



**INSTITUT
MITTAG-LEFFLER**

THE ROYAL SWEDISH ACADEMY OF SCIENCES

Annual Report 2025



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 scientific board with representatives from all Nordic countries.

The premises of the institute encompass several buildings: the main building with library, office and discussion spaces for staff and guest 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 Nordic countries. The institute is a hub for the international mathematical research community and for mathematicians in the Nordic countries.

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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Annual Report 2025



The Director of Institut Mittag-Leffler.
Photo: Institut Mittag-Leffler

A Brief Review of 2025

During 2025, 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. The cooperation with International Press continues. During 2025, the institute organized two research programs: *Cohomological aspects of quantum field theories and Interfaces and unfitted discretization models*.

The long-term funding situation for the institute greatly improved during 2025. In December the Board of the Swedish Research Council decided to “finance IML with 10 MSEK annually from 2027 with an evaluation every five years, to ensure that the institute maintains its high quality, as a basis for the decision of the council for the next five-year period”. This is a very important

decision: for the first time in the modern history of the institute, the funding situation allows us to look decades rather than just a few years ahead. For anyone familiar with the development of mathematical research, this a significant change and I would like to take this opportunity to thank the Swedish Research Council, especially Director General Katarina Bjelke and former Secretary General for Natural and Engineering Sciences, Matthias Marklund, for understanding the value and ways of our science, of Institut Mittag-Leffler, and for taking this important decision.

This decision – regular funding of mathematical research by the Swedish research council and the KAW mathematics program – puts the conditions for mathematical research in Sweden at the top European level. It is our duty to transform these resources to world leading mathematical research and world leading mathematicians also in coming generations.

During 2025 the main building of the institute has been improved. Walls and ceilings in several rooms have been renovated and restored. The parts of the building

>>

that were altered in the 1970's and 1980's have been completely refurbished; the metal spiral staircase has been replaced with many new facilities upstairs.

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 Paris.

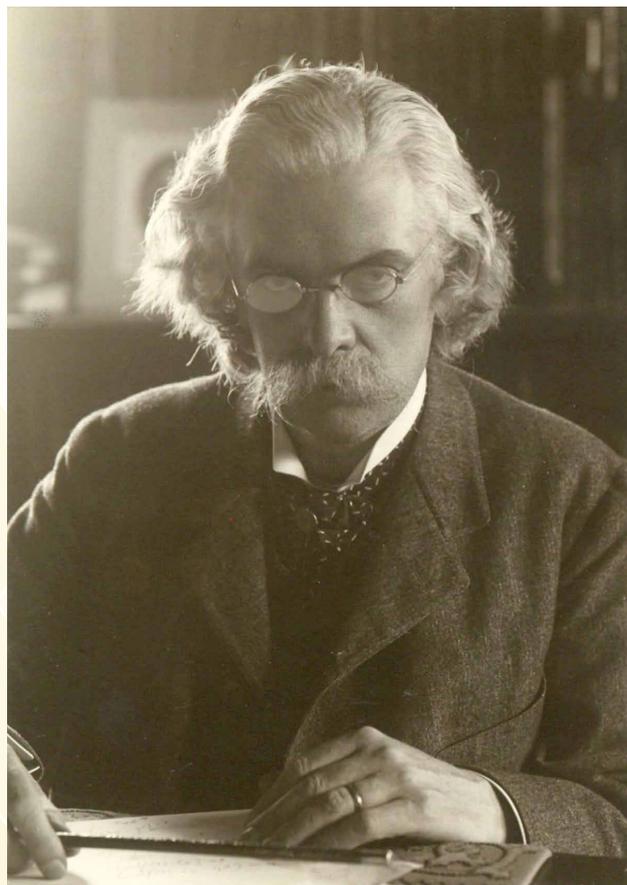
Institut Mittag-Leffler is very grateful to all those who have contributed during 2025. First and foremost, to all mathematicians who choose to conduct their research at the institute and to contribute to its scientific environment, especially to our colleagues in Sweden and other Nordic countries. We 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.

In August 2026 I am stepping down as director of the institute after eight years. I am very grateful for this time. I want to thank the Royal Swedish Academy of Sciences and Uppsala University for the support. Many people helped me in many ways over the years for which I am very grateful. I would particularly like to thank Kurt Johansson, Hans Ringström, and Sofie Upmark for the close cooperation over all these eight years.



Tobias Ekholm, *Director*



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



Photo: Christian Wahlen

The scientific board of Institut Mittag-Leffler.

Scientific Board Meeting of Institut Mittag-Leffler

May 6, 2025

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 2025:

MICHAEL BENEDICKS

KTH Royal Institute of Technology, Stockholm, Sweden

BO BERNDTSSON

Chairman, Chalmers University of Technology,
Gothenburg, Sweden

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University of Iceland, Reykjavík, Iceland

NILS DENCKER

Lund University, Lund, Sweden

TOBIAS EKHOLM

Director of Institut Mittag-Leffler, Djursholm, Sweden

SØREN FOURNAIS

University of Copenhagen, Copenhagen, Denmark

JOHAN HÅSTAD

KTH Royal Institute of Technology, Stockholm, Sweden

MAARIT JÄRVENPÄÄ

University of Oulu, Oulu, Finland

KRISTIAN RANESTAD

University of Oslo, Oslo, Norway

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KTH Royal Institute of Technology, Stockholm, Sweden

PER SALBERGER

Chalmers University of Technology, Gothenburg, Sweden

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Uppsala University, Uppsala, Sweden

ANNA-KARIN TORNBERG

KTH Royal Institute of Technology, Stockholm, Sweden

JEFFREY STEIF

Chalmers University of Technology, Gothenburg, Sweden



Participants of the Nordic Department Chair Meeting 2025.

Nordic Department Chair Meeting at Institut Mittag-Leffler

May 8–9, 2025

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

KONRAD ABRAMOWICZ

Umeå University

JOHAN BJÖRKLUND

University of Gävle

MATS BOIJ

KTH Royal Institute of Technology

GEORGIOS DIMITROGLOU RIZELL

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MIKKO J. SILLANPÄÄ

University of Oulu

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ERIK LINDSTRÖM

Lund University

JANI LUKKARINEN

University of Helsinki

ADRIAN MUNTEAN

Karlstad University

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The Research Council of Norway

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Norwegian University of Science and Technology

JACOB SCHACH MØLLER

Aarhus University

MOGENS STEFFENSEN

Head of the Department of Mathematical Sciences in
Copenhagen

BENEDIKT STEINAR MAGNÚSSON

University of Iceland

PETER WALL

Luleå University of Technology

BERNT WENNBERG

Chalmers/University of Gothenburg

ANTONELLA ZANNA MUNTHE-KAAS

University of Bergen

PUBLICATIONS

Acta Mathematica

Two volumes including four issues are published annually (around 800 pages).

Published issues 234:1, 234:2, 235:1 and 235:2 including 6 articles in total.

EDITORIAL COMMITTEE

Editor-in-Chief:

Tobias Ekholm
Institut Mittag-Leffler and Uppsala University

Technical Editor:

International Press of Boston, Inc.

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Massachusetts Institute of Technology

Hélène Esnault
University of Copenhagen

Jesper Grodal
University of Copenhagen

Helge Holden
NTNU – Norwegian University of Science and Technology

Tuomas Hytönen
Aalto University

Kurt Johansson
KTH Royal Institute of Technology

Dan Petersen
Stockholm University

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, 63:1 and 63:2, including 15 articles in total.

EDITORIAL COMMITTEE

Editor-in-Chief:

Hans Ringström
Institut Mittag-Leffler and KTH Royal Institute of Technology

Editorial Assistant:

International Press of Boston Inc.

EDITORS:

Georgios Dimitroglou Rizell
Uppsala University

Pär Kurlberg
KTH Royal Institute of Technology

Volodymyr Mazorchuk
Uppsala University

Dan Petersen
Stockholm University

Lyudmila Turowska
Chalmers University of Technology

Fredrik Viklund
KTH Royal Institute of Technology

Erik Wahlén
Lund University

Genkai Zhang
Chalmers University of Technology

Financial Support 2025

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

Lennart Bondesson (1944–2024)

Linköping University

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

Research Program

Cohomological Aspects of Quantum Field Theory

January 15–April 25, 2025

Organizers:

Francesco Bonechi
INFN section of Florence

Alberto Cattaneo
University of Zurich

Nikita Nekrasov
Simons Center for Geometry and Physics

Maxim Zabzine
Uppsala University

SCIENTIFIC REPORT

Quantum Field Theory (QFT) is a cornerstone of modern theoretical physics with broad applications that span high energy physics, condensed matter, statistical mechanics, and mathematics. Since its origins in the 1920s, QFT has undergone major conceptual and technical developments, including renormalization, gauge theories, and non-perturbative methods such as lattice gauge theory and instantons. Beginning in the 1970s, a new and profound interaction emerged between QFT and modern mathematics, particularly geometry. This relationship has significantly influenced the development of areas like topological field theories, string theory, and new quantum invariants in geometry.

The mathematical formalization of concepts like TQFT via the Atiyah-Segal axioms and the development of vertex algebras are prominent examples. The ideas and techniques of QFT had huge impact on the development of mathematics.

This program concentrated on the homological/cohomological techniques in QFTs. In mathematics the homological/cohomological techniques are typically associated with the study of (co)chain complexes, which can be explored through both their homology and cohomology. This is a wide subject with applications ranging from abstract algebra to geometry. Within the infinite dimensional setting these ideas can be used to define QFT formally and perform some of the explicit calculations. This was the main subject of this program.

The main discussions and achievements of the program are related to different sets of ideas which can be schematically grouped in 3 topics:

1. Cohomological field theory and enumerative invariants; cohomological field theory can be defined as space of fields (e.g., a bundle of an infinite dimensional supermanifold) with an odd homological vector field acting on the space of fields. Typically this odd vector field mimicks either the de Rham differential in this infinite dimensional setting or its appropriate equivariant extension.
2. BV-formalism and formal geometry; the Batalin-Vilkovisky (BV) formalism is the ultimate cohomological approach to treat the gauge theories which has developed in the subject with solid mathematical and geometrical foundations. The BV formalism is closely related to cohomological theories described above through the procedure called gauge fixing. Although cohomological field theory may admit a non-perturbative definition through the appropriate moduli space problem and in BV framework it remains an open questions how to deal with non-perturbative issues.

>>

3. Categorification of QFT; the categorial approach to QFT (à la Atiyah-Segal) appears very naturally both within cohomological field theories and within the BV formalism when we are forced to systematically study systems with boundaries, corners etc. Extending enumerative geometry, we are interested in the categorification of geometrical invariants, i.e. lifting numerical invariants to invariants with values in vector spaces or more generally in chain complexes (such that the numerical invariants appear as Euler characteristics). The idea of categorification of invariants is naturally encoded within the QFT framework.

The program was centered around fostering continuous dialogue between the mathematical and theoretical physics communities. A significant amount of time was devoted to developing a deeper mutual understanding of various QFT constructions within a rigorous mathematical framework. To support this goal, the program placed strong emphasis on a series of mini-courses—typically consisting of three lectures each designed to provide a modern, accessible introduction to key topics at the intersection of these fields.

One of the central themes explored throughout the program was the role of higher algebraic and higher categorical structures in Quantum Field Theories (QFTs). In particular, significant attention was given to the use of L_∞ -algebras and L_∞ -algebras, and related homotopy-algebraic frameworks that naturally arise in the formalization of gauge symmetries, deformation theory, and the Batalin–Vilkovisky (BV) quantization. These structures provide a powerful language for encoding the intricate algebraic relations that govern field theories, especially in the presence of gauge redundancies and extended objects. Furthermore, the program investigated the relevance of higher categories in organizing QFTs with boundaries, defects, and extended operators, reflecting the modern understanding that physical theories can be systematically stratified by their dimensional content. The interplay between perturbative algebraic quantum field theory (pAQFT) and factorization algebras was also discussed at length, with particular attention to their relation with BV. The discussions highlighted how these abstract mathematical tools not only clarify the internal consistency of various QFT models but also pave the way for new dualities and computational techniques.

SEMINARS

W WORKSHOP

JANUARY 20, 2025

W

Giovanni Canepa
University of Geneva

Double BFV quantisation and application to 3d Gravity

JANUARY 20, 2025

W

Alberto Cattaneo
Zurich University

Yang–Mills theory from a topological theory

JANUARY 20, 2025

W

Yegor Zenkevich
Edinburgh University

Spiralling branes and integrable systems

JANUARY 21, 2025

W

Ezra Getzler
Northwestern University & Uppsala University

Homotopy moments maps and differential characters

JANUARY 21, 2025

W

Minghao Wang
Boston University

Invariants of Kahler manifolds and Feynman graph integrals

JANUARY 21, 2025

W

Konstantin Wernli
University of Southern Denmark

Globalization in perturbative BV theories

JANUARY 21, 2025

W

Henrique Bursztyn
Instituto Nacional de Matemática Pura e Aplicada

Symplectic groupoids via 2-shifted lagrangian structures

JANUARY 22, 2025

W

Alexander Buryak
HSE University

Pairs of compatible Poisson brackets and cohomological field theories

>>



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

JANUARY 22, 2025



Shuhan Jiang

Max Planck Institute

Cohomological Field Theories and Generalized Seiberg-Witten Equations

JANUARY 22, 2025



Nikita Nekrasov

Simons Center for Geometry and Physics

BV-like formalism in relativistic hydrodynamics

JANUARY 22, 2025



Alejandro Cabrera

Universidade Federal do Rio de Janeiro

Symplectic supergeometry behind the Mathai-Quillen formalism and applications

JANUARY 23, 2025



Si Li

Tsinghua University

Stochastic Process and Noncommutative Geometry

JANUARY 23, 2025



Alexander Gorsky

The Institute for Information Transmission Problems of the Russian Academy of Sciences

Dualities between the integrable many-body systems on the way to p -adics

JANUARY 23, 2025



Henry Liu

Kavli Institute for the Physics and Mathematics of the Universe

Wall-crossing and vertex algebras, in cohomology, K -theory, and beyond

JANUARY 23, 2025



Kasia Rejzner

University of York

Functional analytic aspects of BV formalism in perturbative algebraic quantum field theory

JANUARY 24, 2025



Denis Nesterov

Vienna University

Compactifications of configuration spaces of points

>>

JANUARY 24, 2025

Michele Schiavina

Pavia University

BV-BFV formalism in Perturbative Algebraic Quantum Field Theory



FEBRUARY 5, 2025

Si Li

Tsinghua University

Homological Method in Topological/Holomorphic QFT (mini-course), lecture 2

JANUARY 27, 2025

Kasia Rejzner

University of York

An introduction to pAQFT (mini-course), lecture 1

FEBRUARY 6, 2025

Si Li

Tsinghua University

Homological Method in Topological/Holomorphic QFT (mini-course), lecture 3

JANUARY 27, 2025

Shuhan Jlang

Max Planck Institute for Mathematics in the Sciences

Equivariant Localization in Batalin-Vilkovisky Formalism

FEBRUARY 7, 2025

Alex Takeda

Uppsala University

Partially defined TQFTs and properadic algebras

JANUARY 28, 2025

Kasia Rejzner

University of York

An introduction to pAQFT (mini-course), lecture 2

FEBRUARY 10, 2025

Brian William

Boston University

Observables in holomorphic/topological quantum field theory (mini-course), lecture 1

JANUARY 29, 2025

Kasia Rejzner

University of York

An introduction to pAQFT (mini-course), lecture 3

FEBRUARY 11, 2025

Brian William

Boston University

Observables in holomorphic/topological quantum field theory (mini-course), lecture 2

JANUARY 30, 2025

Miquel Cueva

Georg-August-Universität, Göttingen

Deformations of Lagrangian Q-submanifolds

FEBRUARY 11, 2025

Brian William

Boston University

Observables in holomorphic/topological quantum field theory (mini-course), lecture 3

JANUARY 31, 2025

Fridrich Valach

University of Hertfordshire

Full supergravity and generalised geometry

FEBRUARY 13, 2025

Theodore Voronov

Manchester University

Canonical and (higher) derived brackets (mini-course), lecture 1

FEBRUARY 3, 2025

Si Li

Tsinghua University

Homological Method in Topological/Holomorphic QFT (mini-course), lecture 1

FEBRUARY 14, 2025

Irina Bobrova

The Max Planck Institute for Mathematics in the Sciences

Painlevé equations and double quasi-Poisson brackets

FEBRUARY 4, 2025

Pietro Grassi

Università del Piemonte Orientale

Quantum Field Theories On Supermanifolds

>>



Ground floor, lounge area of Institut Mittag-Leffler

FEBRUARY 19, 2025

Christian Blohmann

Max Planck Institute for Mathematics

Homotopy reduction of the homotopy momentum map of general relativity

FEBRUARY 20, 2025

Theodore Voronov

Manchester University

Canonical and (higher) derived brackets (mini-course), lecture 2

FEBRUARY 21, 2025

Ján Pulmann

University of Edinburgh

Lagrangian Relations, Half-Densities and Quantum L_∞ Algebras

FEBRUARY 24, 2025

Yegor Zenkevich

University of Edinburgh

Free field realizations (mini-course), lectures 1

FEBRUARY 25, 2025

Yegor Zenkevich

University of Edinburgh

Free field realizations (mini-course), lectures 2

FEBRUARY 25, 2025

Theodore Voronov

Manchester University

Canonical and (higher) derived brackets (mini-course), lecture 3

FEBRUARY 26, 2025

Yegor Zenkevich

University of Edinburgh

Free field realizations (mini-course), lectures 3

FEBRUARY 27, 2025

Christian Blohmann

Max Planck Institute for Mathematics

Cohomological zero locus of Noether currents and reduction



FEBRUARY 28, 2025

Pedro H. Carvalho
 University of Hradec Králové
Homological reduction of Courant algebroids

MARCH 4, 2025

Martin Cederwall
 Chalmers University of Technology
Extended geometry: superalgebras and cohomological formulation

MARCH 6, 2025

Thomas Strobl
 The University of Lyon
Principaloid bundles

MARCH 7, 2025

Eugenia Boffo
 Comenius University Bratislav
BRST of spinning particles and BV target space field theory

MARCH 11, 2025

Olaf Holm
 Humboldt University
Quantum mechanics via cohomology and factorization algebras

MARCH 12, 2025

Ezra Getzler
 Northwestern University & Uppsala University
The Variational Bicomplex and BV Cohomology (mini-course), lecture 1

MARCH 13, 2025

Ezra Getzler
 Northwestern University & Uppsala University
The Variational Bicomplex and BV Cohomology (mini-course), lecture 2

MARCH 13, 2025

Ezra Getzler

Northwestern University & Uppsala University
The Variational Bicomplex and BV Cohomology (mini-course), lecture 3

MARCH 14, 2025

Victor Mishnyakov

Nordic Institute for Theoretical Physics
Matrix Models, Painlevé Equations, and beta-deformation (from the Painlevé VI point of view)

MARCH 17, 2025

Mathieu Stienon

Penn State University
Formal exponential maps and the Atiyah class of dg manifolds

MARCH 18, 2025

Domenico Fiorenza

Sapienza University of Rome
 L_∞ -morphisms between twisted Courant r -Lie algebras and untwisted Courant $(r+1)$ -Lie algebras

MARCH 19, 2025

Noriaki Ikeda

Ritsumeikan University
Hamiltonian Lie algebroids: physical applications and cohomological descriptions

MARCH 20, 2025

Chris Hull

Imperial College
Quantum Magnetic Monopoles and Hodge Theory

MARCH 21, 2025

Stefano Ronchi

University of Göttingen
Higher cotangent groupoids

MARCH 25, 2025

Marco Gualtieri

Toronto University
Groupoids and Generalized Kahler geometry (mini-course), lecture 1

MARCH 26, 2025

Marco Gualtieri

Toronto University
Groupoids and Generalized Kahler geometry (mini-course), lecture 2

MARCH 27, 2025

Marco Gualtieri

Toronto University
Groupoids and Generalized Kahler geometry (mini-course), lecture 3

MARCH 28, 2025

Caleb Jonker

Toronto University
Generalized Kähler-Ricci flow as a Hamiltonian deformation

MARCH 28, 2025

Thomas Weber

Charles University
Noncommutative differential calculi via Hopf algebraic methods

MARCH 31, 2025 (W)

Glenn Barnich

Brussels University
Model spaces as constrained Hamiltonian systems I. Application to $SU(2)$

MARCH 31, 2025 (W)

Mathai Varghese

University of Adelaide
T-Duality with H-Flux for sigma models

MARCH 31, 2025 (W)

Daniel Álvarez

University of Toronto
Symplectic 2-groupoids and Courant algebroids over homogenous spaces.

APRIL 1, 2025 (W)

Maxim Grigoriev

Mons University
Background fields and (super)symmetries in the presymplectic BV-AKSZ approach

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Photo: Institut Mittag-Leffler

Cohomological Aspects of Quantum Field Theory, organizers.

APRIL 1, 2025 (W)
 Ivo Sachs
 Munich University
A BV action from super moduli space

APRIL 3, 2025 (W)
 Anton Alekseev
 University of Geneva
Batalin-Vilkovisky structures on moduli of flat connections

APRIL 2, 2025 (W)
 Ping Xu
 Penn State University
Noncommutative Calculus for DG Manifolds

APRIL 3, 2025 (W)
 Mykola Dedushenko
 Simons Center
Deformations of contact manifolds and CFT

APRIL 2, 2025 (W)
 Niels Kowalzig
 University of Rome
Higher structures on homology groups

APRIL 4, 2025 (W)
 Victor Mishnyakov
 Nordic Institute for Theoretical Physics
Refined Matrix Models and DIM Recursion Relations

APRIL 3, 2025 (W)
 Maor Ben-Shahar
 Massachusetts Institute of Technology
Color-Kinematics and Double copy from BV

APRIL 4, 2025 (W)
 Hitoshi Konno
 Tokyo University Marine
Elliptic Quantum Groups and Geometry of Quiver Varieties

APRIL 3, 2025 (W)
 Nathan Berkovits
 São Paulo State University
Equivalence Proof of Pure Spinor and Ramond-Neveu-Schwarz Superstring Amplitudes

APRIL 7, 2025
 Nikita Nekrasov
 Simons Center
The Count of Instantons (mini-course), lecture 1

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PARTICIPANTS

APRIL 8, 2025

Nikita Nekrasov

Simons Center

The Count of Instantons (mini-course), lecture 2

APRIL 9, 2025

Nikita Nekrasov

Simons Center

The Count of Instantons (mini-course), lecture 3

APRIL 10, 2025

Konstantin Wernli

University of Southern Denmark

Cutting, gluing and functoriality in perturbative scalar field theory

APRIL 11, 2025

Ivan Dneprov

Mons University

Background fields in the presymplectic BV-AKSZ formalism

APRIL 14, 2025

Andrey Losev

Shanghai University

Towards 2-dimensional Kontsevich-Manin numbers

APRIL 16, 2025

Leon Menger

University of Notre Dame

Homotopy Transfer from Gauge-fixed BF Theory

APRIL 17, 2025

Chiara Esposito

University of Salerno

Equivariant formality and reduction

APRIL 23, 2025

Stefan Waldmann

Würzburg University

The HKR Theorem – a new look at a classical result

APRIL 24, 2025

Andreas Swerdlow

Manchester University

Morphisms of Derived Poisson Manifolds and Thick Morphisms

Anton Alekseev

University of Geneva, Switzerland

Daniel Álvarez

University of Toronto, Canada

Paolo Aschieri

Università degli Studi del Piemonte Orientale, Italy

Glenn Barnich

Vrije Universiteit Brussel, Belgium

Maor Ben-Shahar

MIT Massachusetts Institute of Technology, United States

Nathan Berkovits

São Paulo State University, Brazil

Christian Blohmann

Max Planck Institute for Mathematics, Germany

Irina Bobrova

The Max Planck Institute for Mathematics in the Sciences, Germany

Eugenia Boffo

Charles University, Czechia

Francesco Bonechi

Istituto Nazionale di Fisica Nucleare, Italy

Henrique Bursztyn

Instituto de Matemática Pura e Aplicada, Brazil

Alexander Buryak

HSE University, Russia

Alejandro Cabrera

Universidade Federal do Rio de Janeiro, Brazil

Giovanni Canepa

University of Geneva, Switzerland

David Carchedi

George Mason University, United States

Pedro Carvalho Silva

University of Hradec Králové, Czechia

Luca Cassia

Melbourne University, Austria

Alberto Cattaneo

University of Zurich, Switzerland

Martin Cederwall

Chalmers University of Technology, Sweden

Igor Chaban

The Igor Krichever Center for Advanced Studies, United States

Sachin Chauhan

Uppsala University, Sweden

Nicola Ciccoli

Università di Perugia, Italy

Ivan Contreras

Amherst College, United States

Miquel Cueva Ten

University of Göttingen, Germany

Mykola Dedushenko

Simons Center for Geometry and Physics, United States

>>

Michele Del Zotto
Uppsala University, Sweden

Ivan Dneprov
Mons University, Belgium

Chiara Esposito
University of Salerno, Italy

Domenico Fiorenza
Sapienza University of Rome, Italy

Daniil Getta
HSE University, Russia

Ezra Getzler
Northwestern University, Department of Mathematics, United States

Alexander Gorsky
The Institute for Information Transmission Problems, Russia

Pietro Grassi
Università del Piemonte Orientale, Italy

Maxim Grigoriev
Mons University, Belgium

Maxim Gritskov
HSE University, Russia

Marco Gualtieri
University of Toronto, Canada

Kunal Gupta
Uppsala University, Sweden

Pedram Hekmati
University of Auckland, New Zealand

Olaf Hohm
Humboldt University, Germany

Chris Hull
Imperial College, United Kingdom

Noriaki Ikeda
Ritsumeikan University, Japan

Shuhan Jiang
Max Planck Institute for Mathematics in the Sciences, Germany

Henrik Johansson
Uppsala University, Sweden

Caleb Jonker
University of Toronto, Canada

Hitoshi Konno
Tokyo University Marine, Japan

Niels Kowalzig
University of Rome, Italy

Si Li
Tsinghua University, China

Ulf Lindström
Uppsala University, Sweden

Henry Liu
Kavli Institute for the Physics and Mathematics of the Universe, Japan

Pietro Longhi
Uppsala University, Sweden

Andrey Losev
HSE University, Russia

Roman Mauch
Uppsala University, Sweden

Leon Menger
University of Notre Dame, United States

Andrei Mikhailov
Instituto de Física Teórica, Brazil

Victor Mishnyakov
Nordic Institute for Theoretical Physics, Sweden

Antonio Michele Miti
Università La sapienza Roma, Italy

Nikita Nekrasov
Simons Center for Geometry and Physics, United States

Denis Nesterov
ETH Zurich, Switzerland

Jakob Palmkvist
Chalmers University of Technology, Sweden

Nathalie Paquette
University of Washington, United States

Vera Posch
Trinity College, Ireland

Jan Pulmann
University of Edinburgh, United Kingdom

Surya Raghavendran
University of Edinburgh, United Kingdom

Kasia Rejzner
University of York, United Kingdom

Stefano Ronchi
University of Göttingen, Germany

Vladimir Roubtsov
Universitet of Angers, France

Ingmar Saberi
LMU Munich, Germany

Ivo Sachs
LMU Munich, Germany

Michele Schiavina
University of Pavia, Italy

Ekaterina Shemyakova
University of Toledo, United States

Dima Sorokin
Istituto Nazionale di Fisica Nucleare, Italy

Pelle Steffens
Technische Universität München, Germany

Mathieu Stienon
Pennsylvania State University, United States

Thomas Strobl
University of Lyon, France

Tim Sulimov
St. Petersburg Department of Steklov Mathematical Institute of the Russian Academy of Sciences, Russia

Andreas Swerdlow
The University of Manchester, United Kingdom

Fridrich Valach
University of Hertfordshire, United Kingdom

Brenno Carlini Vallilo
The Andrés Bello University, Chile

Mathai Varghese
University of Adelaide, Australia

Ted Voronov
University of Manchester, United Kingdom

Stefan Waldmann
Die Julius-Maximilians-Universität Würzburg, Germany

Minghao Wang
Boston University, United States

Konstantin Wernli
University of Southern Denmark, Denmark

Owen G William
University of Massachusetts, United States

Brian Williams
Boston University, United States

Ping Xu
Pennsylvania State University, United States

Maxim Zabzine
Uppsala University, Sweden

Polina Zakorko
Technion, Russia / Israel

Yegor Zenkevich
Edinburgh University, United Kingdom

Guodong Zhou
School of Mathematical Sciences, China

Photo: Markus Marcellic



The seminar hall, Wallenbergsalen.

Research Program

Interfaces and Unfitted Discretization Methods

August 27–December 12, 2025

Organizers:

Anna-Karin Tornberg
KTH Royal Institute of Technology

Sara Zahedi
KTH Royal Institute of Technology

Per-Gunnar Martinsson
University of Texas at Austin

Alfio Quarteroni
Politecnico di Milano and EPFL Lausanne

SCIENTIFIC REPORT

Interfaces and Unfitted Discretization Methods

The program *Interfaces and Unfitted Discretization Methods* addressed mathematical and computational challenges in the numerical solution of partial differential equations (PDEs) involving interfaces and internal boundaries. Such problems arise in many applications, including multiphase flows, geophysics, materials science, and biomedical modelling.

A central focus was on *unfitted discretization techniques*, where the computational mesh does not conform to interface geometries. This class of methods includes CutFEM, XFEM, immersed and fictitious domain methods, as well as numerical methods for surface PDEs and phase-field models for interface problems. These approaches offer flexibility for complex or evolving geometries but introduce challenges related to stability, accuracy, conditioning, and solver efficiency.

The program also covered *integral equation methods*, particularly suitable when volumetric meshes can be avoided through potential theory, and emphasized the interaction between discretization techniques, solvers, and preconditioners. By bringing together researchers from different communities, the program aimed to identify common challenges and promote cross-fertilization between methods and applications.

The scientific activities were organized around three themes:

- (i) formulations and discretizations of interface problems,
- (ii) solvers and preconditioners, and
- (iii) applications and real-world problems.

Significant progress was reported on *multiscale and multiphysics methods* for interface problems that are robust with respect to disparate spatial scales and stiffness parameters. Advances were also presented in *multilevel and multidomain preconditioning strategies*, including multigrid and domain decomposition methods tailored to unfitted discretizations, leading to improved robustness and scalability.

Another important achievement concerned *accuracy-preserving stabilization techniques*, addressing long-standing issues related to consistency and parameter sensitivity in unfitted methods. From the application side, strong interest emerged in biological and *medical modelling*, particularly brain modelling, as well as in *geophysical applications* involving flow and wave propagation in highly fractured and geometrically complex media.

New techniques for discretizing boundary integral equations were presented, and significant progress was made in terms of developing theory that explains their behavior.

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Junior Fellows, *Interfaces and Unfitted Discretization Methods*, 2025.

Quadrature methods for singular and nearly singular (surface) integrals was a key component, and advances in methods for accelerating the computations were discussed. The use of integral equation techniques in an expanding set of applications were explored, drawing on the range of expertise that was present. Related work on methods for the discretization and solution of partial differential equations defined on curved surfaces was also successful.

A major emerging theme was the increasing impact of *artificial intelligence and machine learning* on research in interface problems. Discussions highlighted opportunities for combining data-driven approaches with classical numerical methods, for example in surrogate modelling, adaptive discretization, and solver acceleration, while stressing the need for mathematical rigor and reliability.

Participants also discussed how these developments may influence *academic teaching and training*, emphasizing a shift toward deeper conceptual understanding and the informed use of advanced computational tools.

Another emergent direction concerns new techniques for building data sparse approximations to global operators. The objective is to form compact mathematical models of complex multi-physics problems, in order to enable the direct solution of the resulting equilibrium equations, thus sidestepping the highly challenging problem of finding convergent iterative solvers. In particular, it was found that new randomized techniques for reconstructing operators from observations of their action on random fields provide a particularly promising path forward.

Additional research directions included the further development of the analysis of unfitted discretizations for mixed-dimensional models, as well as for time-dependent problems in evolving domains. Attention was also devoted to challenges arising from topological changes, such as interface merging or splitting, in particular regarding how accuracy and robustness of numerical simulations can be assessed and maintained in such scenarios. The approximation of geometric quantities, such as curvature, together with the analysis of discretization errors and the conservation of quantities such as volume and area

in numerical representations of interfaces, especially in three spatial dimensions, were among the important topics raised during the seminars and remain key subjects for further research.

The program featured three *workshops and a special focus week*, each aligned with one of the main themes. All workshops included *round table discussions* devoted to identifying key challenges and future research directions, which proved particularly effective in fostering interaction and collaboration.

In between the workshops, a rich program of *research seminars* ran throughout the semester, with at least two seminars per week. The seminars contributed to a lively and productive scientific environment.

In addition to the regular research seminars, the program included several *introductory lectures and short courses* to introduce current research areas, and to help facilitate integration between the different scientific communities that participated. Moreover, the junior fellows organized shorter talks, delivered by themselves and by participating PhD students from KTH, which provided opportunities for junior researchers to present their work and actively engage in the program.

The high scientific level and diversity of invited speakers played a crucial role in the overall success of the program and in strengthening interdisciplinary connections.

SEMINARS

Ⓜ WORKSHOP
Ⓢ FOKUS WEEK

SEPTEMBER 1, 2025

Leslie Greengard
New York University

Lightweight, geometrically flexible algorithms for the evaluation of layer and volume potentials

SEPTEMBER 1, 2025

Björn Engquist
The University of Texas at Austin

Numerical Methodologies for Multiscale Limits, homogenization and interfaces

SEPTEMBER 1, 2025

Anna Scotti
Politecnico di Milano

N-1 dimensional interfaces: mixed formulation and discretization methods

SEPTEMBER 1, 2025

Michael O'Neil
New York University

Mie scattering in layered media

SEPTEMBER 1, 2025

Mats Larson
Umeå University

Weak and Strong Stabilization of Cut Finite Elements

SEPTEMBER 1, 2025

Axel Voigt
Dresden University of Technology

Towards a two-scale model for morphogenesis – How cellular processes influence tissue deformations

SEPTEMBER 2, 2025

Travis Askham
New Jersey Institute of Technology

Integral formulations and numerical methods for a class of half-space interface problems

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SEPTEMBER 2, 2025 (W)
Erik Burman
University College London
Unfitted finite element methods for ill-posed interface problems

SEPTEMBER 2, 2025 (W)
Joar Bagge
The University of Texas at Austin
Rigid particles and deformable capsules in wall-bounded Stokes flow

SEPTEMBER 2, 2025 (W)
Nanna Berre
Norwegian University of Science and Technology
Cut Finite Element Methods for Poroelasticity

SEPTEMBER 2, 2025 (W)
Antonio Huerta
Polytechnic University of Catalonia
NURBS-Embedded HDG for Incompressible Flows

SEPTEMBER 2, 2025 (W)
Panel
Challenges

SEPTEMBER 2, 2025 (W)
Chiara Sogantone
Sapienza University of Rome
Fast Integral Solvers for Self-Similar Geometries

SEPTEMBER 3, 2025 (W)
George Biros
The University of Texas at Austin
Deep learning surrogates for Stokesian particulate flows

SEPTEMBER 3, 2025 (W)
Connor Greene
New Jersey Institute of Technology
A High-order Boundary Integral and Function Extension Method for the Poisson-Nernst-Planck Equations

SEPTEMBER 3, 2025 (W)
Tom Hughes
The University of Texas at Austin
Immersed Isogeometric Modeling and Analysis in Computational Medicine

SEPTEMBER 4, 2025 (W)
Richard Tsai
The University of Texas at Austin
A multilevel randomized algorithm for solving boundary integral equations

SEPTEMBER 4, 2025 (W)
Guglielmo Scovazzi
Duke University
Immersed approximate domains: The Shifted Boundary Method

SEPTEMBER 4, 2025 (W)
Beatrice Crippa
Politecnico di Milano
A mixed-dimensional model of the electrical treeing

SEPTEMBER 4, 2025
Fabian Heimann
University College London
Higher Order Unfitted Space-Time Finite Element Methods

SEPTEMBER 4, 2025 (W)
Michael Siegel
New Jersey Institute of Technology
A fast mesh-free boundary integral method for two-phase flow with soluble surfactant

SEPTEMBER 4, 2025 (W)
Bryan Quaife
University of Florida
Boundary Integral Methods for Particle Diffusion in Complex Geometries: Shielding, Confinement, and Escape

SEPTEMBER 4, 2025 (W)
Panel session
Role of ML/AI



Workshop II, *Interfaces and Unfitted Discretization Methods*.

SEPTEMBER 5, 2025

Ricardo Nochetto

University of Maryland at College Park

TraceFEM: Ensuring and Circumventing Discrete Inf-Sup Conditions



SEPTEMBER 9, 2025

Marie E. Rognes

Simula Research Laboratory

Brain membranes and vasculature: a computational mathematics tale of dimensional gaps

SEPTEMBER 5, 2025

Alex Barnett

Flatiron Institute

Slender and close: accurate Stokes flows for rigid particles in challenging geometries



SEPTEMBER 9, 2025

Alfio Quarteroni

Politecnico di Milano & École Polytechnique Fédérale de Lausanne

Göran Gustafsson lectures at KTH: Physics-Informed & Data-Driven Models for PDEs I

SEPTEMBER 5, 2025

Hannah Potgieter

Simon Fraser University

Numerical Approximation of p -Laplace Eigenpairs



SEPTEMBER 10, 2025

Stefano Berrone

Politecnico di Torino

Stabilization-free Virtual Element Method: motivation, construction and a posteriori error estimates

SEPTEMBER 5, 2025

Ganghui Zhang

Tsinghua University & Universität Regensburg

Isoparametric finite element methods for mean curvature flow and surface diffusion



SEPTEMBER 10, 2025

Alfio Quarteroni

Politecnico di Milano & École Polytechnique Fédérale de Lausanne

Göran Gustafsson lectures at KTH: Physics-Informed & Data-Driven Models for PDEs II

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Organizers, *Interfaces and Unfitted Discretization Methods*, 2025.

SEPTEMBER 11, 2025

Patrick Farrell

University of Oxford

The latent variable proximal point algorithm for variational problems with inequality constraints

SEPTEMBER 11, 2025

Alfio Quarteroni

Politecnico di Milano & École Polytechnique Fédérale de Lausanne

Göran Gustafsson lectures at KTH: Physics-Informed & Data-Driven Models for PDEs III

SEPTEMBER 12, 2025

Dennis Trautwein

University of Regensburg

Parametric finite element approximation of two-phase Navier–Stokes flow with viscoelasticity

SEPTEMBER 16, 2025

Alex Barnett

Flatiron Institute

Introduction to Boundary Integral Equations

SEPTEMBER 17, 2025

Buyang Li

The Hong Kong Polytechnic University

Numerical analysis of PDE-driven surface evolution: Geometric flow, free boundary, fluid-structure interaction

SEPTEMBER 18, 2025

Heather Wilber

University of Washington

Contour integration to the rescue

SEPTEMBER 18, 2025

Sara Zahedi

KTH Royal Institute of Technology

Introduction to Cut Finite Element Methods

SEPTEMBER 23, 2025

Arnold Reusken

RWTH Aachen University

Navier–Stokes Equations on Surfaces: Analysis and Numerical Simulations

SEPTEMBER 25, 2025

David Hewett

University College London

Acoustic scattering by fractal inhomogeneities

SEPTEMBER 26, 2025

Dennis Trautwein

University of Regensburg

Ganghui Zhang

University of Oxford

Structure-preserving methods for surface and interface problems

SEPTEMBER 30, 2025

Alexandre Ern

Ecole des Ponts ParisTech

Unfitted HHO methods

OCTOBER 2, 2025

Jack Xin

University of California, Irvine

Stochastic Interacting Particle Methods and Generative Learning for High Dimensional PDEs

OCTOBER 3, 2025

Kshitij Patil

Simon Fraser University

The spectrum of the Steklov-Helmholtz operator

OCTOBER 7, 2025

Sebastian Aland

The Technische Universität Bergakademie Freiberg & Hochschule für Technik und Wirtschaft Dresden

A combined sharp- and diffuse-interface model for simulation of soft wetting

OCTOBER 9, 2025

Harald Garcke

Universität Regensburg

The Cahn-Hilliard equation, the Mullins-Sekerka problem and the origin of life

OCTOBER 10, 2025

Guido Kanschat

Ruprecht-Karls-Universität Heidelberg

Introduction to domain decomposition and multigrid methods

OCTOBER 13, 2025 (W)

Anna-Karin Tornberg

KTH Royal Institute of Technology

Intro lecture: Fast summation methods

OCTOBER 13, 2025 (W)

Per-Gunnar Martinsson

The University of Texas at Austin

Intro lecture: Fast direct solvers for elliptic PDEs

OCTOBER 14, 2025 (W)

Guido Kanschat

Ruprecht-Karls-Universität Heidelberg

Intro lecture: Domain decomposition and multigrid methods for unfitted finite elements

OCTOBER 14, 2025 (W)

Paola Gervasio

University of Brescia

The Internodes method for coupling PDEs with non-conforming interfaces

OCTOBER 14, 2025 (W)

Ludvig af Klinteberg

Mälardalen University

Prolate-based kernel splits for fast summation of Stokes potentials

OCTOBER 14, 2025 (W)

Shravan Veerapaneni

University of Michigan

Shape and functional optimization of microswimmers with meshfree methods

OCTOBER 14, 2025 (W)

Ronald Kriemann

Max-Planck Institute for the Mathematical Sciences

H-Matrices: Arithmetic, Solvers and Preconditioners

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OCTOBER 15, 2025 (W)
Daniele Boffi
King Abdullah University of Science and Technology &
University of Pavia
*Implementation aspects of a distributed Lagrange
multiplier approach for FSI and interface problems*

OCTOBER 15, 2025 (W)
Stéphanie Chaillat-Loseille
Centre national de la recherche scientifique
*Boundary Domain Decomposition method for elastic
multiple scattering problems*

OCTOBER 15, 2025 (W)
Olaf Steinbach
Graz University Of Technology
Space-time finite element methods for the Stokes problem

OCTOBER 15, 2025 (W)
Carolina Urzua-Torres
Delft University of Technology
*Space-time BEM for the Wave Equation: What do we know
so far?*

OCTOBER 15, 2025 (W)
Marion Darbas
Sorbonne Paris Nord University
*Local Multiple Traces Formulation for Transmission
Problems in Linear Elasticity*

OCTOBER 15, 2025 (W)
Adrianna Gillman
University of Colorado Boulder
*Towards efficient solution techniques for the HPS method
applied to three dimensional problems*

OCTOBER 15, 2025 (W)
Alessio Fumagalli
Politecnico di Milano
Reduced models techniques for subsurface simulations

OCTOBER 15, 2025 (W)
Daniel Fortunato
Flatiron Institute
*Fast and accurate simulation of close-to-touching discs in
Stokes flow*

OCTOBER 16, 2025
Guido Kanschat
Ruprecht-Karls-Universität Heidelberg
*Introduction to domain decomposition and multigrid
methods, Part 2*

OCTOBER 21, 2025
Sven Gross
RWTH Aachen University
*CutFEM for Poisson and Stokes interface problems: solvers
and preconditioners*

OCTOBER 23, 2025
Grady Wright
Boise State University
*A New Quadrature Framework for Geometrically Complex
Domains*

OCTOBER 24, 2025
Simon Dirckx
University of Texas at Austin
The Spectral Overlapping Multislab Method

OCTOBER 28, 2025
Svetlana Tlupova
Farmingdale State University
*Regularization based methods for accurate evaluation of
surface integrals in Stokes flow*

OCTOBER 30, 2025
Carlos Perez-Arancibia
University of Twente
*Maxwell à la Helmholtz: Helmholtz Boundary Integral
Equations for Electromagnetic Scattering*

NOVEMBER 4, 2025
Martina Bukač
University of Notre Dame
*Partitioned numerical methods for fluid-structure
interaction*

NOVEMBER 4, 2025
Andrea Moiola
University Pavia
*A space-time continuous and coercive formulation for the
wave equation*

>>



NOVEMBER 5, 2025

Peter Hansbo

Jönköping University

FSF3571 course on CutFEM, Lecture 1: Introduction and CutFEM for Basic Model Problems

NOVEMBER 6, 2025

Sheehan Olver

Imperial College London

Newtonian potentials have displacement structure

NOVEMBER 6, 2025

Carlos Jerez-Hanckes

Inria Paris Centre

Local Multiple Traces Formulation for Heterogeneous Electromagnetic Scattering

NOVEMBER 7, 2025

Mats G Larson

Umeå University

FSF3571 course on CutFEM, Lecture 2: Analysis of CutFEM (Second-Order Symmetric Problems)

NOVEMBER 7, 2025

Francesca Renzi

Politecnico di Milano

FSI with large added mass through loosely-coupled fitted and unfitted methods

NOVEMBER 7, 2025

Maximilian Kloppe

TU Bergakademie Freiberg

Phase-Field Modeling of Elastic Surfaces in flow

NOVEMBER 11, 2025

Pei Fu

Nanjing University of Aeronautics and Astronautics

A cut finite element method based on the discontinuous Galerkin framework for hyperbolic problems

NOVEMBER 12, 2025

Christoph Lehrenfeld

University of Göttingen

FSF3571 course on CutFEM, Lecture 3: Integration on Cut Elements

NOVEMBER 13, 2025

Christoph Lehrenfeld
University of Göttingen

Time discretization in unfitted finite element methods on moving domains

NOVEMBER 13, 2025

Christian Vergara
Politecnico di Milano

Unfitted methods for Fluid-structure interaction

NOVEMBER 14, 2025

Edith Frisk Gärtner
KTH Royal Institute of Technology

Fast evaluation of layer and volume potentials for the modified Helmholtz equation

NOVEMBER 18, 2025

Björn Stinner
University of Warwick

Finite element approximation of rough PDEs on evolving curves

NOVEMBER 18, 2025

Manuel Solano
Universidad de Concepción

The Transfer Path Method: An unfitted-mesh approach for finite element calculations

NOVEMBER 19, 2025

Mats G. Larson
Umeå University

FSF3571 course on CutFEM, Lecture 4: Weak and Strong Stabilization (Bulk and Surface Problems)

NOVEMBER 20, 2025

Tonatiuh Sanchez-Vizuet
University of Arizona

An adaptive unfitted discretization for a free boundary problem in magnetic plasma confinement

NOVEMBER 21, 2025

Genming Bai
University of Michigan, Ann Arbor

Fast algorithms and numerical analysis for geometric flows and curvature-driven interface problems

NOVEMBER 21, 2025

Gioana Teora
Politecnico di Torino

Introduction to Virtual Element Methods

NOVEMBER 25, 2025

Fruzsina Agocs
University of Colorado Boulder

An efficient boundary integral equation solution technique for solving aperiodic scattering problems near periodic boundaries

NOVEMBER 26, 2025

Mats G. Larson
Umeå University

FSF3571 course on CutFEM, Lecture 5: Weak Stabilization (Surface Problems)

NOVEMBER 27, 2025

Donna Calhoun
Boise State University

The Immersed Interface Method and application in computational chemistry

NOVEMBER 28, 2025

Mats G. Larson
Umeå University

FSF3571 course on CutFEM, Lecture 6: Lagrange Multiplier Methods

NOVEMBER 28, 2025

Joshua Bannister
University College London

Fractal and pre-fractal discretisation methods for the Lippmann-Schwinger equation

NOVEMBER 28, 2025

Jamie Manriquez
Lund University

The Transfer Path Method for interface problems using HDG

NOVEMBER 28, 2025

Sebastian Myrbäck
KTH Royal Institute of Technology

A high-order conservative cut finite element method for problems in time-dependent domains

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Gösta's study.

DECEMBER 2, 2025

Mats G. Larson

Umeå University

FSF3571 course on CutFEM, Lecture 7: CutFEM in Time-Dependent Domains

DECEMBER 4, 2025

Guido Kanschat

Ruprecht-Karls-Universität Heidelberg

From DG for almost incompressible elasticity to pressure robust flow discretizations



DECEMBER 3, 2025

Erik Burman

University College London

Stabilised finite element methods for incompressible flow at high Reynolds number



DECEMBER 4, 2025

Alexey Chernov

Carl von Ossietzky Universität Oldenburg

Nitsche's mortar method meets polynomials and boundary integral equations



DECEMBER 3, 2025

Ilaria Perugia

University of Vienna

Structure-preserving LDG discretization of nonlinear reaction-diffusion systems



DECEMBER 4, 2025

Antonio Huerta

Polytechnic University of Catalonia

The Whys Behind NURBS-Embedded, Unfitted Hybridizable Discontinuous Galerkin for Incompressible Flows



DECEMBER 3, 2025

Miguel Fernandez

Inria Paris Centre

Time-splitting and unfitted meshes in incompressible fluid-structure interaction



DECEMBER 4, 2025

Roland Becker

Université de Pau

Newton's method on subspaces



>>

DECEMBER 4, 2025 
Stig Larsson
Chalmers University of Technology
Error estimates for discontinuous Galerkin time-discrete methods via maximal regularity

DECEMBER 4, 2025 
Panel session
Early Career Choices

DECEMBER 5, 2025 
Stefan Turek
Dortmund University of Technology
Can we realize much faster FEM-based CFD solvers (to compete with AI)?

DECEMBER 5, 2025 
Anders Szepessy
KTH Royal Institute of Technology
Fluid dynamics and its constitutive relations: is the pressure stochastic?

DECEMBER 5, 2025 
Paul Houston
University of Nottingham
High-order Discontinuous Galerkin Methods on Polytopic Meshes

DECEMBER 5, 2025 
Franz-Theo Suttmeier
Universität Siegen
On Cows, Horses, Goats and FEM

DECEMBER 8, 2025
Jamie Manriquez
Lund University
FSF3571 course on CutFEM, Lecture 8: Hybridized CutFEM for Elliptic Interface Problems

DECEMBER 9, 2025 
Inga Berre
University of Bergen
Mixed-Dimensional Compositional Models for Multiphase Flow with Phase Separation in Fractured Geothermal Systems

DECEMBER 9, 2025 
André Massing
Norwegian University of Science and Technology
Cut Finite Element Methods for Computational Neurosciences

DECEMBER 9, 2025 
Luca Formaggia
MOX, Department of Mathematics, Politecnico di Milano
Deep-learning based model reduction: Application to problems with internal interfaces in subsurface flow and microcirculation

DECEMBER 9, 2025 
Peter Hansbo
Jönköping University
Augmented Lagrangian methods for contact problems

DECEMBER 9, 2025 
Vanessa Llerasas
University of Montpellier
phiFEM: A robust and flexible method for PDEs on unfitted meshes

DECEMBER 9, 2025 
Nilima Nigam
Simon Fraser University
The spectral geometry of eigenvalue problems on interfaces

DECEMBER 9, 2025 
Sören Bartels
University of Freiburg
Babuska's paradox in linear and nonlinear bending theories

DECEMBER 10, 2025 
Géraldine Pichot
Inria Paris Centre
The spectral domain decomposition method GenEO as a robust preconditioner for single-phase flow in fractured porous media.

DECEMBER 10, 2025 
Manas Rachh
The Indian Institute of Technology Bombay
Complex scattering makes for simple numerics

>>

PARTICIPANTS

DECEMBER 10, 2025



Maxim Olshanskii

University of Houston

The cause and cure of spurious boundary forces in an Eulerian finite element method for moving boundary flow problems

DECEMBER 10, 2025



Ricardo Ruiz-Baier

Monash University

Mixed finite element methods for Biot/PNP equations

DECEMBER 10, 2025



Anna Broms

Imperial College London

A fast and accurate method of fundamental solutions for close-range hydrodynamics in large-scale Stokes suspensions

DECEMBER 10, 2025



Shilpa Khatri

University of California, Merced

Close Evaluation of Layer Potentials

DECEMBER 10, 2025



Robert Nürnberg

University of Trento

A variational front-tracking method for multiphase flow with triple junctions

DECEMBER 11, 2025



Harald van Brummelen

Eindhoven University of Technology

Diffuse-Interface Models for Elasto-Capillary Fluid-Solid Interaction

DECEMBER 10, 2025



Panel session

Future Challenges

Ludvig af Klinteberg

Mälardalen University, Sweden

Fruzsina Agocs

University of Colorado Boulder, United States

Sebastian Aland

TU Bergakademie Freiberg, HTW Dresden, Germany

Travis Askham

New Jersey Institute of Technology, United States

Joar Bagge

The University of Texas at Austin, United States

Genming Bai

University of Michigan, Ann Arbor, United States

Joshua Bannister

University College London, United Kingdom

Alex Barnett

Flatiron Institute, United States

Soeren Bartels

University of Freiburg, Germany

Roland Becker

Université de Pau, France

Nanna Berre

Norwegian University of Science and Technology, Norway

Inga Berre

University of Bergen, Norway

Stefano Berrone

Politecnico di Turin, Italy

George Biros

The University of Texas at Austin, United States

Daniele Boffi

KAUST and Pavia, Saudi Arabia/Italy

Steffen Börm

Kiel University, Germany

Anna Broms

Imperial College London, United Kingdom

Martina Bukač

University of Notre Dame, United States

Erik Burman

University College London, United Kingdom

Donna Calhoun

Boise State University, United States

Stéphanie Chaillat-Loseille

Centre national de la recherche scientifique, France

Alexey Chernov

Carl von Ossietzky Universität Oldenburg, Germany

Beatrice Crippa

Politecnico di Milano, Italy

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Conferences



Photo: Institut Mittag-Leffler



Spectral Analysis of Quantum Hamiltonians: May 2025.

Spectral Analysis of Quantum Hamiltonians

MAY 26–MAY 30, 2025

SCIENTIFIC REPORT

The conference focused on rigorous qualitative methods for studying eigenvalues of linear operators in analysis and mathematical physics. The field originates from Hermann Weyl's groundbreaking work in 1912 and has since become central to both pure and applied mathematics. Spectral theory now plays a key role in areas ranging from the behavior of quantum gases to elasticity theory and engineering.

The mathematical nature of the problems relate to the spectral analysis of elliptic differential operators; typically these are (magnetic) Schrödinger operators, often with boundary conditions. The methods developed in the 70's rely on the spectral theorem, variational methods (min-max), perturbation theory, the theory of Sobolev spaces, embedding theorems and semigroup theory. One of the seminal results of the 70's is the Cwikel–Lieb–Rozenblum inequality for a Schrödinger operator, which gives a bound on the number of negative eigenvalues in terms of the potential. This celebrated inequality served as a recurring theme during the conference.

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Organizers:
Magnus Goffeng
Lund University
Ari Laptev
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Simon Larson
Chalmers University of Technology
Alexander Pushnitski
King's College London
Mikael Sundqvist
Lund University

Recent developments in spectral theory and mathematical physics showcase both foundational progress and innovative advances. Key results include refined Lieb-Thirring inequalities for Schrödinger and Pauli operators with zero-energy resonance and spectral estimates for operators with singular potentials such as Radon measures or delta interactions. Notably, sharp eigenvalue bounds and Weyl-type asymptotics have been extended to non-smooth domains and fractional operators. The Steklov problem, a central topic in spectral geometry, has seen progress in understanding eigenvalue distributions and boundary regularity effects—building on early contributions by Rozenblum.

Advances in semiclassical analysis include first generic results on magnetic tunneling effects and non-asymptotic spectral estimates for Schrödinger operators linking to the uncertainty principle and Anderson localization. New tools, such as refined definitions of essential numerical ranges and connections to noncommutative geometry via Dixmier traces, deepen our understanding of spectral behavior and computation. Finally, unique continuation and observability results on hyperbolic surfaces and spectral sampling inequalities highlight the ongoing relevance of harmonic analysis and PDE techniques. Many of these breakthroughs build on the legacy of Grigori Rozenblum, whose influence continues to shape the field.

Recent work in spectral theory reveals several promising new directions that extend classical results into novel and less-explored regimes. There is growing interest in operators with singular or non-smooth structures—such as those with Radon measures, delta potentials on Lipschitz surfaces, and support on fractal sets—leading to a unified abstract framework for deriving sharp eigenvalue estimates. Advances in non-asymptotic spectral analysis, particularly for the Schrödinger equation, allow for robust estimates across potential types without relying on classical regularity assumptions, with applications to uncertainty principles and Anderson localization.

Magnetic effects in quantum systems, especially magnetic tunneling, have emerged as a significant focus, with the first general results now extending the semiclassical theory beyond its traditional electric setting. At the same time, connections to noncommutative geometry through Dixmier trace formulas are uncovering deep links between density of states and operator theory. Quantitative unique continuation and spectral sampling from thick sets open new avenues in control theory and inverse problems, while new approaches to Steklov-type problems provide tools for dealing with irregular domains. Together, these directions reflect a shift toward greater generality, geometric flexibility, and cross-disciplinary techniques.



Main library of Institut Mittag Leffler, statue of Gösta Mittag-Leffler.

Photo: Markus Marcetic

Specially invited participants and/or speakers:

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Charlotte Dietze
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Stochastic partial differential equations: Statistics meets numerics

JUNE 2–JUNE 6, 2025

Organizers:

Annika Lang
Chalmers University of Technology

Claudia Strauch
Aarhus University

Mathias Trabs
The Karlsruhe Institute of Technology

SCIENTIFIC REPORT

Stochastic partial differential equations (SPDEs) arise in fields such as the natural sciences, engineering, and finance, and have been studied intensively from analytical and probabilistic perspectives. To make these models useful in practice, both statistical and numerical methods are essential. Although closely related, the two directions have long developed separately. This conference brought leading experts together to strengthen interaction between them.

Both statistical and numerical research on SPDEs began in the 1990s and have advanced rapidly since. The statistical goal is to estimate underlying model parameters from partial observations of solutions, using schemes that range from spectral methods to local measurements and discrete sampling. Numerical analysis, meanwhile, focuses on discretization techniques: spatial approximation via spectral methods, finite differences, or finite elements, and time discretization through schemes such as Euler–Maruyama methods or exponential integrators.

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The talks during the conference highlighted major progress in both statistical and numerical directions of research on SPDEs. Fundamental advances were presented in numerical methods, ranging from introductory schemes to adaptive time stepping, domain decomposition, and high-order sampling techniques. On the statistical side, surveys emphasized the rapid growth of inference methods, including nonparametric estimation for linear and nonlinear SPDEs, Bayesian approaches for semi-linear models, and new results on estimator convergence rates. Novel models, such as nonlinear SPDEs for particle systems and McKean–Vlasov diffusions, broaden the scope of applications, while methods for filtering, change-point estimation, and inference in wave and heat equations demonstrate the versatility of SPDE statistics. Further achievements include deeper insights into noise structures, self-similarity, and invariant distributions, as well as the use of neural operator surrogates to connect SPDEs with modern machine learning. Together, these contributions mark significant steps toward unifying theory, computation, statistics, and applications of SPDEs.

Future research on SPDEs calls for closer integration of theory, computation, statistics, and applications. One promising direction is to establish reliable distributional properties of numerical approximations, providing a stronger foundation for both statistical inference and uncertainty quantification. Alongside this, methods for simulating functionals of SPDEs directly—without requiring full sample paths—offer the potential for far more efficient computations tailored to specific application goals.

Another key challenge is to identify domains where SPDE models arise naturally, such as the Dean–Kawasaki equation or hydrodynamical limits. A systematic collection of applications and benchmark problems would strengthen the link between theory and practice, while offering common ground for testing methods. Equally important is the development of stable, accessible algorithms that can be easily applied by non-experts, thereby broadening the impact of SPDE-based modeling.

Finally, the interplay between statistics and numerics gives rise to fundamental questions, such as: to what extent do statistical estimators depend on the numerical methods chosen? Understanding this dependence will be crucial for building trustworthy tools that combine inference with computation in a seamless way.

The conference started with two keynote lectures by specialists in statistics:

Markus Reiß

Humboldt-Universität zu Berlin, Germany

and numerics:

Charles-Edouard Bréhier

University de Pau et des Pays de l'Adour, France

Photo: Markus Marcellic



Round library, bust of Anne Charlotte Leffler.

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Main library of Institut Mittag-Leffler.

Photo: Markus Marcellis



Boundaries, stability, and singularities in general relativity

– A meeting celebrating Helmut Friedrich’s 80th birthday

JUNE 9–JUNE 13, 2025

Organizers:
 Piotr Chruściel
 Beijing Institute of Mathematical
 Sciences and Applications
 and Center of Theoretical Physics of
 the Polish Academy of Sciences,
 Warsaw
 Hans Ringström
 KTH Royal Institute of Technology

SCIENTIFIC REPORT

The workshop gathered leading researchers in mathematical general relativity and related fields to provide an opportunity for discussions, exchange of ideas, and new collaborations. The list of topics discussed at the workshop include the problem of proving stability of the Kerr and Kerr de Sitter spacetimes; the collision of black holes; quasi-local mass; stability of big bang formation; minimal surfaces; instability of AdS spacetimes; the initial boundary value problem; the positive mass theorem; fluid dynamics; and Lorentz geometry.

In the last twenty years, several groups have worked intensively on the resolution of the black hole stability problem, and in the last years, they have finally succeeded. Moreover, in groundbreaking new work, solutions representing the inspiral and collision of two black holes have been constructed. Several results concerning stable big bang formation have also been obtained. In particular, a result providing a general condition (without reference to a background solution) guaranteeing big bang formation with curvature blow up appeared in 2023. Further, there have been dramatic new developments on initial boundary value problems,

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including our understanding of the dynamics of anti-de Sitter spacetime. Last but not least, gluing techniques of initial data sets have been developed, which have proved to be very useful in constructing spacetimes with interesting global properties.

The black hole stability problem remains an important direction of future research, in particular, the problem of proving stability in the case of high angular momentum remains open. In the workshop, the construction of time periodic solutions in toy models were discussed. It would be very interesting to upgrade such results to the case of Einstein's equations with a negative cosmological constant. One talk in the workshop illustrated that to initial data on the singularity, there is a corresponding solution to Einstein's equations asymptoting to the initial data. However, the derived asymptotics in the big bang stability results are not strong enough to demonstrate

that the solutions induce data on the singularity. It would be desirable to understand this connection better.

There were many appreciated seminars. In particular, Peter Hintz gave a seminar in which he constructed the aforementioned solutions describing the inspiral and collision of black holes.

Roger Penrose gave a talk congratulating Helmut on his birthday and describing the idea of conformal cyclic cosmology.



Photo: Markus Marcetic

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

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Homotopy Theory and Floer Homology

JUNE 23–JUNE 27, 2025

Organizers:

Andrew Blumberg
Columbia University

Laurent Cote
University of Bonn

Baris Kartal
University of Edinburgh

SCIENTIFIC REPORT

Floer homology was introduced roughly forty years ago by Andreas Floer as an infinite-dimensional generalization of Morse homology. It has since become a major tool in fields like symplectic topology, dynamics and low dimensional topology.

A natural question, anticipated by Floer and first seriously explored by Cohen–Jones–Segal (CJS) in the mid 1990s [1], asks whether Floer homology can be interpreted as the singular homology of a space and whether there exist Floer versions of other cohomology theories. CJS proposed an approach to this question by lifting Floer homology to a stable homotopy type. In the years following the original work of CJS, these ideas lay mostly dormant in the symplectic community.

However, there has been renewed progress in recent years, and the field is now undergoing rapid development, driven by the advancements in the foundations— such as flow categories—, new approaches to virtual methods, and introduction of new tools from homotopy theory.

The goal of this conference was to bring together researchers interested in *Floer homotopy theory*, and more broadly the applications of homotopy theory to Floer theory, with the aim of disseminating the latest developments in the field and fertilizing new collaborations.

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The conference brought together experts from around the world in symplectic geometry and homotopy theory. These interactions have already led to several new research collaborations among the participants. It also helped bridging the areas of homotopy theory that are less known to symplectic geometers with the Floer theory.

One lasting legacy of this conference is a open-problem list, available here: [2].

This list was prepared collaboratively by all conference participants. It is intended to serve as a resource for the community, providing direction and stimulus for future work in the field. As pointed out in the document, new progress has already been made on several problems posed.

Many new directions were discussed at the conference, some of which are included in [2]. Among these, we would like to highlight:

1. Abouzaid–Blumberg’s proposed new foundations for homotopy theory based on flow categories. This program promises to substantially simplify applications to symplectic geometry. There is, however, much foundational work to be done, to which several conference participants plan to contribute.
2. There was discussion of using ideas from Floer homotopy theory in contact homology. This was the subject of Abouzaid’s talk, and there has been subsequent work in this direction by Chanda–Hirschi.
3. Abouzaid–Bai used symplectic geometric methods to prove that the natural map from complex bordism to the bordism theory of complex derived orbifolds splits. This result was of great interest to algebraic topologists at the conference.

Other directions that were discussed include broadening the applications of Floer homotopy theory, development of new computational tools, construction and structure of spectral Fukaya category and mirror symmetry over more general ring spectra.

Among the many successful talks, we highlight three which seemed to ignite particular interest among participants.

1. **Alice Hedenlund** *Floer Homotopy via Twisted Spectra*: Hedenlund discussed the transition from the Cohen–Jones–Segal framework to twisted spectra, which provide a robust environment for non-frameable Floer homotopy types. The talk detailed a six-functor formalism for these spectra (with T. Moulinos) and their applications to Seiberg–Witten Floer theory (with S. Behrens and T. Kragh) and structured flow categories (with T. P. Oldervoll).
2. **Mohammed Abouzaid** *Orbispace and Floer homotopy*: Building on the foundational formalism developed with Blumberg, Abouzaid detailed an extension designed to formulate homotopy types for orbispaces. This theoretical expansion, developed in conversations with Z. Zhou, aims to provide new computational tools and frameworks for contact homology.
3. **Kenneth Blakey** *Applications of Floer homotopy theory to degenerate Lagrangian intersections*: This talk focused on the application of Floer homotopy theory to long-standing problems in symplectic geometry. Specifically, the speaker presented a new method for establishing lower bounds for degenerate Lagrangian intersections. He also discussed related joint work with C. Bonciocat.

[1] Ralph L Cohen, John DS Jones, and Graeme B Segal. Floer’s infinite dimensional morse theory and homotopy theory. pages 297–325, 1995.

[2] Noah Porcelli et al. Open problems in Floer homotopy theory. Problem session notes from the Institut MittagLeffler workshop, 2025. https://drive.google.com/file/d/1WN-x_RGJYgnTA30Y6QsoWiKlgdTU5Af/view

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Egor Shelukhin

University of Montreal, Canada

Ivan Smith

University of Cambridge, United Kingdom

Alex Takeda

Uppsala University, Sweden

Hiro Lee Tanaka

Texas State University, United States

Umut Varolgunes

Koc University, Turkey

Luya Wang

Institute for Advanced Study, United States

Abigail Ward

University of Cambridge, United Kingdom

Guangxi Yan

MIT Massachusetts Institute of Technology, United States

Filip Zivanovic

Simons Center for Geometry and Physics, United States



EWM-EMS Summer School: Stability in topological data analysis

JUNE 30–JULY 4, 2025

Organizers:

Barbara Giunti
University at Albany

Lisbeth Fajstrup
Aalborg University

Claudia Landi
University of Modena and Reggio Emilia

Wojciech Chachólski
Royal Institute of Technology in Stockholm

SCIENTIFIC REPORT

Topological Data Analysis (briefly, TDA) is a successful discipline at the intersection of mathematics and data analysis that aims at developing new techniques based on algebraic topology, commutative algebra, metric geometry, and category theory to explore and provide meaningful, tight representations of complex data. The school we organized focused on the stability question, as it is one of the central mathematical aspects in TDA. Because real-world data is usually affected by noise, the developed topological or algebraic invariants need to be robust to data perturbation. Specifically, the focus was on general techniques to achieve stability of invariants in TDA that can be applied to different kinds of objects. Ultimately, the goal of the school was to encourage

students to develop their own application-motivated results in TDA by considering well-established principled strategies.

The school gathered a lot of international attention and was followed by more than 50 online participants. Moreover, during these sessions, participants divided into 5 groups to work on research projects motivated by the morning questions. Several groups made a good start on their work, and, to the best of our knowledge, are continuing to work on the projects. This is particularly impressive since the event was a summer school and not a workshop, so the participants were mainly at an

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early career stage, and we did not expect the problem sessions (originally meant more like homework sessions with questions from the lectures) to turn into research projects and collaborations.

In the afternoon sessions, 5 novel research directions were investigated by likewise many groups of participants:

- *Constructing a Stable Scoring Function for bi-PHCA* (Elizabeth Thompson, Ana Zeragarac, Adaku Uchendu, Serena, Jānis Lazovskis, Qiquan Wang, Lars Salbu, Odin Garda, Rolando, Martina Scolamiero)
- *Probabilistic stability of persistence diagrams* (Pepijn Roos Hoefgeest, Clemens Bannwart, Håvard Bakke Bjerkevik, Sifei Li, Katharine Turner),
- *Barcodes of path extended and stretched persistence module*, (Ondřej Draganov, Arthur Reidenbach, Uğur Bektaş Cantürk),
- *Hierarchical stabilization of relative Betti numbers* (Berat Geven, Bjørnar Gullikstad Hem, Claudia Landi, Isaac Ren, Daniel Tolosa),
- *Stable Fibered Barcode* (Robyn Brooks, David Lanners, Isabella Mastroianni, Anna Pape).

The participants have been instructed to keep the organizers informed in case any of these projects turn into a paper and properly acknowledge the Institut Mittag-Leffler in it.

The participants were in general extremely satisfied with all the activities. They reported that the lecturers were good not only in content but also in the schedule, long enough to have enough material but spread enough not to overload. The half-scheduled afternoon activities, which left ample time for networking without being dispersive, were also helpful not only to work on research activities but also to build connections. We copied below the feedback from several participants, showcasing how successful the whole event has been.

The school featured three distinguished lecturers:

Elizabeth Munch

Associate Professor at Michigan State University (<https://elizabethmunch.com/>)

Martina Scolamiero

Assistant Professor at KTH, Stockholm (<https://www.kth.se/profile/scola>)

Katharine Turner

Senior Lecturer at Australian National University (ANU) (<https://maths.anu.edu.au/people/academics/katharine-turner>)

They each gave five 45-minute lectures. In addition, two participants (Inés García-Redondo and Clemens Bannwart) gave a 30-minute talk each.



The seminar building at Institut Mittag-Leffler.

Photo: Markus Marcetic

PARTICIPANTS

- Ali Ahtsham**
University of Management and Technology (UMT), Pakistan
- G V Ambika**
IISER Tirupati, India
- Clemens Bannwart**
University of Modena and Reggio Emilia, Italy
- Francesca Bertoglio**
University of Bologna, Italy
- Matteo Biagetti**
Area Science Park, Italy
- Liya Boukhbin**
Washington State University, United States
- Robyn Brooks**
University of Utah, United States
- Uğur Bektaş Cantürk**
University of Southampton, United Kingdom
- Mauricio Adrian Che Moguel**
University of Vienna, Austria
- Xinle Dai**
Harvard University, United States
- Serena Grazia De Benedictis**
University of Bari Aldo Moro, Italy
- Gökçen Dilaver Tunç**
Hacettepe University, Turkey
- Ondřej Draganov**
Université Côte d'Azur, Austria/France
- Ty Easley Washington**
University in Saint Louis, United States
- Daniel Expósito Patiño**
Galician Supercomputing Center (CESGA), Spain
- Lisbeth Fajstrup**
Aalborg University, Denmark
- Inés García-Redondo**
Imperial College London, United Kingdom
- Berat Geven**
Middle East Technical University, Turkey
- Jehan Ghafari**
University of Buckingham, United Kingdom
- Ishika Ghosh**
Michigan State University, United States
- Barbara Giunti**
SUNY University at Albany, United States
- Bjørnar Gullikstad Hem**
The École Polytechnique Fédérale de Lausanne, Norway
- Odin Hoff Gardå**
University of Bergen, Norway
- Faustine Busumabu Janes**
University of Dar es Salaam, Tanzania
- Christina Kapatsori**
KTH Royal Institute of Technology, Sweden
- Peguy Kem-Meka Tiotsop Kadzue**
African Institute for Mathematical Sciences, Cameroon
- Rolando Kindelan Nuñez**
University of Chile, Chile
- Claudia Landi**
University of Modena and Reggio Emilia, Italy
- David Lanners**
Durham University, United Kingdom
- Jānis Lazovskis**
Riga Technical University, Latvia
- Minh Le**
Ho Chi Minh City Open University, Vietnam
- Jingyi Li**
École Polytechnique, Inria Saclay, France
- Sifei Li**
Just Group plc, United Kingdom
- Barbara Mahler**
Karolinska Institutet, Sweden
- Isabella Mastroianni**
Università degli Studi di Genova, Italy
- Frances McConnell**
Macalester College, United States
- Lars Moberg Salbu**
University of Bergen, Norway
- Elizabeth Munch**
Michigan State University, United States
- Anna Pape**
Universität Bonn, Germany
- Matteo Pegoraro**
KTH Royal Institute of Technology, Sweden
- Arghya Pratihar**
Indian Statistical Institute, India
- Amber Ramey**
SUNY University at Albany, United States
- Valimbavaka Hosana Ranaivomanana**
Stellenbosch University, South Africa
- Isaac Ren**
KTH Royal Institute of Technology, Sweden
- Pepijn Roos Hoefgeest**
KTH Royal Institute of Technology, Sweden
- Rabia Sagheer**
Institute of Business Administration Karachi, Pakistan
- María Isabel Sánchez Muñiz**
University of Minnesota, United States
- Martina Scolamiero**
KTH Royal Institute of Technology, Sweden
- Elizabeth Thompson**
Washington State University, United States
- Amber Thrall**
Washington State University, United States
- Daniel Tolosa**
Arizona State University, United States

>>

Altansuren Tumurbaatar
Emory University, United States

Katharine Turner
Australian National University, Australia

Adaku Uchendu
MIT Lincoln Laboratory, United States

Elena Wang
Michigan State University, United States

Qiquan Wang
Imperial College London, United Kingdom

Marquia Williams
University at Albany, United States

Ana Zegarac
Eidgenössische Technische Hochschule Zürich, Switzerland

Ziwei Zhang
Free University Berlin, China

Photo: Markus Marcetic



Seminar hall, Wallenbergsalen.



Full circle: 100 years of the circle method

JULY 7–JULY 11, 2025

Organizers:

Julia Brandes
Chalmers University of Technology

Tim Browning
ISTA Institute of Science and
Technology Austria

Pankaj Vishe
Durham University

SCIENTIFIC REPORT

This workshop honoured the centenary of the development of the Hardy-Littlewood-Ramanujan circle method, which has established itself as a vital tool that sits at the confluence of arithmetic algebraic geometry, discrete harmonic analysis, and additive combinatorics. During the conference we worked out that a hundred years ago brings us approximately to *Partitio Numerorum VI* from December 1925. This is where Hardy and Littlewood considered the “almost all” version of Waring’s problem, having previously (in *Partitio V*) considered the “almost all” version of Goldbach’s conjecture, which was published in 1924. The originators of the circle method would be astonished to sit in the seminar villa at the Institut Mittag-Leffler and witness the broad scope of these ideas, ranging from additive combinatorial constructions in finite field vectors spaces to the

singularity types of moduli spaces of rational curves. The primary goal of the workshop was to share cutting edge research around the circle method and its applications, in addition to shaping discussions around the development of the subject in the century to come. We invited a diverse group of established and emerging researchers, in order to enhance interactions between groups working with the circle method and foster future collaborations.

The program was scientifically highly successful and the level of interactions exceeded the expectations of the organisers, which was wonderfully facilitated by the setup of the Institut Mittag-Leffler and the excellent support provided by the administrative staff.

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Trevor Wooley described a fascinating interaction between the circle method and a new notion of L^p -subconvex sets, which he has set up a general framework for exploring. Jianyu Liu described recent (and very general) advances involving prime solutions to Diophantine equations, together with numerous ideas for future directions. Simon Rydin Myerson described his project to write down an extremely general version of the circle method that works over arbitrary global fields, and obtains a linear dependence in the number of variables.

We had a special session on interactions of additive combinatorics and ergodic theory with the circle method, led by Sean Prendiville and Sarah Peluse. The former described higher order Fourier analysis (stemming from work of Tim Gowers) in the function field setting, whereas the latter described her new new multilinear circle method and its application to a core problem in ergodic theory. We also had an afternoon dedicated to exciting interactions between the circle method over function fields and deep problems in algebraic geometry about moduli spaces.

Special invited participants and/or speakers

Professor Trevor Wooley FRS is the foremost expert in the application of the circle method and was an active participant of the meeting.

Professor Jianya Liu is also a distinguished researcher working on applications of the circle method to prime numbers.

Professor Sarah Peluse is an ICM speaker in 2026.

PARTICIPANTS

Christian Bernert

Leibniz University Hannover, Germany

Kirsti Biggs

KTH Royal Institut of Technology, Sweden

Dante Bonolis

Duke University, United States

Julia Brandes

University of Gothenburg and Chalmers University of Technology, Sweden

Tim Browning

Institute of Science and Technology Austria, Austria

Matthew de Courcy-Ireland

Stockholm University, Sweden

Rainer Dietmann

Royal Holloway University of London, United Kingdom

Daniel Flores

Purdue University, United States

Jakob Glas

Leibniz Universität Hannover, Germany

Anouk Greven

Universität Göttingen, Germany

Matthew Hase-Liu

Columbia University, United States

Rok Havlas

University of Göttingen, Germany

Philippa Holdridge

University of Warwick, United Kingdom

Vinay Kumaraswamy

KTH Royal Institute of Technology, Sweden

Junxian Li

University of California Davis, United States

Jianya Liu

Shandong University, China

Akshat Mudgal

University of Warwick, United Kingdom

Matthew Northey

Durham University, United Kingdom

Scott Parsell

West Chester University, United States

Sarah Peluse

Stanford University, United States

Javier Pliego

Universita degli studi di Genova, Italy

Sean Prendiville

Lancaster University, United Kingdom

Olivier Robert

Jean Monnet University, France

Simon Rydin Myerson

Chalmers University, Sweden

Efthymios Sofos

University of Glasgow, United Kingdom

Anna Theorin Johansson
Chalmers University of Technology, Sweden

Pankaj Vishe
Durham University, United Kingdom

Mengdi Wang
École polytechnique fédérale de Lausanne, Switzerland

Victor Wang
Institute of Science and Technology Austria, Austria

Mieke Wessel
Göttingen University, Germany

Trevor Wooley
Purdue University, United States

Lena Wurzinger
Institute of Science and Technology Austria, Austria

Sizhe Xie
Shandong University, China

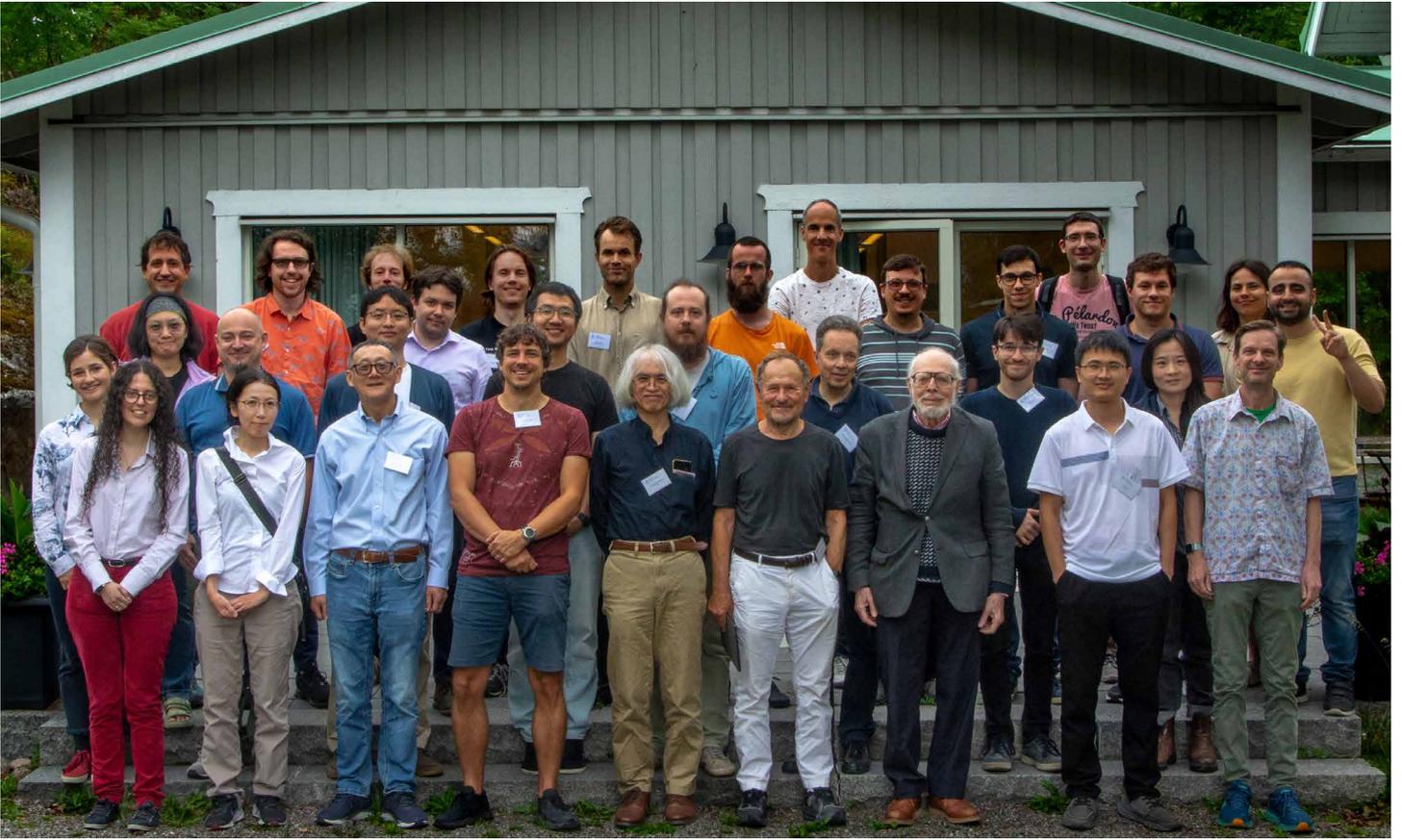
Shuntaro Yamagishi
Institute of Science and Technology Austria, Austria

Kiseok Yeon
University of California Davis, United states

Photo: Markus Marcellic



The upper study at Institut Mittag-Leffler.



Anyons from Small to Large Scales

JULY 14–JULY 18, 2025

Organizers:

Martin Fraas
University of California

Douglas Lundholm
Uppsala University

Yoshiko Ogata
Kyoto University

SCIENTIFIC REPORT

The workshop focused on the rigorous mathematical theory of anyons in two-dimensional quantum systems. Anyons arise in topologically ordered phases such as quantum Hall systems and are described using braided tensor categories, braid-group representations, and effective Chern–Simons-type theories. The subject spans operator-algebraic superselection theory, tensor networks, topological quantum field theory (TQFT), and continuum many-body models.

Recent progress has clarified how anyonic structures emerge from microscopic lattice Hamiltonians, how tensor-network states encode topological data, and how interacting anyon gases can be treated rigorously in the

continuum. The workshop brought together researchers from mathematics and physics to connect these approaches.

Alex Bols, David Pérez-García and Daniel Wallick presented new microscopic results in lattice DHR superselection theory: Levin-Wen models, Symmetry enriched topological phases and a proof of Haag duality. Yasuyuki Kawahigashi talked about tensor networks for anyonic systems from the perspective of subfactor theory in operator algebras. From the TQFT and categorical side, Shawn Cui discussed braiding universality and leakage-free gates, Colleen Delaney introduced a complexity-

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theoretic organization of anyon models, Eric Rowell presented zesting and condensed fiber products, and Zhenghan Wang proposed a conjectural description of the space of gapped Hamiltonians realizing a fixed anyon model.

On the statistical-physics side, Alireza Ataei, Théotime Girardot and François Visconti presented improved derivations for ground states of nearly bosonic anyon gases in the continuum. Jinyeop Lee reported first rigorous results on anyon gas dynamics. Ask Ellingsen and Filippa Getzner discussed stability of effective nonlinear and nonlocal Chern–Simons–Schrödinger models using soliton solutions, while Davide Fermi, Nicolas Rougerie, and Qiyun Yang addressed connections between anyon models, Aharonov–Bohm fluxes, and dimensional reduction.

Wang’s conjectural picture of the global structure of topological phases and gapped Hamiltonians stimulated new work from the lattice perspective. Interactions between Delaney’s complexity viewpoint and operator-algebraic approaches, particularly those of Pérez-García, suggested new links between topological phases and quantum complexity.

From the statistical-physics perspective, recent progress on density functionals, energy bounds, and dynamics points toward a systematic theory of interacting anyon gases. Developments on the stability of Chern–Simons–Schrödinger functionals, nonlinear Landau levels, and Berry phases suggest new connections to low-energy structure and quantum-information aspects of abelian anyon systems. The workshop also helped unify lattice, continuum, and dimensionally reduced models.

The program combined quantum lattice systems, TQFT and categorical methods, and statistical-physics approaches. Introductory talks by Shawn Cui and Eric Rowell were particularly effective in establishing common ground across communities.

The participation of Gerald Goldin was especially noteworthy. Goldin is one of the originators of the mathematical-physical theory of anyons, with seminal work from the early 1980s. His joint work with Menikoff and Sharp first identified the possibility of nonabelian braid-group representations in two-dimensional quantum systems.



Photo: Markus Marcellis

The old seminar room at Institut Mittag-Leffler.

PARTICIPANTS

Maria Stella Adamo

University of Erlangen–Nuremberg, Germany

Eddy Ardonne

Stockholm University, Sweden

Alireza Ataei

Uppsala University, Sweden

Sven Bachmann

The University of British Columbia, Canada

Alex Bols

Eidgenössische Technische Hochschule Zürich, Switzerland

Nicolas Bridges

Purdue University, United States

Morris Brooks

University of Zurich, Switzerland

Domenico Cafiero

Politecnico di Milano, Italy

Matthew Corbelli

University of California, Davis, United States

Michele Correggi

Politecnico di Milano, Italy

Shawn Cui

Purdue University, United States

Michele Del Zotto

Uppsala University, Sweden

Colleen Delaney

Purdue University, United States

Ask Ellingsen

Uppsala University, Sweden

Davide Fermi

Politecnico di Milano, Italy

Martin Fraas

UC Davis, United States

Jürg Fröhlich

Eidgenössische Technische Hochschule Zürich, Switzerland

Alan Getz

University of British Columbia, Canada

Filippa Getzner

Uppsala University, Sweden

Theotime Girardot

Gran Sasso Science Institute, Italy

Gerald Goldin

Rutgers University, United States

Corey Jones

North Carolina State University, United States

Kohtaro Kato

Nagoya University, Japan

Yasuyuki Kawahigashi

the University of Tokyo, Japan

Kan Kitamura

Rikagaku Kenkyūjyo, Japan

Boris Kjaer

Copenhagen University, Denmark

Gaultier Lambert

KTH Royal Institute of Technology, Sweden

Edwin Langmann

KTH Royal Institute of Technology, Sweden

Jinyeop Lee

The University of British Columbia, Canada

Angelo Lucia

Politecnico di Milano, Italy

Douglas Lundholm

Uppsala University, Sweden

Per Moosavi

Stockholm University, Sweden

Dinh-Thi Nguyen

University of Science, Vietnam National University Ho Chi Minh City, Vietnam

Yoshiko Ogata

Kyoto University, Japan

David Perez-Garcia

Universidad Complutense de Madrid, Spain

Daniel Ranard

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Nicolas Rougerie

Centre national de la recherche scientifique & École normale supérieure de Lyon, France

Eric Rowell

Texas A&M University, United States

Darya Rudneva

Stockholm University, Sweden

Alberto Ruiz-de-Alarcón

CUNEF University, Spain

Christoph Schweigert

Hamburg University, Germany

Michael Sigal

University of Toronto, Canada

Jan Philip Solovej

University of Copenhagen, Denmark

Wulf Staubach

Uppsala University Sweden

Yoh Tanimoto

University of Rome Italy

Nat Tantivasadakarn

California Institute of Technology, United States

Francois Visconti

LMU Munich, Germany

Daniel Wallick

The Ohio State University, United States

Zhengan Wang

University of California, Santa Barbara, United States

Qiyun Yang

École normale supérieure de Lyon, France

Qing Zhang

University of California, Santa Barbara, United States

Pengming Zhang

Sun Yat-sen University, China

Other Events

Kleindagarna

Organizer:

Maria Saprykina
KTH Royal Institute of Technology,
Stockholm

Supporting organization:

Brummer & Partners

During the year 2025, Kleindagarna took place three times: in January, June and August. Each time, high school teachers of mathematics were invited to the Institut Mittag-Leffler for three days, 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 the university professors. 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.

Every Klein-session includes a cultural program which includes a tour of the Institut Mittag-Leffler together with a historical overview held by Kristian Bjerklöv (KTH) and a presentation of old and rare books from Gösta Mittag-Leffler's library, held by Maria Saprykina (KTH).

These three days are usually very highly appreciated by all the participants: both the high school teachers and the university professors and doctoral students. In the (anonymous) evaluation form, many teachers express their gratitude for this event. Typical comments are: "Thank you for the three fantastic days! I feel very inspired...", "You made these days really rich in learning." "The group discussions very inspiring". Several lecture pilots have already visited the assigned Klein lectures at high schools.

All of them reported that this contact between the high school and the university is very important for all the participants (both the high school teachers and students and the lecture pilots).

This year's themes include: mathematical models for climate, mathematics behind web-programming, planar geometry (in particular, Picks theorem), combinatorics (the problems of coloring of a map), elements of graph theory and its applications for modeling real-world systems, different definitions of dimension, an introduction to non-standard analysis, investigation of the concept of numbers, an introduction to numerical methods, an introduction to the general relativity theory, the concept of integrable polygons and conditional convergence of series.

SPEAKERS AND LECTURE TITLES

JANUARY 2024

Tomas Persson

A mathematicians view of the climate (En matematiker tittar på klimatet)

Tomas Ekholm

Mathematics in web-programming (Matematik inom webprogrammering)

Dan Petersen

Pick's theorem in the plane (Picks teorem i planet)

Lisa Nicklasson

Coloring of maps and graphs (Färgläggning av kartor och grafer).

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JUNE 2024

Martina Scolomiero (KTH)

From graphs to geometry via modelling of systems
(Från grafer till geometri för modellering av system)

Kristian Bjerklöv (KTH)

Dimension (Dimension)

Olow Sande (Umeå Universitet)

Non-standard analysis – can one compute with infinitesimals? (Icke-standardanalys – kan man räkna med infinitesimaler?)

Tomas Sjödin (Linköpings Universitet)

Från rationella tal och framåt: hur naturliga existensfrågor leder till abstrakta objekt

AUGUST 2024

Sara Zahedi (KTH)

Numerical methods (Numeriska metoder)

Anna Sakovich (UU)

From geometry to the relativity theory (Från geometri till relativitetsteori)

Julie Rowlett (Chalmers)

Integrable polygons (Integrable polygons)

Alan Sola (SU)

Conditionally convergent series (Betingat konvergenta serier)

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 is 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.

Photo: Markus Marčetič





Kleindagarna I

JANUARY 8–JANUARY 10, 2025

LECTURERS

Tomas Ekholm
KTH Royal Institute of Technology, Stockholm

Lisa Nicklasson
Mälardalens universitet

Tomas Persson
Lunds universitet, Lund

Dan Petersen
Stockholms universitet, Stockholm

LESSON PILOTS

Magnus Fries
Lunds universitet, Lund

Oliver Lindström
Stockholms universitet, Stockholm

Maria Saprykina
KTH Royal Institute of Technology, Stockholm

Johanna Skåntorp
KTH Royal Institute of Technology, Stockholm

PARTICIPANTS

Johan Cheander
Perstorp tekniska gymnasium, Perstorp
Sheida Delgoshaei
Sigtunaskolan humanistiska läroverket, Sigtuna

Jan Direll
Västerviks gymnasium, Västervik

Tobias Eriksson
Betty Petterssons Gymnasium, Stockholm

Sandra Güven
Arlandagymnasiet, Sigtuna

Olga Helling
Bäckängsgymnasiet, Borås

Johanna Hellman
Värmdö gymnasium, Värmdö

Jonatan Holmström
Hulebäcksgymnasiet, Mölnlycke

Henrik Jansson
Danderyds gymnasium, Danderyd

Vera Lundström
Elitidrottsgymnasiet, Umeå, Umeå

Olof Munther
Sundsgymnasiet i Vellinge, Vellinge

Johan Näslund
Storsjögymnasiet i Östersund, Östersund

Natalie Petersson
Furulundsskolan Sölvesborg, Sölvesborg

Anne-Maj Raaholt
Hulebäcksgymnasiet, Mölnlycke

Tomas Rönnåbakk Sverin
Åva gymnasium, Täby

Martin Sandgren
Malmö Borgarskola, Malmö

Anna Schastnaya
Kärrtorps gymnasium, Kärrtorp

Elena Sundkvist
Campus Viktor Rydberg, Stockholm

Douglas Vinberg
Sannarpsgymnasiet Halmstad, Halmstad

Maria Visén
Sundsvalls gymnasium, Sundsvall



Kleindagarna II

JUNE 16–JUNE 18, 2025

LECTURERS

Kristian Bjerklöv
KTH Royal Institute of Technology, Stockholm

Olow Sande
Umeå University, Umeå

Martina Scolamiero
KTH Royal Institute of Technology, Stockholm

Tomas Sjödin
Linköping University, Linköping

LESSON PILOTS

Joel Frisk Gärtner
KTH Royal Institute of Technology, Stockholm

Hadid Rehman
Uppsala University, Uppsala

Maria Saprykina
KTH Royal Institute of Technology, Stockholm

Erik Tamm
KTH Royal Institute of Technology, Stockholm

PARTICIPANTS

Gullu Ahmadova
Magnus Åbergsgymnasiet, Trollhättan

Yukiko Asami-Johansson
Högskolan i Gävle, Gävle

Chakriya Bengtsson
Stockholm Science and Innovation School, Stockholm

Håkan Deleskog
Ester Mosesongymnasiet, Göteborg

Johan Egerhall
Nyströmska skolan i Söderköping, Söderköping

Savas Ertas
Öresundsgymnasiet i Landskrona, Landskrona

Olga Fokina
Broskolan Örnsköldsviks kristna skola, Örnsköldsvik

Kerstin Glimmerfors
Nacka gymnasium, Stockholm

Tim Hylén
Bladins gymnasium, Malmö

Jenny Kjellberg
Täljegymnasiet i Södertälje, Södertälje

Sabina Kostet
Statens Institutionsstyrelse, Sis Rebecka, Björkaskolan, Stockholm

Sofia Neovius
Sigtunaskolan humanistiska läroverket, Sigtuna

Hans Nilsson
Kunskaps gymnasiet Globen, Stockholm

Jonas Ottoson
Stockholm Science and Innovation School, Stockholm

Mattias Ramström
Rodengymnasiet, Norrtälje

Elmer Rådahl
Maja Beskowgymnasiet i Umeå, Umeå

Emilie Sahlberg-Issa
Magnus Åbergsgymnasiet, Trollhättan

Christoffer Standar
Magnus Åbergsgymnasiet, Trollhättan

Mikael Sund
NTI-gymnasiet i Karlstad, Karlstad

Frida Torrång
Bruksgymnasiet, Uppsala

Jonas Vikström
Grillska gymnasiet i Västerås, Västerås



Kleindagarna III

AUGUST 13–AUGUST 15, 2025

LECTURERS

Julie Rowlett
Chalmers tekniska högskola, Stockholm

Anna Sakovich
Uppsala universitet, Uppsala

Alan Sola
Stockholms universitet, Stockholm

Sara Zahedi
KTH Royal Institute of Technology, Stockholm

LESSON PILOTS

Elliot Backman
KTH Royal Institute of Technology, Stockholm

Jakob Nordin Gröning
KTH Royal Institute of Technology, Stockholm

Samuel Odeberg Hollifeldt
Uppsala universitet, Uppsala

Alejandro Rodriguez
Lunds tekniska högskola, Lund

Maria Saprykina
KTH Royal Institute of Technology, Stockholm

PARTICIPANTS

Erik Backlund
Angeredsgymnasiet i Göteborg, Göteborg

Per Björnberg
Västerviks gymnasium, Västervik

Linda Elvén
Taserudsgymnasiet i Arvika, Arvika

Anna-Kari Friberg
Svenska sektionen vid Europskolan i Luxemburg, Luxemburg

Malin Holgersson
Filbornaskolan, Helsingborg

Anders Karlsson
Ållebergsgymnasiet, Falköping

Anna Karp
LM Engströms gymnasium i Göteborg, Göteborg

Amanda Lauridsen
Taserudsgymnasiet i Arvika, Arvika

Georgios Martiou
Angeredsgymnasiet, Göteborg

Ayad Nasser
Möckelngymnasiet, Karlskoga

Jörgen Nilsson
Perstorp tekniska gymnasium, Perstorp

Anna-Maria Orban
Taserudsgymnasiet i Arvika, Arvika

Matthias Rezac
Viskastrandsgymnasiet, Borås

Alexandra Söderqvist
Realgymnasiet i Borås, Borås

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