



Regensburg GAP days

A conference in **G**eometric Group Theory, **A**rithmetic Geometry
and **A**nalysis of PDEs



University of Regensburg

28th-30th July 2025

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Schedule

Regensburg GAP days 2025

	Monday 28th			Tuesday 29th			Wednesday 30th		
	Analysis of PDEs	Geometric group theory	Arithmetic Geometry	Analysis of PDEs	Geometric group theory	Arithmetic Geometry	Analysis of PDEs	Geometric group theory	Arithmetic Geometry
9.00-9.30	Registration and welcome			Mumtaz	-		Nobili 3	-	
9.30-10.00	Blawid	Campagnolo 1	Pati 1	Nobili 1	Campagnolo 2	Pati 2		Campagnolo 3	Pati 3
10.00-10.30	Eden? break?								
10.30-11.00	Coffee break			Coffee break			Coffee break	Coffee break	
11.00-12.00	Iacobelli			Marchionna				Wiersema	
12.00-13.30	Lunch			Lunch			Lunch and goodbye		
13.30-14.00	Palmirotta	Yatsina	Feuerpfeil	Nobili 2	Lazar	Martinez-Marin			
14.00-14.30	Papageorgiou	Tonic	Vego		Bellynck	Lee			
14.30-15.00	Coffee break			Poster session + coffee break					
15.00-15.30	Feistl- Held	Thillaisundaram	Zou (online)						
15.30-16.00	Coffee break								
16.00-16.15	Gildehaus			Academic Career panel (Wiersema, Campagnolo, Iacobelli, Nobili, Gildehaus)					
16.15-17.00									
17.00-17.15	Conference photo			Break					
17.15-17.30	For who wants: Take away pizza and pub quiz								
17.30-18.00									
18.00-18.30									
19.00-on:				Conference dinner at Brauhaus am Schloss					

Geometric Group Theory

Minicourse (Caterina Campagnolo, Universidad Autonoma de Madrid)

Title: *An introduction to bounded cohomology and its applications*

Abstract: Bounded cohomology is a cohomology theory that first appeared in work of Johnson in the 70's and was then mightily developed by Gromov in the 80's as an invariant of groups and spaces. Since then it has expanded as a dynamical field with relations to many areas of geometric group theory.

It is a homotopy invariant, but it proved to have far reaching implications for the geometry and the algebraic properties of the spaces and groups under consideration. Furthermore it carries a seminorm that provides numerical constraints in several applications.

In this minicourse we will introduce the basics of the theory, present archetypal examples and finish with some important applications.

Plenary talk (Bianca Marchionna, University of Heidelberg)

Title: *The importance of being totally disconnected*

Abstract: Totally disconnected locally compact (t.d.l.c.) groups represent a relevant class of locally compact groups. They include, for instance, p-adic Lie groups and automorphism groups of various simplicial complexes (and generalisations). Notably, every group equipped with the discrete topology is a t.d.l.c. group. In these terms, the theory of t.d.l.c. groups extends the one of abstract groups, leading to a rich body of knowledge that encompasses group-theoretical, geometric, and cohomological aspects. What are the main highlights of this extension? Why exactly "t.d.l.c."? In this talk, we will explore some answers to these questions while providing the necessary background.

Contributed talks

Jean-Baptiste Bellynck (Ludwig-Maximilians-Universität München)

Title: *Pseudo-Anosov homeomorphisms and train tracks on the twice-punctured torus*

Abstract: The talk will give a brief, pictorial, introductory and exciting overview on surface mapping class groups, pseudo-Anosov homeomorphisms, foliations and train tracks! We describe a classical procedure on how to (non-naturally) obtain train tracks from pseudo-Anosov homeos and a more modern procedure by Agol on how to do the reverse. As a concrete example a family of pseudo-Anosov homeos of the twice-punctured torus is given. This is joint work with Eiko Kin from Osaka University.

Anitha Thillaisundaram (Lund University)

Title: *Varieties isogenous to a higher product with prescribed numerical invariants*

Abstract: A smooth complex projective variety X of dimension n is said to be isogenous to a higher product if it is the quotient of a product of n compact Riemann surfaces under a suitable action of a finite group G . The case $n = 2$ has been well studied over the past 2 decades, with the most well-known of such varieties being the Beauville surfaces. Beauville surfaces have nice geometric properties; in particular they have been used to provide counterexamples to the Friedman-Morgan speculation. The finite group G associated to a Beauville surface is called a Beauville group, and has drawn interest among group theorists. In this case $n = 2$, the (topological) Euler number of the surface is $(-2)^2 = 4$ and the first Betti number is zero.

The case $n = 3$ has recently been investigated, with concrete examples of such varieties, also for those where the Euler number is $(-2)^3 = -8$ and the first Betti number is zero. A natural question is whether there exist such varieties in dimensions greater than 3 with Euler number $(-2)^n$ and trivial first Betti number. In joint work with Amir Dzambic, we show that such varieties do not exist. Our proof uses structural properties of groups of small order.

Ioana-Claudia Lazar (Politehnica University of Timisoara)

Title: *CAT(0) triangle-pentagon complexes*

Abstract: We compare a combinatorial curvature condition (given by m -location, $m \geq 4$) to a metric curvature condition (given by the CAT(0) metric). We show that a certain triangulation of CAT(0) triangle-pentagon complexes is 7-located and locally 5-large. We show that, when metrized with a certain metric, 7-located discs are locally CAT(0) spaces. We investigate the structure of the minimal displacement set both in an 8-located simplicial complex with the SD'-property and in a CAT(0) cubical complex. We give two definitions for m -location. One of them says that a simplicial complex is m -located, $m \geq 4$ if it is flag and every full homotopically trivial loop of length at most m , is contained in a 1-ball.

Vera Tonić (University of Rijeka)

Title: *Hurewicz mapping theorem for asymptotic dimension of countable approximate groups*

Abstract: In topological dimension theory, a well known Hurewicz theorem for dimension-lowering maps states that if $f : X \rightarrow Y$ is a closed map of metric spaces, then $\dim X \leq \dim Y + \dim(f)$, where $\dim(f) := \sup \{\dim(f^{-1}(y)) \mid y \in Y\}$. This theorem was extended to asymptotic dimension asdim , and in particular to asdim of groups – in 2006, Dranishnikov and Smith proved a Hurewicz-type formula, which states that if $f : G \rightarrow H$ is a group homomorphism, then $\text{asdim } G \leq \text{asdim } H + \text{asdim } \ker(f)$. The goal of this talk is to show that the analogous formula is true for countable approximate groups, i.e., to show that if $(\mathcal{E}, \mathcal{E}^\infty), (\Lambda, \Lambda^\infty)$ are countable approximate groups and $f : (\mathcal{E}, \mathcal{E}^\infty) \rightarrow (\Lambda, \Lambda^\infty)$ is a global morphism between them, then $\text{asdim } \mathcal{E} \leq \text{asdim } \Lambda + \text{asdim } ([\ker(f)]^c)$.

Sofiya Yatsyna (Royal Holloway, University of London)

Title: *On certain homological invariants of TDLC groups*

Abstract: In extending notions from Farrell-Tate cohomology, Gedrich and Gruenberg (1987) introduced two new interesting homological invariants for a ring: SILP, the supremum of the injective lengths of the projectives, and SPLI, the supremum of the projective lengths of the injectives. Particularly, they showed that given a suitable commutative ring and group, if SPLI is finite, then SILP is also finite. Emmanouil (2010) generalises this result and shows that for any group, SILP and SPLI are equal over the integers. This talk will explore the development of an analogous theory for the category of totally disconnected locally compact groups and discuss whether projective and injective modules are really dual.

Poster session

Giovanni Sartori (Heriot-Watt University)

Title: *JSJ trees for all Artin groups*

Max Gheorghiu (HHU Düsseldorf)

Title: *Poincaré duality for profinite groups via condensed mathematics*

Illja Rusakov (Universität Regensburg)

Title: *Homological Invariant Growth of Groups*

Kristina Dengler (Universität Regensburg)

Title: *Model categories for o-minimal geometry*

Arithmetic Geometry

Minicourse (Maria Rosaria Pati, Università degli Studi di Genova)

Title: *Iwasawa Theory from the foundations to some recent developments*

Abstract: Iwasawa theory is a collection of techniques developed since the 1950's to study the behavior of certain arithmetic groups in infinite towers of number fields. It is named after the work of the Japanese mathematician Kenkichi Iwasawa, who studied the growth of class groups along the cyclotomic tower, and their connection to the p-adic zeta function of Kubota and Leopoldt. Such connection is known as Iwasawa's Main Conjecture and it has been proved by Mazur and Wiles in the 1980's. Beginning with work of Mazur and Swinnerton-Dyer in the 1970's, the ideas of Iwasawa theory were extended to elliptic curves and other p-adic Galois representations. Each instance has its own Main Conjecture relating certain Galois cohomology groups (the algebraic side) with p-adic L-functions (the analytic side). We will give an overview of this theory starting from its foundations, continuing with the Iwasawa theory for elliptic curves and ending with the anticyclotomic Iwasawa Main Conjecture for higher weight modular forms.

Lecture 1: The Main conjecture of Iwasawa. To understand Iwasawa theory requires some knowledge of the background out of which it arose. So the goal of this first lecture is to provide an introduction to the classical Iwasawa theory over \mathbb{Q} and state the Main Conjecture of Iwasawa.

Lecture 2: The Iwasawa theory of elliptic curves. We will describe the Iwasawa theory of elliptic curves, in which class groups are replaced by certain Galois cohomology subgroups known as Selmer groups and the p-adic L-function interpolates special values of the complex L-function of E . We will see that in some cases, it is possible to reformulate a Main Conjecture "without L-functions", that is replacing the p-adic L-function by an element in an Iwasawa cohomology group coming from an Euler system. We will focus mainly on the anticyclotomic setting.

Lecture 3: Anticyclotomic Iwasawa theory for modular forms. We will extend further the theory developed in the previous lectures by replacing the elliptic curve with the Galois representation attached by Deligne to an higher weight modular form f . We will see that, along the anticyclotomic \mathbb{Z}_p -extension of an imaginary quadratic field satisfying some mild hypothesis, one can construct an Euler system of cohomology classes coming from cycles on a suitable fiber abelian variety over a Shimura curve.

Plenary talk (Hanneke Wiersema, University of Cambridge)

Title: *The modularity theorem and Serre's modularity conjecture*

Abstract: One of the most famous results in number theory is Fermat's Last Theorem. The result is as follows: if n is an integer greater than 2, then there are no non-zero integers x, y and z such that $x^n + y^n = z^n$.

The proof came more than three centuries after it was first conjectured and led to huge innovations in number theory. The key to the proof is the modularity theorem: a deep connection between modular forms and elliptic curves. In this talk we give an introduction to the modularity theorem and the related Serre's modularity conjecture.

Contributed talks

Júlia Martinez-Marin (University of Bristol)

Title: *Finding rational points on K3 surfaces*

Abstract: K3 surfaces can be considered a 2-dimensional analogue of elliptic curves. However, their rational points are not yet well understood. In this talk, we focus on K3 surfaces of degree 2, as their geometry allows us to use elliptic curves to produce infinitely many rational points.

Julian Feuerpfeil (Università degli Studi di Milano Bicocca)

Title: *Chasing maximal pro- p Galois groups via Koszul algebras*

Abstract: Let p be a prime number and K be a field containing a root of 1 of order p (and $\sqrt{-1}$ if $p=2$). Based on a previous conjecture by F. Bogomolov, L. Positselski conjectured in 2005, that the maximal pro- p Galois group of $\sqrt[p^\infty]{K}:=K(\sqrt[p^n]{a}:n\in\mathbb{N},a\in K)$ is a free pro- p group. This group coincides with the commutator subgroup of $G_K(p)$ if K also contains a root of 1 of order p^n for all n . There are large classes of fields for which this conjecture is known to hold, e.g., local, and global fields and fields whose maximal pro- p Galois group is of elementary type, but the general case is still open. Positselski showed that the conjecture would follow from strong Koszulity properties of the Milnor K -theory of $K \bmod p$. In 2022 C. Quadrelli and T. Weigel gave another criterion for the afore mentioned conjecture depending (in a sophisticated way) on only two Galois cohomology groups, which allowed them to prove the conjecture for groups of elementary type. In their paper they also asked if there exists a connection between these two seemingly unrelated approaches.

In this talk we would like to present a theorem linking the two results and some consequences of it. If time permits we also present a proof of Positselski's Module Koszulity Conjecture 1 for pro- p groups of elementary type.

Meghan Lee (Wake Forest University)

Title: *Isolated j -invariants arising from the modular curve $X_0(n)$*

Abstract: An isolated point of degree d is a point on an algebraic curve which is not part of an infinite family of degree d points parametrized by some geometric object. We develop an algorithm to test whether a rational, non-CM j -invariant j gives rise to an isolated point on the modular curve $X_0(n)$, for any $n \in \mathbb{Z}^+$, using key results from Menendez and Zywin. This extends the prior algorithm of Bourdon et al. which tests whether a rational, non-CM j -invariant j gives rise to an isolated point on any modular curve $X_1(n)$. From this work, we determine that the set of j -invariants corresponding to isolated points on $X_1(n)$ is neither a subset nor a superset of those corresponding to isolated points on $X_0(n)$.

Ana Marija Vego (ETH Zürich)

Title: *Asai Euler system in Coleman families*

Abstract: The Iwasawa Main Conjecture connects p-adic L-functions with certain Iwasawa modules. In the case of a real quadratic field, if F is a Hilbert modular form, the conjecture states that the characteristic ideal of a Selmer group associated to F is generated by a p-adic L-function. Using the Asai–Flach Euler system, Lei, Loeffler, and Zerbes have established bounds toward this conjecture for the Asai representation. We will explore the possibility of extending their work by analytically varying the Asai Euler system in three-parameter families—one parameter varying in a cyclotomic family, and the other two in p-adic Coleman families—potentially yielding further progress on the conjecture.

Konrad Zou (Max-Planck Institut für Mathematik)

Title: *Categorical local Langlands generically for GL_n*

Abstract: In this talk we will give an impressionistic account on the Langlands program with a view towards the categorical local Langlands program in the sense of Fargues-Scholze. We will talk about the generic part of this conjecture and will see some applications to the cohomology of PEL type A Shimura varieties. If time permits, we will sketch aspects of the proof.

Poster session

Edwina Aylward (University College London)

Title: *Reduction type of genus 2 curves*

Theresa Kaiser (Universität Heidelberg)

Title: *Old- and Newforms for GL_3 Drinfeld Cusp Forms*

Analysis of PDEs

Minicourse (Camilla Nobili, University of Surrey)

Title: *Mixing and Enhanced Dissipation: A PDE-Theoretic Perspective*

Abstract: This minicourse offers a comprehensive overview of *mixing* and *enhanced dissipation*—phenomena of central importance in both physics and mathematics due to their fundamental role in fluid mechanics and wide-ranging applications, particularly in chemical processes, geosciences, and engineering.

We begin by tracing the physical foundations of mixing and enhanced dissipation, revisiting classical work by G.I. Taylor, Rhines, Young, and others, which first elucidated the interplay between advection and diffusion in passive scalar transport. This physical intuition motivates a rigorous mathematical treatment of the linear advection-diffusion equation in incompressible flows.

The core of the course focuses on recent advances in the quantitative analysis of mixing and enhanced dissipation. We will examine how advection-driven mixing leads to accelerated decay of scalar quantities—beyond classical diffusion time scales—and discuss sharp estimates on dissipation rates in relation to the structure of the velocity field. Special attention will be given to shear flows and the crucial role of hypocoercivity. Key results from the literature (e.g., Constantin, Kiselev, Ryzhik & Zlatos 2008; Bedrossian & Coti Zelati 2017; Coti Zelati, Delgadino & Elgindi 2019) will be presented, along with recent joint work with Johannes Benthous on (super-)enhanced dissipation in time-dependent and intermittent flows. Some of these flows are inspired by mixing mechanisms used in laboratory settings and offer insight into the design of efficient mixing protocols.

The course concludes with a discussion of the Batchelor scale conjecture and reviewing recent results that brings us close to a rigorous resolution. Connections to nonlinear PDEs—such as the Cahn–Hilliard and Kuramoto–Sivashinsky equations—will also be discussed, showing how insights from the linear theory of enhanced dissipation play a key role in understanding more complex nonlinear dynamics.

Plenary talk (Mikaela Iacobelli, ETH Zürich)

Title: *Challenges and Breakthroughs in the Mathematics of Plasmas*

Abstract: This colloquium will explore some fundamental issues in the mathematics of plasmas, focusing on the stability and instability of solutions to Vlasov-type equations, which are crucial for describing the behavior of charged particles in a plasma. A general introduction to kinetic theory is given, making the subject accessible to a wide audience of mathematicians. Key mathematical concepts such as well-posedness, stability, and the behavior of solutions in singular limits are discussed. In addition, a new class of Wasserstein-type distances is introduced, offering new perspectives on the stability of kinetic equations.

Contributed talks

Guendalina Palmirotta (Universität Paderborn)

Title: *Fractal Schrödinger equation on hyperbolic spaces*

Abstract: We introduce the Schrödinger equation with a fractional Laplacian on real hyperbolic spaces and their discrete analogues, homogeneous trees. While on real hyperbolic spaces, the Strichartz estimates for the fractional Laplacian exhibit a loss of derivatives (due to the Knapp phenomenon), in the setting of homogeneous trees, this loss vanishes due to the triviality of the estimates for small times.

This is a joint work with Jean-Philippe Anker and Yannick Sire.

Manuela Feistl-Held (TH Rosenheim)

Title: *Microscopic Derivation of Vlasov type equations*

Abstract: I present a probabilistic technique for the proof of the mean-field limit and propagation of chaos of a N -particle system in three dimensions with highly singular interactions.

The two recent results lead to a derivation of the Vlasov-Poisson equation on the one hand and to a derivation of the Vlasov-Dirac-Benney equation on the other hand, depending on the pair interaction potential.

In the first application we prove for typical initial data convergence of the empirical distributions to solutions of the Vlasov-Poisson system for Coulomb interaction and cut-off size much smaller than the typical inter particle distance.

More precisely, the interaction fulfils $f^N(q) = \pm \frac{q}{|q|^3}$ for $|q| > N^{-\frac{5}{12} + \sigma}$ and has a cut-off at $|q| = N^{-\frac{5}{12} + \sigma}$ where $\sigma > 0$ can be chosen arbitrarily small.

In the second application we prove also for typical initial data, convergence of the empirical distributions to solutions of the Vlasov-Dirac-Benney system with compactly supported pair potentials of the form $N^{3\beta-1} \phi(N^\beta x)$ for $\beta \in [0, \frac{1}{7}]$ and $\phi \in L^\infty(\mathbb{R}^3) \cap L^1(\mathbb{R}^3)$. Thus our result leads to a derivation of the Vlasov-Dirac-Benney equation from the microscopic N -particle dynamics with a strong short range force. In particular, for typical initial data, we show convergence of the Newtonian trajectories to the characteristics of the Vlasov type equations.

Effie Papageorgiu (Universität Paderborn)

Title: *L^p asymptotic behavior for the heat equation on hyperbolic space*

Abstract: The Central Limit Theorem in the PDE setting can be stated as follows: the solution to the heat equation with L^1 initial data u_0 behaves asymptotically as the mass $M = \int u_0$ times the fundamental solution h_t (the heat kernel).

Since the heat kernel is rather sensitive to the underlying geometry, it is a natural task to examine whether such a large-time behavior remains true when changing the setting. We show that on (real) hyperbolic space not only the quantity corresponding to M should be varying with p , but it should also be a function rather than a constant; in fact, this function turns out to have a completely different expression for $1 \leq p < 2$ and for

$2 \leq p \leq \infty$. The results extend to symmetric spaces of non-compact type, and recover and extend results by Vazquez, Anker et al, Naik et al.

Julian Blawid (Universität Regensburg)

Title: *Stress-Modulated Growth of Elastic Tissue at Small Strains*

Abstract: We present a model for stress-modulated growth of a body driven by the presence of nutrients and prove existence of solutions for small strains. The growth process is governed by an ODE on a Banach space and the total deformation is determined by the solution of the formal Euler-Lagrange equations of a hyperelastic variational problem. Moreover, the nutrient concentration is given by the solution of a linear elliptic reaction-diffusion equation. The model features a multiplicative decomposition of the total deformation gradient into an elastic part and a part related to the growth process which is key for the analysis as it allows for separating the two processes in the momentum balance.

Hanifah Mumtaz (Universität Regensburg)

Title: *Ginzburg-Landau Approximation of the Ericksen-Leslie System: Energy, Well-Posedness, and Asymptotics in Bounded Domains*

Abstract: Nematic liquid crystals are a foundational class of soft matter materials, essential in both cutting-edge technologies such as liquid crystal displays and in the modeling of complex fluid flows with orientational order. Understanding their behavior on bounded domains is particularly relevant for practical applications, as most physical devices and experiments involve finite, confined geometries where boundary effects can significantly influence the system's dynamics.

This talk addresses recent advances in the mathematical analysis of nematic liquid crystal flows via the Ginzburg-Landau approximation to the Ericksen-Leslie system posed on bounded domains. I will discuss a rigorous framework for establishing local well-posedness for strong solutions under natural boundary conditions, employing refined energy estimates that yield uniform (in the penalization parameter) a priori bounds. By leveraging asymptotic expansions and spectral analysis, we derive convergence rates for the Ginzburg-Landau model towards (exact) Ericksen-Leslie system. These results enhance our understanding of how to apply techniques from sharp-interface dynamics in complex fluids to liquid crystal systems. The talk is aimed at applied analysts interested in nonlinear PDE, mathematical fluid dynamics, and singular limit problems.

Poster session

Jilly Kevo (Universität Bonn)

Title: *Trace and Index of Callias operators on Hyperbolic Space*

Duy DO (Paris-Saclay University)

Title: *Stabilisation of infinite-dimensional systems*

Sana Ben Hafsia (Paris-Est Créteil University)

Title: *Existence results for non-local Operator problems*

Gender Studies

Plenary talk (Lara Gildehaus, Klagenfurt University)

Title: *The invisible boundaries – Understanding and reducing gender biases in mathematics*

Abstract: Although there are now hardly any formal barriers to accessing mathematics, and theoretically anyone can be enthusiastic about mathematics, current studies, and participation figures repeatedly indicate that actual access to mathematics is not equal. Therefore, in my presentation, I will try to shed light on existing gender biases in mathematics from school to university to the academic field and discuss their effects. Practical implications for more gender-sensitive mathematics teaching and learning will then be addressed.

Miscellaneous information

Conference venue

The conference will take place at the at the 1st floor of the Mathematics building of Regensburg University (Attention: **not** the department "Mathematik und Informatik" of the OTH).

All the plenary talks and career panels will be given in H31.

The parallel session of Geometric Group Theory will be held in H31.

The parallel session of Arithmetic Geometry will be held in M103.

The parallel session of analysis of PDEs will be held in M102.

The registration, the poster session and the coffee breaks will be in M104.

The "Eltern-Kind Zimmer" for childcare is located at the 0th floor in M008 (contact the organisers for the key).

Conference dinner

A conference dinner will take place at 7:00pm on Tuesday July 29th at

Brauhaus am Schloss, Waffnergasse 6, 93047 Regensburg

The restaurant, which is located in the city centre, can be easily reached by public transport (e.g. Linie 2, 6) from the conference venue.

Other

Transport: If you purchased the Deutschland Ticket for the month of July, then you can get any bus in Regensburg for free.

If not, you can purchase single or daily tickets directly on the buses or on the RVV app.

Wifi: Access to eduroam and BayernWLAN is available throughout the Mathematics department and in the whole campus.

Lunch: In the lunch break, you will have mainly three available options in the campus: Mensa, Cafeteria or Unikat.

Mensa and Cafeteria admits only card payments and they offer respectively warm dishes or sandwiches and pizzas. The prices are fairly low. Unikat, allowing both cash and card payment, is a pizzeria-restaurant where prices are usual pizzeria prices.

All of them offer also vegetarian and vegan options.

Organisers

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Campus map

Universität Regensburg

General Plan

Sources: Digital Data of
State Office for
Building
and Construction

Design: Bauabteilung, July 2024

