Universität Münster

Opening Conference: 2nd Funding Period of Mathematics Münster

September 16-18, 2026

Book of Abstracts

MM Mathematics Münster
Cluster of Excellence

Foreword

The Cluster of Excellence 'Mathematics Münster: Dynamics - Geometry - Structure' has recently obtained continued funding for its second term, and the upcoming conference will serve as a celebration of this achievement. Much like the Cluster bridges the full spectrum of mathematics at Münster – from pure to applied – the conference aims to unite prominent international mathematicians, Cluster researchers, and early career scholars. This dynamic event will offer a platform for lively exchange across diverse areas of mathematics. We look forward to inspiring interdisciplinary dialogue and collaboration, showcasing both external expertise and the innovation emerging from within our Cluster.

Shirly Geffen, Gustav Holzegel, Franziska Jahnke, Chiranjib Mukherjee, Thomas Nikolaus, Mario Ohlberger, Eva Viehmann, Hendrik Weber, Burkhard Wilking, Caterina Zeppieri

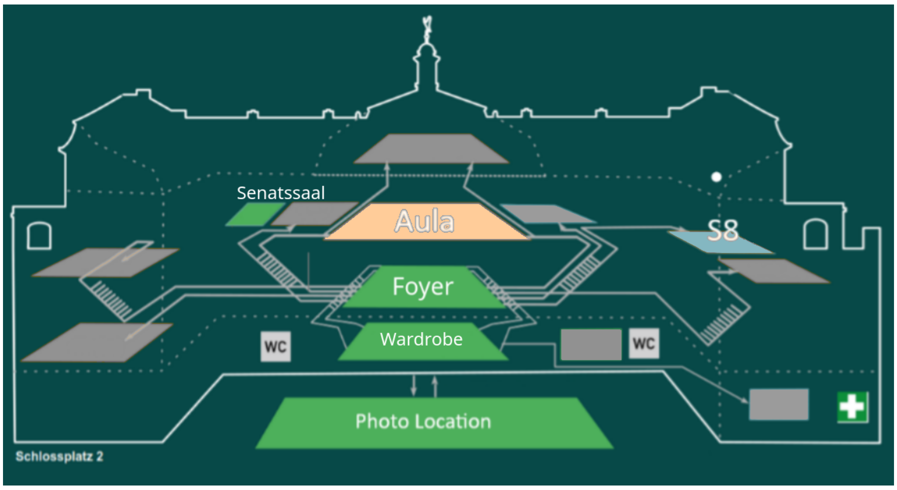
In case of questions, we are happy to assist you. You can find contact persons at the conference office during the breaks.

Schedule & Venue

Wednesday, 16.09.		Thursday, 17.09.		Friday, 18.09.	
08:30	Registration	**08:30**	Women's Breakfast		
09:00	**Opening**			**09:00**	**Nekrashevych**
09:45	**De Filippis**	**10:00**	**Hamenstädt**	**09:45**	**Virág**
10:30	Coffee Break	**10:45**	Coffee Break	**10:30**	Coffee Break
11:00	**Pilloni**	**11:15**	**Garban**	**11:00**	**Burklund**
11:45	**Luk**	**12:00**	**Alaifari**	**11:45**	**Sinapova**
12:30	Lunch	**12:45**	Lunch	**12:30**	Lunch
14:30	**Tent**	**15:15**	**Dereich**	**14:30**	**Kerr**
15:15	**Ramzi**	**16:00**	Coffee Break	**15:15**	**Mann**
15:40	**Kranz**	**16:30**	**Kupffer**	**15:40**	**Mildenberger**
16:00	Coffee Break	**16:55**	**Fang**	**16:00**	Coffee Break
16:30	Poster Blitz	**17:30**	Public Lecture: **Bär**		
17:15	Poster Session				
18:00	Reception	**19:30**	Dinner		

Venue

The conference is scheduled to be held at the University of Münster, in the "Schloss", located in close proximity to the city center at Schlossplatz 2, 48149 Münster.
The presentations will take place in the Auditorium ("Aula") and lecture hall S8. Coffee breaks will be hosted in the Schloss's main hall ("Foyer").



General Information

Programme and Registration. The workshop will start the morning of Wednesday, 16 September, and run until the afternoon of Friday, 18 September. Registration will be in the main hall ("Foyer") of the Schloss between 8:30 and 9:00.

Child care. Child care is available on Wednesday, 9:30am – 12:00pm and Thursday, 9:30am – 12:00pm. Meeting point is at the conference office (Foyer).

Quiet Room. A quiet room will be available throughout the conference for attendees who need a calm space. Information about the location will be provided at the venue.

Wifi. If your institution is part of the eduroam community you can simply connect to the "eduroam" network. Otherwise you can connect to the network with SSID "GuestOnCampus" which has 1GB data limit per day and is not encrypted.

Photography. The conference photo will take place on Wednesday after the first invited talk. We meet in front of the "Schloss".
We will be taking photos at the conference. The images may be used on the Cluster's website, in print media and on social media. Images will only be shared with third parties after careful consideration and for the purposes of journalistic reporting. If you do not wish to be photographed, please inform our photographers as soon as possible at the conference. You may also withdraw your consent at a later date.

Poster Session and Reception. The poster session and the reception will take place on Wednesday right after talks in the afternoon in the same location as the coffee breaks.

Introductory Talks. The introductions will prepare for the talks of Robert Burklund, Bálint Virág and Volodymyr Nekrashevych.

Women's Breakfast. The women's breakfast will take place in the Senatssaal at the Schloss on Thursday, from 8:30 until 10:00. Our main goal with this breakfast is to connect mathematicians who are well established in their career with those who are at the beginning of their path, and provide time for an exchange.

Public Lecture. On Thursday at 5:30pm there will be a public lecture "Bernhard Riemann - Visionär der modernen Mathematik" by Christian Bär (Universität Potsdam) in German. The lecture is being held to mark the 200th anniversary of Bernhard Riemann's birth. It will trace key stages of Riemann's unusual life and introduce Riemannian geometry and the Riemann hypothesis to a broader audience. The conference dinner will take place right after this lecture.

Conference Dinner. The conference dinner will be on Thursday at 7:30pm at the "LUX Restaurant" (Dompl. 10.). You can reach the restaurant by foot, around 1km, from the conference location. All registered participants are welcome at the dinner, the food and water will be covered from the conference budget.

Lunch Break. There are a couple of nearby restaurants where you can enjoy lunch:

A: Mensa Bispinghof (Canteen), Bispinghof 9, 750m

B: ÁRO (Asian Fusion, Bowls), Neutor 3, 600m

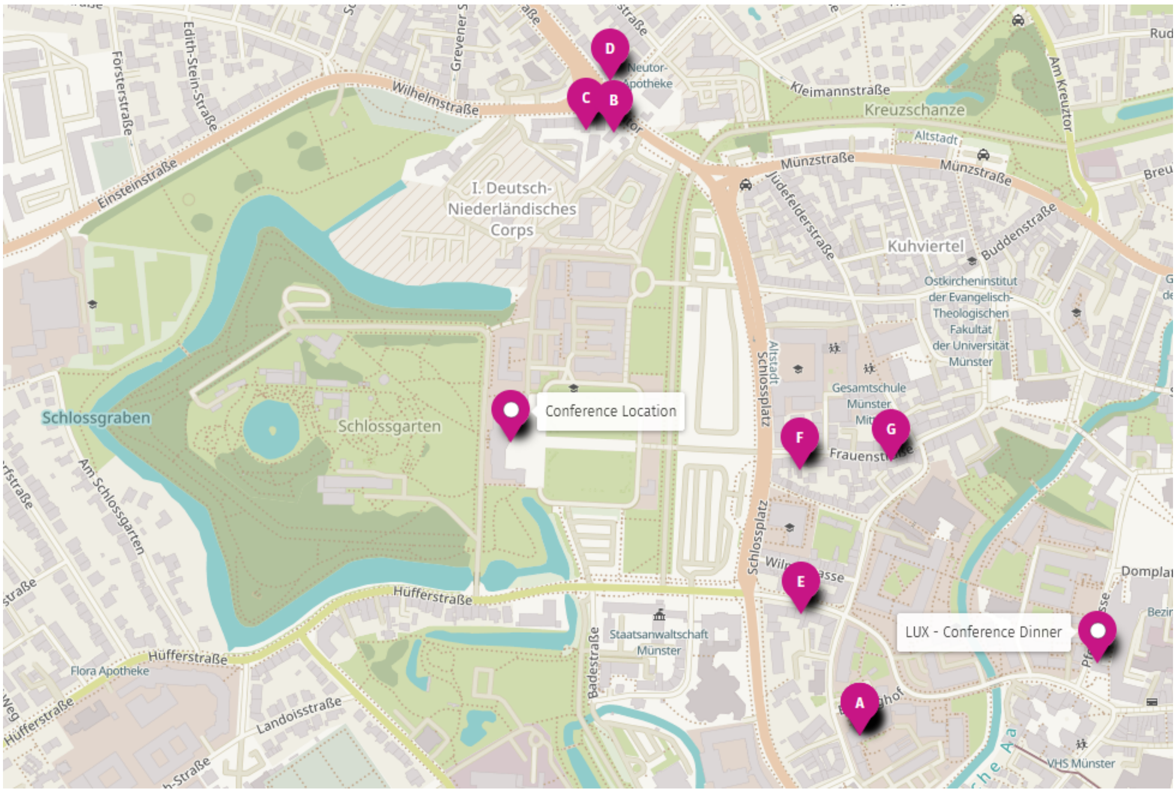
C: Gustav Grün (Bowls, Wraps), Wilhelmstraße 1, 600m

D: CUCHARA (Curries), Steinfurter Str. 3, 650m

E: Knopf's Knolle (Baked potatos), Universitätsstraße 25, 550m

F: Frauenstraße 24 (Turkish, Diverse), Frauenstraße 24, 500m

G: café fam (Café, Snacks), Frauenstraße 14, 600m



Abstracts

Wednesday

Aula, Wednesday 9:45 – 10:30

Nonuniform Ellipticity and Nonlinear Potentials

Christiana De Filippis

Università degli studi di Parma

The representation formula for the Poisson equation gives an explicit expression of solutions in terms of the data, yielding zeroth- and first-order pointwise bounds via convolution with suitable Riesz potentials. Their mapping properties allow for a sharp regularity transfer from data to solutions, so that nonlinear PDEs can be treated, up to the C^1-level as they were linear. I will then discuss a novel potential-theoretic approach to the (ir)regularity of solutions to certain nonuniformly elliptic PDEs arising in geometric and physical models.

S8, Wednesday 11:00 – 11:45

Zeta functions of curves

Vincent Pilloni

Université Paris-Saclay

Zeta functions of algebraic varieties provide a vast generalization of Riemann's zeta functions. We will report on some conjectures and progress concerning zeta functions of genus 2 curves.

S8, Wednesday 11:45 – 12:30

Shock formation in gas dynamics

Jonathan Winghong Luk

Stanford University

I will discuss shock formation for partial differential equations governing gas dynamics, beginning with the seminal work of Riemann. I will then survey recent results in multiple spatial dimensions for increasingly complex physical situations, emphasizing the fundamental role of geometric ideas.

S8, Wednesday 14:30 – 15:15

Universal hyperbolic graphs and spaces and their isometry groups

Katrin Tent

Universität Münster

I will present a construction of a universal homogeneous hyperbolic metric space, i.e. a metric space in which every finite hyperbolic space with rational distances can be isometrically embedded, in analogy to the Urysohn space. The isometry group of this space is a totally disconnected polish group and I will discuss simplicity and primitivity of the group and its action.

S8, Wednesday 15:15 – 15:40

Categorification of rings

Maxime Ramzi

Universität Münster

Given an additive category C, taking its Grothendieck group K_0 is a way to extract concrete "numerical information" out of C - for example, it replaces finite dimensional vector spaces over a field with their dimension, a simpler invariant.

Conversely, given an abelian group A, one may wonder whether it is K_0 of a certain additive category, whether A can be "categorified". In various areas of mathematics, categorifying questions about numerical invariants has turned out to be a powerful method. In the context of knot invariants, Khovanov asked whether Q and $Z[1/n]$ can be categorified as rings, that is, be expressed as K_0 of an additive category equipped with a tensor product. This question was partly answered by Levy, who then asked whether all commutative rings can be categorified. In this talk, I will explain the precise question Levy asked, and explain a positive answer to this question.

S8, Wednesday 15:40 – 16:00

Dynamical comparison for groupoids and applications

Julian Kranz

Universität Münster

Dynamical comparison is a regularity property for étale groupoids with important structural implications for the associated C^*-algebras and the homology of the associated topological full groups. I will review recent progress on establishing dynamical comparison for large classes of groupoids and on using it to find unexpected isomorphisms among seemingly different classes of C^*-algebras.

Thursday

Aula, Thursday 10:00 – 10:45

A tale about Riemann surfaces and mapping class groups

Ursula Hamenstädt

Universität Bonn

A Riemann surface is a closed surface equipped with a complex structure. If the genus is at least two, then equivalently it is a closed hyperbolic surface. We'll give an overview of some of the properties of the moduli space of such surfaces and their mapping class group, and we connect geometric information to the construction of geometric representations of the mapping class group on suitably chosen L^p-spaces and discuss some open questions.

Aula, Thursday 11:15 – 12:00

Continuous Symmetry and Phase Transitions in Lattice Spin Systems

Christophe Garban

Université Lyon 1

A central problem in statistical physics is to understand how spins placed on the lattice Z^d interact and collectively organize at different temperatures. When the spins take values in a discrete set — for instance in the celebrated Ising model, where $\sigma_x \in \{-1, +1\}$ — the mechanisms governing phase transitions are by now relatively well understood.

The situation changes dramatically when the spins take values in a continuous space, such as the unit circle S^1 in the XY model or the unit sphere S^2 in the classical Heisenberg model. In this setting, new phenomena appear, and the behavior depends strongly on whether the underlying symmetry is Abelian or non-Abelian. In particular, the non-Abelian case remains far more mysterious.

In this talk, I will introduce the mathematics of spin systems with continuous symmetry, emphasizing their deep connections with analysis, including harmonic functions, harmonic maps, and geometric analysis. I will also describe some recent results and open problems in the area.

No prior background in statistical physics or probability will be assumed. Based on joint works with J. Aru, D. van Engelenburg, P. Dario, N. de Montgolfier, A. Sepúlveda and T. Spencer.

Aula, Thursday 12:00 – 12:45

How Can We Learn from Paths? Signatures, Kernels and Stochastic Regression

Rima Alaifari

RWTH Aachen

Many data sets arising in stochastic systems, dynamics, and time series are naturally represented by paths rather than by points in a finite-dimensional space. The signature transform, which associates to a path a hierarchy of iterated integrals, provides a powerful way of encoding such objects while retaining rich algebraic and analytic structure. In this talk, I will introduce the basic ideas behind signatures and explain how they can be used for learning problems on path space. I will focus in particular on stochastic regression and on signature kernels, which allow one to work with the signature representation without computing its infinitely many coordinates explicitly. Along the way, I will highlight connections between rough path theory, kernel methods, partial differential equations, and data-driven learning.

Aula, Thursday 15:15 – 16:00

Mean-Field Decoupling of Neurons in Infinite-Width Neural Network Training

Steffen Dereich

Universität Münster

Wide neural networks may be viewed as high-dimensional interacting particle systems: each neuron evolves during training, while interacting with the others through empirical averages determined by the network output and the loss. This perspective naturally suggests a mean-field limit as the width tends to infinity. However, in contrast to classical mean-field models, the relevant scaling for feature learning is delicate. The μP parametrisation is designed to produce nontrivial infinite-width training dynamics, avoiding the purely linearised behaviour of the neural tangent kernel regime.

Earlier mean-field results focused mainly on shallow networks, while other approaches have developed more general descriptions of wide-network limits and feature learning. Our result complements this work by explicitly relating the finite network to its limiting dynamics throughout training.

In this talk, I will discuss a new decoupling result for neural network training in the μP setting. Starting from Gaussian initialisation, we show that the original interacting neuron system can be explicitly coupled to a completely decoupled system. In this decoupled system, individual neurons evolve independently of each other according to effective one-particle dynamics. They interact with the rest of the network only through deterministic mean-field quantities. The result can be understood as a propagation-of-chaos statement adapted to the μP scaling, with an explicit coupling between the true dynamics and the decoupled system.

Aula, Thursday 16:30 – 16:55

Bi-infinite random walk paths and geodesic flow on hyperbolic groups

Luzie Kupffer

Universität Münster

It is well-established that Patterson-Sullivan measures on the boundary of a hyperbolic space, along with the associated Bowen-Margulis-Sullivan measure, provide valuable insights into the action of a group of isometries on the space's boundary through analysis of the geodesic flow. Given that paths of a random walk on a hyperbolic groups lie close to the group's quasi-geodesics, it is natural to ask whether similar behaviour can also be seen in the flow along bi-infinite random walk paths.

In this talk, I will show how studying bi-infinite random walks on a discrete hyperbolic group G leads to an analogue of the Patterson-Sullivan measure on $\partial^2 G$. This measure can be constructed in multiple measure-equivalent ways, each giving distinct perspectives on its intrinsic structure. Moreover, as in the classical case, the action $G \curvearrowright \partial^2 G$ is ergodic with respect to this measure. Central to the construction of these measures is the almost sure convergence of the random walk to the boundary ∂G and the study of the distribution of the hitting points.

This talk is based on joint work with Mahan Mj and Chiranjib Mukherjee.

Aula, Thursday 16:55 – 17:20

On the uniqueness of Kerr-de Sitter

Allen Juntao Fang

Universität Münster

The uniqueness of the Kerr-de Sitter family of black hole spacetimes as stationary solutions to the Einstein vacuum equations is a crucial ingredient to understanding the final states of positive cosmological constant universes, such as our physical universe. In the asymptotically flat case, Kerr was shown to be the unique analytic stationary solution to the Einstein vacuum equations via a combination of results by Hawking, Carter, and Robinson. Outside of analyticity, Alexakis, Ionescu, and Klainerman showed several conditional rigidity results for Kerr. In this talk, I will discuss some recent work in the spirit of Alexakis, Ionescu, and Klainerman showing the uniqueness of the stationary region of Kerr-de Sitter within the smooth class of stationary solutions to the Einstein vacuum equations with a positive cosmological constant.

Aula, Public Lecture, Thursday at 17:30

Bernhard Riemann – Visionär der modernen Mathematik

Christian Bär

Universität Potsdam

This talk is part of a public lecture series in Münster and will be held in German.

Am 17. September 2026 jährt sich der Geburtstag Bernhard Riemanns zum 200. Mal. Obwohl Riemann nur 39 Jahre alt wurde und vergleichsweise wenige Arbeiten veröffentlichte, veränderte er die Mathematik grundlegend. Seine Ideen prägen bis heute unser Verständnis von Raum, Geometrie, Zahlen und Naturgesetzen.

Der Vortrag zeichnet einige Stationen seines ungewöhnlichen Lebenswegs nach und stellt zwei besonders folgenreiche Aspekte seines Werkes vor. Zum einen geht es um die nach ihm benannte Geometrie gekrümmter Räume, die später zur mathematischen Grundlage von Einsteins Allgemeiner Relativitätstheorie wurde und heute in zahlreichen Gebieten der Mathematik und Physik eine zentrale Rolle spielt. Zum anderen wird die Riemannsche Vermutung erläutert, eines der berühmtesten ungelösten Probleme der Mathematik, das auf überraschende Weise mit der Verteilung der Primzahlen verbunden ist.

Friday

S8, Friday 9:00 – 9:45

New amenable groups

Volodymyr Nekrashevych

Texas A&M University College

Amenability is a fundamental finiteness condition in group theory introduced almost 100 years ago by J. von Neumann. But even now, the border between the classes of amenable and non-amenable groups is not well understood. Recent years have seen the development of new methods of proving amenability of groups, which expanded the class of "non-elementary" amenable groups. I will give a survey of the results in this area and their applications.

→ A talk tutorial on Volodymyr Nekrashevych's talk will be held by **Miguel Donoso Echenique**, Universität Münster, during the lunch break on Thursday 14:00 – 14:25

S8, Friday 9:45 – 10:30

Continuum RSK Correspondence: From Brownian Motion to Random Geometry

Bálint Virág

University of Toronto

In the KPZ universality class, random growth and last-passage models in the plane converge to a universal object known as the directed landscape - a random directed metric encoding optimal paths and last-passage times. In this talk, I will describe a bijection that recovers the full directed landscape from a sequence of independent Brownian motions. This construction is the natural scaling limit of the classical Robinson–Schensted–Knuth (RSK) correspondence and gives a clean dictionary between simple noise and rich random directed geometry.

Joint work with Duncan Dauvergne.

→ A talk tutorial on Bálint Virág's talk will be held by **Felipe Espinosa Vergara**, Universität Münster, before the session on Friday 08:30 – 08:55.

S8, Friday 11:00 – 11:45

Geometry in chromatic characteristic

Robert Burklund

Københavns Universitet

In this talk I will give an overview of recent developments in spectral algebraic geometry and how they shed light on some of the basic questions of stable homotopy theory.

→ The talk tutorial *What is descent?* introducing Robert Burklund's talk will be held by **Georg Lehner**, Universität Münster, right before the talk on Friday 10:30 – 10:55.

S8, Friday 11:45 – 12:30

Cardinal arithmetic

Dima Sinapova

Rutgers University

Cardinal arithmetic is about investigating the values of powersets of infinite objects, going back to Hilbert's First Problem: the continuum hypothesis (CH). CH is the statement that the size of the reals (which can be identified as the powerset of the natural numbers) is the least uncountable cardinal. Famously, Cohen proved that CH is independent from the usual axioms of mathematics. Since then, modern set theory has analyzed the properties of the powerset function of infinite cardinals in general. In this talk, we will focus on recent results about the powerset value of singular cardinals and interaction with infinitary combinatorics.

Aula, Friday 14:30 – 15:15

From form to content: amenability in dynamics and operator algebras

David Kerr

Universität Münster

The concept of amenability, in its most powerful incarnations across groups, dynamics, and operator algebras, can be viewed as an organizing principle for detecting, manipulating, and managing structural data. This plays out at the technical level through tilings (groups), tower decompositions (dynamics), and finite-dimensional approximation (operator algebras). What is remarkable is that amenability can be used as a tool both for the internal analysis of objects that possess it as a property and for the investigation of phenomena that lie beyond its own horizon. The former is a program that operates at the finest scales and typically leads to classification theorems, while the latter serves to illuminate the broader expanses of the theory in question. I will discuss some recent examples of the latter principle in the application of dynamics to operator algebras.

Aula, Friday 15:15 – 15:40

The categorical local Langlands correspondence

Lucas Mann

Universität Münster

The Langlands program is a set of far-reaching conjectures that permeate modern number theory and complex analysis. Over the years, different versions of the program have appeared, and a particularly important one for arithmetic is the local Langlands conjecture: It predicts a surprising relation between the representation theory of matrix groups over p-adic fields on the one side and Galois theoretic information on the other, with deep applications to number theory. A recent breakthrough was obtained by Fargues-Scholze in their seminal paper on the geometrization of the conjecture, lifting the classical conjectures to a powerful geometric framework and "categorifying" both sides, but leaving the conjectured equivalence still open. In joint work with David Hansen, we provide a strategy for proving Fargues-Scholze's conjectures, which (up to a work-in-progress conjecture on certain compatibilities) gives a full proof in the case of GL_n and many classical groups.

Aula, Friday 15:40 – 16:00

Tail estimates for multiplicative heat equations in the subcritical regime

Sophie Mildenberger

Universität Münster

We establish tail estimates for multiplicative stochastic heat equations driven by a wide class of subcritical Gaussian noises. In the classical settings of the one-dimensional multiplicative stochastic heat equation (mSHE), driven by space–time white noise, and the two-dimensional parabolic Anderson model (PAM), driven by spatial white noise, time-dependence of the noise leads to better tail estimates even at lower scaling regularity. Indeed, moments of PAM exist only for small times while mSHE exhibits global moments. Working within the framework of regularity structures, we develop a robust approach that allows us to leverage time-dependence for more general noises. The resulting tail estimates reflect the combined effect of the space-time scaling regularity and the temporal dependence of the driving noise.

Poster Session

Magnetic skyrmions in ultrathin soft ferromagnets

Thomas Behaghel

Skyrmions are particle-like, topologically non-trivial spin textures. They appear, for example, in ultrathin ferromagnets. We model them as energy minimizers with a prescribed topological structure and study them using variational methods. In particular, we prove the existence of minimizers and analyze their position, rotation, and radius.

An Entropy-Preserving Cut-Cell Stabilization Method for Hyperbolic Conservation Laws

Gunnar Birke

Cut cells provide an efficient meshing technique based on a simple idea: the geometry of interest is embedded in a Cartesian background mesh. Intersections of the geometry with Cartesian mesh elements are removed, producing so-called cut cells, while the remainder of the background mesh stays unchanged. Although this approach is simple and efficient, the cut cells can have arbitrary size and shape. In the context of hyperbolic conservation laws, where explicit Runge–Kutta methods are widely used, stabilization is needed to obtain a practical time-step size that is independent of the size of small cut cells in the mesh.

A variety of stabilization methods have been developed to address this issue successfully. However, the structure-preserving properties of the resulting schemes remain delicate: even if stabilization is applied to a structure-preserving base scheme, it must itself be carefully designed to preserve the desired properties.

In this contribution, we consider Domain of Dependence stabilization and discuss how it can be applied to an entropy-preserving discontinuous Galerkin (DG) scheme without destroying entropy preservation.

Stationary Boundaries on the Space of Amenable Subgroups and C^*-Simplicity

Anna Cascioli

Every countable group acts on its space of subgroups, and the induced dynamics on the space of amenable subgroups encode structural features of the group. We study stationarity for this action and give a sufficient condition for the existence of a probability measure μ on G that admits a nontrivial μ-boundary modeled on the space of amenable subgroups of G. This leads to non-uniqueness of stationary measures and connects to C^*-simplicity, a property that arises naturally in the study of unitary representations of a group. The criterion applies to wreath products and to Thompson's group F. This is joint work with Martín Gilabert Vio and Eduardo Silva.

Thick Points under Gaussian Free Field Dynamics

Felipe Espinosa-Vergara

We investigate the evolution of thick points under two natural dynamics for the Gaussian free field (GFF) in dimension 2. The first dynamic we analyze is the Ornstein–Uhlenbeck GFF. We prove that, simultaneously for all points, the evolution of their thickness is continuous. Additionally, we characterize all deterministic functions $f\colon \mathbb{R} \to \mathbb{R}$ such that there are points whose thickness function is f.

The second dynamic we study is the stationary solution of the additive stochastic heat equation. In this case, the thickness of points is not continuous. Moreover, this rougher dynamic generates super-thick points, namely points with thickness greater than 2. As a function of $\gamma > 2$, we identify infinitely many phase transitions corresponding to the existence of exceptional times at which at least N points are γ-thick. These phase transitions, occurring at $\gamma^2 = 8,\ 6,\ \frac{16}{3},\ \ldots$, converge to 4 as $N \to \infty$. Mapping to the critical FK-model parameter via $q = 4\cos^2\left(\frac{4\pi}{\gamma^2}\right)$, these critical values correspond to the Beraha numbers, which are precisely the points at which the conformal field theory (CFT) for critical FK percolation should be minimal.

Adaptive Model Order Reduction for Defect Identification

Benedikt Klein

Parameter identification in time-dependent partial differential equations (PDEs) gives rise to large-scale, ill-posed inverse problems. Solving such problems numerically requires regularization and repeated solves of forward and adjoint problems, making established approaches such as the iteratively regularized Gauss–Newton method (IRGNM) computationally expensive.

In this work, we present an adaptive reduced-basis variant of the IRGNM embedded in an error-controlled trust-region framework for efficient parameter identification in high-dimensional settings. By constructing reduced state and parameter spaces adaptively during the online phase, the proposed approach eliminates the need for a globally accurate reduced model. This adaptive construction enables goal-oriented enrichment while avoiding the prohibitive offline costs associated with classical model reduction techniques. In addition, restricting the iterates to low-dimensional adaptive subspaces provides an implicit regularization effect. Numerical experiments demonstrate that the proposed approach significantly reduces computational costs while maintaining accuracy.

A condensed version of ongoing projects

Catrin Mair

In my poster, I will present three ongoing projects, which center around the pro-étale exodromy theorem (first shown by Wolf and recently re-proved by van Dobben de Bruyn). It states that the hypercomplete pro-étale ∞-topos of a scheme X can be reconstructed as a functor category (within the condensed world) on its condensed category Gal(X) of locally coherent points. The theorem can be viewed as an extended version of Lurie's theorem on conceptual completeness for the étale topos of X which uses the language of ultracategories. Further, the study of the condensed homotopy type of X relies fundamentally on the pro-étale exodromy theorem and Gal(X). The projects now generalize in different directions: First, schemes are replaced by geometric objects of similar nature in the study of the condensed homotopy type; second, the pro-étale exodromy theorem is used as a model for a general condensed approach to conceptual completeness; and third, variants of Gal(X) and pro-étale exodromy are studied for different topologies in algebraic geometry.

Fibrations over coset spaces and condensed group cohomology

Raquel Murat

Topological groups provide a natural setting in which algebraic and topological structures interact. In this poster, we present two projects exploring different aspects of this interaction.

Firstly, let G be a topological group and let $K, L \subseteq G$ be closed subgroups, with $K \subseteq L$. We prove that if L is a locally compact pro-Lie group, then the map $q : G/K \to G/L$ is a Serre fibration, and a Hurewicz fibration if G is paracompact. As an application of this, we obtain two older results by Skljarenko, Madison and Mostert.

Second, we consider the problem of defining group cohomology for locally compact groups. In the last decades, numerous versions of it have been developed. However, the category of locally compact abelian groups is not abelian, hence there is no clear way of doing homological algebra in it. We fix this by defining group cohomology in the newly developed frame of condensed mathematics, given that the category of condensed abelian groups is abelian.

Generalized inductive limits and traces of C^*-algebras

Lukas Obermeyer

Inductive limit constructions are ubiquitous in the study of C^*-algebras, allowing one to access a C^*-algebra through more tractable building blocks. The framework here is the category of C^*-algebras with *-homomorphisms as morphisms, which respect the C^*-algebraic structure. Approximately finite-dimensional (AF) C^*-algebras, for instance, arise as inductive limits of finite-dimensional ones. While already interesting, this class is relatively small. To access larger classes of C^*-algebras, the common approach is to consider more general building blocks that are still well understood. In our project, we study a different approach. While keeping the building blocks finite-dimensional, we allow more general connecting maps: linear maps that preserve the order structure of C^*-algebras in a strong sense, but are not necessarily multiplicative. Taking limits of such systems in a larger category than before yields so-called generalized inductive limits.

On my poster, I will discuss conditions under which a generalized inductive limit is again a C^*-algebra. This perspective provides a desirable inductive limit description for a large class of C^*-algebras. We show how this framework can be used to recover the trace simplex, an important invariant, of certain C^*-algebras.

Boundedness, Decay, and Stability on Anti-de Sitter-Type Spacetimes

Milos Provci

Anti-de Sitter (AdS) spacetime is a model of a spacetime with negative cosmological constant. Unlike asymptotically flat spacetimes, it has a timelike conformal boundary (TCF), which causal curves can reach in finite affine time. Consequently, hyperbolic evolution is not fully determined by initial data, and Cauchy problems require additional boundary conditions (BCs) at the TCF. These can be classified through their effect on energy estimates: we consider reflective and dissipative BCs, distinguished by the behavior of the energy flux through the TCF. AdS black-hole spacetimes have an additional dissipation mechanism at the event horizon.

I juxtapose established results with ongoing work. Under reflective BCs, major results are due to Moschidis, Holzegel–Smulevici, and Graf–Holzegel, including full linear stability of Schwarzschild–AdS (SAdS). By contrast, fewer results are available for dissipative BCs: these include linear stability for pure AdS due to Holzegel–Luk–Smulevici–Warnick and recent work by A. Tullini on the wave equation on SAdS.

I comment on the choice between reflective and dissipative BCs and present key results on SAdS under dissipative BCs that are necessary for full linear stability. I also present boundedness and decay for the Dirac equation on SAdS under both reflective and dissipative BCs. Finally, I discuss joint work with A. Tullini on the wave equation on Kerr–AdS with dissipative BCs.

Double duals and how to fix them

Phil Pützstück

A vector space is isomorphic to its double dual if and only if it is finite-dimensional. This "reflexivity" question makes sense for any duality, and we survey many examples: duality of abelian groups against Z or Q/Z, Pontryagin duality of locally compact abelian groups against R/Z, Z-linear duality of chain complexes, and Anderson duality of spectra in the sense of stable homotopy theory. In the purely algebraic settings, only sufficiently finite objects are reflexive (with a curious exception in the case of Z-linear duals of abelian groups). From a topological viewpoint, the main culprit is that the dual of an infinite discrete group naturally carries a generally non-discrete topology, which algebraic duality forgets. The fix promised in the title is condensed mathematics, due to Clausen–Scholze, which allows us to conveniently incorporate topology into algebra. We explain how the condensed versions of Z-linear duality and Anderson duality admit a much larger class of reflexive objects, and also how to import Pontryagin duality to stable homotopy theory. This is based on joint work with Thomas Nikolaus.

Expected hyperbolic volume of random ideal polytopes

Philipp Schange

Ideal hyperbolic polytopes have all their vertices at infinity and hence edges of infinite length, yet they still have finite volume. In the Klein model, hyperbolic space is represented by the open Euclidean unit ball. Its boundary sphere represents the points at infinity, while hyperbolic geodesics appear as straight Euclidean line segments. Thus, the convex hull of independent uniform points on the sphere defines a random ideal hyperbolic polytope. Building on results for random beta polytopes, we derive explicit formulas for the expected hyperbolic volumes of such polytopes. This is joint work with Zakhar Kabluchko.

PinT Meets Block Krylov: Increasing Hardware Efficiency for Time-Dependent Simulations

Alexander Schell

High-order discretizations offer significant potential to overcome performance limitations in the simulation of PDEs on modern hardware architectures. However, in some application areas, such as porous-media simulations, many users still rely on low-order, matrix-based approaches. Consequently, these methods are typically *memory-bandwidth limited* and exhibit low *arithmetic intensity*, that is, a low ratio of floating-point operations to bytes transferred. This significantly limits their efficiency on modern hardware.

In this work, we propose a *Parallel-in-Time (PinT)* approach for the simulation of time-dependent PDEs that addresses these performance challenges while retaining matrix-based linear solvers. By reformulating an *all-at-once* system for multiple consecutive time steps, we expose additional algebraic structure that allows us to solve the resulting system using vectorized linear solvers such as *Block Krylov* methods. Two concrete realizations are presented:

1. *Block-Jacobi-type matrix splitting.* A matrix-splitting approach reformulates the *all-at-once* system as a matrix equation.

2. *Diagonalization-based approach.* The equations are decoupled by diagonalizing the system, as in *ParaDiag* methods.

The proposed approaches improve hardware utilization and enable better performance on modern architectures. The framework is broadly applicable to both linear and nonlinear PDEs.

Diagonals in Kirchberg Algebras

Philipp Sibbel

Cartan subalgebras and C^*-diagonals are special commutative subalgebras that encode the structure of a C^*-algebra, with deep links to dynamics and classification. Using graph-based models, we construct C^*-diagonals in every stable Kirchberg algebra, as well as in all Cuntz algebras.

Scissors automorphism groups

Robin J. Sroka

Can you cut a cube into finitely many polytopal pieces that can be rearranged by isometries to form a regular tetrahedron? This is the classical scissors congruence problem in Euclidean 3-space, famously known as Hilbert's third problem. We consider the complementary question: instead of asking whether two polytopes are scissors congruent, we study the group of all transformations that realize the scissors congruence relation. By varying the notion of polytope, these "scissors automorphism groups" encompass many groups of piecewise homeomorphisms originally studied in geometric group theory and dynamics, including the Brin-Thompson, interval exchange, and rectangle exchange transformation groups. In a series of joint works with Kupers, Lemann, Malkiewich, and Miller, we develop a general strategy for studying the homology of scissors automorphism groups, connecting Hilbert's third problem to questions in geometric group theory and dynamics. Our approach employs homological stability ideas to relate the homology of these groups to Zakharevich's scissors congruence K-theory. Building on work of Malkiewich, we access this K-theory using tools from the study of Steinberg modules. Applications include a group-theoretic interpretation of scissors congruence K-theory in the setting of Hilbert's third problem, as well as homology calculations for groups of dynamical origin, extending and recovering earlier work by Szymik-Wahl, Li, and Tanner.

Einstein metrics and Harmonic maps

Adam Thompson

Einstein metrics are Riemannian metrics whose Ricci curvature is a multiple of the metric itself: this constitutes a (weakly) elliptic second-order partial differential equation. Since we are very far from having a general understanding of the Einstein condition, producing new examples—particularly in the compact setting—is important for shedding light on possible behaviours. Our poster focuses on how solutions can be built from families of solutions on lower-dimensional manifolds, and on how harmonic maps into moduli spaces of solutions naturally arise when one tries to do this. In particular, we include our previous work (joint with R.A. Lafuente) constructing non-compact examples in this way, and discuss how this could guide a construction of compact examples.

Explicit Minimizers of the Confined Anisotropic Riesz Potential

Edoardo Tolotti

In this poster, we fully characterize, in any spatial dimension, the minimizer of a class of nonlocal and anisotropic Riesz energies defined over probability measures supported on ellipsoids. When the Riesz kernel is in the super-Coulombic and Coulombic regimes, we prove that the minimizer is, surprisingly, independent of the anisotropy. In contrast, in the sub-Coulombic regime, we show that this property fails: we exhibit an anisotropy for which the isotropic minimizer is not optimal.

On the Existence of Geodesics in the Space of Closed Curves

Nikolas Uesseler

Spaces of parametrized curves arise naturally in shape analysis, where one seeks meaningful ways to compare shapes, interpolate between them, and study optimal deformations. A widely used choice for defining a geometry on these spaces is the elastic metric, which measures both stretching and bending along a path. For open curves, the square root velocity transform turns this metric into a much simpler one, making the associated geodesic problem more tractable. For closed curves, however, the closure condition becomes a nonlinear constraint after this change of coordinates, and the existence of geodesics between two prescribed curves is no longer immediate.

I will present an approach to this existence problem based on Young measures. This framework allows one to relax the energy and, in a suitable sense, the closure constraint, leading to a relaxed problem for which minimizers can be obtained when classical compactness arguments are not sufficient. Under additional assumptions, such relaxed minimizers can correspond to classical geodesics. The aim of the poster is to highlight the usefulness of this relaxation for closed curves, and when it leads back to classical solutions.

Towards a 3d TQFT with values in Habiro Cohomology

Ferdinand Wagner

Habiro cohomology is a cohomology theory in arithmetic geometry, but it also has a surprising connection to quantum invariants of 3-manifolds (in fact, that's where the subject had its origin). Scholze has sketched a far-reaching program to explain this connection: There should be a (fully extended) 3-dimensional topological quantum field theory with values in Habiro cohomology. By passing to different specialisations of Habiro cohomology, such a 3d TQFT would unify several existing invariants, most notably Reshetikhin–Turaev invariants, i.e. the exact (and mathematically rigorous) quantisation of Chern–Simons theory at roots of unity, as well as the (non-rigorous) perturbative quantisation of Chern–Simons theory around roots of unity. We will report on some progress towards realising Scholze's program.

Can one hear the shape of a typical network?

Alexander Van Werde

Spectral graph theory studies properties of a network through the eigenvalues of associated matrices. One can understand a lot from this perspective, but how much? Is it typical for a graph to be characterized up to isomorphism by its spectrum? My poster concerns some recent progress on this question, leveraging tools from random matrix theory and algebraic number theory.

Einstein Metrics on Homogeneous Torus Bundles

Vincent Wolff

We investigate the existence of homogeneous Einstein metrics on infinite families of compact simply connected homogeneous torus bundles over a common base. We prove that, after excluding a nowhere-dense set of exceptional tori, the existence of torus bundles that admit a homogeneous Einstein metric is a closed condition. A motivating example is provided by the Aloff–Wallach spaces $W_{k,l} := \mathrm{SU}(3)/S^1_{k,l}$, where $S^1_{k,l}$ is a circle with slope (k,l) in a (two dimensional) maximal torus of $\mathrm{SU}(3)$. In this case, homogeneous Einstein metrics are known to exist by other methods. Our result places this example in a broader framework and applies to more general families.