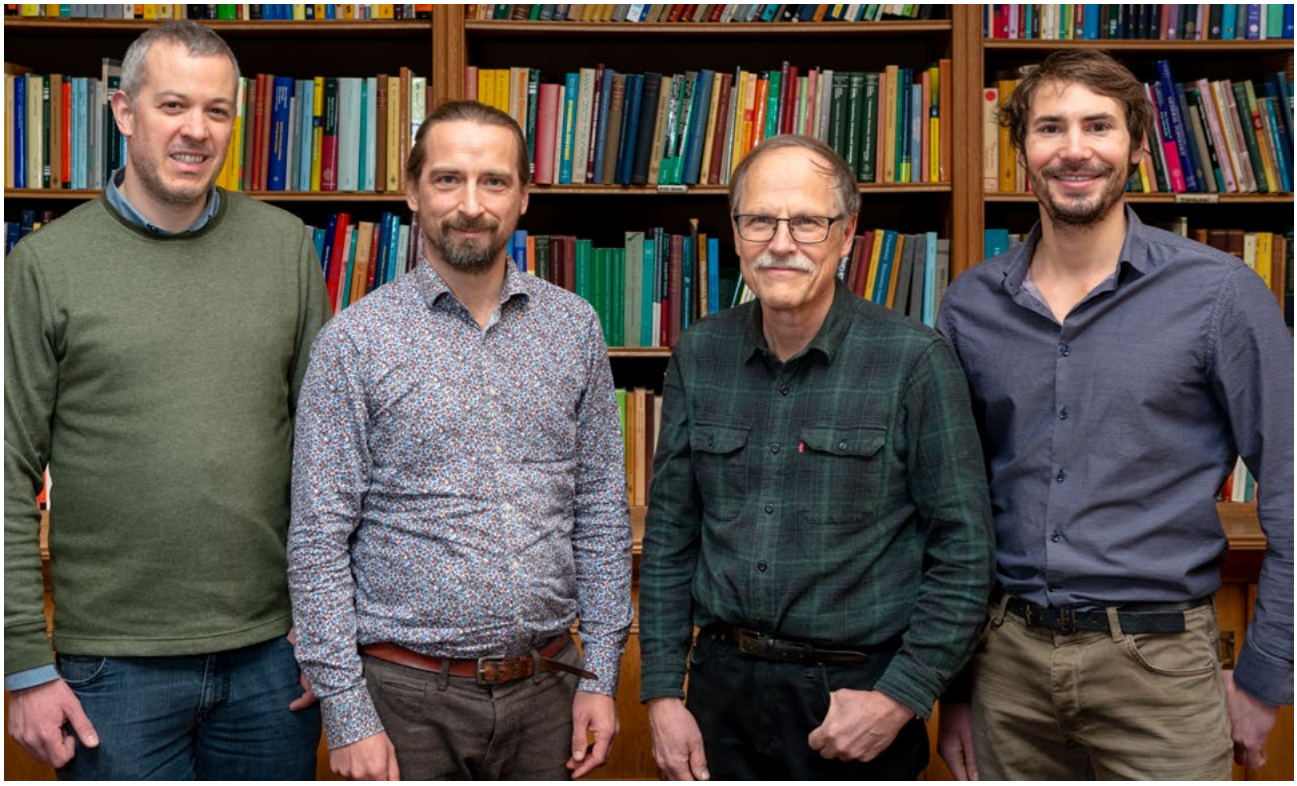
Several other notable research areas discussed during the program included the KPZ fixed point, a central object in the field of local random growth models, in particular the RSK construction of the directed landscape by Duncan Dauvergne, Balint Virag and Nikolaos Zygouras, as well as several recent universality results on dimer models by Arno Kuijlaars, Béatrice de Tilière and Cédric Boutillier.

A number of connections with other areas of analysis and probability theory were also explored: orthogonal polynomials and Riemann-Hilbert methods, the relationships with the Gaussian free field and Sine-Gordon field, random geometry and conformal field theory.

Other active areas of research related to random matrix theory were represented such as perturbations of banded Toeplitz matrices by Mireille Capitaine and Martin Vogel, the connection between random matrix statistics and zeros of the Riemann zeta function by Ashkan Nikegbhali, and the six vertex model by Vadim Gorin.

The program also significantly helped advance collaborations between program participants, for example between organizers and long-term guests at the Institute, such as the collaborations between Jonathan Breuer and Maurice Duits, Elliot Paquette and Gaultier Lambert, and between Yuanyuan Xu and Kevin Schnelli.

Photo: Institut Mittag-Leffler



Organizers of the research program *Random Matrices and Scaling Limits*, 2024.

The program also promoted new active research directions, such as random graphs as models of quantum disorder (Antti Knowles), random matrix questions pertaining to physics of integrable systems and free fermions (Pierre Le Doussal, Gregory Schehr and Herbert Spohn), and the connection between machine learning and certain random matrix models (Lucas Benigni and Elisabeth Collins-Woodfin).

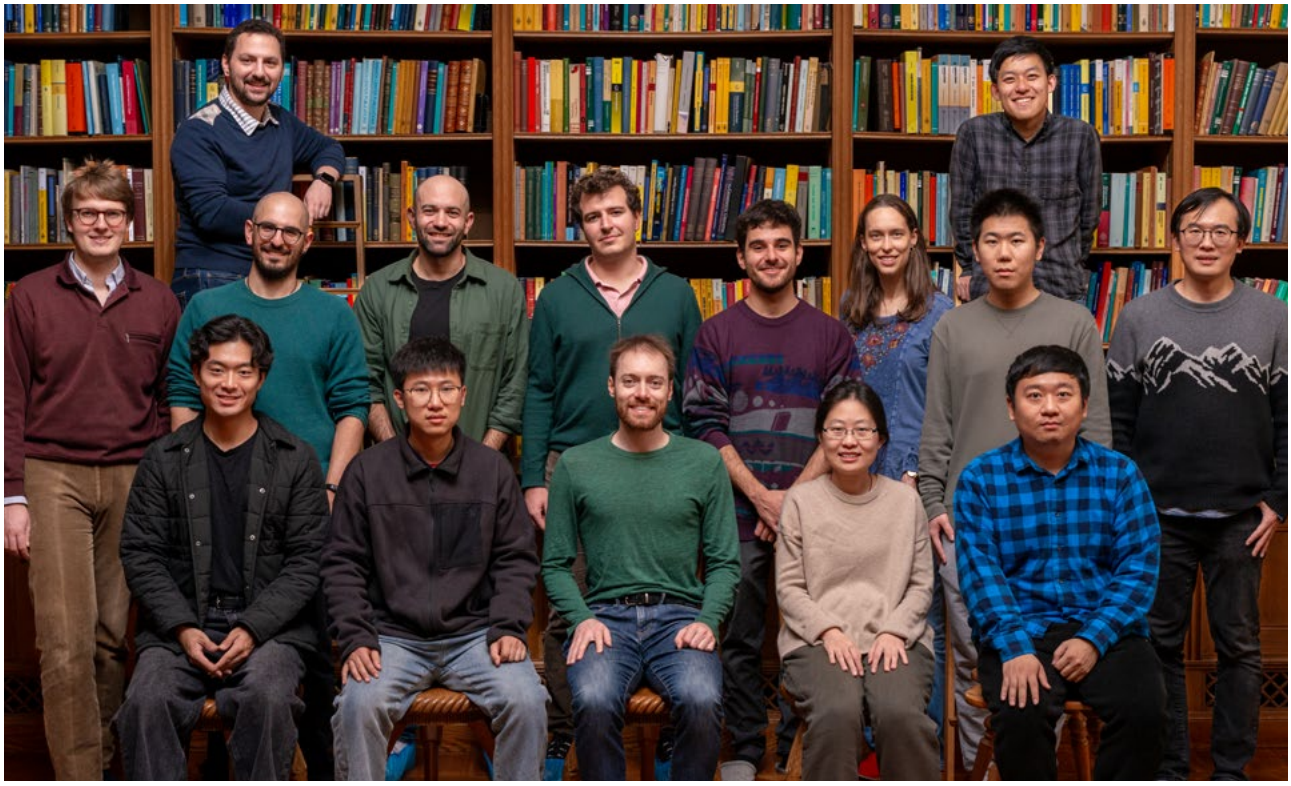
Throughout the program, we had four weekly talks given by participants, and the junior fellows also had a weekly seminar and reading group. To start the program, the junior fellows gave short talks to introduce themselves. This was followed by the first intense focus week (September 2–6). This workshop focused on random matrices and integrable models in the KPZ-universality class. In October, we had a second focus week covering topics on ß-ensembles and non-Hermitian random matrices (October 14–18).

Throughout the program, the junior fellows ran a reading course on Gaussian multiplicative chaos (GMC) and its connection to random matrix theory. GMC is a basic object in modern probability theory which relates to random geometry and extreme statistics of log-correlated fields. It also plays a role to describe the scaling limits of characteristic polynomials of many random matrix models. The goal of the reading group run by Ahmad Barhoumi was to introduce the construction of GMC and discuss several applications. The course was also supplemented by several seminars on the topic, including a mini-course by Ofer Zeitouni, and seminars by Joseph Najnudel on the relationships to circular ß-ensembles and Georgio Cippolini on characteristic polynomials of non-Hermitian random matrices.

Finally in relation to the program, Courtney Paquette gave a two-hour mini-course on *High-dimensional Optimization and random matrices* discussing recent results on the mean-field behavior of neural networks during the training phase which was intended for the junior fellows and PhD students at KTH Royal Institute of Technology.

Special invited participants and/or speakers: Horng-Tzer Yau, Ofer Zeitouni, Alice Guionnet, Balint Virag and Herbert Spohn.

Photo: Institut Mittag-Leffler



Junior fellows of the research program *Random Matrices and Scaling Limits*, 2024.

SEMINARS

(W) WORKSHOP

SEPTEMBER 2, 2024 (W)
Herbert Spohn
Technical University Munich
Random matrix theory and integrable many-particle systems

SEPTEMBER 2, 2024 (W)
Arno Kuijlaars
Katholieke Universiteit Leuven
Doubly periodic tilings from the point of view of matrix valued orthogonal polynomials

SEPTEMBER 2, 2024 (W)
Neil O'Connell
University College Dublin
Discrete Whittaker processes

SEPTEMBER 3, 2024 (W)
Thomas Bothner
University of Bristol
Universality for random matrices with an edge spectrum singularity

SEPTEMBER 3, 2024 (W)
Elizabeth Collins-Woodfin
McGill University
Using RMT to understand phase transitions in spherical spin glass

SEPTEMBER 3, 2024 (W)
Joseph Najnudel
University of Bristol
Subcritical multiplicative chaos and the characteristic polynomial of the CBE

SEPTEMBER 3, 2024 (W)
Jinho Baik
University of Michigan
Directed last passage percolation in the upper large deviation regime

SEPTEMBER 4, 2024 (W)
Horng-Tzer Yau
Harvard University
Spectral statistics of Random regular graphs

>>

SEPTEMBER 4, 2024
Jonathan Breuer
The Hebrew University of Jerusalem
Towards a Floquet Theory for Periodic Jacobi Matrices on Trees

SEPTEMBER 4, 2024
Balint Viràg
University of Toronto
The directed landscape from Brownian motion

SEPTEMBER 5, 2024
Antti Knowles
University of Geneva
Random graphs as models of quantum disorder

SEPTEMBER 5, 2024
Klara Courteaut
New York University
The log-gas on a Jordan arc

SEPTEMBER 5, 2024
Alexey Bufetov
Leipzig University
Mallows measure and ASEP

SEPTEMBER 5, 2024
Tamara Grava
University of Bristol
Soliton gas for the focusing nonlinear Schrödinger equation

SEPTEMBER 6, 2024
Guillaume Barraquand
Ecole Normale Supérieure Paris
Last passage percolation in a strip

SEPTEMBER 6, 2024
Ofer Zeitouni
Weizmann Institute
Log determinants, log correlated fields, and eigenvectors

SEPTEMBER 9, 2024
Ofer Zeitouni
Weizmann Institute
Introduction to Gaussian Multiplicative Chaos

SEPTEMBER 10, 2024
Matthew Nicoletti
MIT Massachusetts Institute of Technology
Perfect t-embeddings of the uniform hexagon

SEPTEMBER 10, 2024
Tomas Berggren
KTH Royal Institute of Technology
Crystallization of the Aztec diamond

SEPTEMBER 11, 2024
Nathan Hayford
KTH Royal Institute of Technology
The Ising model on a random planar lattice: exact genus zero free energy

SEPTEMBER 12, 2024
Theo Assiotis
University of Edinburgh
Infinite-dimensional diffusions from random matrix dynamics

SEPTEMBER 12, 2024
Patrik Ferrari
Universität Bonn
IAM TASEP with dynamics restricted by moving wall

SEPTEMBER 17, 2024
Alon Nishry
Tel Aviv University
Charge fluctuations in the hierarchical Coulomb gas

SEPTEMBER 18, 2024
Elizabeth Collins-Woodfin
McGill University
High-dimensional dynamics of SGD for generalized linear models

SEPTEMBER 19, 2024
Vadim Gorin
University of California, Berkeley
Six-vertex model in the rare corners regime

SEPTEMBER 24, 2024
Cedric Boutillier
Sorbonne Université
Minimal bipartite dimers and maximal Riemann surfaces

>>

Photo: Markus Marcetic

Ground floor, lounge area of Institute Mittag-Leffler.

SEPTEMBER 24, 2024
Nikolaos Zygouras
University of Warwick
RSK construction of the KPZ fixed point

SEPTEMBER 25, 2024
Philippe Moreillon
University of Geneva
Disk counting statistics of the eigenvalues of truncated unitary matrices

SEPTEMBER 25, 2024
Guido Mazzuca
Tulane University
Central limit theorem for the real beta ensemble in the high temperature regime, and the Toda lattice

SEPTEMBER 26, 2024
Leslie Molag
University of Madrid
Fluctuations of random normal matrices in various regimes of non-Hermiticity

SEPTEMBER 26, 2024
Gernot Akemann
Bielefeld University
Complex normal, symmetric or self-dual random matrices: Approximation by a 2d Coulomb gas and analytic results for characteristic polynomials

OCTOBER 1, 2024
Yacin Ameur
Lund University
The Coulomb gas near a spectral outpost

OCTOBER 1, 2024
Luke Peilen
Temple University
Local Laws and Fluctuations for Log and Riesz Gases

OCTOBER 2, 2024
Yizhe Zhu
University of South California
Non-backtracking methods for sparse random matrices

OCTOBER 3, 2024
Nicholas Simm
University of Sussex
Derivative moments of CUE characteristic polynomials and the Riemann zeta function

OCTOBER 3, 2024
Jimmy He
Ohio State University
Boundary current fluctuations for the half space ASEP

>>

Photo: Markus Marcetic

The round library of Institut Mittag-Leffler.

OCTOBER 4, 2024
Nicholas Simm
University of Sussex
Secular Coefficients and the Holomorphic Multiplicative Chaos

OCTOBER 8, 2024
Mustazee Rahman
Durham University
Endpoint of the KPZ fixed point

OCTOBER 9, 2024
Mateusz Piorkowski
KTH Royal Institute of Technology
Algebraic equations for arctic curves of the periodic Aztec diamond

OCTOBER 10, 2024
Igor Krasovsky
Imperial College London
Strong and weak confinement in the Freud ensemble of random matrices

OCTOBER 14, 2024 (W)
Paul Bourgade
New York University
Fluctuations for non-Hermitian dynamics

OCTOBER 14, 2024 (W)
Fredrik Viklund
KTH Royal Institute of Technology
Coulomb gas on a Jordan domain

OCTOBER, 14 2024 (W)
Giorgio Cipolloni
University of Arizona
Extrema of non-Hermitian eigenvalue statistics

OCTOBER, 15 2024 (W)
Brian Rider
Temple University
Solvable families of random block tridiagonals

OCTOBER, 15 2024 (W)
Benedek Valko
University of Wisconsin
Pair correlation for the Sine-beta process for even beta

>>

OCTOBER, 15 2024
Duncan Dauvergne
University of Toronto
Three limits of RSK

OCTOBER, 15 2024
Yuanyuan Xu
Chinese Academy of Sciences
Universality of extremal eigenvalues of large non-Hermitian random matrices

OCTOBER, 16 2024
Pierre Le Doussal
Laboratoire de Physique, ENS Paris
Weak noise theory of the O'Connell-Yor polymer and integrable matrix extensions

OCTOBER, 16 2024
Gregory Schehr
LPTHE, Sorbonne University
Linear Statistics for Coulomb and Riesz gases: higher order cumulants

OCTOBER, 16 2024
Lucas Benigni
Université de Montréal
Eigenvalue distribution of the Neural Tangent Kernel under a quadratic scaling

OCTOBER, 17 2024
Béatrice de Tilière
University Paris Dauphine PSL
Fock's dimer model on the Aztec diamond

OCTOBER, 17 2024
Mireille Capitaine
Institute de Mathématiques de Toulouse
Outliers of perturbations of banded Toeplitz matrices

OCTOBER, 17 2024
Tom Claeys
Catholic University of Louvain
Large deviations for the log-Gamma polymer

OCTOBER, 17 2024
Dong Wang
Chinese Academy of Sciences
Asymptotics of biorthogonal polynomials related to Muttalib-Borodin ensemble in the hard to soft transitive regime

OCTOBER, 18 2024
Elliot Paquette
McGill University
Kahane's coverage question and the image of Gaussian analytic function

OCTOBER, 18 2024
Alice Guionnet
École normale supérieure de Lyon
Asymptotic expansion of the partition function for β-ensembles with complex potentials

OCTOBER 22, 2024
Scott Mason
New York University
Fractional correlations of the sine-Gordon field at the free-fermion point

OCTOBER 24, 2024
Joakim Cronwall
Lund University
The correlation kernel near the boudary in the random normal matrix model

OCTOBER 29, 2024
Djalil Chafaï
The École normale supérieure Paris
Aspects of the Cutoff Phenomenon for Diffusions

OCTOBER 29, 2024
Ashkan Nikeghbali
University of Zürich
The Riemann zeta function and random zetas

OCTOBER 30, 2024
Charlie Dworaczek Guera
KTH Royal Institute of Technology
The sinh-model: Quantum separation of variables and Lukyanov's conjecture

>>

VOCTOBER 30, 2024
Daniel Ofner
The Hebrew University of Jerusalem
Exploring Orthogonal Polynomial Ensembles via Recurrence Relations

OCTOBER 31, 2024
Pierre Van Moerbeke
UCLouvain
Statistical fluctuations of tilings near cusps

OCTOBER 31, 2024
David García-Zelada
Sorbonne Université
Outliers for normal random matrices

NOVEMBER 5, 2024
Mark Adler
Brandeis University
An Asymmetric Discrete Tacnode Kernel

NOVEMBER 6, 2024
Joscha Henheik
Institute of Science and Technology Austria
Zigzag strategy for random matrices

NOVEMBER 6, 2024
Jiaming Xu
KTH Royal Institute of Technology
Airy Beta line ensemble through Dunkl operators

NOVEMBER 7, 2024
Alessandra Occelli
University of Angers
An interpolating distribution for a PNG model in half space with two external sources

NOVEMBER 7, 2024
Benjamin Landon
University of Toronto
Tail bounds for stationary KPZ models

NOVEMBER 13, 2024
Yuchen Liao
University of Wisconsin – Madison
Lower tail large deviations for the stochastic six vertex model

NOVEMBER 13, 2024
Yun Li
Tsinghua University
Limits of the truncated circular beta ensembles

NOVEMBER 14, 2024
Francesco Mezzadri
University of Bristol
Tridiagonal matrix models for non-Hermitian beta-ensembles and their spectral densities

NOVEMBER 19, 2024
Alix Deleporte
Université Paris-Saclay
Semiclassical analysis of free fermions

NOVEMBER 21, 2024
Martin Vogel
Université de Strasbourg
Eigenvalue asymptotics and eigenvector localization for non-Hermitian noisy Toeplitz matrices

NOVEMBER 26, 2024
Christian Webb
University of Helsinki
Bosonization in critical and near critical models of statistical field theory

NOVEMBER 27, 2024
Jimmy He
Ohio State University
Shift invariance of half space integrable models

NOVEMBER 27, 2024
Félix Parraud
KTH Royal Institute of Technology
The spectrum of tensor of random and deterministic matrices

DECEMBER 3, 2024
Mario Kieburg
University of Melbourne
Correlations between Singular Values and Eigenvalues of Complex Matrices

>>

Photo: Markus Marcetic

The upper round library of Institut Mittag-Leffler.

DECEMBER 3, 2024
Alfredo Deaño
Universidad Carlos III de Madrid
Recent results and some problems on matrix-valued orthogonal polynomials

DECEMBER 4, 2024
Albert Zhang
Courant Institute, New York University
Quantitative universality for gaps of Wigner matrices

DECEMBER 4, 2024
Yujin Kim
Courant Institute, New York University
Absolute continuity of non-Gaussian and Gaussian multiplicative chaos measures

DECEMBER 5, 2024
Zhigang Bao
University of Hong Kong
Phase transition for the smallest eigenvalue of covariance matrices

DECEMBER 5, 2024
Tom Alberts
University of Utah
Conformal field theory of Gaussian free fields in a multiply connected domain

DECEMBER 10, 2024
Karl Liechty
DePaul University
The six-vertex model with DWBC

DECEMBER 10, 2024
Peter Nejjar
Potsdam University
The second class particle process at shocks

DECEMBER 11, 2024
Charlie Dworaczek Guera
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The β-ensembles at high temperature

DECEMBER 11, 2024
Levi Haunschmid-Sibitz
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The stochastic six-vertex model speed process

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KU Leuven, Belgium

Yizhe Zhu
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Nikolaos Zygouras
Warwick University, United Kingdom

Conferences

Photo: Institut Mittag-Leffler

Workshop on Nonlinear Parabolic PDEs

MAY 20–MAY 24, 2024

Organizers:

Verena Bögelein
Universität Salzburg

Ugo Gianazza
University of Pavia

Juha Kinnunen
Aalto University

Kaj Nyström
Uppsala University

SCIENTIFIC REPORT

Nonlinear evolutionary partial differential equations are of fundamental importance in mathematical analysis. They are used to model time-dependent phenomena such as flows in porous media, turbulent filtration processes, groundwater flows through gravel or fractured crystalline rocks, shallow water waves, turbulent polytropic filtration of gas or the moving boundary between two phases of a material undergoing a phase change (for instance the melting of ice to water, as in the Stefan problem). Such phenomena or processes are typically modeled by parabolic PDE's which are singular and/ or degenerate (the so-called doubly nonlinear diffusion equations may exhibit both features).

In recent years, there have been quite a number of breakthroughs in the theory of singular and degenerate parabolic PDEs. For example, it was shown that weak solutions of the porous medium equation are higher integrable in the sense of Elcrat and Meyers. This result was extended to porous medium type systems and Trudinger's equation. Moreover, several parameter ranges of doubly nonlinear parabolic equations are nowadays covered. Also, the Hölder continuity of weak solutions is widely understood both for non-negative and for signed solutions. Finally, there has been significant progress in the regularity theory for solutions to the Stefan problem, particularly as far as the determination of quantitative moduli of continuity is concerned.

On the other hand, many important problems remain unresolved, so that the overall available regularity theory is still somehow fragmented, and a general and comprehensive understanding has yet to be achieved. For example, even the uniqueness of weak solutions to doubly non-linear equations is still not fully understood.

The workshop focused on the following themes related to nonlinear parabolic PDEs:

- comparison principles and uniqueness of weak solutions,
- boundary regularity,
- regularity of the spatial gradient,
- behavior of solutions in the subcritical range,
- regularity of solutions to the Stefan problem.

As it is apparent for anyone familiar with the field, the novelties are not mutually exclusive and progress in one of the above-listed themes definitely impacts one or more of the other research topics, since several themes overlap in a specific research problem.

We wanted to bring together leading experts in the field to find new perspectives how to approach the major open problems and to discuss new directions of research.

We also wanted to include postdoctoral researchers and graduate students, so that they could become aware of interesting problems and share ideas with more senior researchers. Both aims have been achieved.

Interesting and important connections between different areas, which had not been imagined before, were established.

See the conference webpage for a complete list of the workshop seminars. They all consisted in 30-minute-talks: at first sight, this might look quite a restrictive choice (concentrate deep and technical results in a rather short time), but in our opinion it forced the speakers to focus on essential issues, without spending time on immaterial aspects. All the participants eventually agreed that it was a good solution, also because the long breaks we inserted easily allowed the interested people to ask more detailed questions.

With respect to what we had originally planned, only one seminar had to be canceled, because the speaker could not attend. Moreover, the talks were in large part shared online with interested researchers who could not personally attend, and they were also recorded, so that anyone of the participants could have the opportunity to listen to them one more time.

Photo: Institut Mittag-Leffler

The seminar room, Wallenbergsalen.

PARTICIPANTS

Emiliano Peña Ayala
Uppsala University, Sweden

Sun-Sig Byun
Seoul National University, Korea

Fabian Bäuerlein
University of Salzburg, Austria

Verena Bögelein
University of Salzburg, Austria

Yumi Cho
Seoul National University, Republic of Korea

Simone Ciani
University of Bologna, Italy

Filomena De Filippis
University of Parma, Italy

Frank Duzaar
University of Salzburg, Austria

Julian Fischer
Institute of Science and Technology Austria, Austria

Ugo Gianazza
University of Pavia, Italy

Raffaella Giova
University of Naples Parthenope, Italy

Peter Hästö
University of Helsinki, Finland

Sunghan Kim
Uppsala University, Sweden

Wontae Kim
Aalto university, Finland

Juha Kinnunen
Aalto University, Finland

Naian Liao
University of Salzburg, Austria

Erik Lindgren
Uppsala University, Sweden

Paolo Marcellini
University of Florence, Italy

Kristian Moring
University of Duisburg-Essen, Germany

Kim Myyryläinen
Aalto University, Finland

Antonella Nastasi
University of Palermo, Italy

Kaj Nyström
Uppsala University, Sweden

Jihoon Ok
Sogang University, Korea

Mikko Parviainen
University of Jyväskylä, Finland

Antonia Passarelli di Napoli
Università degli Studi di Napoli "Federico II", Italy

Hadid Rehman
Uppsala University, Sweden

Christoph Scheven
University Duisburg-Essen, Germany

Sebastian Schwarzacher
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Photo: Markus Marcetic

Gula Villan, apartments and dining hall at institut Mittag-Leffler.

Photo: Institut Mittag-Leffler

Summer School: Water Waves and Nonlinear Dispersive Equation

MAY 27 – MAY 31, 2024

Organizers:
Gabriele Brüll
Lund University
Anna Geyer
Delft University of Technology

SCIENTIFIC REPORT

Nonlinear dispersive equations have attracted significant attention from mathematicians during the last decades due to their ubiquitous applications in fields such as fluid dynamics, optics, and electromagnetics. The interplay between nonlinear and dispersive effects leads to a variety of wave phenomena, ranging from smooth solutions and stability to singularity formations, blow-up, and instabilities. A complete understanding of the water-wave problem, even under the simplest assumptions on the fluid, is largely missing, leaving many interesting problems open. By focusing on certain regimes such as shallow or deep water, one can derive nonlinear dispersive water-wave model equations. A rigorous qualitative study of their solutions enhances our understanding of the water-wave problem and provides deeper insights into ocean dynamics and their impact on global climate phenomena. Consequently, water-wave models reside at the intersection of pure and applied mathematics and have significant applications to societal issues, such as climate studies.

The summer school achieved several key milestones. The program featured three main lecture series by distinguished professors Mariana Haragus, Vera Hur, and Vincent Duchene. These lectures covered topics of current research such as steady periodic solutions, stability analysis, and energy methods for water-wave models. The clarity, depth, and engaging delivery of these lectures were highly praised by attendees, stimulating lively discussions and deepening the participants' understanding of complex concepts.

The program's structure, balancing lectures with interactive sessions, was particularly successful. The mini-projects, were a significant highlight. These projects allowed students to collaborate in small groups, applying the theoretical knowledge gained from the lectures to solve practical problems using cutting edge techniques. The opportunity to present their findings at the end of the week provided valuable feedback from peers and experts, further enhancing their learning experience. Additionally, the poster session allowed participants to present their research, receive constructive feedback, and engage in meaningful discussions with their peers and lecturers. The social activities, including a poster session, pizza night, hike, and conference dinner, further enhanced the collaborative spirit and made the lecturers and organizers more approachable. The positive and inclusive atmosphere of the event was frequently noted in the feedback from participants and lecturers alike.

The summer school not only consolidated existing knowledge but also opened new directions for research and collaboration. The interactive nature of the mini-projects and the collaborative spirit fostered among participants led to the formulation of innovative approaches and questions for future exploration. The establishment of an online chat group for networking, sharing event information, and academic job postings indicates a lasting impact on the participants' professional lives. This initiative will facilitate ongoing collaboration, potentially leading to joint research projects and publications in the field of nonlinear dispersive equations and water waves.

The summer school consisted of three lecture series, two short talks, project work, a poster pitch session, discussion groups and several social activities.

At the heart of the summer were the lecture series given by the invited speakers Mariana Haragus, Vera Hur, and Vincent Duchene on stability, Stokes waves and energy methods for water wave models. Their expertise and engaging presentation styles were instrumental in the success of the event. Furthermore, Handan Borluk and Björn de Rijk delivered inspiring short talks, offering valuable insights into fractional equations and dispersive decay properties.

Photo:Markus Marcetic

Discussion room in the main building.

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Photo: Institut Mittag-Leffler

Numerical Methods for PDEs and their Applications

JUNE 3–JUNE 7, 2024

Organizers:

Jennifer Ryan
KTH Royal Institute of Technology

Sandra May
Uppsala University

Sigal Gottlieb
University of Massachusetts

SCIENTIFIC REPORT

This one-week workshop brought together highly qualified female participants who work in the field of numerical methods for PDEs and their applications. The goal was to connect junior female researchers with peers as well as internationally renowned senior researchers in the field. The scientific area included a range of topics in the numerical analysis of PDEs, including computational fluid dynamics, finite volume, finite element, spectral, and integral equation methods, and their applications. We also included related areas such as uncertainty quantification and machine learning. The main criterion for choosing participants was their research excellence. A significant overlap of research interests of the participants in several topics (e.g. cut cell methods, integral equation methods, development of software, uncertainty quantification, water waves and tsunamis) guaranteed in-depth scientific discussions.

The workshop consisted of scientific talks, a poster session, as well as networking opportunities. Presentations were of extremely high quality, both scientifically and with respect to stimulating discussions. Many were followed up by small-group discussions together with experts in the field. The workshop hosted presentations by experts such as Ann Almgren, Marsha Berger, Inga Berre, Yingda Cheng, Fengyan Li, and Julia Kowalski as well as junior scientists such as Saray Busto, Monika Eisenmann, Anna Persson, Laura Scarabosio, Christian Taylor, and Xinyu Zhao. The talks ranged from ensuring numerical schemes preserved physics (entropy, energy, etc.) over techniques for uncertainty quantification to machine learning and computational efficiency. Applications of the numerical methods were in medical imaging, ice sheet modelling, modelling Earth's deep interior, as well as predicting tsunamis.

This workshop facilitated establishing new collaborations and discussions of new research directions through scientific exchange. Further, it contributed to building a network of female scientists in numerical methods for PDEs.

Senior renowned invited participants included Ann Almgren, Marsha Berger, Inga Berre, Gunilla Kreiss, Anna-Karin Tornberg, Yingda Cheng, Fengyan Li and Julia Kowalski.

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Quantum Dynamics and Spectral Theory

JUNE 9–JUNE 14, 2024

Organizers:

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Hebrew University of Jerusalem

Gerald Teschl
Universität Wien

Hynek Kovarik
Università degli studi di Brescia

SCIENTIFIC REPORT

The relation between quantum dynamics and spectral theory created a huge amount of literature not only in spectral theory, but also in other ares of mathematics such as harmonic analysis, theory of oscillatory integrals or scattering theory. To be more specific, let us mention the following scientific areas:

- Dispersive estimates.
  These estimates are closely related to the asymptotic behaviour of the resolvent of the associated Hamiltonian near the threshold of the continuous spectrum. New aspects of this relation have been recently studied in for magnetic Schrödinger operators, Klein-Gordon operators, Pauli operators or Dirac operators.

- Dynamics and spectra of quasi-periodic operators. Quasi-periodic operators display a wide range of spectral phenomena: dense-point spectrum, singular continuous spectrum, Cantor type spectra and eigenfunctions with multifractal structure. While some general results exist regarding the dynamical manifestations of these spectral properties, in most such models the complete dynamical picture is still not fully understood.

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- Operators on graphs.
  Graphs provide an accessible platform for studying problems associated to effects of geometry on spectra and dynamics generated by quantum Hamiltonians. While the short-time behaviour is typically one-dimensional, the long-time behaviour of the associated evolution operator depends heavily on the global geometry of the graph. This phenomenon has been intensively studied in the literature. As far as the connection between geometry and spectral properties in graphs, this is very far from being understood. Certain families of models have been studied, but the area is still lacking in methods for the general spectral analysis of operators on graphs.

In the workshop we brought together researchers who study the above-mentioned problems in different contexts and using different techniques which complement and support each other. Our aim was to generate a creative research environment favourable for building new scientific collaborations.

Several results presented at the workshop opened new directions in the topics discussed in the meeting. For example:

- Lieb-Thirring type inequalities for one-dimensional functional difference operators.
- Necessary and sufficient conditions for universality limits in the local statistical behaviour of eigenvalues.
- The ten-martini problem for Strumian Hamiltonians.
- Application of inverse spectral theory to Camassa-Holm-type equations.
- Landis conjecture for quantum graphs.

Photo:Markus Marcetic

Journal library of Institute Mittag-Leffler.

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Photo: Institut Mittag-Leffler

Toric and Tropical Techniques in Symplectic Field Theory

JUNE 24–JUNE 28, 2024

Organizers:

Grigory Mikhalkin
University of Geneva

Ilia Itenberg
Sorbonne Université

Georgios Dimitroglou Rizell
Uppsala University

SCIENTIFIC REPORT

Holomorphic curves encode deep information of both algebraic and symplectic varieties. One explanation of this is that they are an integral part of the framework of Kontsevich' homological mirror symmetry program, which predicts several correspondences between highly non-trivial algebraic and symplectic invariants. Enumerating holomorphic curves is therefore in general a very difficult task. One approach consists of deformations of the variety or symplectic manifold. In algebraic geometry one is usually interested in toric degenerations or tropical limits, while in the symplectic setting neck-stretching is a different technique with the same goal. Both the methods of symplectic field theory (SFT) and tropical geometry allows certain holomorphic curve invariants to be understood and counted in the corresponding limits which, if data is chosen appropriately, can be simpler than the original problem.

Another important technique and phenomenon that arises both in the world of symplectic and tropical geometry is when the count of curves makes a jump as some data changes. This phenomenon is called wall-crossing, and the effects on the invariants when crossing the walls can be analysed by using both SFT and tropical techniques. Wall-crossing itself is also an important technique for computations, since if one has the relevant formulae, it enables us to relate computations for one object to another, where one of them hopefully is simpler to understand.

The main achievement of the conference was bringing together leading experts from several different subfields of both algebraic geometry and symplectic topology. Several notable recent achievements in these fields were presented, including the following:

- Understanding the geometry of the KSBA moduli spaces of log Calabi-Yau surfaces, and their toric structure, using the algebraic formulation of punctured open Gromov-Witten invariants as studied by Pierrick.
- Vivek Shende and Tobias Ekholm has developed a theory of open Gromov-Witten invariants in the Calabi-Yau setting where the counts take values in the skein module of a Lagrangian submanifold.
- A probabilistic approach to the understanding of the geometry of amoebas in the projective plane by Jean-Yves Welschinger, with applications to the expected volume of an amoeba, and probability of a curve being Harnack.
- The counts of pseudoholomorphic discs with boundary on a Lagrangian torus obtained by passing to a limit in the form of a symplectic SFT-type degeneration, which can be seen to be analogous to toric degenerations, as developed in the theory of Venugopalan-Woodward.

The overlap between the techniques of symplectic, tropical, and algebraic geometry have not yet been fully explored and understood. There are techniques from both fields that allows one to construct and understand varieties that are mirror in the sense of homological and SYZ mirror symmetry. An important aspect of this is understanding wall crossings when data is changed. This is typically necessary for understanding the entire mirror, as opposed to some open subset of it. Another important computational tool is toric degenerations, which reduces the computations to the case of a toric manifold. Crucial invariants to these ends are the theories of Floer homology, the Fukaya category, and its deformations. The deformations of the are governed by certain Gromov-Witten invariants of the ambient manifold which arise in both symplectic topology and algebraic geometry. These can be computed using tropical and toric geometry, or techniques from SFT. A new direction is to further develop a systematic understanding that relates these two different perspectives. For instance, the algebro-geometric approach to symplectic homology by Gross-Siebert that is based on toric counts of open Gromov-Witten invariants, which is related to the invariants of SFT as well as the Hamiltonian version of Floer homology.

An important step for unifying the techniques of tropical geometry and symplectic topology is the closed curve-counts in the setting of log geometries due to Parker, and the open counts by Venugopalan-Woodward; the latter theory was presented at the workshop. In their work, degenerations are performed that allows holomorphic disc counts in symplectic manifolds to be carried out using the analogue of a tropical limit. Analysing these limits is a good starting point for relating the tropical and symplectic counts.

Here is a non-exhaustive list of talks that we found particularly novel:

- Pierrick Bousseau: *The KSBA moduli space of stable log Calabi-Yau surfaces*
- Sheel Ganatra: *Homological mirror symmetry for Batyrev mirror pairs*
- Vivek Shende: *Foundations for skein-valued curve counting*
- Sushmita Venugopalan: *Tropical curve counting on almost toric manifolds*
- Jean-Yves Welschinger: *Amoeba measures of random complex plane curves*

We managed to get world-leading experts from several different fields to participate in the workshop. This includes algebraic geometry (Mark Gross, Pierrick Bousseau), random algebraic geometry (Jean-Yves Welschinger), symplectic topology and Fukaya catagories (Mohammed Abouzaid, Sheel Ganatra, John Pardon, Sushmita Venugopalan, Chris Woodward), and symplectic field theory (Mike Hutchings and Richard Hind), and open Gromow-Witten invariants (Vivek Shende, Jake Solomon).

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EWM-EMS Summer School: Kinetic Theory Arising from Mathematical Biology

JULY 1–JULY 5, 2024

Organizers:

Josephine Evans
University of Warwick

Susanne Solem
Norwegian University of Life Sciences

Havva Yoldas
Delft University of Technology

SCIENTIFIC REPORT

This was an EWM conference in kinetic theory arising in mathematical biology. Around half our participants were presenting work directly about kinetic equations modelling processes from mathematical biology and the others talked about very closely related areas including coagulation and fragmentation models and non-linear diffusion equations and stochastic interacting particle systems.

Kinetic equations model large numbers of interacting agents through keeping track of the probability density of a "typical" agent. This type of modelling began with the work of Boltzmann and Maxwell on gas kinetics. Modelling biological systems this way is an emerging and fruitful area of research in both physics and mathematics. The most well studied models relate to flocking and swarming or to run and tumble chemotaxis.

The conference focused on the analyses of these models and related equations. The fact that these models come from biology means they come with less studied and mathematically rich features such as lack of natural entropies, pattern formation at stationarity and travelling waves. This area also brings new opportunities to collaborate with people working in biology and biophysics and brings us into contact with very different types of modelling.

We had two three-hour minicourses given by Prof. Yao Yao from the National University of Singapore and prof. Marie Doumic from INRIA. Yao Yao spoke about long time behaviour of Keller-Segal type equations with pourous medium type diffusions. This was a beautiful presentation of both the classical literature and Yao's own work including very intuitive and elegant proofs. Marie Doumic spoke about three problems in protein fragmentation. This was an inspiring example of how collaboration with applied scientists can bring interesting mathematical problems which were treated with a broad range of techniques.

We also had two long talks from established researchers in the field from Francis Filbet and Marie-Therese Wolfram. These were about long time behaviour and hydrodynamics of the Kuramoto alignment model and about kinetic models for pedestrian dynamics.

Finally, in addition to talks by junior participants, activities not directly related to mathematics were encouraged. We had a treasure hunt to break the ice, a successful afternoon of discussion about life in academia and other various social activities.

The majority of our participants were early career researchers and most people gave a talk (we prioritised later PhD students and early postdocs to give talks). We had very many excellent talks. These ranged from more applied to more analytical, with influences from probability, numerics, experiments and analysis of PDEs. We also had a large amount of time for collaboration built into the schedule and many interesting discussions emerged from the talks that were given. Hopefully these will lead to new directions in the field in the future.

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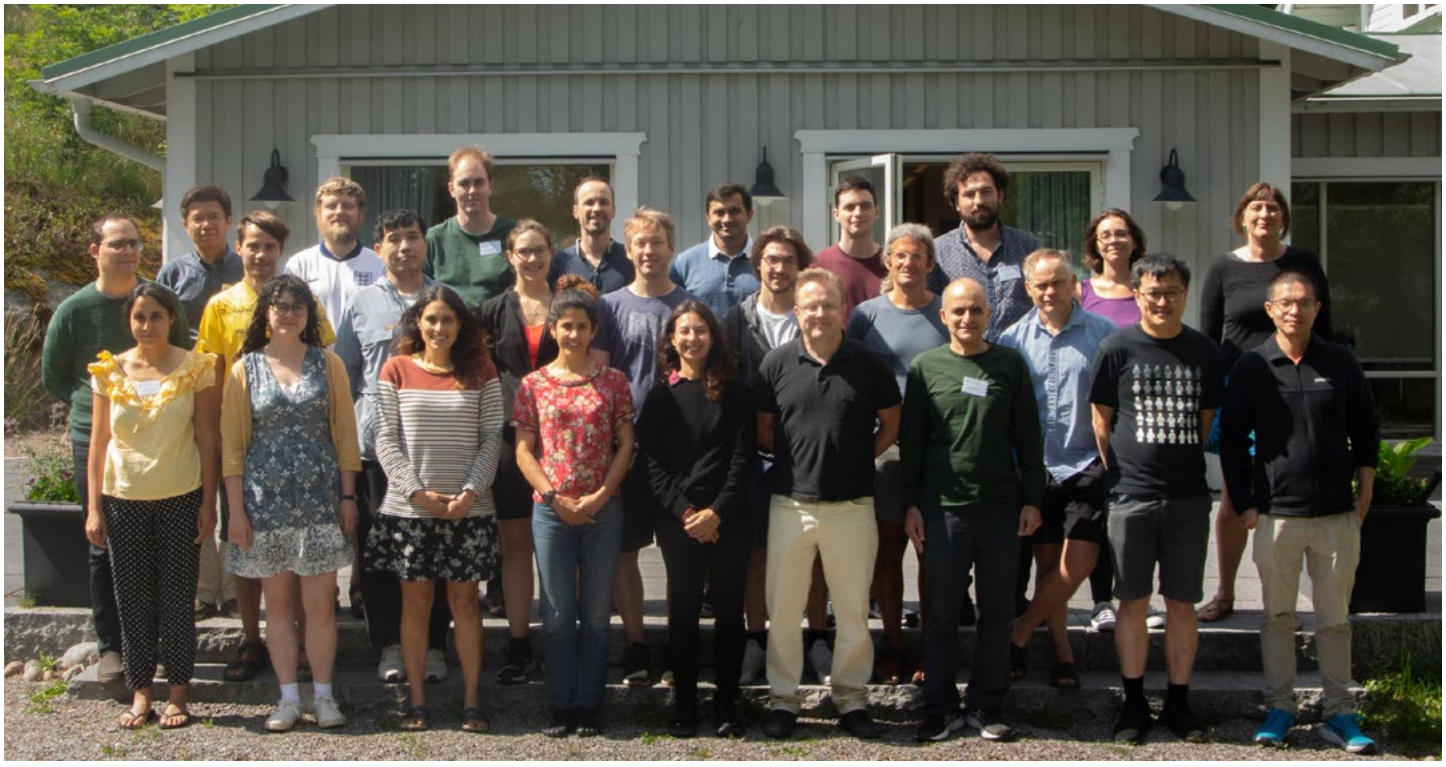

Extremal Graphs and Hypergraphs

JULY 8–JULY 12, 2024

Organizers:

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Klas Markström
Umeå University

Maryam Sharifzadeh
Umeå University

Andrew Treglown
University of Birmingham

Yi Zhao
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SCIENTIFIC REPORT

This workshop focussed on recent developments and open problems in extremal and probabilistic combinatorics. Extremal and probabilistic combinatorics is a rich and active area of combinatorics, which traces its roots back to the pioneering work of Paul Erdős and his collaborators from the 1930s onwards.

One of the primary aims of the area is to understand optimisation in discrete structures and their typical properties. For instance, how many edges can a graph on n vertices have if it is triangle-free? The answer is known as Mantel's theorem, and is an example of a Turán-type question. With this innocuous problem, one can then ask: how many triangle-free graphs are there? What does a typical triangle-free graph look like? What is likely size of the largest triangle-free subgraph of a random graph with edge probability p? How large an independent set is one guaranteed to find in an n-vertex triangle-free graph? How many triangles can one find in a graph which has more edges than the threshold given by Mantel's theorem?

Following in the footsteps of Erdős, researchers in the area often heavily use probabilistic tools and methods, whence the name for the area. With important connections to discrete probability and the study of random graphs as well as additive number theory on the one hand, and important application to theoretical computer science and to the study of algorithms and optimal networks and codes, extremal and probabilistic

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combinatorics has grown tremendously in recent years. It has blossomed in tandem with the advent of the digital age, and has seen incredible progress on many conjectures that had seemed wholly out of reach only a decade ago.

A few months after the event, work is ongoing on the host of projects that were started during the highly productive week in Mittag-Leffler, and we expect that within six months, at least a dozen preprints will have appeared directly as a result of the workshop, which will also have seen the birth of many new collaborations that will prove fruitful in the longer term.

Partial list of ongoing research projects started during the workshop:

- *Ramsey properties of randomly perturbed graphs* – J. Balogh, S. Das, V. FalgasRavry, L. Mattos and P. Morris
- *Full transversals in partial equi-n squares* – J. Balogh, C. Bowtell, S. Das, V. FalgasRavry, N. Kamcev, L. Mattos and P. Morris
- *Star decompositions and anti-Ramsey theory* – S.A. Lo, K. Markström, D. Mubayi, K. Staden, M. Stein and L. Weber
- *Dimension of symmetric homomorphism density profiles* – R. Hancock, H. Huang, D. Král, A. Lamaison and E. Räty
- *Loose paths and cycles in linear hypergraphs* – J. Han, P. Keevash, R. Mycroft, and Y. Zhao
- *Graph removal lemmas and integer solutions to linear equations* — N. Behague. N. Morrison, J. Noel and M. Sharifzadeh.

The above is a fraction of the projects started by subgroups of the participants — indeed, these are merely the projects the organisers were involved in, and the workshop itself was buzzing with creativity.

Dhruv Mubayi set the workshop in motion with a seminar on the stunning recent progress in Ramsey theory, discussing major advances on diagonal numbers, offdiagonal numbers, Zarankiewicz problems and the Erdős-Rogers function.

Nina Kamčev presented a canonical Ramsey theorem in random graphs, complementing the celebrated Rödl-Ruciński Random Ramsey theorem and introducing an application of the Conlon-Gowers transference principle.

Peter Keevash presented some deep progress in the combinatorial and analytic theories of isoperimetric stability and sharp thresholds, with important applications to additive and extremal combinatorics.

Leticia Mattos talked about a resolution of a long-standing problem about the maximal number of edge-disjoint cliques in random graphs, using involved differential equations methods to provide a tight lower bound for this parameter, matching a recent upper bound of Acan and Kahn (which itself disproved a conjecture of Alon and Spencer).

Shagnik presented some new results and outstanding conjecture on the new subject of fractionally intersecting families.

Natasha Morrison gave the final seminar of the workshop, and presented a major advance on embeddings of spanning trees with bounded degree in pseudorandom (n, d, lambda)-graphs. This involved a key new idea to the area, namely applying the existence of sorting networks of logarithmic size for embedding trees, and represents significant progress towards an important open problem of Alon, Krivelevich and Sudakov.

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Yi Zhao
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Photo: Markus Marcetic

Study room in the main building.

Photo: Institut Mittag-Leffler

Quantum Fields and Probability II

JULY 15–JULY 19, 2024

Organizers:

Fredrik Viklund
KTH Royal Institute of Technology

Christophe Garban
Université Lyon 1

Antti Kupiainen
University of Helsinki

Rémi Rhodes
Université d'Aix-Marseille

SCIENTIFIC REPORT

Over the past 70 years, quantum field theories (QFTs) have been successfully utilized to model and analyze diverse physical phenomena, for instance critical behavior in statistical mechanics and interactions among fundamental particles. However, the rigorous mathematical framework for constructing and understanding these models remains limited. During the conference Quantum fields and probability II at Institut Mittag-Leffler we explored this fundamental problem. The meeting was the second in a series of activities (we organized QFT and probability I in 2022), that will culminate in a full semester program in 2027. An important goal for these activies is to bring together researchers from different fields that do not usually interact. With this in mind, we invited a substantially different set of researchers for this workshop compared to the one we organized in 2022.

Among the main focus areas were:

- The random geometry approach to CFT (including SLE and related models);
- Liouville CFT and Gaussian multiplicative chaos;
- Coulomb gas models, including links to the quantum hall effect;
- Gauge theories (lattice gauge theories, random surface approach, amd SPDE approach).

Several interesting directions emerged during the meeting. We mention especially the two talks by Wiegmann and Klevtsov on coulomb gases and the quantum hall effect on hyperbolic surfaces. There has recently been much activity analyzing the many particle asymptotics of coulomb gases in the plane in various settings. Here a very natural generalization of this line of questioning to consider the models on surfaces was presented. Non-rigorous computations of the constant term in a free energy expansion reveals tight links to spectral determinants. Teschner's talk on Virasoro representations in Liouville theory formulated several interesting problems that may be accessible using recent probabilistic advances, quoting from the abstract: "The goal of this talk is to formulate and motivate a conjecture on the density describing the weight of an irreducible representation in the decomposition of the fusion product of the Virasoro representations appearing in the spectrum of Liouville conformal field theory. We hope that a proof of this conjecture can be achieved using the probabilistic approach to Liouville CFT."

Shen and Chevyrev gave very well-received talks of a more introductory character on the SPDE approach to QFT.

I traveled from Chile just for the week of the conference. There were several reasons: I had participated in the first edition of this conference in 2022 and had many great interactions. Conferences at IML are always well-organized and provide a good environment to connect with colleagues. Finally, the list of speakers was excellent, including some of the top experts in the field. Even so, my expectations were surpassed by the quality of this conference. I not only had the chance to hear about the most recent and relevant 1 results in the field and reconnect with researchers I already knew, but I also started a collaboration with a researcher I had never met before. This conference allowed us to discover shared interests, and as a result, he came to Chile for a month at the end of the year. We expect many results from this collaboration. In summary, this conference opened many doors for me, and I have no doubt that I will return – even if it takes more than a day just to get to IML.

The meeting was a fantastic opportunity to get a panorama of the interface between probability and quantum field theory, which is a new and exciting frontier as well as a huge new scientific challenge. Being able to attend courses on several of aspects of the most recent developments, and to ask questions and discuss with the world's foremost experts on these topics (be they mathematicians or physicists), especially in the unique setting of the Institute Mittag-Leffler, was a unique experience which already stimulated a lot of progress in my case.

Conferences at IML are always very special, with an open and active atmosphere. This time was certainly a success; one could feel that something is in the air - that expertise from different fields like random geometry, stochastic PDEs, statistical mechanics and CFT is starting to find common ground to tackle some of the notorious open problems of quantum field theory.

Photo: Markus Marcetic

Round library, bust of Anne Charlotte Leffler.

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Wang Yilin
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Photo: Institut Mittag-Leffler

Enumerative Invariants, Quantum Fields and String Theory Correspondences

JULY 22–JULY 26, 2024

Organizers:

Michele Del Zotto
Uppsala University

Albrecht Klemm
University of Bonn

Guglielmo Lockhart
Uppsala University

SCIENTIFIC REPORT

This scientific report concerns the second edition of a workshop we have organized at Institut Mittag-Leffler on the topic of enumerative geometry of Calabi-Yau manifolds and its relations to other areas of mathematics and theoretical physics. This field is in a phase of rapid development, and our intention has been to further stimulate growth and cross-contamination during the workshop, focusing on new directions of research that have developed since the first edition of the workshop, which took place in Summer 2024. Areas of mathematics that were covered include Topological Modular Forms, generalized symmetries, novel aspects of Donaldson-Thomas/Gromov-Witten theory of Calabi-Yau three-folds and four-folds, cohomological Hall Algebras (CoHA), and modularity of Calabi-Yau periods. On the physics side, connections with string theory/M-theory compactification, topological string theory, localization methods, dualities, and supersymmetric partition functions were addressed.

The workshop was organized thematically, with morning review talks followed in the afternoon by open discussion sessions and specialized research seminar on related topics. This format allowed us to discuss in a more informal way various very recent results, including groundbreaking unpublished work by some participants (most notably Brini, Bryan, Feyzbakhsh, and Klemm).

The workshop has been instrumental to highlight and generate interactions among enumerative geometry and various areas of physics and mathematics that are interconnected by string theory correspondences.

Several novel directions of research were discussed at the workshop. On the topic of DT invariants of CY three- and fourfolds, these include: a proposal for a generalized Donalson-Thomas topological field theory encoding DT invariants; novel arithmetic properties of Calabi-Yaus; and an interpretation of DT invariants from the perspective of 3d N=2 supersymmetric indices. Another significant area of discussion were the generating functions of D8-D6-D4-D2-D0 brane bound states generalizing the topological vertex; our workshop has led to significant progress in establishing the foundations of this research area. Additional new directions that were identified and pursued during the workshop include: the physical interpretation of CoHA in terms of an algebra of BPS states, a significant open problem involving an interplay between enumerative geometry, Cluster Algebras, Tropical Geometry, and string dualities; and the interplay between Topological Modular Forms, the BPS observables of higher dimensional superconformal theories (SCFTs), and enumerative invariants of CY threefolds. We foresee that advances in each of these areas will lead to significant progress in enumerative geometry and related disciplines.

During the conference, there were several successful talks and discussion sessions:

- Four overview talks on major areas of current research, consisting of one hour of review of the state of the art, followed by half hour of illustration of the speaker's ongoing work on the topic:
  - Soheyla Feizbakas: *"Donaldson-Thomas theory"*
  - Ben Davison: *"Cohomological Hall Algebras"*
  - Cyril Closset: *"Geometric Engineering"*
  - Jan Manschot: *"Four-manifold Invariants"*

- Five research talks presenting recent works by the following speakers:
  - Sergei Gukov: *"Where does modularity come from for 3- and 4-manifold invariants?"*
  - Miguel Moreira: *"Virasoro constraints for sheaves and quivers"*
  - Boris Pioline: *"BPS dendroscopy for local del Pezzo surfaces"*
  - Vivek Shende:*"Cluster transformation from skein valued curve counting"*
  - Jiahua Tian: *"3d N=2 from CY4 and brane boxes"*

- Ten discussion sessions lead by experts on the topic, including the following particularly successful sessions:
  - *Topological Modular Forms*, led by Pavel Putrov and Du Pei
  - *Mathematical formulation of Refined Topological Strings*, led by Andrea Brini
  - *Calabi-Yaus and Arithmetics*, led by Albrecht Klemm
  - *Orbifold DT invariants*, led by Jim Bryan

The workshop featured talks by leading international researchers in mathematics and physics, including Andrea Brini, Jim Bryan, Ben Davison, Soheyla Feyzbakhsh, Stavros Garoufalidis, Sergei Gukov, Sheldon Katz, Jan Manschot, Boris Pioline and Vivek Shende.

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The Rolf Schock Prize Symposium in Mathematics 2024

KUNGL. VETENSKAPS-AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

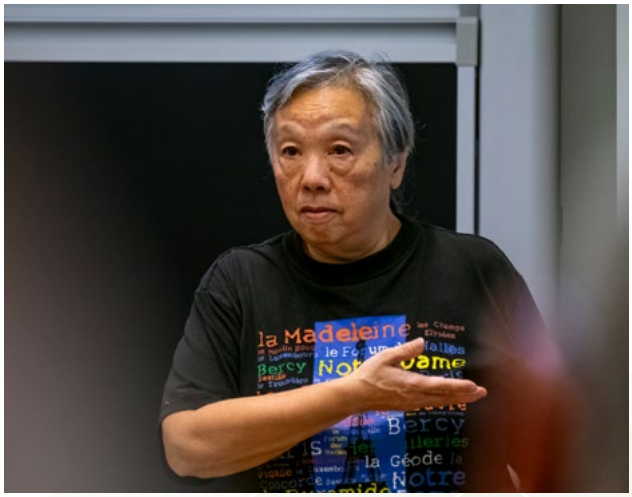
November 12, 2024

Organizers:
Michael Benedicks
KTH Royal Institute of Technology
Royal Swedish Academy of Sciences

The 2024 Rolf Schock Prize in Mathematics is awarded to Lai-Sang Young, Courant Institute, New York University, USA *"for long-lasting and deep contribution to the theory of non-uniformly hyperbolic dynamical systems"*.

Lai-Sang Young was born 1952 in Hong Kong. She received her PhD from University of California, Berkeley, in 1978 and is since 1999 professor in mathematics at Courant Institute, New York University, USA. She has previously received several prestigious awards like the Ruth Lyttle Satter Prize in 1993 and the Heinz Hopf Prize in 2023. She is a member of both the National Academy of Sciences and the American Academy of Sciences.

Photo: Institut Mittag-Leffler



Lai-Sang Young. Laureate of the 2024 Rolf Schock Price in Mathematics.

SEMINARS

NOVEMBER 12, 2024
Lai-Sang Young
Courant Institute, New York University
Typical trajectories and observable events in dynamical systems

NOVEMBER 12, 2024
TERE M-SEARA
U. Politècnica de Catalunya
Instabilities in the three body problem

NOVEMBER 12, 2024
Dmitry Turaaev
Imperial College
Averaging in slow-fast Hamiltonian systems with mixed fast dynamics

NOVEMBER 12, 2024
Anders Karlsson
Université de Genéve/Uppsala University
Generalized notions of Lyapunov exponents by a metric approach

NOVEMBER 12, 2024
Omri Sarig
Weizman Institute of Science
Measures of Maximal Entropy for C Infinity Surface Diffeomorphisms

Kleindagarna

Organizer:

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

Maria Saprykina
KTH Royal Institute of Technology, Stockholm

Supporting organization:

Brummer & Partners

For three days, high school teachers of mathematics were invited to Institut Mittag-Leffler together with mathematics professors and university teachers. 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 Kleindagarna 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. Kleindagarna is an appreciated learning and development opportunity aiming to create lessons in mathematics with an instant impact on high school students all around Sweden.

1. This year's themes arose from the following subjects: combinatorics, optimization and its application, chaotic dynamical systems, differential geometry and mathematical logic. The lectures were delivered by professional mathematicians from several leading universities in Sweden, who are specialized in the corresponding subjects.

2. Names of the lecturers and the titles of the lectures:

JANUARY 2024:

Per Enquist: *Kortaste vägen problem, och annan optimering i nätverk.*
Ninni Carlsund Levin: *Två numeriska metoder – en för ekvationer och en för integraler.*
Roy Skjelnes: *Symmetrier.*
Kristian Bjerklöv: *Komplicerat beteende i till synes enkla modeller.*

JUNE 2024

Kristian Bjerklöv: *Något om serier.*
Mattias Dahl: *Eulerkarakteristisken.*
Axel Hultman: *Att bevaka ett konstgalleri.*
Thomas Kragh: *Ekvivalens och likhet.*

AUGUST 2024

Lars-Daniel Öhman: *Hur många finns det? Femtioelva? – Om kombinatorisk enumeration.*
Ozan Öktem: *Tomografi – Matematik och fysik som räddar liv, avbildar proteiner, hittar olja, upptäcker vapen, ...*
Jan Kronqvist: *Optimeringslära – ett område inom tillämpad matematik.*
Klaus Krönke: *Krökning av ytor i rummet.*

The lectures by specialists are followed by discussions in small groups. As a result of these discussions, for each of the above topics a lesson for high school students was produced. The plan is that each of these new lessons is tested with a class of high school students. A test lesson is attended by a representative of the organizing team, a so-called lecture pilot, who us usually a doctoral student in mathematics. The list of this year's lecture pilots is given below. Several test lessons of this year have already been conducted, the dates been defined by the high school curriculum.

Kleindagarna I–III >>

Photo: Roberto Karlsson

Kleindagarna I

JANUARY 10–12, 2024

LECTURERS

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Daniel Erlandsson
Fridagymnasiet, Mölnlycke

Daniel Gottfridsson
Platengymnasiet, Motala

Sara Gramdanell
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Campus Viktor Rydberg, Gymnasium

Wang Wei Sönnerhed
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Enrique Zuloaga
Hedda Anderssongymnasiet, Lund

Frédéric Öhrn-Daumas
Nacka Gymnasium, Stockholm

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Photo: Roberto Karlsson

Kleindagarna II

JANUARY 10–12, 2024

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KTH Royal Institute of Technology, Stockholm

Axel Hultman
Linköpings Universitet, Linköping

Thomas Kragh
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Photo: Institut Mittag-Leffler

Kleindagarna III

AUGUST 16–AUGUST 18, 2023

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Marianne Forss
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Fabio Giuliari
Vara Folkhögskolan, filialen i Mariestad

Kerstin Glimmerfor
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Financial Report 2024

Förvaltningsberättelse

Förvaltaren för Makarna Mittag-Lefflers matematiska stiftelse får härmed avge årsredovisning för räkenskapsåret 1 januari–31 december 2024.

Org.nr 802408-0890

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 forskningsverksamhet samt publicerar matematiska tidskrifter varför alla uttag redovisas över resultaträkningen som kostnader för drift av stiftelsen.

KVA förvaltar ett kapital med ett marknadsvärde som per 2024-12-31 uppgår till 2 797 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 -5 624 582 kr som därmed tas från fonden för att driva Institut Mittag-Leffler.

Väsentliga händelser under räkenskapsåret

Under året har lokalerna genomgått omfattande renovering vilket bidrar till ökade fastighetskostnader.

Personalkostnader är kostnader för anställda och arvoderade tjänster vid Kungl. Vetenskapsakademien, tjänster som är förlagda på institutet.

>>

Flerårsöversikt

	2024	2023	2022	2021	2020
Huvudintäkter	16 516 031	24 420 895	20 217 859	7 817 711	25 525 568
Årets resultat	8 990 633	-1 902 172	-3 084 598	22 417 021	11 374 962
Ingående kapital	219 148 137	221 050 310	224 134 909	201 717 888	190 342 926
Utgående kapital	228 138 770	219 148 137	221 050 310	224 134 909	201 717 888
Årlig förändring i %	4,10%	-0,86%	-1,38%	11,11%	5,98%

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

RESULTATRÄKNING

	Not	2024	2023
Stiftlesens intäkter			
Bidrag		14 009 245	23 958 280
Övriga stiftelseintäkter		2 468 536	462 615
		16 516 031	**24 420 895**
Stiftelsens kostnader			
Övriga externa kostnader	2	-20 168 588	-28 847 410
Av- och nedskrivningar av materiella anläggninstillgångar		-606 745	-627 542
Övriga stiftelserkostnader		-1 327 030	-903 115
		-22 102 363	**-30 378 067**
Rörelseresultat		**-5 586 331**	**-5 957 172**
Finansiella poster			
Resultat från övriga finansiella anläggningstillgångar	3	14 031 345	3 469 503
Övriga ränteintäkter och liknande resultatposter	4	545 620	585 497
		14 576 965	**4 055 000**
Årets resultat		**8 990 633**	**-1 902 172**

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BALANSRÄKNING

Tillgångar		2024	2023
Anläggningstillgångar			
Materiella anläggningstillgångar			
Inventarier, verktyg och installationer	5	340 039	351 799
Förbättringsutgifter på annans fastighet	6	12 237 872	12 731 237
		12 577 911	13 083 036
Finansiella anläggningstillgångar			
Andra långfristiga värdepappersinnehav	7	230 827 102	218 842 068
		230 827 102	218 842 068
Summa anläggningstillgångar		**243 405 013**	**231 925 104**
Omsättningstillgångar			
Kortfristiga fordringar			
Övriga fordringar		-	-
Förutbet. kostnader och uppl. intäkter		1 058 280	1 452 940
		1 058 280	1 452 940
Kassa och bank		6 762 741	5 529 973
Summa omsättningstillgångar		7 821 021	6 982 913
Summa tillgångar		**251 226 034**	**238 908 016**

Eget kapital och skulder			
Eget kapital			
Bundet eget kapital			
Bundet eget kapital vid räkenskapsårets början		205 734 529	209 932 384
Förändringar av bundet kapital		5 160 149	-4 197 855
Bundet eget kapital vid räkenskapsårets slut		210 894 678	205 734 529
Fritt eget kapital			
Fritt eget kapital vid räkenskapsårets början		13 413 609	11 117 926
Överfört till och från bundet eget kapital		-5 160 149	4 197 855
Årets resultat		8 990 633	-1 902 172
Fritt eget kapital vid räkenskapsårets slut		17 244 093	13 413 609
Summa eget kapital		**228 138 770**	**219 148 138**
Kortfristiga skulder			
Leverantörsskulder		1 179 037	1 653 336
Övriga skulder		1 860 589	1 535 077
Skuld erhållna ej nyttjade bidrag		19 919 511	16 349 526
Uppl. kostnader och förutbet. intäkter		128 128	221 940
		23 087 265	19 759 879
Summa skulder		**23 087 265**	**19 759 879**
Summa eget kapital och skulder		**251 226 034**	**238 908 016**

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NOTER

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 ändamålet.

Not 2 – Övriga externa kostnader

	2024	2023
Lokalkostnader	-4 711 665	-6 526 376
Projektkostnader	-8 354 372	-14 857 712
IT-kostnader	-960 026	-1 395 913
Personalkostnader	-4 770 742	-2 309 691
Övrigt	-1 371 783	-3 757 720
	-20 168 588	**-28 847 411**

Not 3 – Resultat från övriga finansiella anläggningstillgångar

Utdelningar	8 237 977	7 623 547
Ränteintäkter	1 695 882	960 795
Realisationsresultat	4 097 485	-5 114 839
Återföring nedskrivning / Nedskrivning värdepapper	0	0
	14 031 345	**3 469 503**

Not 4 – Övriga ränteintäkter och liknade resultatposter

Fondrabatter	692 784	585 497
Kursvinst	-147 163	0
	545 621	**585 497**

Not 5 – Inventarier, verktyg och installationer

Ackumulerade anskaffningsvärden		
Vid årets början	2 066 173	2 066 173
Nyanskaffningar	101 620	-
Vid årets slut	**2 167 793**	**2 066 173**
Netto anskaffningsvärde	**2 167 793**	**2 066 173**
Ackumulerade avskrivningar enligt plan		
Vid årets början	-1 714 374	-1 599 259
Årets avskrivning på anskaffningsvärden	-113 380	-115 115
Vid årets slut	**-1 827 754**	**-1 714 374**
Redovisat värde vid årets slut	**340 039**	**351 799**

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Not 6 - Förbättringsutgifter på annans fastighet

	2024	2023
Ackumulerade anskaffningsvärden		
Vid årets början	17 103 740	17 103 740
Nyanskaffningar	-	-
Vid årets slut	17 103 740	17 103 740
Netto anskaffningsvärde	17 103 740	17 103 740
Ackumulerade avskrivningar enligt plan		
Vid årets början	-4 372 503	-3 860 076
Årets avskrivning på anskaffningsvärden	-493 365	-512 427
Vid årets slut	-4 865 868	-4 372 503
Redovisat värde vid årets slut	**12 237 872**	**12 731 237**

Not 7 – Andra långfristiga värdepappersinnehav

Ackumulerade anskaffningsvärden		
Vid årets början	218 842 068	224 600 595
Köp	27 023 355	55 209 955
Försäljning	-15 038 321	-60 968 482
Utgående anskaffningsvärden	230 827 102	218 842 068
Bokfört värde	230 827 102	218 842 068
Marknadsvärde	318 483 165	286 631 206

Stockholm den 28 maj 2025

Hans Ellegren
Ständig sekreterare

Min revisionsberättelse har avgivits den

Magnus Prööm
Auktoriserad revisor

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