Deutsche Mathematiker-Vereinigung

ANNUAL MEETING 2022

PROGRAM

WELCOME TO BERLIN!

Welcome to the annual meeting 2022 of the Deutsche Mathematiker-Vereinigung hosted by the Berlin Mathematics Research Center MATH+ in cooperation with the Department of Mathematics and Computer Science of Freie Universität Berlin!

The conference will begin with the formal presentation of the Hermann Minkowski Medal of the DMV and the von Kaven Award of the Deutsche Forschungsgemeinschaft. The Hermann Minkowski Medal has been awarded for the first time in 2020 and this year the mathematician Martina Hofmanovà will be the second awardee. The von Karven Award is intended to honor outstanding applicants to the Heisenberg and Emmy Noether program and this year will be presented to Gandalf Lechner from FAU Erlangen.

The scientific program includes 10 keynote talks of speakers from Germany, France, United Kingdom, Austria, and Switzerland as well as more than 200 talks in 14 sections and 13 minisymposia which will give an insight into the state of research in a wide range of mathematics. This would not have been possible without the enthusiasm, commitment and creativity of the 11 members of the program committee, of the 29 organizers of minisymposia and of the 30 section leaders.

This program will be completed by awarding the winners of the Bundeswettbewerb Mathematik and of the DMV cartoon prize, a reading by Norbert Lossau, a public talk of Christof Schütte – President of the “Zuse Institut Berlin” – and by the General DMV Meeting.

We would like to take the opportunity to thank the supporting institutions of MATH+, FU and TU Berlin, Humboldt University, the Weierstrass Institute for Applied Analysis and Stochastics, and the Zuse Institute Berlin, for their support in preparing and realizing of this Conference.

Joachim Escher
(Vice President of DMV)

Ralf Kornhuber
(on behalf of the Organizing Committee)

PROGRAM
Monday, September 12

08.00–09.00 REGISTRATION AND COFFEE _ Arnimallee 22

09.00–09.30 OPENING _ Arnimallee 22
Welcome, Award of the Minkowski Medal and the von Kaven Award

09.30–10.30 PLENARY LECTURE _ Arnimallee 22
▷ Martin Bridson (University of Oxford)
Finite shadows of infinite groups and the geometry of 3-dimensional manifolds

10.30–11.00 COFFEE BREAK _ Arnimallee 22

11.00–13.00
▷ S 01 Mathematical Logic
▷ S 02 Algebra and Number Theory
▷ S 03 Algebraic Geometry
▷ S 09 Applied Analysis and Partial Differential Equations
▷ S 10 Numerical Mathematics and Scientific Computing
▷ MS 04 Nonlinear Algebra in the Sciences

13.00–14.00 LUNCH

14.00–15.00 PLENARY LECTURE _ Arnimallee 22
▷ Alexandra Carpentier (Universität Potsdam)
Composite-composite testing and extensions

15.00–15.30 COFFEE BREAK _ Arnimallee 22

15.30–17.30
▷ S 01 Mathematical Logic
▷ S 02 Algebra and Number Theory
▷ S 03 Algebraic Geometry
▷ S 10 Numerical Mathematics and Scientific Computing
▷ MS 04 Nonlinear Algebra in the Sciences
▷ MS 07 Extremal and Probabilistic Combinatorics

17.45–20.00 WELCOME RECEPTION _ Arnimallee 22

PROGRAM
Tuesday, September 13

09.00–10.00 PLENARY LECTURE _ Arnimallee 22
▷ Bernhard Schölkopf (Max Planck Institute for Intelligent Systems Tübingen)
Intelligent system: Symbolic, statistical, and causal

10.00–10.30 COFFEE BREAK _ Arnimallee 22

10.30–12.30
▷ S 01 Mathematical Logic
▷ S 02 Algebra and Number Theory
▷ S 03 Algebraic Geometry
▷ S 09 Applied Analysis and Partial Differential Equations
▷ S 10 Numerical Mathematics and Scientific Computing
▷ MS 01 Mathematical Analysis of Complex Quantum Systems
▷ MS 07 Extremal and Probabilistic Combinatorics
▷ MS 09 The Future of Digital Infrastructures for Mathematical Research
▷ MS 10 Locally Convex Methods in Analysis
▷ MS 13 What are Lectures in Mathematics and What Should They Be?

12.30–14.00 LUNCH

14.00–15.00 PLENARY LECTURE _ Arnimallee 22
▷ Alexander Martin (Friedrich-Alexander Universität Erlangen-Nürnberg)
Mixed integer optimization problems on networks with PDE constraints

15.00–15.30 COFFEE BREAK _ Arnimallee 22

15.30–17.45 General Assembly of DMV _ Arnimallee 22

17.45–18.00 ACTIVE COFFEE BREAK _ Arnimallee 22

18.00–21.00 Bundeswettbewerb Mathematik, Reading, and Cartoon Prize _ Arnimallee 22

PROGRAM
Wednesday, September 14

09.00–10.00 PLENARY LECTURE _ Arnimallee 22
▷ Adrian Constantin (Universität Wien)
Stratospheric planetary flows from the perspective of the Euler equation on a rotating sphere

10.00–10.30 COFFEE BREAK _ Arnimallee 22

10.30–12.30
▷ S 02 Algebra and Number Theory
▷ S 03 Algebraic Geometry
▷ S 04 Differential Geometry and Geometric Analysis
▷ S 05 Discrete Mathematics
▷ S 06 Topology and Geometry
▷ S 07 Functional Analysis, Real and Complex Analysis
▷ S 09 Applied Analysis and Partial Differential Equations
▷ S 13 Mathematical Statistics, Data Science and Machine Learning
▷ S 14 History and Didactics of Mathematics
▷ MS 01 Mathematical Analysis of Complex Quantum Systems
▷ MS 09 The Future of Digital Infrastructures for Mathematical Research
▷ MS 10 Locally Convex Methods in Analysis

12.30–14.00 LUNCH

14.00–15.00 PLENARY LECTURE _ Arnimallee 22
▷ Des Higham (University of Edinburgh)
Should we be perturbed about deep learning?

15.00–15.30 COFFEE BREAK _ Arnimallee 22

15.30–17.30
▷ S 01 Mathematical Logic
▷ S 03 Algebraic Geometry
▷ S 04 Differential Geometry and Geometric Analysis
▷ S 05 Discrete Mathematics
▷ S 07 Functional Analysis, Real and Complex Analysis
▷ S 08 Ordinary Differential Equations and Dynamical Systems
▷ S 09 Applied Analysis and Partial Differential Equations
▷ S 13 Mathematical Statistics, Data Science and Machine Learning
▷ S 14 History and Didactics of Mathematics
▷ MS 01 Mathematical Analysis of Complex Quantum Systems

19.00–22.00 CONFERENCE DINNER _ Alte Pumpe, Lützowstraße 42, 10785 Berlin

PROGRAM
Thursday, September 15

09.00–10.00 PLENARY LECTURE _ Arnimallee 22
▷ Fanny Kassel (Institut des Hautes Études Scientifiques (IHÉS))
Discrete subgroups of Lie groups in higher rank

10.00–10.30 COFFEE BREAK _ Arnimallee 22

10.30–12.30
▷ S 01 Mathematical Logic
▷ S 03 Algebraic Geometry
▷ S 05 Discrete Mathematics
▷ S 06 Topology and Geometry
▷ S 08 Ordinary Differential Equations and Dynamical Systems
▷ S 12 Probability, Computational Stochastics, and Financial Mathematics
▷ S 13 Mathematical Statistics, Data Science and Machine Learning
▷ MS 01 Mathematical Analysis of Complex Quantum Systems
▷ MS 05 Nonlinear Evolution Equations and Applications

12.30–14.00 LUNCH

14.00–15.00 PLENARY LECTURE _ Arnimallee 22
▷ Rahul Pandharipande (ETH Zürich)
A tour of the geometry of points in affine space

15.00–15.30 COFFEE BREAK _ Arnimallee 22

15.30–17.30
▷ S 03 Algebraic Geometry
▷ S 06 Topology and Geometry
▷ S 07 Functional Analysis, Real and Complex Analysis
▷ S 11 Discrete and Nonlinear Optimization
▷ S 12 Probability, Computational Stochastics, and Financial Mathematics
▷ S 13 Mathematical Statistics, Data Science and Machine Learning
▷ MS 02 Global Analysis and Geometry
▷ MS 03 Mathematics and Arts
▷ MS 05 Nonlinear Evolution Equations and Applications
▷ MS 06 Translation Surfaces
▷ MS 12 Higher Differential Geometry

17.45–18.00 ACTIVE COFFEE BREAK _ Arnimallee 22

18.00–19.00 PUBLIC LECTURE _ Arnimallee 22
Christoph Schütte (ZIB Berlin and FU Berlin)
Relevance and ignorance

19.00–20.00 INFORMAL GET TOGETHER _ Arnimallee 22

PROGRAM
Friday, September 16

09.00–10.00 PLENARY LECTURE _ Arnimallee 22
▷ Oscar Randal-Williams (University of Cambridge)
Homeomorphisms of Euclidean space

10.00–10.30 COFFEE BREAK _ Arnimallee 22

10.30–12.30
▷ S 05 Discrete Mathematics
▷ S 08 Ordinary Differential Equations and Dynamical Systems
▷ S 11 Discrete and Nonlinear Optimization
▷ S 12 Probability, Computational Stochastics, and Financial Mathematics
▷ MS 02 Global Analysis and Geometry
▷ MS 03 Mathematics and Arts
▷ MS 06 Translation Surfaces
▷ MS 08 Advances in K-Theory, Symmetry, and Periodicity
▷ MS 11 Algebra and Low-Dimensional Topology

12.30–14.00 LUNCH

14.00–15.00 PLENARY LECTURE _ Arnimallee 22
▷ Hugo Duminil-Copin (Institut des Hautes Études Scientifiques (IHÉS))
Critical phenomena through the lens of the Ising model

15.00–15.30 COFFEE BREAK _ Arnimallee 22

15.30–17.30
▷ S 08 Ordinary Differential Equations and Dynamical Systems
▷ S 11 Discrete and Nonlinear Optimization
▷ MS 02 Global Analysis and Geometry
▷ MS 03 Mathematics and Arts
▷ MS 08 Advances in K-Theory, Symmetry, and Periodicity
▷ MS 11 Algebra and Low-Dimensional Topology
▷ MS 12 Higher Differential Geometry

PLENARY LECTURES

Monday

Martin Bridson (University of Oxford)
▷ ***Finite shadows of infinite groups and the geometry of 3-dimensional manifolds***
Alexandra Carpentier (Universität Potsdam)
▷ ***Composite-composite testing and extensions***

Tuesday

Bernhard Schölkopf (Max Planck Institute for Intelligent Systems Tübingen)
▷ ***Intelligent system: Symbolic, statistical, and causal***
Alexander Martin (Friedrich-Alexander Universität Erlangen-Nürnberg)
▷ ***Mixed integer optimization problems on networks with PDE constraints***

Wednesday

Adrian Constantin (Universität Wien)
▷ ***Stratospheric planetary flows from the perspective of the Euler equation on a rotating sphere***
Des Higham (University of Edinburgh)
▷ ***Should we be perturbed about deep learning?***

Thursday

Fanny Kassel (Institut des Hautes Études Scientifiques (IHÉS))
▷ ***Discrete subgroups of Lie groups in higher rank***
Rahul Pandharipande (ETH Zürich)
▷ ***A tour of the geometry of points in affine space***
Christof Schütte (ZIB Berlin and FU Berlin)
▷ ***Relevance and ignorance***

Friday

Oscar Randal-Williams (University of Cambridge)
▷ ***Homeomorphisms of Euclidean space***
Hugo Duminil-Copin (Institut des Hautes Études Scientifiques (IHÉS))
▷ ***Critical phenomena through the lens of the Ising model***

PLENARY LECTURES
Monday, September 12

Main Lecture Hall (B.001), Department of Chemistry, Arnimallee 22a

09.30–10.30 Chair: Ilka Agricola

Martin Bridson (University of Oxford)

Finite shadows of infinite groups and the geometry of 3-dimensional manifolds

There are many situations in geometry and group theory where it is natural, convenient or necessary to explore infinite groups via their actions on finite objects (equivalently, their profinite completions). But how much understanding can one really gain about an infinite group by examining its finite images? I will sketch some of the rich history of this problem and describe how input from geometry and low-dimensional topology have transformed the subject in recent years. I shall then sketch recent work, rooted in the geometry of 3-manifolds, that highlights the importance of finite presentation in this context. And I shall describe some compelling open questions.

14.00–15.00 Chair: Alain-Sol Sznitman

Alexandra Carpentier (Universität Potsdam)

Composite-composite testing and extensions

Testing theory is a corner stone of mathematical statistics, with many practical applications. While asymptotic and parametric testing is relatively well understood, many additional issues arise in non-parametric or high dimensional models. This is particularly the case when the two hypotheses are composite, i.e., do not consist of a single point. In this case, only few theoretical results are available, and seemingly simple questions remain open. In this talk, I will introduce the problem of composite-composite testing, and present some own (together with co-authors) results in this field.

PLENARY LECTURES
Tuesday, September 13

Main Lecture Hall (B.001), Department of Chemistry, Arnimallee 22a

09:00–10.00 Chair: Frank Noé

Bernhard Schölkopf (Max Planck Institute for Intelligent Systems Tübingen)

Intelligent system: Symbolic, statistical, and causal

We describe basic ideas underlying research to build and understand artificially intelligent systems: from symbolic approaches via statistical learning to interventional models relying on concepts of causality. Some of the hard open problems of machine learning and AI are intrinsically related to causality, and progress may require advances in our understanding of how to model and infer causality from data.

14.00–15.00 Chair: Martin Skutella

Alexander Martin (Friedrich-Alexander Universität Erlangen-Nürnberg)

Mixed integer optimization problems on networks with PDE constraints

Motivated by challenging questions in the transformation and control of our energy system, we study mixed integer optimization problems on networks with PDE constraints. Control decisions are typically modeled by integer optimization methods, while the physical behavior of water, gas and hydrogen is represented in a continuous nonlinear way, e.g., by partial differential equations (PDEs). The topic of this talk is to discuss mathematical approaches and insights for the efficient coupling of integer and continuous nonlinear optimization in this context. We will also demonstrate the numerical success using examples from gas network optimization within the framework of the SFB/TR 154.

PLENARY LECTURES
Wednesday, September 14

Main Lecture Hall (B.001), Department of Chemistry, Arnimallee 22a

09.00–10.00 Chair: Joachim Escher

Adrian Constantin (Universität Wien)

Stratospheric planetary flows from the perspective of the Euler equation on a rotating sphere

We discuss stationary solutions of Euler's equation on a rotating sphere and their relevance to the dynamics of stratospheric flows in the atmosphere of the outer planets of our solar system. We present some rigidity and stability results. – This is joint work with Pierre Germain (Courant Institute of Mathematical Sciences, New York).

14.00–15.00 Chair: Heike Faßbender

Des Higham (University of Edinburgh)

Should we be perturbed about deep learning?

Many commentators are asking whether current AI solutions are sufficiently robust, resilient, and trustworthy; and how such issues should be quantified and addressed. In an extreme case, it has been shown that a traffic "Stop" sign on the roadside can be misinterpreted by a driverless vehicle as a speed limit sign when minimal graffiti is added. The vulnerability of systems to such adversarial interventions raises questions around security and ethics, and there has been a rapid escalation of heuristic attack and defence strategies. I believe that mathematicians can contribute to this landscape. From a numerical analysis perspective, this is a conditioning issue: how sensitive is the input-output map to perturbations in the input, or to the map itself? After discussing traditional adversarial attacks on input data, I will focus on a class of recently proposed variations where the attacker has complete access to the full AI system. Here, changes to the weights and biases in a deep learning network, or modifications of the underlying architecture, can lead to a perturbed system whose output is (a) unchanged on a large validation set that is hidden from the attacker, but (b) dramatically altered on a specific target input of interest. I will describe a new "network attack" algorithm that (a) can be proved to succeed with high probability under realistic assumptions, and (b) can be seen to operate effectively in practice. – The talk is based on joint work with Alexander Bastounis (Edinburgh), Alexander Gorban (Leicester), Ivan Tyukin (Kings) and Eliyas Woldegeorgis (Leicester).

PLENARY LECTURES
Thursday, September 15

Main Lecture Hall (B.001), Department of Chemistry, Arnimallee 22a

09.00–10.00 Chair: Anke Pohl

Fanny Kassel (Institut des Hautes Études Scientifiques (IHÉS))

Discrete subgroups of Lie groups in higher rank

Discrete subgroups of Lie groups play a fundamental role in several areas of mathematics. In the case of $SL(2, R)$, they are well understood and classified by the geometry of the corresponding hyperbolic surfaces. In the case of $SL(n, R)$ with $n > 2$, they remain more mysterious, beyond the important class of lattices (i.e., discrete subgroups of finite covolume for the Haar measure). These past twenty years, several interesting classes of discrete subgroups have emerged, which are "thinner" than lattices, more flexible, and with remarkable geometric and dynamical properties. We will present some recent developments in the subject.

14.00–15.00 Chair: Gavril Farkas

Rahul Pandharipande (ETH Zürich)

A tour of the geometry of points in affine space

The study of the space of d distinct and unordered points in C^n is fundamental from several perspectives. In algebraic geometry, the space sits naturally inside the Hilbert scheme of d points – which captures information about the collisions of points. I will explain the remarkable structure of the Hilbert scheme in low dimensional cases (concentrating on $n \leq 3$). The geometry is related to many different streams in mathematics: combinatorics, representation theory, knot theory, and gauge theory to name a few. My goal is to present a landscape of connections, known results, and open questions.

18:00–19.00 Chair: Ralf Kornhuber

Christof Schütte (ZIB Berlin and FU Berlin)

Relevance and ignorance

Public Lecture

PLENARY LECTURES
Friday, September 16

Main Lecture Hall (B.001), Department of Chemistry, Arnimallee 22a

09.00–10.00 Chair: Holger Reich

Oscar Randal-Williams (University of Cambridge)

Homeomorphisms of Euclidean space

The topological group of homeomorphisms of d-dimensional Euclidean space is a basic object in geometric topology, closely related to understanding the difference between diffeomorphisms and homeomorphisms of all d-dimensional manifolds (except when $d = 4$). I will explain some methods that have been used for studying the algebraic topology of this group, and report on a recently obtained conjectural picture of it.

14.00–15.00 Chair: Günter M. Ziegler

Hugo Duminil-Copin (Institut des Hautes Études Scientifiques (IHÉS))

Critical phenomena through the lens of the Ising model

The Ising model is one of the most classical lattice models of statistical physics undergoing a phase transition. Initially imagined as a model for ferromagnetism, it revealed itself as a very rich mathematical object and a powerful theoretical tool to understand cooperative phenomena. Over one hundred years of its history, a profound understanding of its critical phase has been obtained. While integrability and mean-field behavior led to extraordinary breakthroughs in the two-dimensional and high-dimensional cases respectively, the model in three and four dimensions remained mysterious for years. We will present recent progress in these dimensions based on a probabilistic interpretation of the Ising model relating it to percolation models.

Sections

SECTION
S 01 Mathematical Logic

Section Leaders: Aleksandra Kwiatkowska and Sandra Müller

SESSION 1 _ Monday, September 12 _ 11.00–13.00 _ Takustraße 9: SR 006
Chairs: Aleksandra Kwiatkowska and Sandra Müller

11.00 Philipp Hieronymi (Universität Bonn, Germany)
▷ *A strong version of Cobham's theorem (and other thoughts on decidability in expansions of Presburger arithmetic)*

12.00 Matteo de Ceglie (Universität Salzburg, Austria)
▷ *The Multiverse Operator and Hamkins' multiverse*

12.30 Rob Sullivan (University of Münster, Germany)
▷ *The externally definable Ramsey property*

SESSION 2 _ Monday, September 12 _ 15.30–17.30 _ Takustraße 9: SR 006
Chairs: Aleksandra Kwiatkowska and Sandra Müller

15.30 Maxwell Simon Levine (University of Freiburg, Germany)
▷ *Singular cardinals and square principles*

16.30 Takehiko Gappo (Rutgers University, USA)
▷ *Determinacy in the Chang model*

SESSION 3 _ Tuesday, September 13 _ 10.30–12.30 _ Takustraße 9: SR 006
Chairs: Aleksandra Kwiatkowska and Sandra Müller

10.30 Nadav Meir (Uniwersytet Wrocławski, Poland)
▷ *Lexicographic products of structures and theories*

11.30 Balthasar Grabmayr (University of Haifa, Israel)
▷ *First steps towards absolute versions of metamathematical results*

12.00 Christine Gaßner (Universität Greifswald, Germany)
▷ *Second-order logic and Russell's axiom of choice*

SESSION 4 _ Wednesday, September 14 _ 15.30–17.30 _ Takustraße 9: SR 006
Chairs: Aleksandra Kwiatkowska and Sandra Müller

15.30 Philipp Schlicht (University of Bristol, United Kingdom)
▷ *Interaction of determinacy and forcing*

16.30 Bartosz Wcisło (University of Gdańsk, Poland)
▷ *Conservative and non-conservative variants of truth predicates*

17.00 Adrián Portillo (University of Wrocław, Poland)
▷ *On stable quotients*

SESSION 5 _ Thursday, September 15 _ 10.30–12.30 _ Takustraße 9: SR 006
Chairs: Aleksandra Kwiatkowska and Sandra Müller

10.30 Corey Switzer (Kurt Gödel Research Center for Mathematical Logic, University of Vienna, Austria)
▷ *Ideal independence and filters*

11.00 Jana Marikova (University of Vienna, Austria)
▷ *Definable matchings in o-minimal bipartite graphs*

11.30 Valentina Disarlo (Universität Heidelberg, Germany)
▷ *The model theory of the curve graph*

ABSTRACTS

Philipp Hieronymi (Universität Bonn, Germany)
A strong version of Cobham's theorem (and other thoughts on decidability in expansions of Presburger arithmetic)

Let $k, l > 1$ be two multiplicatively independent integers. A subset X of Nn is k-recognizable if the set of k-ary representations of X is recognized by some finite automaton. Cobham's famous theorem states that a subset of the natural numbers is both k-recognizable and l-recognizable if and only if it is Presburger-definable (or equivalently: semilinear). We show the following strengthening. Let X be k-recognizable, let Y be l-recognizable such that both X and Y are not Presburger-definable. Then the first-order logical theory of $(N, +, X, Y)$ is undecidable. This is in contrast to a well-known theorem of Büchi that the first-order logical theory of $(N, +, X)$ is decidable. Our work strengthens and depends on earlier work of Villemaire and Bès.

The essence of Cobham's theorem is that recognizability depends strongly on the choice of the base k. Our results strengthens this: two non-Presburger definable sets that are recognizable in multiplicatively independent bases, are not only distinct, but together computationally intractable over Presburger arithmetic. This is joint work with Christian Schulz.

Matteo de Ceglie (Universität Salzburg, Austria)

The Multiverse Operator and Hamkins' multiverse

Ten years ago, Hamkins (2012) changed the landscape of the foundations of mathematics, by introducing a novel conception that tried to clarify some ambiguous notions in current set theoretic practice. In particular, he provided a revolutionary interpretation for the practice of forcing: a multiverse of different set theoretic universes. Indeed, while the general idea behind pluralism in the philosophy of mathematics is more or less the same every time, the actual mathematical details can vary enormously from one characterisation to the other. Even though all these different set theoretic multiverses share the same, general, philosophical idea, they differ wildly from the mathematical perspective. In this paper, I propose a novel, more general, framework for the set theoretic multiverse: the Universal Multiverse. This new framework is not a new set theoretic multiverse. Instead, it is a general theory of the multiverse, that investigates the various set theoretic multiverses from a common and abstract point of view. This means highlighting the common features of all multiverses, studying them as mathematical structures without any other metaphysical and ontological connotation. To do so, I introduce a Multiverse Operator, Mlt_i, that maps set theoretic universes to the multiverse generated from them using a particular generating method. For example, if we apply set generic forcing to V, we end up with Steel's set generic multiverse, thus the multiverse operator Mlt_{generic} applied to V maps to Steel's set generic multiverse. I claim that this Multiverse Operator, together with a set theoretic multiverse, forms a Tarski Structure, i.e., it obeys the following axioms: (1) $V\kappa \subseteq Mlt(V\kappa)$; (2) $V\kappa \subseteq V\lambda \implies Mlt(V\kappa) \subseteq Mlt(V\lambda)$; (3) $Mlt(Mlt(V\kappa)) \subseteq Mlt(V\kappa)$ In this paper, as a case study, I will analyse Hamkins' multiverse (as characterised in Gitman, Hamkins (2011)) using the multiverse operator, and show that it is indeed a Tarski structure.

Rob Sullivan (University of Münster, Germany)

The externally definable Ramsey property

In this talk, I will introduce a weakened version of the Ramsey property: the "externally definable Ramsey property", where the colourings considered are restricted to those that are externally definable. We will explore several examples (and non-examples) of ultrahomogeneous structures with this property, and we will also discuss how to characterise ultrahomogeneous structures with the externally definable Ramsey property in terms of their topological dynamics. This is joint work with Nadav Meir.

Maxwell Simon Levine (University of Freiburg, Germany)
Singular cardinals and square principles

Singular cardinals are an interesting topic in set theory because they are subject to both ZFC proofs and independence results using forcing. On one hand, the PCF theory devised by Shelah in the 1990's can establish some surprising constraints on the properties of singular cardinals. The most famous of these results is that if $\aleph_\omega$ is a strong limit, then $2^{\aleph_\omega} < \aleph_{\omega_4}$; the optimal bound is unknown, but it cannot be any smaller than $\aleph_{\omega_1}$. In order to get a clearer view of this area, we study a tension between the combinatorial properties of large cardinals and those of canonical inner models. Of particular interest are *square principles*. Jensen originally distilled the principle $\square_\kappa$ (where κ is some given cardinal) to analyze the properties of Gödel's Constructible Universe *L*. A wide variety of square principles have been studied, with a varying impact on the reflection properties of large cardinals. The models of interest in this area realize some compatibility of both square principles and the compactness properties exhibited by large cardinals.

This talk will survey the general concepts and some of the fundamental results pertaining to singular cardinals and square principles, with some focus on the contributions of the speaker. A number of themes will be presented: First, the complex web of interrelationships studied by Cummings, Foreman, and Magidor between square principles, the scales used in PCF theory, and the stationary reflection principles entailed by large cardinals. Second, we will consider the pronounced distinction between singular cardinals of countable and uncountable cofinality, as they relate to square principles. We will also discuss recent results having to do with compactness of square principles.

Takehiko Gappo (Rutgers University, USA)
Determinacy in the Chang model

The Chang model is the minimal inner model of ZF closed under countable sequences. In this talk, I will present the result that the Axiom of Determinacy holds in the Chang model assuming the existence of a hod mouse with a Woodin limit of Woodin cardinals. This is a joint work with Grigor Sargsyan (IMPAN).

Nadav Meir (Uniwersytet Wrocławski, Poland)

Lexicographic products of structures and theories

In combinatorics, there are numerous notions of a product of two given graphs, one of them being the lexicographic product. We will present a construction called the lexicographic product of structures, generalizing the lexicographic product of graphs and the lexicographic order.

As we will see, this product admits relative quantifier elimination with respect to its building blocks. This is not the case if we iterate the product infinitely many times. In this case, there is an infinitary analogue of quantifier elimination, which we will present.

Finally, we will show some applications of the lexicographic product to model theory and to structural Ramsey theory.

All of the notions mentioned above will be defined, and only basic knowledge of first-order structures and formulas will be assumed

Balthasar Grabmayr (University of Haifa, Israel)

First steps towards absolute versions of metamathematical results

There is a well-known gap between metamathematical theorems and their interpretations. Take Tarski's Theorem. According to its prevalent interpretation, the collection of all arithmetical truths is not arithmetically definable. However, the underlying metamathematical theorem merely establishes the arithmetical undefinability of a set of specific Gödel codes of certain artefactual entities, such as infix strings, which are true in the standard model. That is, as opposed to its informal reading, the metamathematical theorem is formulated and proved relative to a specific choice of the Gödel numbering and the notation system. Similar observations apply to Gödel and Church's theorems, which together with Tarski's Theorem are commonly taken to be among the most important discoveries of modern logic. The primary goal of this talk is to discuss if and how this gap can be closed.

The talk consists of two parts. In the first part, I examine the extent to which Gödel, Tarski and Church's theorems are invariant regarding notation systems and Gödel numberings. I first introduce deviant notation systems and numberings which give rise to definable truth predicates, provable consistency sentences and computable decision procedures, in contradiction to the fundamental theorems due to Tarski, Gödel and Church respectively. However, I argue that these "counterexamples" do not refute the theorems' prevalent interpretations, since the employed numberings and notation systems are inadmissible choices

in the formalisation process. Moreover, I show that once natural classes of admissible numberings are singled out, the considered theorems indeed are invariant regarding numberings and notation systems.
As a counterpoint, I show in the second part of the talk that the transition from mathematical to informal claims is problematic in the context of certain axiomatic type-free truth theories. In particular, I show that even strongly restrictive constraints on admissible Gödel numberings are not sufficient to determine the consistency of particular type-free truth theories. Hence, the formalisation of certain informal principles of truth in a formal setting is highly sensitive to the underlying formalisation choices. As a result, I argue that certain kinds of axiomatic truth theories should not be taken to faithfully reflect informal reasoning regarding the underlying principles of truth. The second part of the talk is based on joint work with Albert Visser.

Christine Gaßner (Universität Greifswald, Germany)
Second-order logic and Russell's axiom of choice

First, we give an overview of second-order logic with comprehension and compare different Henkin interpretations described in detail by Henkin (1950), Asser (1981), Shapiro (1991), Väänänen (2019), and others. In addition, we describe a method for constructing Henkin structures derived from the Fraenkel–Mostowski–Specker method which is known as a method for constructing models of ZFA. Finally, we summarize consequences for the relations between different formulations of the axiom of choice. We consider some choice principles whose formulations go back to considerations of Russell, and provide new insights into the relationships between these principles in second-order predicate logic with Henkin interpretation (HPL). In particular, we deal with the so-called Russell-Asser axioms and the so-called Asser axioms and specify their relations in HPL.

References
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Russell, B.: On some difficulties in the theory of transfinite numbers and order types. Proc. of the London Math. Soc. s2–4 (1), 1907, pp. 29–53.
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Väänänen, J. A.: Second-order and higher-order logic. Stanford Encyclopedia of Philosophy. August, 2019.

Philipp Schlicht (University of Bristol, United Kingdom)

Interaction of determinacy and forcing

Determinacy principles provide a unified theory of definable sets of reals beyond Borel and analytic sets, while forcing is an important technique to study the independence of properties of sets of reals. This suggests to study the interaction of the two. How robust are determinacy principles under well behaved forcings? I will discuss the history as well as recent joint results with Jonathan Schilhan and Johannes Schürz on iterations of proper forcing. A sample application of our results is the following: starting from a model of analytic determinacy, one can construct a model of analytic determinacy and the Borel conjecture.

Bartosz Wcisło (University of Gdańsk, Poland)

Conservative and non-conservative variants of truth predicates

It is an extremely familiar phenomenon in logic that if $U_1 \subseteq U_2$ is a pair of theories and U_2 contains a predicate provably resembling a truth or satisfaction predicate for U_1, then U_2 is not conservative over U_1. However, when we are trying to analyse this intuitive statement in a closer way, it is not entirely clear what we mean by a predicate "resembling" a truth predicate. This intuition can be reformulated in a precise manner if we treat the truth predicate axiomatically in the following way: to a fixed base theory B (in our case, it will be Peano Arithmetic, PA), we add a fresh predicate $T(x)$ with the intended reading "x is an arithmetical sentence true in the standard model" together with axioms governing the predicate T. Then we can try to understand how the properties of the resulting theory U, a truth theory, depend on the choice of axioms governing the predicate T. In particular, we can ask which axioms governing the truth predicate make the resulting truth theory conservative.
By a result of Kotlarski, Krajewski, and Lachlan if we axiomatise the truth predicate with purely compositional axioms, then the resulting theory is conservative over its base theory. On the other hand, if we extend a compositional truth predicate over PA with the full induction scheme in the extended language, then we can easily prove the uniform reflection scheme over arithmetic thus obtaining a non-conservative theory.
In the past decade, by work of Cieśliński, Enayat, Łełyk, Pakhomov, and the author, we obtained a much clearer understanding of which truth-theoretic axioms are really responsible for the nonconservativity of truth theories. The emerging picture is that there exists a "minimal natural" axiom for the truth predicate which guarantees that the resulting theory exceeds arithmetic in its proof-theoretic consequences, namely $Delta_0$-induction for the truth predicate. This principle turns out to be exactly equivalent to a number of very distinct axioms. Some of them do not really resemble induction, but seem to be natural variants of compositionality principles.

Adrián Portillo (University of Wrocław, Poland)

On stable quotients

We solve two problems from the paper "On maximal stable quotients of definable groups in NIP theories" by M. Haskel and A. Pillay, which concern maximal stable quotients of groups type-definable in NIP theories. The first result says that if G is a type-definable group in a distal theory, then $G^{st} = G^{00}$ (where G^{st} is the smallest type-definable subgroup with G/G^{st} stable, and G^{00} is the smallest type-definable subgroup of bounded index). In order to get it, we prove that distality is preserved under passing from T to the hyperimaginary expansion T^{heq}. The second result is an example of a group G definable in a non-distal, NIP theory for which $G = G^{00}$ but G^{st} is not an intersection of definable groups. Our example is a saturated extension of $(\mathbb{R}, +, [0, 1])$. Moreover, we make some observations on the question whether there is such an example which is a group of finite exponent. We also take the opportunity and give several characterizations of stability of hyperdefinable sets, involving continuous logic.

Corey Switzer (Kurt Gödel Research Center for Mathematical Logic, University of Vienna, Austria)

Ideal Independence and Filters

A family $\mathcal{I} \subseteq [\omega]^\omega$ is called *ideal independent* if given any finite, distinct $A, B_0, \ldots, B_{n-1} \in \mathcal{I}$ the set $A \setminus \bigcup_{i<n} B_i$ is infinite. The least size of a maximal (with respect to inclusion) ideal independent family is denoted $\mathfrak{s}_{mm}$ and has recently been tied to several interesting questions in cardinal characteristics and Boolean algebra theory. In this talk we will sketch our new proof that this number is ZFC-provably greater or equal to the ultrafilter number – the least size of a base for a non principle ultrafilter on ω. Time permitting we will also mention some consistency results including the existence under CH of a maximal ideal independent family that remains maximal in any proper ω^ω-bounding, p-point preserving forcing extension. – This is joint work with Jonathan Cancino and Vera Fischer.

Jana Marikova (University of Vienna, Austria)

Definable matchings in o-minimal bipartite graphs

We investigate conditions under which an o-minimally definable bipartite graph contains a definable perfect matching. While the infinite marriage theorem fails in our setting, we establish for instance a definable version of a result by Lyons and Nazarov on Borel matchings in the presence of a measure. This is work in progress.

Valentina Disarlo (Universität Heidelberg, Germany)

The model theory of the curve graph

The coarse geometry of the curve graph $C(S)$ of a finite type surface S is a powerful tool for the study of the mapping class group of S. A celebrate theorem by Ivanov in the 1990s states that the automorphism group of $C(S)$ is the extended mapping class group. Following his result, many other similar graphs have this same property. In this talk we will address this phenomenon from the point of view of model theory. I will present a joint work with Thomas Koberda (Virginia) and Javier de la Nuez Gonzalez (KAIST) about the model theory of the curve graph and other similar graphs. In particular we will prove that the theory of the curve graph is ω-stable, give bounds on its Morley rank, and show that it has a form of quantifi er elimination. I will also show that many of the complexes which are naturally associated to a surface are interpretable in the curve graph. Our work would provide a model-theoretical frame for Ivanov's metaconjecture.

SECTION
S 02 Algebra and Number Theory

Section Leaders: Claudia Alfes-Neumann and Christopher Voll

SESSION 1 _ Monday, September 12 _ 11.00–13.00 _ Takustraße 9: SR 046
Chair: Christopher Voll

11.00 Anke Pohl (Universität Bremen, Germany)
▷ *Cohomological interpretation of automorphic functions*

12.00 Keivan Mallahi-Karai (Jacobs University Bremen, Germany)
▷ *Polynomiality of the faithful dimension for nilpotent groups over finite truncated valuation rings*

12.30 Philipp Korell (Otto-von-Guericke-Universität Magdeburg, Germany)
▷ *Mixed binomial edge ideals*

SESSION 2 _ Monday, September 12 _ 15.30–17.30 _ Takustraße 9: SR 046
Chair: Claudia Alfes-Neumann

15.30 Petra Schwer (Otto-von-Guericke-Universität Magdeburg, Germany)
▷ *Chimney retractions of affine buildings encode orbits on affine flag varieties*

16.30 Mima Stanojkovski (RWTH Aachen and MPI MiS, Leipzig, Germany)
▷ *Automorphisms and isomorphism testing of elliptic groups*

17.00 Joshua Maglione (Otto-von-Guericke-Universität Magdeburg, Germany)
▷ *Igusa zeta functions and hyperplane arrangements*

SESSION 3 _ Tuesday, September 13 _ 10.30–12.30 _ Takustraße 9: SR 046
Chair: Anke Pohl

10.30 Anna-Maria Pippich (Universität Konstanz, Germany)
▷ *The arithmetic height of the moduli space of abelian surfaces*

11.30 Annika Burmester (Universität Hamburg, Germany)
▷ *Formal multiple q-zeta values*

12.00 Heiko Knospe (TH Köln, Germany)
▷ *Distributions of Iwasawa lambda-invariants for Dirichlet characters*

SESSION 4 _ Wednesday, September 14 _ 10.30–12.30 _ Takustraße 9: SR 046
Chair: Petra Schwer

10.30 Edgar Assing (Universität Bonn, Germany)
▷ *On automorphic density theorems and related counting problems*

11.30 Verity Mackscheidt (RWTH Aachen, Germany)
▷ *PBW deformations – A combinatorial approach via interpolation categories*

ABSTRACTS

Anke Pohl (Universität Bremen, Germany)
Cohomological interpretation of automorphic functions

Bruggeman, Lewis and Zagier provided a cohomological interpretation of Maass wave forms for hyperbolic surfaces of finite area, in which each construction and isomorphism is explicit. Recently Bruggeman and I extended these results to a class of hyperbolic surfaces of infinite area and to automorphic functions that are more general than Maass wave forms.
After presenting our motivation for searching for such cohomological interpretations of Laplace eigenfunctions, I will give a gentle survey of the constructions of these cohomological interpretations with an emphasis on insights and heuristics.

Keivan Mallahi-Karai (Jacobs University Bremen, Germany)
Polynomiality of the faithful dimension for nilpotent groups over finite truncated valuation rings

The faithful dimension of a finite group G, denoted by $m_{\mathrm{faithful}}(G)$, is the smallest integer n such that G can be embedded in $\mathrm{GL}_n(\mathbb{C})$. In this talk, we address the problem of determining the faithful dimension of a finite p-group of the form $G_R := \exp(\mathfrak{g} \otimes_{\mathbb{Z}} R)$ defined using the Lazard correspondence, where $\mathfrak{g}$ is a nilpotent $\mathbb{Z}$-Lie algebra and R ranges over finite truncated valuation rings. We will discuss recent results on the piecewise polynomiality of $m_{\mathrm{faithful}}(G_F)$, as F ranges over all finite fields, as well as the question of determining $m_{\mathrm{faithful}}(G_R)$ when $\mathfrak{g}$ is the free metabelian nilpotent Lie algebra of class c on n generators and R ranges over all finite truncated valuation ring. – Joint work with Dzmitry Rumiantsau (Jacobs University Bremen, Germany) and Hadi Salmasian (University Of Ottawa, Canada).

Philipp Korell (Otto-von-Guericke-Universität Magdeburg, Germany)
Mixed binomial edge ideals

The minimal primes of a binomial edge ideal can be constructed entirely from the underlying graph in terms of binomial edge ideals. However, the same is not true for parity binomial edge ideals. Assigning a parity to the edges of a (multi)graph, we introduce mixed binomial edge ideals as a generalization of both binomial and parity binomial edge ideals. In this framework, we determine the minimal primes of any mixed binomial edge ideal from the underlying multigraph in terms of mixed binomial ideals. Moreover, we perform "recursive" computations of Hilbert–Poincare polynomials in correspondence with graph manipulations. – Joint work with Thomas Kahle (Otto-von-Guericke-Universität Magdeburg, Germany)

Petra Schwer (Otto-von-Guericke-Universität Magdeburg, Germany)
Chimney retractions of affine buildings encode orbits on affine flag varieties

Groups like GL_n, SL_n or SP_n play an important role in many areas of mathematics. It has been known for a long time that some of their properties (when studied over the reals or complex numbers) are best understood via the associated symmetric spaces. Jaques Tits later introduced buildings as a tool to study the respective groups over other field and developed, together with Bruhat, a theory that also captures reductive groups evaluated over non-archimedean local fields with discrete valuations, like the p-adic numbers.
In this talk I will explain how certain subgroup structures of such a reductive group over a non-Archimedian local field can be explained via Coxeter combinatorics and the geometry of an (affine) Bruhat–Tits building, its apartments and retractions. The retractions of an affine building, for example, encode the orbits of certain subgroups on the affine flag variety and affine Grassmannian associated to the group.

Mima Stanojkovski (RWTH Aachen and MPI MiS Leipzig, Germany)
Automorphisms and isomorphism testing of elliptic groups

For a prime number p, an elliptic p-group is a group of class 2 and exponent p whose Pfaffian describes an elliptic curve. I will report on joint work with Christopher Voll and ongoing work with Joshua Maglione on the computation of autmorphisms and isomorphism classes of elliptic groups, leveraging on the geometry of the defining elliptic curve.

Joshua Maglione (Otto-von-Guericke-Universität Magdeburg, Germany)
Igusa zeta functions and hyperplane arrangements

We define a class of multivariate rational functions associated with hyperplane arrangements called flag Hilbert–Poincaré series. We show how these rational functions are connected to local Igusa zeta functions and class counting zeta functions for certain graphical group schemes studied by Rossmann and Voll. We report on a general self-reciprocity result and explore other connections within algebraic combinatorics. – This is joint work with Christopher Voll and with Lukas Kühne.

Anna-Maria Pippich (Universität Konstanz, Germany)
The arithmetic height of the moduli space of abelian surfaces

Let $\mathcal{A}_g$ denote the moduli stack of principally polarized abelian varieties of dimension g. The arithmetic height of $\overline{\mathcal{A}}_g$ is defined to be the arithmetic degree of the metrized Hodge bundle on $\overline{\mathcal{A}}_g$. In 1999, Kühn proved a beautiful formula for the arithmetic height of $\overline{\mathcal{A}}_1$ in terms of special values of the Riemann zeta function. In this talk, we report on joint work with Barbara Jung generalizing Kühn's result to the case $g = 2$.

Annika Burmester (Universität Hamburg, Germany)
Formal multiple q-zeta values

Multiple zeta values are the building blocks of products of Riemann zeta values, in particular the space spanned by all multiple zeta values is an algebra. There are two product expression of them coming from the representation as infinite nested sums and as iterated integrals. Comparing both product formulas including some regularization process gives the extended double shuffle relations of multiple zeta values. Conjecturally, these give all relations between multiple zeta values. Racinet formalized the extended double shuffle relations in terms of a pro-unipotent affine group scheme with values in some ring of non-commutative power series, which allowed him to show that the algebra of formal multiple zeta values is polynomial.
In this talk, we will provide an analogous non-commutative algebraic setup for multiple q-zeta values, these are q-series which yield multiple zeta values for the limit q to 1. In particular, we will give a conjecturally complete set of relation for multiple q-zeta values and rephrase this in terms of non-commutative power series. We end by indicating what remains to be shown in order to prove that the algebra of formal multiple q-zeta values is also polynomial.

Heiko Knospe (TH Köln, Germany)

Distributions of Iwasawa lambda-invariants for Dirichlet characters

In joint work with Daniel Delbourgo, we study the Iwasawa λ-invariants of Dirichlet characters χ of any order and generalize a prediction of Ellenberg, Jain and Venkatesh. We vary χ where both the order of χ and the prime p are fixed, and vary p for a fixed character χ. Furthermore, we study the proportion of χ-regular and F-regular primes, where F is a totally real abelian number field. We provide numerical evidence for our predictions and tabulate the values of the λ-invariant for every character of conductor < 1000 and odd primes of small size.

Edgar Assing (Universität Bonn, Germany)

On automorphic density theorems and related counting problems

When applying the spectral theory of automorphic forms to certain arithmetic counting or lifting problems one quickly encounters the so called exceptional spectrum, which requires special treatment. This leads to Sarnak's density conjecture. It was put forward in his 1990 ICM address for principal congruence subgroups of real rank 1 groups. We will discuss a natural generalization of Sarnak's density conjecture to higher rank. In our discussion we will touch two distinct counting problems. The first one is of arithmetic interest and follows under some minor technical hypothesis from the density conjecture. The second one shows up on the geometric side of the Kuznetsov formula. It can be solved directly and leads to a proof of the density conjecture for principal congruence subgroups of $GL(n)$.

Verity Mackscheidt (RWTH Aachen, Germany)

PBW deformations – A combinatorial approach via interpolation categories

We consider graded algebras which are deformed by modifying the defining using a deformation map. Such a deformed algebra is called PBW, if its associated graded algebra is isomorphic to the original algebra.

In this talk, we will classify PBW deformations by characterising the corresponding deformation maps in the setting of orthosymplectic groups. We follow a combinatorial approach carried out in a suitable (Deligne) interpolation category to find deformation maps in terms of arc diagrams, and then specialise them to various groups. – This is joint work with Johannes Flake (RWTH Aachen).

SECTION
S 03 Algebraic Geometry

Section Leaders: Ariyan Javanpeykar and Thomas Krämer

SESSION 1 _ Monday, September 12 _ 11.00–13.00 _ Arnimallee 3: SR 119
Chair: Thomas Krämer

11.00 Christian Liedtke (Technische Universität München, Germany)
▷ *McKay correspondences for finite and linearly reductive group schemes*

12.00 Nero Budur (KU Leuven, Belgium)
▷ *Bernstein–Sato ideals*

SESSION 2 _ Monday, September 12 _ 15.30–17.30 _ Arnimallee 3: SR 119
Chair: Ariyan Javanpeykar

15.30 Alex Küronya (Goethe-Universität Frankfurt am Main, Germany)
▷ *Newton–Okounkov bodies and measures of local positivity*

16.30 Ana Botero (Universität Regensburg, Germany)
▷ *Chern–Weil theory for toroidal metrics on line bundles*

SESSION 3 _ Tuesday, September 13 _ 10.30–12.30 _ Arnimallee 3: SR 119
Chair: Charles Vial

10.30 Samuel Grushevsky (Stony Brook University)
▷ *Non-isomorphic compactifications of moduli of cubic surfaces*

11.30 Patrick Graf (Universität Bayreuth, Germany)
▷ *Uniformization of compact Kähler spaces*

12.00 Frank Gounelas (Universität Göttingen, Germany)
▷ *Curves on K3 surfaces*

SESSION 4 _ Wednesday, September 14 _ 10.30–12.30 _ Arnimallee 3: SR 119
Chair: Frank Gounelas

10.30 Catharina Stroppel (Uni Bonn, Germany)
▷ *Motivic springer theory*

11.30 Camilla Felisetti (Università di Trento, Italy)
▷ *$P = W$ phenomena on singular moduli spaces*

12.00 Yajnaseni Dutta (Universität Bonn, Germany)
▷ *Birational automorphisms of hyperkähler manifolds of $K3[n]$-type*

SESSION 5 _ Wednesday, September 14 _ 15.30–17.30 _ Arnimallee 3: SR 119
Chair: Katharina Hübner

15.30 Bernd Sturmfels (Max Planck Institute for Mathematics in the Sciences, Germany)
▷ *Recovery of plane curves from branch points*

16.30 Marta Panizzut (Technische Universität Berlin, Germany)
▷ *On the Cox ring of the blow up of 7 points in projective 3-space*

17.00 Scott Mullane (Humboldt-Universität zu Berlin, Germany)
▷ *The birational geometry of the moduli space of pointed hyperelliptic curves*

Session 6 _ Thursday, September 15 _ 10.30–12.30 _ Arnimallee 3: SR 119
Chair: Kestutis Cesnavicius

10.30 Charles Vial (Universität Bielefeld, Germany)
▷ *On the algebraicity of de Rham-Betti classes for products of elliptic curves*

11.30 Giuseppe Ancona (Institut de Recherche Mathématique Avancée Strasbourg, France)
▷ *Algebraic classes in mixed characteristic and André's p-adic periods*

Session 7 _ Thursday, September 15 _ 15.30–17.30 _ Arnimallee 3: SR 119
Chair: Giuseppe Ancona

15.30 Kestutis Cesnavicius (Université Paris-Saclay, France)
▷ *Reductive group torsors on a complement of a smooth divisor*

16.30 Katharina Hübner (Ruprecht-Karls-Universität Heidelberg, Germany)
▷ *The wild ramification locus*

17.00 Andrea Di Lorenzo (Humboldt-Universität zu Berlin, Germany)
▷ *Cohomological invariants of moduli of curves and Brauer groups*

ABSTRACTS

Christian Liedtke (Technische Universität München, Germany)

McKay correspondences for finite and linearly reductive group schemes

We establish McKay correspondences for finite and linearly reductive subgroup schemes of SL_2 in positive characteristic. As an application, we obtain a McKay correspondence for all rational double point singularities in characteristic $p > 5$.

Nero Budur (KU Leuven, Belgium)

Bernstein–Sato ideals

We report on the proof a conjecture relating the Bernstein–Sato ideal of a finite collection of multivariate polynomials with cohomology support loci of rank one complex local systems. This generalizes a classical theorem of Malgrange and Kashiwara relating the b-function of a multivariate polynomial with the monodromy eigenvalues on the Milnor fibers cohomology. – Joint work with Robin van der Veer, Lei Wu, Peng Zhou.

Alex Küronya (Goethe-Universität Frankfurt am Main, Germany)

Newton–Okounkov bodies and measures of local positivity

Newton–Okounkov bodies are a convex-geometric way to understand the vanishing behaviour of global sections of line bundles in an asymptotic sense. While they have interesting connections with a variety of mathematical topics including representation theory, Diophantine approximation, and mathematical physics, here we will focus on their relationship with birational geometry. More specifically, we will see how they encode local positivity of line bundles and how they give rise to interesting invariants that are mostly unexplored even in the toric case.

Ana Botero (Universität Regensburg, Germany)

Chern–Weil theory for toroidal metrics on line bundles

Using the theory of b-divisors and non-pluripolar products we show that Chern–Weil theory and a Hilbert Samuel theorem can be extended to a wide class of singular semi-positive metrics. We then apply these results to study the line bundle of Siegel–Jacobi forms on the universal abelian variety with the Peterson metric. We show on the one hand that the ring of Siegel–Jacobi forms of constant positive relative index is never finitely generated, and on the other, we recover a formula of Tai giving the asymptotic growth of the dimension of the spaces of Siegel–Jacobi modular forms. – Joint work with J. Burgos Gil, R. de Jong and D. Holmes.

Samuel Grushevsky (Stony Brook University)

Non-isomorphic compactifications of moduli of cubic surfaces

Moduli of cubic surfaces can be compactified from the point of view of geometric invariant theory (GIT), and from the point view of the ball quotient. The Kirwan desingularization resolves the GIT singularities to yield a smooth Kirwan compactification, while the toroidal compactification of the ball quotient is also smooth. We show that these two smooth compactifications are, however, not isomorphic. – Based on joint work with S. Casalaina-Martin, K. Hulek, and R. Laza

Patrick Graf (Universität Bayreuth, Germany)

Uniformization of compact Kähler spaces

It is well-known that the universal cover of a compact Riemann surface is either the projective line, the affine line or the unit disc. The higher-dimensional version of this result concerns compact Kähler manifolds whose canonical bundle is either trivial or (anti-)ample. In recent years, singular Kähler spaces have come into focus due to their appearance in birational geometry. I will report on some recent progress in this direction. – Joint with B. Claudon and H. Guenancia.

Frank Gounelas (Universität Göttingen, Germany)

Curves on K3 surfaces

I will discuss recent results on existence and deformation theory of curves of geometric genus $g \geq 0$ on complex projective K3 surfaces.

Catharina Stroppel (Uni Bonn, Germany)

Motivic springer theory

In this talk we first give an overview on interesting algebras arising in geometric representation theory and then connect them with the theory of motives in the sense of Voevodsky.

Camilla Felisetti (Università di Trento, Italy)

$P = W$ phenomena on singular moduli spaces

Irreducible holomorphic symplectic (IHS) varieties can be thought as a generalization of hyperkähler manifolds allowing singularities. Among them we can find for example moduli spaces of sheaves on K3 and abelian surfaces, which have been recently shown to play a crucial role in non abelian Hodge theory. After recalling the main features of IHS varieties, I will present several results concerning their intersection cohomology and the perverse filtration associated with a Lagrangian fibration, establishing a compact analogue of the celebrated $P = W$ conjecture by de Cataldo, Hausel and Migliorini for varieties which admit a symplectic resolution. – The talk is based on joint works with Mirko Mauri, Junliang Shen and Qizheng Yin.

Yajnaseni Dutta (Universität Bonn, Germany)
Birational automorphisms of hyperkähler manifolds of $K3[n]$-type

Birational self-maps that are not biregular are hard to find on hyperkähler manifolds. For instance, there aren't any on K3 surfaces. In this joint work with D. Mattei and Y. Prieto we showed that a general projective Hyperkähler manifold that is deformation equivalent to the Hilbert scheme of n-points on a K3 surface (i.e., of K3[n]-type) cannot admit certain birational self-maps of finite order. This prompted us to investigate birational self-maps moduli of sheaves on K3 surfaces which are of K3[n]-type. Using Markman's theory of hyperkähler lattices and Bayer–Macri's study of Bridgeland stability on K3 surfaces, we impose explicit numerical constraints on the topological invariants of the sheaves so that certain birational involution exists on their moduli space. – Joint work with Dominique Mattei (Universität Bonn, Germany) and Yulieth Prieto (International Centre for Theoretical Physics, Italy).

Bernd Sturmfels (Max Planck Institute for Mathematics in the Sciences, Germany)
Recovery of plane curves from branch points

We recover plane curves from their branch points under projection onto a line. Our focus lies on cubics and quartics. These have 6 and 12 branch points respectively. The plane Hurwitz numbers 40 and 120 count the orbits of solutions. We determine the numbers of real solutions, and we present exact algorithms for recovery. Our approach relies on 150 years of beautiful algebraic geometry, from Clebsch to Vakil and beyond. – Joint work with Daniele Agostini, Hannah Markwig, Clemens Nollau, Victoria Schleis and Javier Sendra-Arranz.

Marta Panizzut (Technische Universität Berlin, Germany)
On the Cox ring of the blow up of 7 points in projective 3-space

We prove quadratic generation for the ideal of the Cox ring of the blow up of 7 points in projective 3-space. To do this we find special Khovanskii bases, implementing techniques which proved successful in the case of Del Pezzo surfaces. Such bases give us toric degenerations which allow us to get geometric informations about the Cox ring from a family of lattice polytopes. In particular, we focus on the f-vector of such polytopes and we define the Mukai edge graph. – Joint work with Mara Belotti (Technische Universität Berlin, Germany).

Scott Mullane (Humboldt-Universität zu Berlin, Germany)

The birational geometry of the moduli space of pointed hyperelliptic curves

The moduli space of pointed hyperelliptic curves is a seemingly simple object with perhaps unexpectedly interesting geometry. I will report on joint work with Ignacio Barros completing the classification of both the Kodaira dimension and the structure of the effective cone of these moduli spaces.

Charles Vial (Universität Bielefeld, Germany)

On the algebraicity of de Rham-Betti classes for products of elliptic curves

A de Rham–Betti class on a smooth projective variety X over a number field K is a rational class in the Betti cohomology of the analytification of X that descends to a class in the algebraic de Rham cohomology of X via the period comparison isomorphism. These classes are the analogues of Hodge classes, except that one uses the K-structure on de Rham cohomology instead of the Hodge filtration. The period conjecture of Grothendieck implies that de Rham–Betti classes should be algebraic. I will report on joint work with Mingmin Shen, where we prove that any de Rham–Betti class on a product of elliptic curves is algebraic. As a key intermediate step in the proof, we show that certain codimension-2 de Rham–Betti classes on hyper-Kähler varieties are Hodge.

Giuseppe Ancona (Institut de Recherche Mathématique Avancée Strasbourg, France)

Algebraic classes in mixed characteristic and André's p-adic periods

Motivated by the study of algebraic classes in mixed characteristic, we define a countable subalgebra of $\mathbb{Q}_p$ which we call the algebra of "André's p-adic periods". We will explain the analogy and the difference between these p-adic periods and the classical complex periods. For instance, they both contain several examples of special values of classical functions (logarithm, gamma function, …) and they share transcendence properties. On the other hand, the classical Tannakian formalism which is used to bound the transcendence degree of complex periods has to be modified in order to be used in the p-adic setting. We will discuss concrete examples of all these instances though elliptic curves and Kummer extensions.

Kestutis Cesnavicius (Université Paris-Saclay, France)

Reductive group torsors on a complement of a smooth divisor

A conjecture of Nisnevich predicts that for a smooth variety X over a field, a smooth divisor D in X, and a totally isotropic reductive X-group scheme G, every generically trivial G-torsor on $X \setminus D$ trivializes Zariski locally on X. I will discuss this conjecture and related questions about torsors under reductive groups over regular rings.

Katharina Hübner (Ruprecht-Karls-Universität Heidelberg, Germany)
The wild ramification locus

We study the notions of wild and tame ramification in arithmetic geometry. Wildly ramified morphisms tend to behave very differently from what we know about ramification phenomena in characteristic zero. We discuss several approaches to define tame covering spaces and explain how valuative spaces such as adic spaces or Berkovich spaces naturally enter the picture. Points of these spaces are certain valuations, such as discrete valuations coming from a divisor. But in general these valuations tend to be complicated. By analytic methods we show, however, that we can check tameness on divisors.

Andrea Di Lorenzo (Humboldt-Universität zu Berlin, Germany)
Cohomological invariants of moduli of curves and Brauer groups

The Brauer group is a fundamental invariant that plays an important role both in rationality problems and arithmetic. Nevertheless, computations of Brauer groups of moduli stacks only started appearing recently. In this talk I will explain how the theory of cohomological invariants with coefficients in motivic étale cohomology can be used to obtain explicit presentations of Brauer groups of some moduli of curves, e.g., moduli of hyperelliptic curves and their compactifications over a field of characteristic zero, and moduli of elliptic curves over any base field. Joint work with Roberto Pirisi.

SECTION
S 04 Differential Geometry and Geometric Analysis

Section Leaders: Jan Metzger and Christian Bär

Session 1 _ Wednesday, September 14 _ 10.30–12.30 _ Arnimallee 6: SR 031
Chair: Christian Bär

10.30 Penelope Gehring (Max Planck Institute for Gravitational Physics (AEI Potsdam), Germany)
▷ *Non-local boundary conditions for the spin Dirac operator on spacetimes with timelike boundary*

11.00 Markus Wolff (Eberhard Karls Universität Tübingen, Germany)
▷ *Ricci flow on surfaces along the standard lightcone in the $3+1$-Minkowski spacetime*

11.30 Florian Hanisch (Universität Potsdam, Germany)
▷ *The Yamabe problem on Lorentzian manifolds*

12.00 Mihajlo Cekić (Universität Zürich, Switzerland)
▷ *Ergodicity of frame flows on even-dimensional manifolds*

Session 2 _ Wednesday, September 14 _ 15.30–17.30 _ Arnimallee 6: SR 031
Chair: Jan Metzger

15.30 Alberto Richtsfeld (Universität Potsdam, Germany)
▷ *Local index densities for geometric operators*

16.10 Matthias Ludewig (Universität Regensburg, Germany)
▷ *The Clifford algebra bundle on loop space*

16.50 Rubens Longhi (University of Potsdam, Germany)
▷ *Wave front sets of different regularity*

ABSTRACTS

Penelope Gehring (Max Planck Institute for Gravitational Physics (AEI Potsdam), Germany)
Non-local boundary conditions for the spin Dirac operator on spacetimes with timelike boundary

Non-local boundary conditions – for example the Atiyah–Patodi–Singer (APS) conditions – for Dirac operators on Riemannian manifolds are rather well-understood, while not much is

known for such operators on spacetimes. Recently, Bär–Strohmaier and Drago–Große–Murro introduced APS-like conditions for the spin Dirac operator on spacetimes with spacelike and timelike boundary, respectively. While Bär–Strohmaier showed the Fredholmness of the spin Dirac operator with these boundary conditions, Drago–Große–Murro proved the well-posedness of the corresponding initial boundary value problem under certain geometric assumptions.
In this talk, we will follow in the footsteps of the latter authors and discuss whether the APS-like conditions for Dirac operators on Lorentzian manifolds with timelike boundary can be replaced by more general conditions such that the associated initial boundary value problems are still well-posed.

Markus Wolff (Eberhard Karls Universität Tübingen, Germany)
Ricci flow on surfaces along the standard lightcone in the $3+1$*-Minkowski spacetime*
Identifying any conformally round metric on the 2-sphere with a unique cross section on the standard lightcone in the $3+1$-Minkowski spacetime, we gain a new perspective on $2d$-Ricci flow on topological spheres. It turns out that in this setting, Ricci flow is equivalent to a null mean curvature flow first studied by Roesch–Scheuer along null hypersurfaces. Exploiting this equivalence, we can translate well-known results from $2d$-Ricci flow first proven by Hamilton into a full classification of the singularity models for null mean curvature flow in the Minkowski lightcone. Conversely, we obtain a new proof of Hamilton's classical result using only the maximum principle.

Florian Hanisch (Universität Potsdam, Germany)
The Yamabe problem on Lorentzian manifolds
Given a semi-Riemannian metric on a smooth manifold, one may ask the question whether this metric is conformally equivalent to a metric with constant scalar curvature. This problem is well studied in the Riemannian setting and known as Yamabe Problem. It leads to a semi-linear elliptic pde that can always be solved on closed Riemannian manifolds. We will consider the corresponding problem for Lorentzian manifolds, which leads to a semi-linear wave equation. It turns out that it cannot always be solved because solutions break down in finite time – even under additional assumptions on the geometry. We will discuss an approach to this nonlinear equation based on energy techniques, which yield lower bounds for the lifespan of solutions depending on scalar curvature. Examples illustrating the behaviour of the equation will be included. – Joint work with Viktoria Rothe (Württembergische Versicherung).

Mihajlo Cekić (Universität Zürich, Switzerland)

Ergodicity of frame flows on even-dimensional manifolds

Flows of frames over negatively curved Riemannian manifolds (M, g) are one of the oldest examples of partially hyperbolic dynamics. It is well known that frame flows of hyperbolic manifolds are ergodic, while Kahler manifolds never have an ergodic frame flow; Brin conjectured in the 70's that all manifolds with sectional curvature between -1 and -0.25 (i.e., curvature is 0.25-pinched) have ergodic frame flows. In this talk I will explain recent progress on this conjecture: we show that in dimensions $4k+2$ the frame flow is ergodic if (M, g) is ~ 0.27 pinched, and in dimensions $4k$ if it is ~ 0.55 pinched. Our new method uses techniques in hyperbolic dynamics (transitivity group, Parry's representation), topology of structure groups of spheres, and Fourier analysis in the vertical fibre of the unit sphere bundle (based on Pestov identity). This is joint work with Lefeuvre, Moroianu, and Semmelmann.

Alberto Richtsfeld (Universität Potsdam, Germany)

Local index densities for geometric operators

In this talk, I will present a modified version of the proof of Atiyah, Patodi and Bott of the local index theorem, which generalizes to a wider class of geometric differential operators. This will in particular show that the local index density of the Rarita–Schwinger operator can be expressed as a polynomial in the Pontryagin forms. I will also present a version of the Atiyah–Patodi–Singer index theorem for differential operators of first order, whose adapted operators at the boundary are normal.

Matthias Ludewig (Universität Regensburg, Germany)

The Clifford algebra bundle on loop space

We construct a Clifford algebra bundle formed from the tangent bundle of the smooth loop space of a Riemannian manifold, which is a bundle of super von Neumann algebras on the loop space. We show that this bundle is in general non-trivial, more precisely that its triviality is obstructed by the transgressions of the second Stiefel–Whitney class and the first (fractional) Pontrjagin class of the manifold.

Rubens Longhi (University of Potsdam, Germany)

Wave front sets of different regularity

The usual notion of wavefront set identifies the directions along which a distribution u fails to be smooth. We present an equivalent definition that makes use of the Radon transform and which is suitable for a refinement of the notion of wavefront set. The aim is to define identifying the directions along which u fails to have a certain regularity, for example Sobolev or Besov regularity and possibly extend the theorems about the propagation of singularities to this setting.

SECTION
S 05 Discrete Mathematics

Section Leaders: Christian Haase and Thorsten Theobald

Session 1 _ Wednesday, September 14 _ 10.30–12.30 _ Arnimallee 6: SR 032
Chair: Christian Haase

10.30 Omid Amini (CNRS – Ecole Polytechnique, France)
▷ *Hodge theory in combinatorics and combinatorics in Hodge theory*

11.30 Sylvain Spitz (TU Berlin, Germany)
▷ *Generalized permutahedra and optimal auctions*

12.00 Martin Winter (Warwick University, United Kingdom)
▷ *Expansion and rigidity properties of polytope skeleta*

Session 2 _ Wednesday, September 14 _ 15.30–17.30 _ Arnimallee 6: SR 032
Chair: Thorsten Theobald

15.30 Paul Breiding (Universität Osnabrück, Germany)
▷ *Facet volumes of polytopes*

16.00 Ansgar Freyer (TU Berlin, Germany)
▷ *Affine subspace concentration conditions for centered polytopes*

16.30 Sofia Garzon Mora (Freie Universität Berlin, Germany)
▷ *Fine polyhedral adjunction theory*

17.00 Sophie Rehberg (San Francisco State University, USA)
▷ *Pruned inside-out polytopes, combinatorial reciprocity theorems, and generalized permutahedra*

Session 3 _ Thursday, September 15 _ 10.30–12.30 _ Arnimallee 6: SR 032
Chair: Thorsten Theobald

10.30 Robert Weismantel
▷ *Integer linear optimization in high dimensions*

11.30 Xiangying Chen (Otto-von-Guericke-Universität Magdeburg, Germany)
▷ *The geometry of conditional independence structures and their Coxeter friends*

12.00 Andreas Kretschmer (Otto-von-Guericke-Universität Magdeburg, Germany)
▷ *Thin polytopes: Lattice polytopes with vanishing local h^*-polynomial*

Session 4 _ Friday, September 16 _ 10.30–12.30 _ Arnimallee 6: SR 032
Chair: Christian Haase

10.30 Sebastian Debus (UiT The Arctic University of Norway, Norway)
▷ *The poset of Specht ideals for hyperoctahedral groups*

11.00 Stefan Kuhlmann (TU Berlin, Germany)
▷ *Lattice width of lattice-free polyhedra and a relation to Hilbert bases*

11.30 Stephan Gardoll (Goethe University Frankfurt, Germany)
▷ *Combinatorics and preservation of conically stable polynomials*

12.00 Gaurav Sunil Kucheriya (Charles University, Czech Republic)
▷ *Edge-ordered graphs with almost linear extremal functions*

ABSTRACTS

Omid Amini (CNRS – Ecole Polytechnique, France)
Hodge theory in combinatorics and combinatorics in Hodge theory

Several fruitful interactions have been emerging between combinatorics and Hodge theory over the past few years. This consists both in the development of Hodge theoretic results to address open problems in combinatorics (concerning graphs, matroids, and simplicial complexes), and in the reverse direction, in providing a combinatorial description of geometric phenomena appearing in asymptotic Hodge theory, in the study of variations of Hodge structures. This latter point gives in particular rise to the introduction of combinatorial structures of higher rank, and a higher rank version of polyhedral geometry.
The aim of the talk is to provide a survey of these developments.

Sylvain Spitz (TU Berlin, Germany)
Generalized permutahedra and optimal auctions

We study a family of convex polytopes, called SIM-bodies, which were introduced by Giannakopoulos and Koutsoupias (2018) to analyze so-called Straight-Jacket Auctions.
First, we show that the SIM-bodies belong to the class of generalized permutahedra.
Second, we prove an optimality result for the Straight-Jacket Auctions among certain deterministic auctions.

Third, we employ computer algebra methods and mathematical software to explicitly determine optimal prices and revenues. – Joint work with Michael Joswig (TU Berlin, Germany) and Max Klimm (TU Berlin, Germany).

Martin Winter (Warwick University, United Kingdom)

Expansion and rigidity properties of polytope skeleta

A convex polytope is usually not determined by its edge-graph, not even up to combinatorial equivalence. What additional geometric data suffices to rectify this or allows for even stronger forms of reconstructibility up to affine equivalence or isometry? We discuss two types of such data: edge-lengths and expansion parameters (numbers that measure the average pair-wise vertex distance).

(1) We show that a convex polytope is determined up to affine equivalence by its edge-graph, the edge-lengths and some expansion parameter. This implies that the realization space of a polytope (actually, of the edge-graph) has dimension at most $f_0 + f_1 - 1$.

(2) We conjecture that a convex polytope is determined up to isometry by the following data: its edge-gaph, its edge-lengths and the distances of each vertex from some common point in the interior of the polytope. While this is open in general, we prove it for polytopes that are either of a fixed combinatorial type or centrally symmetric.

These results are obtained by applying techniques from spectral gaph theory and convex geometry and also allow for interpretations in the language of tensegrity and rigidity of bar-joint frameworks.

Paul Breiding (Universität Osnabrück, Germany)

Facet volumes of polytopes

We consider what we call facet volume vectors of polytopes. Every full dimensional polytope in $\mathbb{R}^d$ with n facets defines n positive real numbers: the n $(d-1)$-dimensional volumes of its facets. For instance, every triangle defines three lenghts; every tetrahedron defines four areas. We study the space of all such vectors. We show that for fixed integers $d > 1$ and $n > d$ the configuration space of all facet volume vectors of all d-polytopes in $\mathbb{R}^d$ with n facets is a full dimensional cone in $\mathbb{R}^n$, and we describe this cone in terms of inequalities. For tetrahedra this is a cone over a regular octahedron. – Joint work with Pavle Blagojevic and Alexander Heaton.

Ansgar Freyer (TU Berlin, Germany)

Affine subspace concentration conditions for centered polytopes

The linear subspace concentration condition is a requirement on the distribution of the volume within an n-polytope P that contains the origin. P fulfills the linear subspace concentration condition if for any d-subspace L, the total volume of pyramids of the form $\mathrm{conv}(0, F)$, where F is a facet with normal vector in L, is not more than $d/n * \mathrm{vol}(P)$, with equality, if and only if the facet normals of P are fully contained in the union of L with a complementary subspace. This condition plays a key role in the study of the log-Minkowski problem and it has been shown by Henk and Linke that centered polytopes satisfy the linear subspace concentration condition. Recently, K.-Y. Wu proved an affine version of this condition for centered polytopes which are additionally smooth and reflexive, using techniques from toric geometry. The purpose of this talk is to present a geometric proof of Wu's inequality for arbitrary centered polytopes and to discuss the equality case. – This is joint work with Martin Henk and Christian Kipp.

Sofia Garzon Mora (Freie Universität Berlin, Germany)
Fine polyhedral adjunction theory

An adjoint polytope of a lattice polytope P is the polytope obtained from P by pushing its facets inwards by some parameter. Polyhedral Adjunction Theory studies the behavior of such adjoint polytopes and their properties. In this talk we will explore invariants that can be defined on adjoint polytopes and some of the existing results and applications of these invariants. Moreover, we will expand this theory into the so-called Fine Polyhedral Adjunction Theory where the adjoint polytopes are taken in a slightly modified way. We will see how invariants of these new Fine adjoint polytopes are defined and how they help improving some of the existing results from classical polyhedral adjunction.

Sophie Rehberg (San Francisco State University, USA)
Pruned inside-out polytopes, combinatorial reciprocity theorems, and generalized permutahedra

We introduce pruned inside-out polytopes, a generalization of inside-out polytopes introduced by Beck–Zaslavsky (2006), which have many applications such as recovering the famous reciprocity result for graph colorings by Stanley. We study the integer point count of pruned inside-out polytopes by applying classical Ehrhart polynomials and Ehrhart–Macdonald reciprocity. This yields a geometric perspective on and a generalization of several known combinatorial reciprocity results such as a combinatorial reciprocity theorem for generalized permutahedra by Aguiar–Ardila (2017) and Billera–Jia–Reiner (2009) or hypergraphs by Aval–Karaboghossian–Tanasa (2020). Moreover, this can be extended to type B generalized permutahedra. – This is joint work with Matthias Beck.

Robert Weismantel (ETH Zürich, Switzerland)
Integer linear optimization in high dimensions

Our goal is to detect structural results and develop algorithms that are ideally independent on the dimension or depend as little as possible on it. This requires us to assume that the underlying optimization problem has some structure such as bounded subdeterminants or specific sparsity patterns. One of the central questions in this context are upper bounds on the distance between optimal solutions of a linear programming relaxation and its corresponding integer optimization problem. My talk is based on several papers that I will refer to in my slides.

Xiangying Chen (Otto-von-Guericke-Universität Magdeburg, Germany)
The geometry of conditional independence structures and their Coxeter friends

A conditional independence structure consists of triples $(ij|K)$ which can be interpreted in many ways, for example as conditional independence between random vectors, as points with certain distances in an inner product space, as pairs not to be compared in a rank test, or as separation in graphs or topological spaces.
In this talk I will discuss the geometry of these structures and their analogies in other Coxeter types.

Andreas Kretschmer (Otto-von-Guericke-Universität Magdeburg, Germany)
Thin polytopes: Lattice polytopes with vanishing local h^*-polynomial

In this talk I will present the novel notion of thin polytopes: lattice polytopes whose local h^*-polynomials vanish. The local h^*-polynomial is a fundamental invariant in modern Ehrhart theory. Its definition goes back to Stanley with beautiful results achieved by Karu, Borisov and Mavlyutov, Schepers, and Katz and Stapledon. For example, its coefficients are always palindromic and non-negative. In the case of lattice simplices, the study of thinness was originally proposed by Gelfand, Kapranov and Zelevinsky, and in this case the local h^*-polynomial simply equals the so-called box polynomial of the simplex. Our main results are the complete classification of thin polytopes up to dimension 3 and the characterization of thinness for Gorenstein polytopes. – Joint work with Christopher Borger (NOW Gmbh) und Benjamin Nill (Otto von Guericke-Universität Magdeburg).

Sebastian Debus (UiT The Arctic University Of Norway, Norway)
The poset of Specht ideals for hyperoctahedral groups

In this talk we consider Specht ideals and their varieties for the hyperoctahedral group. The Specht polynomials span the irreducible representations which correspond to bipartitions. The ideals that are generated by all Specht polynomials of a given shape are called Specht ideals.

We introduce a bidominance order on the set of bipartitions and classify the covering relations in this poset. Then we prove equivalence between bidominance of bipartitions, inclusion of Specht ideals and Specht varieties. Furthermore, we present a notion of Bn orbit types and prove a set partition of the Specht varieties using orbit types and the bidominance order. – Joint work with Philippe Moustrou (Institut de Mathématiques de Toulouse, France), Cordian Riener (UiT The Arctic University Of Norway, Norway) and Hugues Verdure (UiT The Arctic University Of Norway, Norway).

Stefan Kuhlmann (TU Berlin, Germany)

Lattice width of lattice-free polyhedra and a relation to Hilbert bases

Given a polyhedron defined by an integral matrix and an integral right-hand side. We say the polyhedron is lattice-free if it does not contain an integer vector.

In this talk, we investigate the lattice width of lattice-free polyhedra with respect to the following parameter: the largest minor of the given constraint matrix. The interest in this parameter is motivated by various results from Integer Programming which suggest a deep relation between the parameter and the complexity of Integer Programs.

Our main goal of this talk is to highlight a novel connection between the lattice width, the diameter of finite abelian groups and geometric properties of a finite generating set, the Hilbert basis. We exploit this link to obtain novel bounds on the lattice width which are independent of the dimension. – The presentation is based on joint work with Martin Henk and Robert Weismantel.

Stephan Gardoll (Goethe University Frankfurt, Germany)

Combinatorics and preservation of conically stable polynomials

Given a closed, convex cone $K \subseteq \mathbb{R}^n$, a multivariate polynomial $f \in \mathbb{C}[\mathbf{z}]$ is called K-stable if the imaginary parts of its roots are not contained in the relative interior of K. If K is the non-negative orthant, K-stability specializes to the usual notion of stability of polynomials. We develop generalizations of preservation operations and of combinatorial criteria from usual stability towards conic stability. A particular focus is on the cone of positive semidefinite matrices (psd-stability). In particular, we prove the preservation of psd-stability under a natural generalization of the inversion operator. Moreover, we give conditions on the support of psd-stable polynomials and characterize the support of special families of psd-stable polynomials. – Joint work with Giulia Codenotti and Thorsten Theobald (both Goethe University Frankfurt)

Kucheriya, Gaurav Sunil (Charles University, Czech Republic)

Edge-ordered graphs with almost linear extremal functions

The central theme of Turán type graph problems is to maximize the number of edges a graph can have, under certain (forbidding) conditions, which is known as its extremal function. Here we consider graphs with edge-order, that is, the edges are linearly ordered. A paper by Gerbner, Methuku, Nagy, Pálvölgyi, Tardos and Vizer started the study of these type of extremal problems for edge-ordered variant.

Since the extremal funcion for unordered graphs follows a dichotomy: the function is linear if and only if the forbidden graph is forest. So similar dichotomy was conjectured for edge-ordered and vertex-ordered graphs. Here, I present the solution that settles it in the former case, which is joint work with Gabor Tardos. The conjecture is still open for vertex-ordered graphs and several partial results have already been established. – Joint work with Gábor Tardos (Alfréd Rényi Institute of Mathematics, Budapest, Hungary).

SECTION
S 06 Topology and Geometry

Section Leaders: Marc Kegel, Nathaniel Bottman, Markus Land and Lukas Lewark

SESSION 1 _ Wednesday, September 14 _ 10.30–12.30 _ Arnimallee 6: SR 025–026
Chair: Lukas Lewark

10.30 Filip Misev (Universität Regensburg, Germany)
▷ *Ribbon cobordism between knots and 3-manifolds*

11.00 Peter Feller (ETH Zürich, Switzerland)
▷ *On the length of knots on a Heegaard surface of a 3-manifold.*

11.30 Danica Kosanović (ETH Zürich Switzerland)
▷ *2-knots and knotted families of arcs*

12.00 Matthias Meiwes (RWTH Aachen, Germany)
▷ *Braid stability for Hamiltonian diffeomorphisms*

SESSION 2 _ Thursday, September 15 _ 10.30–12.30 _ Arnimallee 6: SR 025–026
Chair: Markus Land

10.30 Anja Randecker (Universität Heidelberg)
▷ *Big mapping class groups as Polish groups*

11.00 Sebastian Hensel (LMU München, Germany)
▷ *Surface homeomorphisms and fine curve graphs*

11.30 Matthias Ludewig (Universität Regensburg, Germany)
▷ *Topological insulators via coarse geometry*

SESSION 3 _ Thursday, September 15 _ 15.30–17.30 _ Arnimallee 6: SR 025–026
Chair: Marc Kegel

15.30 Paul Wedrich (Universität Hamburg, Germany)
▷ *On skein theory in dimension four*

16.00 Marithania Silvero (Universidad de Sevilla, Spain)
▷ *Taming Khovanov homotopy type*

16.30 Naageswaran Manikandan (Humboldt-Universität zu Berlin and Berlin Mathematical School (BMS), Germany)
▷ *Khovanov homology of fibered-positive links*

17.00 Michael Brandenbursky (Ben Gurion University, Israel, and Regensburg University, Germany)
▷ *C^0-gap between entropy-zero Hamiltonians and autonomous diffeomorphisms of surfaces*

ABSTRACTS

Filip Misev (Universität Regensburg, Germany)
Ribbon cobordism between knots and 3-manifolds

A ribbon cobordism between 3-manifolds is a cobordism which can be built without 3-handles and is, in this sense, less complicated than a general cobordism. The absence of 3-handles also gives ribbon cobordisms a direction *from* a 3-manifold *to* another 3-manifold. Ribbon cobordisms arise in the context of contact geometry, the knot theory of algebraic curves, and in the context of a famous open question posed by Fox in the 1960s known as the slice-ribbon question. I will briefly discuss their role in low-dimensional topology and then present a result obtained in a joint project with Stefan Friedl and Raphael Zentner: Rational homology ribbon cobordism is a partial order within the class of irreducible 3-manifolds. It builds on work of Cameron Gordon (among others) and on a recent preprint by Ian Agol showing the analogous statement for ribbon concordance between knots, and was independently obtained by Marius Huber. – Joint work with Stefan Friedl (Universität Regensburg) and Raphael Zentner (Universität Regensburg).

Peter Feller (ETH Zürich, Switzerland)
On the length of knots on a Heegaard surface of a 3-manifold.

In this talk we explore connections between the topology and the geometry of 3-manifolds. We do this by using Heegaard-splittings (topology) of a 3-manifold to describe hyperbolic structures (geometry) on it. More concretely, for a knot K that lies on a Heegaard surface F of a closed oriented connected 3-manifold M, we describe a sufficient condition for M to carry a hyperbolic structure. Furthermore, whenever our criterion applies, we provide bounds on the length of K. The upshot is that there is no Ricci-flow machine running in the background. Instead, the motor behind what we do is effective hyperbolic Dehn surgery ala Hodgson and Kerckhoff. Applications include a Ricci-flow free proof of Mather's result that random 3-manifolds (in the sense of Dunfield-Thurston) are hyperbolic, and bounds on the diameter and injectivity radius of a random 3-manifold. – Joint work with Alessandro Sisto (Heriot-Watt University, UK) and Gabriele Viaggi (University of Heidelberg, Germany).

Danica Kosanović (ETH Zürich, Switzerland)

2-knots and knotted families of arcs

Knowing when one can embed a surface into a 4-manifold is a question of fundamental importance for 4-manifold theory. It gives rise to a field of 2-knot theory, which is in a certain sense even harder than classical knot theory. However, in some situations – like in the setting when embedded surfaces (disks) have a common "light bulb" (in the boundary) – one can completely classify them up to isotopy. I will explain how in joint work with Peter Teichner we provide such a classification using some fairly general techniques from homotopy theory, leading to surprising applications of higher homotopy groups of spaces of embeddings. – Joint work with Peter Teichner (Max-Planck-Institut für Mathematik, Bonn, Germany)

Matthias Meiwes (RWTH Aachen, Germany)

Braid stability for Hamiltonian diffeomorphisms

Braids play an important role in surface dynamics. For example, there is a strong connection between the existence of specific braid types of orbits and other dynamical properties of maps such as topological entropy, integrability, etc. This means that a way to understand stability and robustness features of the dynamics of maps under perturbation is to study the stability of braids. In my talk, I will address the problem of braid stability for Hamiltonian surface diffeomorphisms in terms of Hofer's metric, which is a remarkable bi-invariant metric on the group of Hamiltonian diffeomorphisms. I discuss a result that any braid of non-degenerate one-periodic orbits with pairwise homotopic strands persists under generic Hofer-small perturbations. This gives rise to interesting connections between topological entropy and Hofer's metric. – My talk is based on joint work with Marcelo R. R. Alves.

Anja Randecker (Universität Heidelberg)

Big mapping class groups as Polish groups

Classical mapping class groups consist of homotopy classes of homeomorphisms of orientable surfaces which have finite topological type. They have a rich theory and are well-studied but they are not particularly interesting from the point of view of topological groups as they are discrete. When we turn our attention to surfaces of infinite type, however, the situation changes drastically: their mapping class groups are uncountable and we can define an interesting topology on them. In particular, they are now Polish groups and we can ask many new questions such as on automatic continuity or the topological behaviour of conjugacy classes. In this talk, I will give a short introduction to surfaces of infinite type and big mapping class groups and then pose some of the new questions. Some answers to the questions are based on joint work with Jesús Hernández Hernández, Michael Hrušák, Israel Morales, Manuel Sedano, and Ferrán Valdez.

Sebastian Hensel (LMU München, Germany)

Surface homeomorphisms and fine curve graphs

In this talk, we will discuss a geometric group theory approach to the group of homeomorphisms of a closed oriented surface. The core tool will be the fine curve graph, a variant of the "classical" curve graph that has proved spectacularly successful in the study of mapping class groups, Teichmüller theory and 3-manifolds. We will give an overview of techniques and how they can be used to answer topological, dynamic and algebraic questions about surface homeomorphism groups. If time permits, we will also sketch some new behaviour in the fine case, which is not encountered for "classical" curve graphs. – The results are joint work with Jonathan Bowden, Katie Mann, Emmanuel Militon and Richard Webb.

Matthias Ludewig (Universität Regensburg, Germany)

Topological insulators via coarse geometry

A topological insulator is a material that is insulating in its interior but having well-conducting states localized near the boundary. We give an introduction into the coarse geometric approach to their mathematical modeling that emerged quite recently. Here, the insulating bulk states correspond to spectral projections of the bulk Hamiltonian which determine elements in the K-theory of the Roe C*-algebra of the underlying space. The boundary behavior of the material is then related to the boundary map associated to a suitable short exact sequence.

Paul Wedrich (Universität Hamburg, Germany)

On skein theory in dimension four

Khovanov homology naturally extends to an invariant of surfaces in oriented smooth 4-manifolds. I will describe the construction of these "skein modules" and methods to compute them via a handle decomposition. Based on joint work with Morrison–Walker and Manolescu–Walker.

Marithania Silvero (Universidad de Sevilla, Spain)

Taming Khovanov homotopy type

Khovanov homology is a powerful link invariant introduced by M. Khovanov around 2000 as a categorification of Jones polynomial. Some years later, Lipshitz and Sarkar refined this invariant by constructing the so-called Khovanov spectra: given a link diagram D, they provide a method to obtain a *space* whose stable homotopy type is a link invariant and whose cohomology is isomorphic to the Khovanov homology of the link. In this talk we will present some simplifications of the Khovanov homotopy type for some quantum gradings. In particular, we provide an algorithm to construct a simplicial complex which coincides with Khovanov spectra in the extreme quantum grading and conjecture that, if not contractible, it has the homotopy type of a wedge of spheres. We also study the Khovanov homotopy type for the special cases of semiadequate links, links with no nesting pairs, and closed braids on 3 and 4 strands.

Naageswaran Manikandan (Humboldt-Universität zu Berlin and Berlin Mathematical School (BMS), Germany)

Khovanov homology of fibered-positive links

We will prove that the first Khovanov homology of fibered-positive links is trivial, motivated by the result obtained for braid-positive links by Marko Stosic. – This is based on joint work in progress with M. Kegel, L. Mousseau, and M. Silvero.

Michael Brandenbursky (Ben Gurion University, Israel, and Regensburg University, Germany)

C^0-gap between entropy-zero Hamiltonians and autonomous diffeomorphisms of surfaces

Let Σ be a surface equipped with an area form. There is a long standing open question by Katok, which, in particular, asks whether every entropy-zero Hamiltonian diffeomorphism of a surface lies in the C^0-closure of the set of integrable diffeomorphisms. A slightly weaker version of this question asks: "Does every entropy zero Hamiltonian diffeomorphism of a surface lie in the C^0-closure of the set of autonomous diffeomorphisms?" In this talk I will answer in negative the later question. In particular, I will show that on a surface Σ the set of autonomous Hamiltonian diffeomorphisms is not C^0-dense in the set of entropy-zero

Hamiltonians. Explicitly constructed examples of such Hamiltonians cannot be approximated by autonomous diffeomorphisms. – Joint work with M. Khanevsky.

SECTION
S 07 Functional Analysis, Real and Complex Analysis

Section Leaders: Agnes Radl and Anke Kalauch

SESSION 1 _ Wednesday, September 14 _ 10.30–12.30 _ Takustraße 9: SR 006

Chair: Agnes Radl

10.30 Dirk Werner (FU Berlin, Germany)
▷ *Über Operatoren, die ihre Norm annehmen*

11.30 Ole Christensen (Technical University of Denmark, Denmark)
▷ *Frames and operator orbits*

12.00 Jan-David Hardtke (Universität Leipzig, Germany)
▷ *Locally octahedral and locally almost square Köthe–Bochner spaces*

SESSION 2 _ Wednesday, September 14 _ 15.30–17.30 _ Takustraße 9: SR 046

Chair: Anke Kalauch

15.30 Cormac Walsh (Inria and CMAP, Ecole Polytechnique, France)
▷ *Order isomorphisms and antimorphisms in partially-ordered vector spaces*

16.30 Janko Stennder (TU Dresden, Germany)
▷ *Operators in pre-Riesz spaces: Moduli and homomorphisms*

17.00 Martin Weber (TU Dresden, Germany)
▷ *On the Cesaro vector lattices and their ideals of finite elements*

SESSION 3 _ Thursday, September 15 _ 15.30–17.30 _ Takustraße 9: SR 046

Chair: Agnes Radl

15.30 Helge Glöckner (Universität Paderborn, Germany)
▷ *Loop groups and Birkhoff decompositions*

16.30 Thu Hien Nguyen (Leipzig University, Germany, and V. N. Karazin Kharkiv National University, Ukraine)
▷ *Some conditions for entire functions to belong to the Laguerre-Pólya class*

ABSTRACTS

Werner, Dirk (FU Berlin, Germany)

Über Operatoren, die ihre Norm annehmen

Ein Operator $T : X \to Y$ zwischen Banachräumen nimmt seine Norm an, wenn es ein $x_0 \in X$ mit $\|x_0\| = 1$ und $\|Tx_0\| = \|T\|$ gibt. Es werden alte und neue Resultate aus diesem Themenkreis dargestellt.

Ole Christensen (Technical University of Denmark, Denmark)

Frames and operator orbits

Frames generalize the standard orthonormal bases in Hilbert spaces: a frame also allows every element in the underlying Hilbert space to be represented as a superposition of its elements, but in contrast to the case of a basis the corresponding coefficients might not be unique. The talk will give a short overview of standard frame theory, and then discuss the possibility of representing a frame as an orbit of a bounded operator. A number of open questions will be discussed. The talk presents joint work with Dr. Marzieh Hasannasab at TU Berlin.

Jan-David Hardtke (Universität Leipzig, Germany)

Locally octahedral and locally almost square Köthe–Bochner spaces

We will discuss how measurable selections can be used to show that a Köthe–Bochner function space $E(X)$ is locally octahedral/locally almost square if X is locally octahedral/locally almost square.

Cormac Walsh (Inria and CMAP, Ecole Polytechnique, France)

Order isomorphisms and antimorphisms in partially-ordered vector spaces

An order isomorphism is a bijective map that is order-preserving in both directions. Interestingly, in many partially-ordered vector spaces, order isomorphisms are automatically affine. Whether or not this is the case for a particular space depends on the structure of its cone of positive elements. In this talk, I will survey results in this area.

We also consider antimorphisms, where now the order is reversed. The interesting case is where the antimorphism maps the open cone of strictly positive elements to itself. Recent work suggests that the existence of such an antimorphism implies strong properties of the space. Indeed, a conjecture of Lemmens–Roelands–van Imhoff makes an intriguing connection with Jordan algebras.

Janko Stennder (TU Dresden, Germany)

Operators in pre-Riesz spaces: Moduli and homomorphisms

We focus on two topics that are related to moduli of elements in partially ordered vector spaces. First, we relate operators that preserve moduli to generalized notions of lattice homomorphisms, such as Riesz homomorphisms, Riesz* homomorphisms, and positive disjointness preserving operators. We also consider complete Riesz homomorphisms, which generalize order continuous lattice homomorphisms. Second, we characterize elements with a modulus by means of disjoint elements and apply this result to obtain moduli of functionals and operators in various settings. On spaces of continuous functions, we identify those differences of Riesz* homomorphisms that have a modulus. Many of our results for pre-Riesz spaces of continuous functions lead to results on order unit spaces, where the functional representation is used. – Joint work with Onno van Gaans (Universiteit Leiden, The Netherlands).

Martin Weber (TU Dresden, Germany)

On the Cesàro vector lattices and their ideals of finite elements

For the Cesàro-matrix $C = (c_n m)_{n,m \in N}$, where $c_{nm} = \frac{1}{n}$, if $n \geq m$ and $c_{nm} = 0$ otherwise, there are defined the Cesàro sequence spaces ces_0, ces_p (for $1 < p < \infty$) and ces_∞. These spaces turn out to be real vector lattices and with respect to a corresponding (naturally introduced) norm all these spaces are Banach lattices, and so possess (or not possess) some interesting properties. In particular, the relations to their generating ideals c_0, ℓ_p and ℓ_∞ are investigated. The ideals of all finite, totally finite and selfmajorizing elements in ces_0, ces_p (for $1 < p < \infty$) and ces_∞ are described in detail. – The talk is based on joint research together with Ugur Gönüllü (Istanbul Kültür University) and Faruk Polat (Çankiri Karatekin University).

Helge Glöckner (Universität Paderborn, Germany)

Loop groups and Birkhoff decompositions

Recall that a unital, associative locally convex topological algebra A over the field of complex numbers is called a continuous inverse algebra (or cia) if its group of invertible elements is open in A and the inversion map is continuous. We say that a cia A is an R-cia if it is a subalgebra of the algebra of continuous complex-valued functions on the complex unit circle S and the set of complex rational functions with all poles outside S is dense in A. This concept generalizes the R-algebras used by I. C. Gohberg and I. A. Fel'dman in the context of Wiener–Hopf equations (the latter are commutative Banach algebras with the corresponding properties). Extending the coefficients of a finite-dimensional complex Lie algebra by an R-cia, we get a topological Lie algebra to which a suitable loop group can be associated. Examples are the Wiener algebra of complex-valued continuous functions on S with absolutely summable Fourier coefficients (which is an R-algebra), the Frechet algebra of all smooth complex-valued functions on S, and the Silva algebra of all real-analytic complex-valued functions on S. We discuss Birkhoff decompositions for the corresponding loop groups, and also for the group Hol(C*,G) of all holomorphic functions from the punctured plane to a linear complex Lie group G, endowed with the infinite-dimensional Lie group structure constructed by Neeb and Wagemann.

Thu Hien Nguyen (Leipzig University, Germany, and V. N. Karazin Kharkiv National University, Ukraine)

Some conditions for entire functions to belong to the Laguerre-Pólya class

We present some necessary and sufficient conditions for entire functions to belong to the Laguerre–Pólya class, or to have only real zeros, in terms of their Taylor coefficients. The Laguerre–Pólya class is a class of entire functions which are locally the uniform limit of a sequence of real polynomials having only real zeros. For an entire function $f(z) = \sum_{k=0}^{\infty} a_k z^k$, we define the second quotients of Taylor coefficients as $q_n(f) := \frac{a_{n-1}^2}{a_{n-2}a_n}$, $n \geq 2$ and find conditions on $q_n(f)$ for f to belong to the Laguerre–Pólya class. Besides, we discuss the partial theta function $g_a = \sum_{k=0}^{\infty} \frac{z^k}{a^{k^2}}$, $a > 1$, and some other special functions. – This is joint work with Anna Vishnyakova.

SECTION
S 08 Ordinary Differential Equations and Dynamical Systems

Section Leaders: Mathias Wilke and Isabelle Schneider

SESSION 1 _ Wednesday, September 14 _ 15.30–17.30 _ Takustraße 9: SR 005
Chair: Isabelle Schneider

15.30 Hans-Otto Walther (Justus-Liebig-Universität Gießen, Germany)
▷ *On solution manifolds for differential equations with variable delays*

16.00 Alejandro López Nieto (Freie Universität Berlin, Germany)
▷ *Global dynamics in delay equations with negative feedback and symmetry*

16.30 Babette de Wolff (Vrije Universiteit Amsterdam, The Netherlands)
▷ *Delayed Feedback Stabilization with and without symmetry*

17.00 Mina Stöhr (Weierstraß Institute Berlin (WIAS), Germany)
▷ *Bifurcations and instabilities of Temporal Dissipative Solitons in DDE-systems with large delay*

SESSION 2 _ Thursday, September 15 _ 10.30–12.30 _ Takustraße 9: SR 005
Chair: Isabelle Schneider

10.30 Jens Starke (University of Rostock, Germany)
▷ *Data-driven detection of unstable states, stability information and bifurcations in laboratory experiments*

11.00 Jan Sieber (University of Exeter, United Kingdom)
▷ *Non-invasive control in slow-fast cellular automata*

11.30 Serhiy Yanchuk (Potsdam Institute for Climate Impact Research, Germany, and Humboldt University of Berlin, Germany)
▷ *Absolute stability in systems with discrete time-delays*

12.00 Matthias Wolfrum (WIAS Berlin, Germany)
▷ *Multiple self-locking in the Kuramoto-system with time delay*

SESSION 3 _ Friday, September 16 _ 10.30–12.30 _ Takustraße 9: SR 005
Chair: Mathias Wilke

10.30 Bogdan Matioc (Universität Regensburg, Germany)
▷ *The quasistationary two-phase Stokes flow by capillarity in the plane*

11.00 Luigi Roberti (University of Vienna, Austria)
▷ *On the surface deflection angle of Ekman flows with varying eddy viscosity*

11.30 Dennis Chemnitz (Freie Universität Berlin, Germany)
▷ *Shear-induced chaos in the Hopf Normal Form with Additive Noise*

12.00 Keivan Mallahi Karai (Jacobs University Bremen)
▷ *Homogenous dynamics and the asymptotic distribution for values for pairs of linear and quadratic forms at integral vectors*

SESSION 4 _ Friday, September 16 _ 15.30–17.30 _ Takustraße 9: SR 005
Chair: Mathias Wilke

15.30 Burcu Gürbüz (Johannes Gutenberg-University Mainz, Germany)
▷ *A model of the Calvin cycle of photosynthesis*

16.00 Alan Rendall (Johannes Gutenberg-Universität Mainz, Germany)
▷ *Phenomenology of an in-host model for hepatitis C*

17.00 Asep Supriatna (Padjadjaran University, Indonesia)
▷ *A system of integral equations as a mathematical model of disease transmission*

ABSTRACTS

Hans-Otto Walther (Justus-Liebig-Universität Gießen, Germany)
On solution manifolds for differential equations with variable delays

It is on submanifolds of the Banach space of continuously differentiable maps on a compact interval that differential equations with variable delays define semiflows of solution operators which are differentiable. The talk presents recent results about the structure of these 'solution manifolds', which in several cases turn out to be nearly as simple as a graph over an open subset of a closed subspace of the appropriate codimension.

Alejandro López Nieto (Freie Universität Berlin, Germany)
Global dynamics in delay equations with negative feedback and symmetry

Discrete time delays often arise in real-world problems in the form of maturation times in population dynamics, time-delayed feedback loops in laser devices, and heat transfer lags in atmospheric models. However, mathematically, the study of differential equations including time delays requires the introduction of an infinite dimensional phase space, thereby yielding complicated dynamics. In the talk, I will address the simplest nontrivial class of delay differential equations (DDEs), those of the form

$$\dot{x}(t) = f(x(t), x(t-1)), \quad t \geq 0.$$

Here $x(t)$ parametrizes a real variable and f has negative delayed feedback, i.e., the derivative of f in the delayed component is always negative. The goal will be to show that, under even-odd symmetry assumptions $f(\xi,\eta) = f(-\xi,\eta) = -f(\xi,-\eta)$, the structure of the maximal compact invariant set also known as global attractor, $\mathcal{A}$, can be described in detail. More precisely, $\mathcal{A}$ possesses a graph structure whose vertices correspond to periodic or stationary solutions of the delay equation and whose edges represent the existence of transient solutions connecting the vertices. The existence of a discrete Lyapunov function for the difference of solutions of the delay equation allows us to characterize precisely which connection graphs are possible and even find explicit examples for which such graphs are realized.

Babette de Wolff (Vrije Universiteit Amsterdam, The Netherlands)
Delayed Feedback Stabilization with and without symmetry

Pyragas control is a delayed feedback scheme that aims to stabilize periodic orbits. The scheme preserves periodic orbits with a given period, but drastically changes the dynamics in their neighborhoods, and hence has the potential to make the periodic orbits stable. While the success of Pyragas control has been confirmed in many experiments, mathematical results on Pyragas control are still relatively rare. This is mostly because the controlled system becomes a delay differential equation (DDE) which generates an infinite dimensional dynamical system and hence poses analytical challenges. In this talk, I will discuss some fundamental observations in the mathematical analysis of Pyragas control. Moreover, I will discuss how Pyragas control can be adapted to stabilize spatio-temporal patterns in systems with symmetry.

Mina Stöhr (Weierstraß Institute Berlin (WIAS), Germany)
Bifurcations and instabilities of Temporal Dissipative Solitons in DDE-systems with large delay

Temporal Dissipative Solitons are localized states that can be found in dynamical systems with time-delayed feedback, where the delay is large. With a broad field of applications, e.g., for the development of pulses in opto-electronic devices and neural systems, our research is focused on understanding the bifurcation scenarios and instabilities of this type of solutions. We will see how the concepts of classical homoclinic bifurcation theory can be used to understand the bifurcations of solitons in DDE-systems. We demonstrate our results with the examples of the FitzHugh–Nagumo system and Morris–Lecar model with time-delayed feedback.

Jens Starke (University of Rostock, Germany)

Data-driven detection of unstable states, stability information and bifurcations in laboratory experiments

Information about the bifurcation structure of laboratory experiments supports mathematical modelling and model verification as a comparison of the bifurcations results in a much more critical test than just comparing data from time-series for some selected parameter values. Furthermore, for cases where closed mathematical equations are not yet known, bifurcation diagrams directly obtained from experiments help in engineering applications to find parameter regions of reliable operation modes. A control based continuation method to perform a bifurcation analysis directly for lab experiments allows to observe and investigate also unstable solution branches which were otherwise not observable in laboratory experiments. As the stationary points are stabilized with these control methods, the stability information of the original system gets lost. We introduce a method to construct the whole bifurcation diagram including information about stability and bifurcation points of the underlying uncontrolled equilibria. The methods are illustrated for the Zeeman catastrophe machine, a bistable mechanical experiment and the uncovering of unstable states in a pedestrian flow experiment. – Joint work with Anna Dittus (University of Rostock, Germany), Konstantinos Spiliotis (University of Rostock, Germany), Ingo Barke (University of Rostock, Germany) and Sylvia Speller (University of Rostock, Germany).

Jan Sieber (University of Exeter, United Kingdom)

Non-invasive control in slow-fast cellular automata

We show how one can use non-invasive control to identify thresholds between stable regimes in a cellular automaton model for tropical forest-grass landscapes. The access the control offers permits us to explore parts of the phase space that are important for transitions corresponding to forest dieback. When looking at this phase space we find that the dynamics is driven by two spatial features: the length of the forest perimeter and the length of the “grass-weighted” forest perimeter (where we count each cell according to the size of the adjacent grass patch). Moreover, we find that there is an emergent relation between these spatial features and the forest fraction, allowing us to establish a scalar ordinary differential equation governing the dynamics of the cellular automaton in practically relevant parameter regimes.

Serhiy Yanchuk (Potsdam Institute for Climate Impact Research, Germany and Humboldt University of Berlin, Germany)

Absolute stability in systems with discrete time-delays

An equilibrium of a delay differential equation (DDE) is absolutely stable, if it is locally asymptotically stable for all delays. We present criteria for absolute stability of DDEs with discrete time-delays. In the case of a single delay, the absolute stability is shown to be equivalent to asymptotic stability for sufficiently large delays. Similarly, for multiple delays, the absolute stability is equivalent to asymptotic stability for hierarchically large delays. Additionally, we give necessary and sufficient conditions for a linear DDE to be hyperbolic for all delays. The latter conditions are crucial for determining whether a system can have stabilizing or destabilizing bifurcations by varying time delays. – Joint work with Matthias Wolfrum (Weierstrass Institute Berlin, Germany), Tiago Pereira (University of Sao Paulo, Brasilia) and Dmitry Turaev (Imperial College London, UK).

Matthias Wolfrum (WIAS Berlin, Germany)
Multiple self-locking in the Kuramoto-system with time delay

We study the Kuramoto–Sakaguchi system of phase oscillators with a delayed mean-field coupling. By applying the theory of large delay to the corresponding Ott–Antonsen equation, we explain fully analytically the mechanisms for the appearance of multiple coexisting partially locked states. Closely above the onset of synchronization, these states emerge in the Eckhaus scenario: with increasing coupling, more and more partially locked states appear unstable from the incoherent state, and gain stability for larger coupling at a modulational stability boundary. The partially locked states with strongly detuned frequencies are shown to emerge subcritical and gain stability only after a fold and a series of Hopf bifurcations. We also discuss the role of the Sakaguchi phase lag parameter. For small delays, it determines, together with the delay time, the attraction or repulsion to the central frequency, which leads to supercritical or subcritical behavior, respectively. For large delay, the Sakaguchi parameter does not influence the global dynamical scenario.

Bogdan Matioc (Universität Regensburg, Germany)
The quasistationary two-phase Stokes flow by capillarity in the plane

We discuss a two-phase evolution problem that describes the two-dimensional quasistationary Stokes flow of two fluids with different densities and viscosities that occupy the entire plane in the regime where surface tension effects are taken into account at the interface that separates the fluids. Using potential theory, the model can be formulated as a nonlinear and nonlocal evolution problem for the function that parameterizes the interface between the fluids, with nonlinearities expressed by singular integral operators. This problem is of parabolic type, well-posed in all Sobolev spaces up to critical regularity, and it features some parabolic smoothing properties. – Joint work with Georg Prokert.

Luigi Roberti (University of Vienna, Austria)

On the surface deflection angle of Ekman flows with varying eddy viscosity

In oceanography, the Ekman layer is the (relatively) thin boundary layer at the surface of the ocean, where frictional effects due to the wind become relevant and wind-driven surface currents arise. One of the key features of flows in the Ekman layer is the fact that the wind-induced surface current is at an angle to the direction of the generating wind. Using a reformulation of the classical ODE model for steady Ekman flows as a Riccati-type problem, I will show how perturbative techniques can be applied to gain insight into how the eddy viscosity (the depth-dependent quantity that models the frictional effects in the boundary layer) affects the surface deflection angle, in the setting of a non-equatorial two-layer ocean with constant eddy viscosity in the lower layer and an arbitrary continuous eddy viscosity profile in the upper layer.

Dennis Chemnitz (Freie Universität Berlin, Germany)

Shear-induced chaos in the Hopf Normal Form with Additive Noise

We are concerned with the problem of finding positive Lyapunov exponents (and thus chaotic behaviour) in the Hopf Normal Form with Addative Noise. Our new approach is to study certain limits of the parameters to reduce the problem to previously studied toy models. The crucial ingredient for this kind of approach, is a result on the continuity of Lyapunov exponents. – Joint work with Maximilian Engel (FU Berlin, Germany).

Keivan Mallahi Karai (Jacobs University Bremen)

Homogenous dynamics and the asymptotic distribution for values for pairs of linear and quadratic forms at integral vectors

In the last three decades the methods from the field of homogenous dynamics have proven to be indispensable in studying asymptotic distribution problems in number theory. One of the landmark results in this area is the celebrated theorem of Eskin–Margulis–Mozes on the quantitative Oppenheim conjecture, which addresses determining the asymptotic distribution of values of an irrational indefinite quadratic form over integral vectors chosen from a ball as its radius tends to infinity. In this talk we will discuss the application of ergodic theoretic methods from homogenous dynamics for determining the joint distribution of values of a pair consisting of a quadratic form and a linear form over the set of integral vectors. This talk is based on the joint work with Jiyoung Han (Tata Institute Of Fundamental Research) and Seonhee Lim (Seoul National University, Korea).

Burcu Gürbüz (Johannes Gutenberg-University Mainz, Germany)

A model of the Calvin cycle of photosynthesis

The dynamical behaviour of systems of ordinary differential equations (ODEs) has been investigated in different forms of chemical reaction networks. One of the well-known chemical reaction networks is the Calvin cycle. The Calvin cycle is part of the reactions of photosynthesis which is of great importance in plant physiology. In this study, a model for the Calvin cycle is considered and the qualitative properties of dynamical solutions are investigated. The dynamical system is analysed with suitable parameters and simulation results are shown by figures. – Joint work with Alan Rendall (Johannes Gutenberg-University Mainz, Germany).

Alan Rendall (Johannes Gutenberg-Universität Mainz, Germany)

Phenomenology of an in-host model for hepatitis C

Hepatitis C is a major global health problem. The number of chronically infected individuals is estimated to be 58 million and many of these will develop cirrhosis or liver cancer. Mathematical modelling could help to improve treatment of this disease. The subject of this talk is a system of five ODE which describes the dynamics of hepatitis C in a host. The aim of the work described is to identify dynamical features of solutions under minimal assumptions on the parameters. The phenomena investigated include the existence of periodic solutions and backward bifurcations and the multiplicity and stability of steady states. – Joint work with Alexis Nangue (Higher Teachers' Training College, University of Maroua, Cameroon).

Asep Supriatna (Padjadjaran University, Indonesia)

A system of integral equations as a mathematical model of disease transmission

In this paper a mathematical model in the form of a system of integral equations describing the transmission of contagious disease is proposed and analyzed. We look at dengue disease transmission as an example. The disease is transmitted between human and mosquitoes. Age-dependent functions are used to describe the survival of individuals in human and mosquitoes populations. In this case, decreasing of mosquito's life expectancy and biting rate are assumed to reflect a wolbachia bacterial infection into the mosquito population. The dengue basic reproduction number is derived and analyzed. The results showed that there is a threshold determining the existence of the non-trivial endemic equilibrium, which is also the same threshold for its stability. We also re-establish the well known rule of thumb of the minimum vaccination coverage to control the disease in the context of vector-borne disease with age-dependent survival rates. Further we discuss the effect of the presence of wolbachia infection in the basic reproduction number and its consequence in the transmission of the disease. We show that the presence of wolbachia is potential as a biological control agent to eliminate the dengue in human population. We compare the strategy of wolbachia introduction with the existing strategy such as vaccination.

SECTION
S 09 Applied Analysis and Partial Differential Equations

Section Leaders: Agnes Lamacz-Keymling and Barbara Zwicknagl

SESSION 1 _ Monday, September 12 _ 11.00–13.00 _ Takustraße 9: SR 055
Chair: Agnes Lamacz-Keymling

11.00 Sebastian Herr (Universität Bielefeld, Deutschland)
▷ *Well-posedness of the Zakharov–Kuznetsov equation*

12.00 Ángel Crespo-Blanco (Technische Universität Berlin, Germany)
▷ *A new class of double phase variable exponent problems: Existence and uniqueness*

12.30 Mario Fuest (Leibniz Universität Hannover, Germany)
▷ *Finite-time blow-up in chemotaxis systems with a logistic source*

SESSION 2 _ Tuesday, September 13 _ 10.30–12.30 _ Takustraße 9: SR 055
Chair: Barbara Zwicknagl

10.30 Alexander Mielke (WIAS Berlin and Humboldt-Universität zu Berlin, Germany)
▷ *Convergence to thermodynamic equilibrium in a degenerate parabolic system*

11.30 Petr Pelech (WIAS Berlin and Forschungsverbund Berlin e. V., Germany)
▷ *Penrose–Fife model as a gradient flow – interplay between signed measures and functionals on sobolev spaces*

12.00 Claudia Grabs (Potsdam University, Germany)
▷ *A geometric model for thin elastic films*

SESSION 3 _ Wednesday, September 14 _ 10.30–12.30 _ Takustraße 9: SR 055
Chair: Agnes Lamacz-Keymling

10.30 Vitalii Konarovskyi (Bielefeld University and Leipzig University, Germany, and Institute of Mathematics of NAS of Ukraine, Kyiv)
▷ *Conservative SPDEs as fluctuating mean field limits of stochastic gradient descent*

11.30 Thomas Eiter (WIAS Berlin, Germany)
▷ *On the resolvent problems associated with rotating viscous flow*

12.00 Robert Lasarzik (WIAS Berlin, Germany)
▷ *Energy-variational solutions in fluid dynamics*

SESSION 4 _ Wednesday, September 14 _ 15.30–17.30 _ Takustraße 9: SR 055
Chair: Barbara Zwicknagl

15.30 Andreas Deuchert (University of Zurich, Switzerland)
▷ *Microscopic derivation of Ginzburg–Landau theory and the BCS critical temperature shift in a weak homogeneous magnetic field*

16.00 Anastasija Pešić (HU Berlin, Germany)
▷ *Variational models for pattern formation in biomembranes*

16.30 Janusz Ginster (Humboldt-Universität zu Berlin, Germany)
▷ *Scaling laws and the emergence of complex patterns in helimagnetism*

17.00 Annegret Glitzky (WIAS Berlin, Germany)
▷ *A drift-diffusion based electrothermal model for organic thin-film devices including electrical and thermal environment*

ABSTRACTS

Sebastian Herr (Universität Bielefeld, Deutschland)
Well-posedness of the Zakharov–Kuznetsov equation

The Cauchy problem for the Zakharov–Kuznetsov equation in spatial dimensions $d >= 2$ with initial data in H^s will be considered. We will discuss Kinoshita's local well-posedness result in $d = 2$ for $s > -1/4$. In joint work with Kinoshita we extended this to the full subcritical range $s > (d-4)/2$, which is optimal up to the endpoint. As a corollary, global well-posedness in L^2 in $d = 3$, and under a smallness condition, in the energy space H^1 in $d = 4$ follow. In addition, we prove global well-posedness and scattering for small initial data of critical regularity in high dimensions.

Ángel Crespo-Blanco (Technische Universität Berlin, Germany)
A new class of double phase variable exponent problems: Existence and uniqueness

This talk is based on the article with the same name by the speaker, Gasiński, Harjulehto and Winkert (JDE 323, 2022). In that paper we introduce a new class of quasilinear elliptic equations driven by the so-called double phase operator with variable exponents. We prove certain properties of the corresponding Musielak–Orlicz Sobolev spaces (an equivalent norm, uniform convexity, Radon–Riesz property with respect to the modular) and the properties of the new double phase operator (continuity, strict monotonicity, (S_+)-property). In contrast to the known constant exponent case we are able to weaken the assumptions on the data. Finally we show the existence and uniqueness of corresponding elliptic equations with right-hand sides that have gradient dependence (so-called convection terms) under very general assumptions on the data. As a result of independent interest, we also show the density of smooth functions in the new Musielak–Orlicz Sobolev space even when the domain is unbounded. – Joint work with Leszek Gasiński (Pedagogical University of Cracow, Poland), Petteri Harjulehto (University of Turku, Finland) and Patrick Winkert (Technische Universität Berlin, Germany).

Mario Fuest (Leibniz Universität Hannover, Germany)
Finite-time blow-up in chemotaxis systems with a logistic source

The possibility of finite-time blow-up is certainly one of the most striking features of the models for chemotactical behavior introduced by Keller and Segel in the 1970s. However, such a drastic form of pattern formation is not always desired from a modelling point of view and one way to counter the destabilizing effect of the taxis term is to add quadratic degradation terms modelling population growth. While it is well known that these modified systems admit global classical solutions in the two-dimensional settings, a recent result shows that this is no longer the case (for a simplified system) in high dimensions. After a brief introduction to chemotaxis systems (mainly with a logistic source), the talk will focus on the main ideas of the finite-time blow-up proof and discuss various challenges. The arguments employed are rather elementary and in particular familiarity with chemotaxis systems is not a prerequisite for this talk.

Alexander Mielke (WIAS Berlin and Humboldt-Universität zu Berlin, Germany)
Convergence to thermodynamic equilibrium in a degenerate parabolic system

We discuss a system of two coupled parabolic equations that have degenerate diffusion constants depending on the energy-like variable w. The energy dissipated by the velocity-like variable v is fed as a source term into the energy equation leading to conservation of the total energy. After providing a thermodynamically motivated gradient structure we establish existence of solutions. For bounded domains we provide convergence into the thermodynamic equilibrium, which is spatially constant and depends on the total momentum and energy. The longtime behavior of finite-momentum and finite-energy solutions on the full space $\mathbb{R}^d$ is open and selfsimilar behavior is expected.

Pelech, Petr (WIAS Berlin and Forschungsverbund Berlin e. V., Germany)
Penrose–Fife model as a gradient flow – interplay between signed measures and functionals on sobolev spaces

We study a non-autonomous system of two evolutionary PDEs, an enhanced version of the Penrose-Fife model introduce in 1990, which first in the history coupled the Allen–Cahn phase-field equation with thermal effects in a thermodynamically consistent way. In our work we consider an activated phase transformation which makes the phase-field equation

non-linear in time derivative; the new term depends only on the direction of the rate, similarly as, e.g., the Coulomb dry friction does.
To investigate the system, an effective approach is to formulate it as a gradient flow; however, while the energy rate lies naturally in H^{-1}, the driving functional bounds the energy only in signed measures. In higher spatial dimensions none of the two spaces is a subset of the other. In addition, the topologies of these spaces are in general farily incompatible. Nevertheless, for a special subset of signed measures, in which solutions always lies, something more can be said. Apart existence of solutions, we focus in our work on the interplay between the two topologies, which is necessary for more detailed study of the system and properties of its solutions. Given these results we are able to characterize the sub-differential of the non-smooth driving functional, which makes the weak formulation more explicit and, in turn, makes the future analysis of the system more feasible. – Joint work with Matthias Liero (WIAS Berlin and Forschungsverbund Berlin e. V., Germany).

Claudia Grabs (Potsdam University, Germany)
A geometric model for thin elastic films

We present a geometric approach to model deformations of thin elastic films seen as two-dimensional surfaces. We assume here, that the thin elastic film shows no resistance to bending, and all stresses are due to stretching of the film. In particular, all stresses are tangential. However, the divergence of the 2D stress tensor field has components normal to the surface that also need to vanish in an equilibrium configuration. We compare experimental data with simulations for different 2D elastic material models. The material is assumed to be isotropic, homogeneous and hyperelastic.

Vitalii Konarovskyi (Bielefeld University and Leipzig University, Germany, and Institute of Mathematics of NAS of Ukraine, Kyiv)
Conservative SPDEs as fluctuating mean field limits of stochastic gradient descent

In my talk, the convergence of stochastic interacting particle systems in the mean-field limit to solutions to conservative stochastic partial differential equations will be shown. We will discuss the optimal rate of convergence and derive a quantitative central limit theorem for such SPDEs. The results apply in particular to the convergence in the mean-field scaling of stochastic gradient descent dynamics in overparametrized, shallow neural networks to solutions to SPDEs. Moreover, we will see that the inclusion of fluctuations in the limiting SPDE improves the rate of convergence, and retains information about the fluctuations of stochastic gradient descent in the continuum limit. – The talk is based on joint work with Benjamin Gess and Rishabh S. Gvalani.

Thomas Eiter (WIAS Berlin, Germany)

On the resolvent problems associated with rotating viscous flow

When studying the time-periodic viscous flow around a rotating rigid body, the associated linearized problems are not well-posed in a setting of classical Sobolev spaces. To resolve this issue, in this talk a suitable framework of homogeneous Sobolev spaces is introduced such that the corresponding resolvent problems are uniquely solvable. If the flow is at rest at infinity, one can further derive uniform resolvent estimates, which lead to the existence of solutions to the time-periodic problem. However, if the flow is not at rest at infinity, then the uniformity of the resolvent estimates requires additional restrictions, and the existence of time-periodic solutions merely follows if the two present oscillating processes are compatible, that is, the rotational velocity of the body and the angular velocity of the time-periodic forcing must be rational multiples of each other.

Robert Lasarzik (WIAS Berlin, Germany)

Energy-variational solutions in fluid dynamics

In this talk, the concept of energy-variational solutions is introduced in the context of the Euler and Navier–Stokes equations. The set of energy-variational solutions has disirable properties, the set of solutions is convex, weakly-star closed and depends continuously on the given data. Moreover, energy-variational solutions fulfill the semi-flow property. This concept is then compared to previously introduced solvability concepts like dissipative, measure-valued and weak solutions. Finally, different selection criteria and their approximation are discussed.

Andreas Deuchert (University of Zurich, Switzerland)

Microscopic derivation of Ginzburg–Landau theory and the BCS critical temperature shift in a weak homogeneous magnetic field

Starting from the Bardeen–Cooper–Schrieffer (BCS) free energy functional, we derive the Ginzburg-Landau functional for the case of a weak homogeneous magnetic field. We also provide an asymptotic formula for the BCS critical temperature as a function of the magnetic field. This extends the previous works arXiv:1102.4001 and arXiv:1410.2352 of Frank, Hainzl, Seiringer and Solovej to the case of external magnetic fields with non-vanishing magnetic flux through the unit cell. – Joint work with Marcel Schaub (LMU Munich, Germany).

Anastasija Pešić (HU Berlin, Germany)

Variational models for pattern formation in biomembranes

Biological membranes are thin structures that are composed of various components. The different components often form microdomains, called lipid rafts, that are arranged in complex patterns. To explain this pattern formation, variational models have been introduced that couple the local composition of the membrane to its local curvature. We consider such models in various parameter regimes and analyze minimizers of the energy functionals via techniques of Γ-convergence. An overview of the available deterministic and stochastic results as well as current developments will be discussed.

Janusz Ginster (Humboldt-Universität zu Berlin, Germany)

Scaling laws and the emergence of complex patterns in helimagnetism

In this talk we discuss a variational approach to study pattern formation in Helimagnets. After a brief introduction to the technique of scaling laws, we turn our attention to studyig the emergence of patterns in magnetic compounds near the helimagnetic/ferromagnetic transition point in case of Dirichlet boundary conditions on the spin field. The energy under investigation is a continuum approximation of a J_1-J_3-model. It contains two parameters, one measuring the incompatibility of the boundary conditions, the other measuring the cost of changes between different chiralities. We prove a scaling law for the minimal energy in terms of these two parameters. The constructions from the upper bound indicate that in some regimes branching-type patterns form close to the boundary of the sample. – Joint work with Barbara Zwicknagl (Humboldt-Universität zu Berlin, Germany).

Annegret Glitzky (WIAS Berlin, Germany)

A drift-diffusion based electrothermal model for organic thin-film devices including electrical and thermal environment

We derive and investigate a stationary model for the electrothermal behavior of organic thin-film devices including their electrical and thermal environment. Whereas the electrodes are modelled by Ohm's law, the electronics of the organic device itself is described by a generalized van Roosbroeck system with temperature dependent mobilities and using Gauss–Fermi integrals for the statistical relation. The currents give rise to Joule heat which together with the heat generated by the generation/recombination of electrons and holes in the organic device occur as source terms in the heat flow equation that has to be considered on the whole domain. The crucial task is to establish that the quantities in the transfer conditions at the interfaces between electrodes and the organic semiconductor device have sufficient regularity, we manage the analytical treatment of the system in two spatial dimensions. We consider layered organic structures, where the physical parameters (total densities of transport stetes, LUMO and HOMO energies, disorder parameter, basic mobilities, activation energies, relative dielectric permittivity, heat conductivity) are piecewise constant and work in a $W^{1,q}$ setting for some $q > 2$. We prove the existence of weak solutions using Schauder's fixed point theorem.

SECTION
S 10 Numerical Mathematics and Scientific Computing

Section Leaders: Mira Schedensack and Caroline Lasser

SESSION 1 _ Monday, September 12 _ 11.00–13.00 _ Arnimallee 6: SR 031
Chair: Joscha Gedicke

11.00 Harry Yserentant (TU Berlin, Germany)
▷ *The Laplace equation, measure concentration, Gauss functions, and quantum theory*

12.00 Shudan Tian (Jena University, Germany)
▷ *Nonconforming finite elements satisfying a strong discrete Miranda–Talenti inequality*

12.30 Dietmar Gallistl (Friedrich-Schiller-Universität Jena, Deutschland)
▷ *Convergence of a regularized finite element discretization of the two-dimensional Monge–Ampère equation*

SESSION 2 _ Monday, September 12 _ 15.30–17.30 _ Arnimallee 6: SR 031
Chair: Katharina Kormann

15.30 Joscha Gedicke (Universität Bonn, Germany)
▷ *A posteriori error analysis for symmetric mixed Arnold–Winther FEM*

16.30 Håkon Hoel (University of Oslo, Norway)
▷ *Higher-order adaptive methods for exit times of diffusion processes*

17.00 Gianluca Ceruti (École Polytechnique Fédérale de Lausanne)
▷ *Low-rank dynamical training of feed-forward neural networks*

SESSION 3 _ Tuesday, September 13 _ 10.30–12.30 _ Arnimallee 6: SR 031
Chair: Harry Yserentant

10.30 Katharina Kormann (Ruhr-Universität Bochum, Germany)
▷ *Relativistic electromagnetic particle-in-cell methods*

11.30 Lars Diening (Universität Bielefeld, Germany)
▷ *Sobolev stability of the L^2-projection*

ABSTRACTS

Harry Yserentant (TU Berlin, Germany)

The Laplace equation, measure concentration, Gauss functions, and quantum theory

We represent in this talk the solutions of the electronic Schrödinger equation as traces of higher-dimensional functions. This allows to decouple the electron-electron interaction potential but comes at the price of a degenerate elliptic operator replacing the Laplace operator on the higher-dimensional space. The surprising observation is that this operator can without much loss again be substituted by the Laplace operator, the more successful the larger the system under consideration is. This is due to a nontrivial concentration of measure effect that has much to do with the random projection theorem known from probability theory and the data sciences. One can see this from different perspectives. One may speculate that for high electron numbers, in the range where statistical physics comes into play, the original Schrödinger equation can largely be replaced by a decoupled, higher-dimensional equation, with solutions whose traces are approximations of the true wave functions. The talk will more focus on practical aspects like the iterative calculation of the groundstates of molecular systems.

Shudan Tian (Jena University, Germany)

Nonconforming finite elements satisfying a strong discrete Miranda–Talenti inequality

In this talk, I will introduce two families of new H^2-nonconforming elements in 2D and 3D, which satisfy a strong discrete Miranda–Talenti inequality. Our construction based on C^0 elements with C^1 continuity on the vertices (2D) or edges (3D), such as the Hermite element. One directly application of those two families elements is to solve non-divergence form equations, which can avoid use additional stabilization terms. For this reason, the Cea estimation and the posterior error estimator can be obtained naturally. Solving biharmonic equations is another good application. Compared with traditional high order H^2-nonconforming elements, our elements have less degrees of freedom. Finally some numerical results are provided to illustrate the performance of the new methods. – Joint work with Dietmar Gallistl (Jena University, Germany).

Dietmar Gallistl (Friedrich-Schiller-Universität Jena, Deutschland)

Convergence of a regularized finite element discretization of the two-dimensional Monge–Ampère equation

This contributions proposes a regularization of the Monge–Ampère equation in a planar convex domain through uniformly elliptic Hamilton–Jacobi–Bellman equations. The regularized problem possesses a unique strong solution u_ε and is accessible to the discretization with finite elements. This work establishes locally uniform convergence of u_ε to the convex Alexandrov solution u to the Monge–Ampère equation as the regularization parameter ε approaches 0. A mixed finite element method for the approximation of u_ε is proposed, and the regularized finite element scheme is shown to be locally uniformly convergent. Numerical experiments provide empirical evidence for the efficient approximation of singular solutions u. – Joint work with Ngoc Tien Tran (Friedrich-Schiller-Universität Jena, Deutschland).

Joscha Gedicke (Universität Bonn, Germany)

A posteriori error analysis for symmetric mixed Arnold–Winther FEM

The development of mixed finite element methods for linear elasticity with strongly imposed symmetry has been a long standing problem until the beginning of this century. Surprisingly for a mixed method, nodal stress degrees of freedom are necessary in order to fulfill the strong symmetry. This interesting mixed finite element also poses some difficulties for the derivation of residual based a posteriori error estimators. In a first attempt we make use of the residual a posteriori error estimator techniques for weakly symmetric stresses introducing an auxiliary approximation of the skew-symmetric gradient via a postprocessing. The second version then makes fully use of the imposed symmetry of the stress approximations utilising integration by parts twice and a suitable decomposition into tangential-tangential and normal-normal parts, similarly to the residual a posteriori error analysis for plate problems. The presented postprocessing technique can also be used to compute directly an a posteriori error bound. This is demonstrated for the Stokes problem and the Stokes eigenvalue problem, where a postprocessing of the eigenvalue is proven to lead to improved convergence rates of the eigenvalue error.

Håkon Hoel (University of Oslo, Norway)

Higher-order adaptive methods for exit times of diffusion processes

The first time a stochastic process starting inside a domain hits the boundary of the domain is referred to as the exit time. Exit times can model the transition time between pesudo-stable states of molecular systems in the canonical ensemble, and they also have applications in pricing of financial options. In this talk, we present a higher-order adaptive method for strong approximations of exit times of diffusion processes in the form of Itô stochastic differential equations (SDE). The method employs an Itô–Taylor scheme for simulating SDE paths and carefully decreases the step-size in the numerical integration as the solution approaches the boundary of the domain. Higher-order schemes and adaptivity are techniques that when carefully combined turn out to complement each other nicely in this approach. Intuitively, adaptive timestepping improves the accuracy of the exit time by reducing the magnitude of the overshoot of the numerical solution when it exits the domain, and higher-order schemes improve the approximation of the state of the diffusion process. But since the adaptive time-stepping in our approach is state dependent, even the adaptive timestepping itself improves when higher-order schemes that approximate the state more accurately are used. We will present theoretical results on convergence and complexity, and discuss how the method can be combined with multilevel Monte Carlo to produce an efficient method for estimating mean exit times. – Joint work with Sankarasubramanian Ragunathan (RWTH Aachen, Germany).

Gianluca Ceruti (École Polytechnique Fédérale de Lausanne)
Low-rank dynamical training of feed-forward neural networks

Neural networks have recently found tremendous interest in a large variety of applications. However, their memory and computational footprint can make them impractical in settings with limited computational resources. In the present contribution, a brief recapitulation on recent developments for dynamical low-rank approximation is presented. Then, based on the novel rank-adaptive unconventional robust numerical integrator for dynamical low-rank approximation, a novel algorithm(DLRT) for finding and efficiently training feed-forward neural networks having low-rank weight matrices is introduced. It is illustrated that up to a prescribed tolerance parameter, the proposed algorithm dynamically adapts during the training phase the ranks of the weight matrices of the neural network, reducing the overall time and memory resources required by both the training and the evaluating process. Furthermore, up to numerical errors, the DLRT algorithm is shown to preserve the monotonic decrease of the loss-function along the low-rank approximations. The efficiency and accuracy of the proposed method is illustrated through a variety of numerical experiments on fully-connected and convolutional networks. – The present contribution is based on a joint work with Steffen Schotthöfer (KIT), Emanuele Zangrando (GSSI), Jonas Kusch (University of Innsbruck), and Francesco Tudisco (GSSI).

Katharina Kormann (Ruhr-Universität Bochum, Germany)
Relativistic electromagnetic particle-in-cell methods

Numerical schemes that preserve the structure of the underlying kinetic equations can provide new insights into the long time behavior of fusion plasmas. In this talk we will present an electromagnetic particle-in-cell solver for the relativistic Vlasov—-Maxwell equations that preserves at the discrete level the non-canonical Hamiltonian structure. The Maxwell equations are discretized by compatible spline finite elements that yield discrete differential operators that retain properties like divcurl $= 0$. Along with a classical particle discretization of the Vlasov equation, this yields a system of differential equations that has a Poisson structure, that is the non-canonical analog of a symplectic structure. We will discuss the time discretization of this system based on a discrete gradients or splitting methods and discuss the additional difficulty due to the gamma factor compared to the non-relativistic case. – Joint work with Eric Sonnendrücker (Max Planck Institute for Plasma Physics, Germany).

Lars Diening (Universität Bielefeld, Germany)

Sobolev stability of the L^2-projection

We prove the $W^{1,2}$-stability of the L^2-projection on Lagrange elements for adaptive meshes and arbitrary pokynomial degree. This property is especially important for the numerical analysis of parabolic problems. We will explain that the stability of the projection is connected to the grading constants of the underlying adaptive refinement routine. For arbitrary dimensions we show that the bisection algorithm of Maubach and Traxler produces meshes with a grading constant 2. This implies $W^{1,2}$-stability of the L^2-projection up to dimension six.

SECTION
S 11 Discrete and Nonlinear Optimization

Section Leaders: Andrea Walther and Martin Skutella

SESSION 1 _ Thursday, September 15 _ 15.30–17.30 _ Arnimallee 6: SR 032
Chair: Martin Skutella

15.30 René Pinnau (TU Kaiserslautern, Germany)
▷ *Optimal control of free boundary problems*

16.30 Stefan Ulbrich (TU Darmstadt, Germany)
▷ *Convergence of numerical sensitivity and adjoint schemes for optimal boundary control of discontinuous solutions of hyperbolic conservation laws*

SESSION 2 _ Friday, September 16 _ 10.30–12.30 _ Arnimallee 6: SR 025–026
Chair: Martin Skutella

10.30 Olaf Parczyk (Freie Universität, Berlin)
▷ *New Ramsey multiplicity bounds and search heuristics*

11.00 Elmar Swarat (Zuse Institute Berlin, Germany)
▷ *Discrete Optimization at work: An optimization approach to toll enforcement*

11.30 Svenja Marie Griesbach (TU Berlin, Germany)
▷ *Public signals in network congestion games*

12.00 Mathieu Besançon (Zuse Institute Berlin, Germany)
▷ *Convex integer optimization with Frank–Wolfe methods*

SESSION 3 _ Friday, September 16 _ 15.30–17.30 _ Arnimallee 6: SR 025–026
Chair: Martin Skutella

15.30 David Martinez-Rubio (Zuse Institute Berlin and TU Berlin, Germany)
▷ *Metric-projected accelerated Riemannian optimization: Handling constraints to bound geometric penalties*

16.00 Timo Kreimeier (Humboldt-Universität zu Berlin, Deutschland)
▷ *Comparing solution strategies for constrained piecewise linear optimization problems*

ABSTRACTS

René Pinnau (TU Kaiserslautern, Germany)

Optimal control of free boundary problems

In this talk we present FBPs in different areas of application, e.g., filter production, and the corresponding optimal control problems. These include the production of the fibre material as well as the control of the filtration process. The problems are analysed and we use the adjoint variables to derive the derivative information which is needed for the respective numerical solution. Further, we discuss possible relaxations and approximations.

Stefan Ulbrich (TU Darmstadt, Germany)

Convergence of numerical sensitivity and adjoint schemes for optimal boundary control of discontinuous solutions of hyperbolic conservation laws

We study the convergence of discretization schemes for the adjoint equation arising in the adjoint-based derivative computation for optimal boundary control problems governed by entropy solutions of conservation laws with source term. As boundary control we consider piecewise continuously differentiable controls with possible discontinuities at switching times, where the smooth parts as well as the switching times serve as controls. The derivative of tracking-type objective functionals with respect to the smooth controls and the switching times can then be represented by an adjoint-based formula. The main difficulties arise from the fact that the correct adjoint state is the reversible solution of a transport equation with discontinuous coefficient and boundary conditions that lead in general to discontinuous adjoints. Moreover, the solution of the adjoint equation is non-unique and the so-called reversible solution leads to the correct adjoint-based derivative representation. We study discrete adjoint schemes of monotone difference schemes in conservation form such as Engquist-Osher or Lax-Friedrichs scheme. We also allow that the state is computed by another numerical scheme satisfying certain convergence properties. We proof convergence results of the discrete adjoint to the reversible solution. The results also imply convergence of a corresponding linearized scheme for the sensitivities. The findings are illustrated by numerical examples. – Joint work with Paloma Schäfer Aguilar (TU Darmstadt, Germany).

Olaf Parczyk (Freie Universität, Berlin)

New Ramsey multiplicity bounds and search heuristics

We study two related problems concerning the number of monochromatic cliques in two-colorings of the complete graph that go back to questions of Erdős. Most notably, we improve the 25-year-old upper bounds of Thomason on the Ramsey multiplicity of K_4 and K_5

and we settle the minimum number of independent sets of size 4 in graphs with clique number at most 4. Motivated by the elusiveness of the symmetric Ramsey multiplicity problem, we also introduce an off-diagonal variant and obtain tight results when counting monochromatic K_4 or K_5 in only one of the colors and triangles in the other. The extremal constructions for each problem turn out to be blow-ups of a finite graph and were found through search heuristics. They are complemented by lower bounds and stability results established using Flag Algebras, resulting in a fully computer-assisted approach. More broadly, these problems lead us to the study of the region of possible pairs of clique and independent set densities that can be realized as the limit of some sequence of graphs. – Joint work with Sebastian Pokutta (ZIB Berlin and TU Berlin, Germany), Christoph Spiegel (ZIB Berlin) and Tibor Szabó (ZIB Berlin).

Elmar Swarat (Zuse Institute Berlin, Germany)

Discrete Optimization at work: An optimization approach to toll enforcement

Discrete optimization is an area that allows to formulate a lot of real-world problems as an mathematical optimization problem, e.g., as a combinatorial optimization problem or as an (mixed) integer program. Following the long tradition of Berlin mathematics to make mathematics for key technologies we will present an example how we solved a real-world problem successfully with an Integer Programming approach with different objectives. While in the last 20 or 30 years many planning problems in airline or railway traffic were solved by combinatorial optimization approaches we tackle a similar problem that was not studied so far. Planning control resources is an important challenge in many real-world applications, e.g., police inspections, ticket inspections or other security related tasks. We focus on the enforcement of the distance-based truck toll on German motorways and main roads (around 52k kilometers). The enforcement of the toll is the responsibility of the German Federal Office for Goods Transport (BAG). It is partly conducted by traffic control gantries or devices for automatic stationary camera control. In addition, more than 500 mobile control inspectors perform spot-checks over the complete network. In an on-going research and development project with the BAG we consider the task to optimize the mobile control tours. Furthermore, feasible rosters need to be generated to prevent the planning of tours for which no crew is available. For the crew scheduling we use a multi-commodity flow model that is coupled with the tour planning part. Our presentation on the optimization of this real-world problem has several aspects. On the one hand the challenge is to find the right model formulation since this has a major influence on the solvability of the IP. On the other hand the modeling power of (mixed) integer programming and the ability of rapid model modifications in order to cope with moving targets is an important instrument to solve real-world problems. We will discuss how we mastered the challenge to bring the optimization algorithm into production. Finally, especially the public sector is an area where problems are mainly solved without mathematical knowledge or algorithms. Hence, it is an important step to apply mathematics as a key technology also in this application area. – This work was funded by the German Federal Office for Goods Transport (BAG).

Svenja Marie Griesbach (TU Berlin, Germany)
Public signals in network congestion games

We consider a largely untapped potential for the improvement of traffic networks that is rooted in the inherent uncertainty of travel times. Travel times are subject to stochastic uncertainty resulting from various parameters such as weather condition, occurrences of road works, or traffic accidents. Large mobility services have an informational advantage over single network users as they are able to learn traffic conditions from data. A benevolent mobility service may use this informational advantage in order to steer the traffic equilibrium into a avorable direction. The resulting optimization problem is a task commonly referred to as signaling or Bayesian persuasion. Previous work has shown that the underlying signaling problem can be NP-hard to approximate within any non-trivial bounds, even for affine cost functions with stochastic offsets. In contrast, we show that in this case, the signaling problem is easy for many networks. We tightly characterize the class of single-commodity networks, in which full information revelation is always an optimal signaling strategy. Moreover, we construct a reduction from optimal signaling to computing an optimal collection of support vectors for the Wardrop equilibrium. For two states, this insight can be used to compute an optimal signaling scheme. The algorithm runs in polynomial time whenever the number of different supports resulting from any signal distribution is bounded to a polynomial in the input size. Using a cell decomposition technique, we extend the approach to a polynomial-time algorithm for multi-commodity parallel link networks with a constant number of commodities, even when we have a constant number of different states of nature. – Joint work Martin Hoefer (Goethe-Universität Frankfurt, Germany), Max Klimm (TU Berlin, Germany) and Tim Koglin (Goethe-Universität Frankfurt, Germany).

Mathieu Besançon (Zuse Institute Berlin, Germany)
Convex integer optimization with Frank–Wolfe methods

Mixed-integer nonlinear optimization is a broad class of problems that feature combinatorial structures and nonlinearities. Typical exact methods combine a branch-and-bound scheme with relaxation and separation subroutines. We investigate the properties and advantages of error-adaptive first-order methods based on the Frank–Wolfe algorithm for such problems, requiring only a gradient oracle for the objective function and linear optimization over the feasible set. In particular, we will study the algorithmic consequences of optimizing the subproblem over the convex hull of the mixed-integer feasible set compared to solving the subproblems over continuous relaxation of the mixed-integer feasible set. Given that the former approach requires a mixed-integer linear solver as an oracle at every iteration, we leverage generic and branch-and-bound specific structure reuse techniques to reduce the per-iteration computational burden. – Joint work with Sebastian Pokutta (ZIB Berlin), Hannah Troppens (ZIB Berlin) and Deborah Hendrych (ZIB Berlin).

David Martinez-Rubio (Zuse Institute Berlin and TU Berlin, Germany)

Metric-projected accelerated Riemannian optimization: Handling constraints to bound geometric penalties

We propose an accelerated first-order method for the optimization of smooth and (strongly or not) geodesically-convex functions over a compact and geodesically-convex set in Hadamard manifolds, that we access to via a metric-projection oracle. It enjoys the same rates of convergence as Nesterov's accelerated gradient descent, up to a multiplicative geometric penalty and log factors. Even without in-manifold constraints, all prior fully accelerated works require their iterates to remain in some specified compact set (which is needed in worst-case analyses due to a lower bound), while only two previous methods are able to enforce this condition and these, in contrast, have limited applicability, e.g., to local optimization or to spaces of constant curvature. Our results solve an open question in (Kim and Yang 2022) and an another question related to one posed in (Zhang and Sra 2016). In our solution, we show we can use projected Riemannian gradient descent to implement an inexact proximal point operator that we use as a subroutine, which is of independent interest. – Joint work with Sebastian Pokutta (ZIB Berlin and TU Berlin, Germany).

Timo Kreimeier (Humboldt-Universität zu Berlin, Deutschland)

Comparing solution strategies for constrained piecewise linear optimization problems

In this talk, two approaches to solving constrained piecewise linear optimization problems will discussed and compared. For this purpose, it is assumed that the optimization problem is given in a matrix-vector based representation, the so-called Abs-Linear form. Any piecewise linear function can be transformed into this representation. Therefore, using the Abs-Linear form both methods explicitly exploit the non-smoothnesses that occur. The approaches are as follows: On the one hand, the optimization problems are solved using a l_1-penalty approach and a solver for unconstrained piecewise linear problems, the Active Signature Method (ASM). On the other hand, the Constrained Active Signature Method (CASM), an extension of the ASM, explicitly handles the constraints to solve such optimization problems. One highlight of both solvers is that the special structure allows to check the optimality of a point with only polynomial effort. Application areas for such problems are given by, e.g., train time tabling, local models of non-smooth optimization problems or training of deep neural networks with the Rectified Linear Unit as activation function.

SECTION
S 12 Probability, Computational Stochastics, and Financial Mathematics

Section Leaders: Ana Djurdjevac, Claudia Schillings and Nicolas Perkowski

SESSION 1 _ Thursday, September 15 _ 10.30–12.30 _ Arnimallee 6: SR 031
Chair: Claudia Schillings

10.30 Annika Lang (Chalmers & University of Gothenburg, Sweden)
▷ *Simulation of random fields on Riemannian manifolds*

11.30 Tommaso Cornelis Rosati (Imperial College London, United Kingdom)
▷ *Energy level dynamics and longtime properties of SPDEs*

12.00 Daniel Bartl (Universität Wien, Austria)
▷ *Statistical estimation of stochastic optimization problems*

SESSION 2 _ Thursday, September 15 _ 15.30–17.30 _ Arnimallee 6: SR 031
Chair: Nicolas Perkowski

15.30 Aleksandra Zimmermann (University of Duisburg-Essen, Germany)
▷ *Convergence of a finite-volume scheme for a heat equation with a multiplicative Lipschitz noise*

16.00 Paul Peter Hager (Humboldt University of Berlin, Germany)
▷ *Optimal stopping and control with signatures*

16.30 Alexander Klump (University of Paderborn, Germany)
▷ *The classical and the soft-killing Inverse First-Passage time problem for Brownian motion*

17.00 Jonas Köppl (Freie Universität Berlin, Germany)
▷ *Dynamical Gibbs variational principles for irreversible interacting particle systems with applications to attractor properties*

SESSION 3 _ Friday, September 16 _ 10.30–12.30 _ Arnimallee 6: SR 031
Chair: Claudia Schillings

10.30 Benjamin Gess (Universität Bielefeld and MPI MIS Leipzig, Germany)
▷ *Non-equilibrium large deviations and parabolic-hyperbolic PDE with irregular drift*

11.30 Björn Sprungk (TU Bergakademie Freiberg, Germany)
▷ *Geometric ergodicity of slice sampling*

12.00 Vitalii Konarovskyi (Bielefeld University and Leipzig University, Germany, and Institute of Mathematics of NAS of Ukraine, Kyiv)
▷ *Coalescing-fragmentating Wasserstein dynamics: Particle approach*

ABSTRACTS

Annika Lang (Chalmers & University of Gothenburg, Sweden)
Simulation of random fields on Riemannian manifolds

Random fields are important building blocks in spatial models disturbed by randomness such as solutions to stochastic partial differential equations. The fast simulation of random fields is therefore crucial for efficient algorithms in uncertainty quantification. In this talk I present numerical methods for Gaussian random fields on Riemannian manifolds and discuss their convergence. Simulations illustrate the theoretical findings. – This talk is based on joint work with Erik Jansson, Mihály Kovács, and Mike Pereira.

Tommaso Cornelis Rosati (Imperial College London, United Kingdom)
Energy level dynamics and longtime properties of SPDEs

We review some results regarding the study of Lyapunov exponents of SPDEs on finite volume and present a new approach through a dynamic separation of scales to treat SPDEs beyond order preservation. We use a similar idea to study global in time well-posedness for perturbations of the 2D stochastic Navier–Stokes equations with additive space-time white noise. – Partially joint work with Martin Hairer.

Daniel Bartl (Universität Wien, Austria)
Statistical estimation of stochastic optimization problems

We develop a novel procedure for estimating the optimizer of general convex stochastic optimization problems from an iid sample. This procedure is the first one that exhibits the optimal statistical performance in heavy tailed situations and also applies in highdimensional settings. We discuss the portfolio optimization problem. – Joint work with Shahar Mendelson (Universität Wien, Austria).

Aleksandra Zimmermann (University of Duisburg-Essen, Germany)

Convergence of a finite-volume scheme for a heat equation with a multiplicative Lipschitz noise

We study the approximation by a finite-volume scheme of a heat equation forced by a Lipschitz continuous multiplicative noise in the sense of Itô. More precisely, we consider a discretization which is semi-implicit in time and a two-point flux approximation scheme (TPFA) in space. Since the nonlinearity in the stochastic integral is not compatible with the weak convergence obtained by the a priori estimates, we adapt the method based on the theorem of Prokhorov and on Skorokhod's representation theorem in order to show stochastically strong convergence of the scheme towards the unique variational solution.

Paul Peter Hager (Humboldt University of Berlin, Germany)

Optimal stopping and control with signatures

We present a new method for solving optimal stopping problems based on a representation of the stopping rule by linear and non-linear functionals (deep n.n.) of the rough path signature and prove that maximizing over these classes of signature stopping times, in fact, solves the stopping problem. Using the algebraic properties of the signature, we can then recast the problem as a deterministic optimization problem depending only on the (truncated) expected signature. The theory encompasses processes such as fractional Brownian motion, which fail to be either semi-martingales or Markov processes. This is from a joint work with C. Bayer, S. Riedel and J. Schoenmakers. In the talk we further examine other signature based methods in optimal control.

Alexander Klump (University of Paderborn, Germany)

The classical and the soft-killing Inverse First-Passage time problem for Brownian motion

The first-passage time of a process is the first time the process crosses a given time-dependent boundary. The classical first-passage time problem asks for the distribution of this stopping time. In the inverse problem the distribution is given and the task is to find a time-dependent boundary such that its first-passage time has the given distribution. The natural questions arising from this problem are the analysis of existence and uniqueness of boundary solutions and the properties of such solutions. In this talk we will be concerned with this classical problem in probability and its soft-killing variant and discuss results obtained by a new stochastic order approach, including uniqueness and properties of solutions.

Jonas Köppl (Freie Universität Berlin, Germany)

Dynamical Gibbs variational principles for irreversible interacting particle systems with applications to attractor properties

We consider irreversible translation-invariant interacting particle systems on the d-dimensional hypercubic lattice with finite local state space, which admit at least one Gibbs measure as a time-stationary measure. Under some mild degeneracy conditions on the rates and the specification we prove, that the relative entropy is non-increasing as a function of time and that a vanishing relative entropy loss for a translation-invariant measure implies, that the measure is Gibbs w.r.t. the same specification as the time-stationary Gibbs measure. As an application, we obtain the attractor property for irreversible interacting particle systems, which says that any weak limit point of any trajectory of translation-invariant measures is a Gibbs measure w.r.t. the same specification as the time-stationary measure. This extends previously known results to fairly general irreversible interacting particle systems.

Benjamin Gess (Universität Bielefeld and MPI MIS Leipzig, Germany)

Non-equilibrium large deviations and parabolic-hyperbolic PDE with irregular drift

Large deviations of conservative interacting particle systems, such as the zero range process, about their hydrodynamic limit and their respective rate functions lead to the analysis of the skeleton equation; a degenerate parabolic-hyperbolic PDE with irregular drift. In this talk, we present a robust well-posedness theory for such PDEs in energy-critical spaces based on concepts of renormalized solutions and the equation's kinetic form. We establish these properties by proving that renormalized solutions are equivalent to classical weak solutions, extending concepts of [DiPerna, Lions; Ann. Math., 1989], [Ambrosio; Invent. Math., 2004] to the nonlinear setting. The relevance of the results toward large deviations in interacting particle systems is demonstrated by applications to the identification of l.s.c. envelopes of restricted rate functions, to zero noise large deviations for conservative (singular) SPDE, and to the Γ-convergence of rate functions. The first of these solves a long-standing open problem in the large deviations for zero range processes. The second makes rigorous an informal link between the non-equilibrium statistical mechanics approaches of macroscopic fluctuation theory and fluctuating hydrodynamics. – Joint work with Benjamin Fehrman (Oxford University, UK).

Björn Sprungk (TU Bergakademie Freiberg, Germany)

Geometric ergodicity of slice sampling

For approximate sampling of a partially known distribution, e.g., posterior distributions in Bayesian statistics, the slice sampling methodology provides a machinery for the design and simulation of a suitable Markov chain without the necessity to tune any parameters as in many

Metropolis-Hastings algorithms. In the machine learning community slice sampling is a frequently used approach, which appears not only there as standard sampling tool. In particular, the elliptical slice sampler attracted considerable attention as a dimension-robust algorithm in the last decade. However, from a theoretical point of view it is not well understood. In this talk, we show the geometric ergodicity of Markov chains generated by elliptical slice sampling as well as simple slice sampling with particular emphasis on their (in)dependence on the state space dimension. – Joint work with Viacheslav Natarovskii (Georg-August-Universität Göttingen, Germany) and Daniel Rudolf (Universität Passau, Germany).

Vitalii Konarovskyi (Bielefeld University and Leipzig University, Germany, and Institute of Mathematics of NAS of Ukraine, Kyiv)
Coalescing-fragmentating Wasserstein dynamics: Particle approach

We will discuss a family of semimartingales that describes the behavior of a particle system with sticky-reflecting interaction. The model is a physical improvement of the Howitt–Warren flow, an infinite system of diffusion particles on the real line that sticky-reflect from each other. But now particles have masses obeying the conservation law and the diffusion rate of each particle depends on its mass. The equation which describes the evolution of the particle system is a new type of equations in infinite-dimensional space and can be interpreted as an infinite-dimensional analog of the equation for sticky-reflected Brownian motion. The particle model appears as a particular solution to the corrected version of the Dean–Kawasaki equation.

SECTION
S 13 Mathematical Statistics, Data Science and Machine Learning

Section Leaders: Tim Conrad and Moritz Schubotz

SESSION 1 _ Wednesday, September 14 _ 10.30–12.30 _ Arnimallee 7: SR 031
Chair: Moritz Schubotz

10.30 Philipp Scharpf (University of Konstanz, Germany)
▷ *Mathematical Entity Linking – methods and applications*

11.00 Ankit Suresh Satpute (FIZ Karlsruhe and University of Göttingen, Germany)
▷ *Analyzing mathematical content to detect disguised scientific plagiarism*

11.30 Johannes Stegmüller (FIZ Karlsruhe and GippLab, Universität Göttingen, Germany)
▷ *Optimizing the accessibility of mathematical expressions for the blind on Wikipedia*

12.00 Isabel Beckenbach (FIZ Karlsruhe, Germany)
▷ *Citation matching at zbMATH Open*

SESSION 2 _ Wednesday, September 14 _ 15.30–17.30 _ Arnimallee 7: SR 031
Chair: Moritz Schubotz

15.30 Cornelius Ihle (University of Göttingen, Germany)
▷ *Decentralized Open Science*

16.00 Marco Beck (University of Göttingen, Germany)
▷ *Making digital editions accessible and usable in the long run – A decentralized approach*

16.30 Dennis Trautwein (University of Göttingen, Germany)
▷ *Measuring and optimizing peer-to-peer networks taking the example of IPFS*

SESSION 3 _ Thursday, September 15 _ 10.30–12.30 _ Arnimallee 7: SR 031
Chair: Tim Conrad

10.30 Michael Ulbrich (TU München, Germany)
▷ *A semismooth Newton stochastic proximal point algorithm with variance reduction*

11.00 Kartikey Sharma (Zuse Institute Berlin, Germany)
▷ *Merlin–Arthur classifiers*

11.30 Konstantin Fackeldey (TU Berlin and ZIB Berlin, Germany)
▷ *SepFree NMF: A toolbox for analyzing the kinetics of time-resolved spectra*

SESSION 4 _ Thursday, September 15 _ 15.30–17.30 _ Arnimallee 7: SR 031
Chair: Tim Conrad

15.30 Jochen Merker (HTWK Leipzig, Germany)
▷ *On sensitivity of methods from machine learning w.r.t. training data*

16.00 Alexander Sikorski (Zuse Institute Berlin, Germany)
▷ *ISOKANN – Learning invariant subspaces of the Koopman Operator*

ABSTRACTS

Philipp Scharpf (University of Konstanz, Germany)
Mathematical Entity Linking – methods and applications

Entity Linking (EL) is applied in information retrieval systems that extract abstract representations from text documents, as it happens, for example in semantic search and recommendation, question answering or generation, document classification or recommendation, plagiarism detection, and conversational systems (chatbots). Until now, a multitude of EL approaches have been developed in academia and industry. However, they are only designed for natural language texts. Documents from Science, Technology, Engineering, and Mathematics (STEM) disciplines typically contain a significant number of mathematical expressions (formulae and identifiers) alongside text. Mathematical information retrieval systems, such as mathematical question answering, require the classical EL approaches to be generalized to Mathematical Entity Linking (MathEL) of mathematical expressions to a semantic knowledge-base, such as Wikidata. To tackle the research gap of a lack of EL approaches for mathematical expressions, this thesis has the research objective to propose, implement, and evaluate methods and applications of MathEL using rule-based Artificial Intelligence, Machine Learning, and Wikidata. The research is guided by the following question: "How can classical EL methods and applications be transferred to enable MathEL?" To achieve the research objective and answer the research question, the following research tasks are derived:

(1) Review the state of the art in classical EL and find out why the reviewed approaches are insufficient for MathEL,
(2) design and evaluate supervised and unsupervised methods for MathEL
(3) design and evaluate applications of MathEL,
(4) discuss the achievements and challenges to outline future work.

Among the developed open-source demonstrators of the MathEL methods and applications are:

(1) interactive visualizations of Machine Learning methods for Formula Concept discovery and recognition,
(2) a formula and identifier annotation recommender system for Wikipedia articles and STEM documents (AnnoMathTeX),
(3) a semantic formula search and mathematical question answering system (MathQA),
(4) a physics question generation and test engine (PhysWikiQuiz), and
(5) an explainable fine-grained hierarchical classification system for mathematical documents (AutoMSC).

Ankit Suresh Satpute (FIZ Karlsruhe and University of Göttingen, Germany)

Analyzing mathematical content to detect disguised scientific plagiarism

Plagiarism is a severe concern in this faster-growing world of scientific data. Scientific misconduct hampers the quality of research. In Germany, plagiarism findings in politicians' thesis have thwarted their career progress and brought the issue of plagiarism into the headlines. In scientific documents, plagiarism is more disguised since there are higher incentives attached to avoid detection. The significance of mathematical expressions is much higher and valued in scientific documents from the STEM fields. However, most of the existing Plagiarism Detection Systems (PDS) focus on identifying altered copies of the text. Non-textual features such as mathematical expressions, chemical formulae, images, etc., are not considered. There exists a gap in utilizing mathematics present in a scientific document to detect disguised forms of scientific plagiarism. This is because mathematics is not easily accessible compared to text and large-scale math plagiarism cases are unavailable. Moreover, the complexity of math makes detecting highly disguised math reuse cases challenging. It is equally important to measure the performance of a math-based PDS. Hence, an evaluation pipeline that quantifies detected math reuse cases would set a base for developing math-based plagiarism detection approaches.

In my Ph.D. work, we plan to use the math present in a scientific document and develop a math-based PDS to detect disguised plagiarism. To define the boundaries of the problem, we will first focus on identifying various math obfuscation types. Experts at the zbMATH Open have pointed out math plagiarism cases, which we will utilize along with other math reuse cases. We will establish a corpus representative of the problem and utilize this corpus for developing various math plagiarism detection approaches. We will identify the features of different mathematical expressions and represent these features in canonical forms. We will then devise mathematics-based similarity assessment methods based on distance measures, pattern detection, and clustering to detect more disguised forms of plagiarism. We would also have to focus on the practicability of detection approaches, balancing the tradeoff between detection accuracy and computational efficiency. To assess a PDS, we will devise a detection metric for math reuse. Ultimately, we combine math-based features with textual and other non-textual features to move towards a hybrid PDS.

Johannes Stegmüller (FIZ Karlsruhe and GippLab, Universität Göttingen, Germany)
Optimizing the accessibility of mathematical expressions for the blind on Wikipedia

How to optimize the accessibility of mathematical expressions for blind people in public knowledge management systems like Wikipedia and its technical backbone MediaWiki by improving the accuracy of the speech output for screen readers?
The de facto standard format for the processing of formulae by voice-synthesis applications is MathML. For MediaWiki, screen readers currently read HTML pages from web-browsers and are using the included MathML to generate speech output. By utilizing the currently used basic representation of formulae in MathML, screen readers may introduce errors in the generated speech. This is because the mathematical expressions represented with the current MathML can have multiple ways of interpretation. To resolve such ambiguities, additional contextual information would be necessary.
To tackle the current problem, we will create a method which is generating optimized MathML for screen readers. This method will be able to generate valid content for "intent" attributes within the generated MathML. These are introduced in the currently drafted MathML 4 standard and contain clarifying information to screen readers on how to interpret formulae. By reading the generated disambiguated intent attributes, future screen readers will be able to synthesize correct speech output for mathematical formulae.
We hypothesize that the quality of existing rule-based LaTeX to MathML with intent conversion methods can be overcome by introducing a new approach based on a machine learning model which allows extending the finite set of conversion rules of these methods. In our approach, we aim to use contextual information from Wikidata to help distinguish conversion cases. As a method for evaluating the converters results, we will use MathMLBen, a benchmark for mathematical format conversion, after adding possibilities to measure the quality of conversion of LaTeX expressions to MathML with intent attributes. With the newly introduced benchmark capabilities, we aim to compare the quality of conversion for existing converters and analyze the results for improvements. To create a practical benefit for blind Wikipedia users, it is planned to deploy the introduced conversion method to the Wikipedia ecosystem. This will

enable the development of live annotations by the mathematical community for adding context to formulae for our conversion method.

Isabel Beckenbach (FIZ Karlsruhe, Germany)

Citation matching at zbMATH Open

Citation matching is the task to assign reference strings to structured references of some digital library. In the case of zbMATH Open we want to find for a given input reference string the correct zbMATH identifier if the article is indexed at zbMATH Open. Otherwise, no result should be given. This allows linking references to its corresponding zbMATH article and computing how often an article is cited. Citation matching is a difficult task. Among other problems one hast to deal with various citation styles and mistakes in the reference strings. A precise citation matching algorithm is needed, as wrong or missing assignments lead to wrong citation numbers of articles and authors. The numbers of citation of the articles of an authors are often used to measure the competiveness of an author. Metrics like the h-index are even used for hiring decisions. Thus, it is important that the citation numbers are as good as possible. In this talk I will present the new citation matching algorithm at zbMATH Open, called marebito. It is built on a MapReduce paradigm and is highly adjustable. It can work with unstructured and partially structured input references and outputs a corresponding zbMATH article, if one exists. The basic idea is to generate for each input reference a small set of candidates. Then, for each candidate a set of features is calculated to measure the similarity of the candidate and the input reference. Finally, the candidates are scored using a linear support vector machine and the candidates with a positive score are returned. Comparing the results of a first version of marebito with those of the old citation matcher used at zbMATH Open shows that the new approach is promising.

Cornelius Ihle (University of Göttingen, Germany)

Decentralized Open Science

We research and extend the field of Decentralized Open Science, which is an initiative to employ decentralized information technology to foster an open science movement. Apart from making research results openly available, the movement aims to make scientific processes transparent and accessible for arbitrary collaborators. Researchers with no established or mutual trust could collaborate on a joint research effort. However, this vision is only possible with the right prerequisites in place. Most importantly, data storage and data sharing should be handled in a decentralized manner to provide a resilient, secure, transparent, and trustless alternative to today's centralized solutions. We will apply a solution not only for recent research data but also for digital archives to allow long-term archiving and availability of important open data sets and digital heritage projects. Secondly, protective tools like Decentralized Similarity Detection are needed to help secure the work of researchers from exploitation and therefore prevent the use of ideas, concepts, words, or structures without appropriately acknowledging the source to benefit where originality is expected. Decentralized Similarity Detection aims to foster collaboration by solving the aforementioned trust issue between researchers by uncovering and detecting misbehavior. Possible collaborators will hesitate to contribute without protective measures and not share their progress and ideas. Further, the document corpus will be jointly maintained to overcome the limits of centralized data-silo-driven similarity detection tools. Lastly, incentive mechanisms will motivate participation and cooperation in decentralized data storage, data sharing, and similarity detection networks. Incentives are needed as open and decentralized systems cannot enforce contribution levels on their participants. Instead, participants vary their contributions to the system according to their liking. However, this can be influenced by monetary, reputation, or service incentives that enforce benefits and penalties on the participant. Our vision is that our contributions to Decentralized Open Science allow for available and accessible corpora and digital archives, open and excessive sharing of research data, and tools to help prevent the plagiarism and exploitations risk when collaborating.

Marco Beck (University of Göttingen, Germany)

Making digital editions accessible and usable in the long run – A decentralized approach

Digitized objects from the memory institutions are the indispensable ground and raw material for every investigation. Many older digital editions are struggling to survive or are no longer accessible, including well-known and important edition projects. The digitization of the editions is usually project-based and funded by third parties, so the question often arises as to what to do with the edition after the end of the project. Until now, there have been no reliable financing models for the long-term operation and, in particular, the long-term maintenance of digital editions and edition platforms. The sustainable, permanent, and secure storage of this type of research data represents a critical point from an infrastructural point of view. Challenges also lie in this area, such as providing immutable digitization data and variable layers of annotative information. Research to date shows that, in particular, the scholarly focus is on ensuring that digital editions can be modeled and archived completely, i.e., as software systems along with their respective runtime environments in a standardized manner. Still, often in this context, the question of how to finance sustainability is also raised. In addition, existing hosting infrastructures and storage are not yet considered. While cloud computing is increasingly increasing availability and redundancy, traditional self-hosting by individual institutions may become less important due to problems such as institutions still being closed, censored, simply lacking the necessary money, losing their technical expertise, or ceasing their commitment to providing data and services. This research aims to determine how digital editions' long-term availability and usability can be improved from a computer science perspective. From this objective, the research points such as identifying the challenges, problems, and technologies of existing digital editions and the technical developments, methods, approaches, and standards used for digital editions can be derived. In particular, the research aims to identify the research gaps as well as the corresponding proposals and new ideas from the perspective of computer scientists. As part of the possible proposal, it will also be examined whether the decentralization of blockchain technology would be a viable concept for storing digital editions.

Dennis Trautwein (University of Göttingen, Germany)
Measuring and optimizing peer-to-peer networks taking the example of IPFS

Recent years have witnessed growing consolidation of web operations. For example, the majority of web traffic now originates from a few organizations, and even micro-websites often choose to host on large pre-existing cloud infrastructures. In response to this, the "Decentralized Web" movement attempts to distribute ownership and operation of web services more evenly. This presentation describes the design, implementation and measurement of the largest and most widely used Decentralized Web platform – the InterPlanetary File System (IPFS). IPFS has millions of daily content retrievals and already underpins dozens of third-party applications. Further, it will outline ongoing work on protocol optimizations and approaches to alleviate common connectivity issues for peer-to-peer networks.

Ulbrich, Michael (TU München, Germany)
A semismooth Newton stochastic proximal point algorithm with variance reduction

We develop an implementable stochastic proximal point (SPP) method for optimization problems as they typically arise in statistical learning. The objective function is composed by a weakly convex, finite-sum loss function and a nonsmooth, convex regularization term. In general, the SPP method requires to solve an implicit equation and therefore it is often only analyzed from a theoretical perspective. We propose an efficient way of implementing the SPP update by a semismooth Newton method, using Fenchel duality and allowing for inexact solves in our convergence theory. The method also includes an SVRG-type variance reduction technique. We obtain convergence to a stationary point with a sublinear rate for constant step sizes and Lipschitz-smooth loss functions. In the strongly convex case we obtain linear convergence to the minimizer, similar to results for variance-reduced stochastic (proximal) gradient methods such as SVRG [3]. Numerical experiments show that the proposed algorithm can compete with state-of-the art methods and achieves higher robustness with respect to the step size selection. – Joint work with Andre Milzarek and Fabian Schaipp.

Sharma, Kartikey (Zuse Institute Berlin, Germany)
Merlin–Arthur classifiers

We present a new theoretical framework for making black box classifiers such as Neural Networks interpretable, basing our work on clear assumptions and guarantees. In our setting, which is inspired by the Merlin–Arthur protocol from Interactive Proof Systems, two functions cooperate to achieve a classification together: the prover selects a small set of features as a certificate and presents it to the classifier. Including a second, adversarial prover allows us to connect a game-theoretic equilibrium to information-theoretic guarantees on the exchanged features. We define notions of completeness and soundness that enable us to lower bound the mutual information between features and class. To demonstrate good agreement between theory and practice, we support our framework by providing numerical experiments for Neural Network classifiers, explicitly calculating the mutual information of features with respect to the class.

Konstantin Fackeldey (TU Berlin and ZIB Berlin, Germany)
SepFree NMF: A toolbox for analyzing the kinetics of time-resolved spectra

Sequentially measured spectroscopic data is stored in a matrix of dimension “number of time steps” versus “number of measured frequencies”. The entries of this matrix quantify the intensity of the respective frequency at the respective measured point in time. In order to gain insides into the kinetics of the observed process, this matrix is used to extract the evolution of the intensities over time. Using our new method SepFree NMF, it is possible to extract kinetic information without knowing the characteristic spectra of the single ingredients and without knowing the number of different entities which contribute to the entire process. This manuscript provides the mathematical background as well as an analysis of a real-word spectroscopy experiment. – Joint work with Renata Sechi (ZIB Berlin, Furukawa Electric Institute of Technology, Budapest, and Budapest University of Technology and Economics, Budapest, Hungary), Surahit Chewle (Federal Institute for Materials Research and Testing (BAM), Berlin, Germany) and Marcus Weber (ZIB Berlin).

Jochen Merker (HTWK Leipzig, Germany)

On sensitivity of methods from machine learning w.r.t. training data

We explore the sensitivity of machine learning algorithms w.r.t. training data by using the data model $F_{(u,y)}$ obtained from the original model F by adding one data point (u, y) as training data. We show that the derivative $\frac{\partial}{\partial y}F_{(u,y)}(u)$ allows in case of linear regression and ridge regression to determine, how sensitive the forecast is at an input u, and we explore the case of neural networks used for remote sensing in environmental science to determine water in clouds. Moreover, we relate this derivative to the complexity of a machine learning method and provide a sensitivity analysis via a bias-variance-complexity decomposition along the lines of Jochen Merker, Gregor Schuldt, “An attempt to explain double descent in modern machine learning”, *Scientific Reports* 2021, No. 2, 141–144, DOI 10.48446/opus-12293, and Jochen Merker, Gregor Schuldt, “Why LASSO seems to simultaneously decrease bias and variance in machine learning”, *Proceedings of ICoMS* 2021, ACM, 86-–89, DOI 10.1145/3475827.3475839. – Joint work with Willi Schimmel (Universität Leipzig, Germany).

Alexander Sikorski (Zuse Institute Berlin, Germany)

ISOKANN – Learning invariant subspaces of the Koopman Operator

The ISOKANN method brings together techniques of classical numerics and machine learning to compute the invariant subspaces and hence the slow scale dynamics of a Markov Process in an unsupervised manner. We use neural networks as function approximators to learn the evaluation of the Koopman operator obtained by Monte Carlo simulations. Repeated iteration of the learning and sampling steps reimplements the classical power iteration method for the computation of eigenfunctions. We further discuss a heuristic to reduce the Monte Carlo sample variance by optimal control theory and thereby speeding up the convergence.

SECTION
S 14 History and Didactics of Mathematics

Section Leaders: Andreas Filler

SESSION 1 _ Wednesday, September 14 _ 10.30–12.30 _ Arnimallee 3: SR 024
Chair: Andreas Filler

10.30 Anja Panse (University of Paderborn, Germany) und Frank Feudel (Humboldt-Universität zu Berlin, Germany)
▷ *Please mind the gap -— How can the use of guided notes be supportive in mathematics lectures?*

11.30 Hans-Jürgen Elschenbroich (Medienberatung NRW, Germany)
▷ *Kegelschnitte erkunden – genetisch, ganzheitlich, dynamisch, anschaulich*

SESSION 2 _ Wednesday, September 14 _ 15.30–17.30 _ Arnimallee 6: SR 007–008
Chair: Andreas Filler

15.30 Peter Ullrich (Universität Koblenz-Landau, Campus Koblenz, Deutschland)
▷ *"Man muß, m. E. bei Weierstraß Dasjenige, was er wirklich gemacht hat, von dem Mÿthus unterscheiden* […]*" – Some remarks on the mathematics of Karl Weierstraß 125 years after his death*

16.30 Eva Kaufholz-Soldat (Universität Koblenz-Landau, Germany)
▷ *Mathematical schools, dissected brains and the nature of women: The reception of Sofya Kovalevskaya at the end of the long 19th century*

ABSTRACTS

Anja Panse (University of Paderborn, Germany) und Frank Feudel (Humboldt-Universität zu Berlin, Germany)
Please mind the gap -— How can the use of guided notes be supportive in mathematics lectures?

In traditional mathematics lectures, many students have problems to process the information presented by the instructor during the lecture, because they are busy with copying the instructor's writings from the blackboard. At worst, they take on a rather passive role by just copying the signs mechanically instead of following the instructor's explanations and reflecting on the content. One approach to address these problems might be the use of guided notes. These are preprinted lecture notes with blanks at certain positions that the students are required to fill in as the lecture progresses. Such guided notes provide several possibilities for guiding students’ behavior during the lecture regarding their note-taking and their attention towards the instructor’s explanations. In particular, the use of guided notes gives instructors room for several activities that could foster students’ active engagement with the content during the lecture. In the talk, we want to illustrate these potentials of guided notes with specific examples from a first-semester course named “Introduction to Mathematical Thinking and Working” at the University of Paderborn. Furthermore, we want to present some results of an accompanying research project in which we investigated how guided notes can support students in their note-taking which is a crucial element of many mathematics lectures. – Joint work with Frank Feudel (Humboldt-Universität zu Berlin, Germany).

Hans-Jürgen Elschenbroich (Medienberatung NRW, Germany)
Kegelschnitte erkunden – genetisch, ganzheitlich, dynamisch, anschaulich

Kegelschnitte sind lange eins der großen Themen der Mathematik und des Mathematikunterrichts gewesen mit bedeutenden Anwendungen in Natur und Technik, heute aber (bis auf löbliche Ausnahmen) leider schulisch fast in Vergessenheit geraten.
Mittlerweile haben wir mit dynamischer Raumgeometrie-Software wie GeoGebra 3D ein digitales Werkzeug, das zum einen der ursprünglichen stereometrischen Vorstellung von Schnitten durch einen Kegel gerecht wird, mit dem aber zum anderen auch planimetrisch Abstände und Ortslinien thematisiert werden können und schließlich analytisch noch implizite Gleichungen und parametrische Funktionen.
Diese Ansätze und Verbindungen sind eigentlich nicht neu, man findet sie auch z. B. bei Lietzmann (1949). Neu ist allerdings, dass durch geeignete Lernumgebungen und mächtige GeoGebra-Befehle jetzt viel von der algebraischen und konstruktiven Komplexität genommen wird und Zugangshürden wegfallen. So wird möglich, das Thema Kegelschnitte schon ab der Sekundarstufe I zu behandeln und in überschaubarer Zeit ausreichend tragfähige Grundvorstellungen zu entwickeln.
Das vorgestellte Konzept ist

– genetisch, weil es der Namensgebung folgt und mit dem Schnitt eines Kegels beginnt;
– ganzheitlich, weil es im Sinne von Schupp (2000) wo immer möglich eine gemeinsame Betrachtung statt isolierter Behandlung verfolgt;
– dynamisch, weil es konsequent mit der dynamischen Raumgeometrie-Software GeoGebra 3D als digitalem Werkzeug arbeitet und die Problemstellungen (meist mit Schiebereglern) systematisch variiert;
– anschaulich, weil es im Sinne von Hibert & Cohn-Vossen (1996) "‘an Stelle der Formeln vielmehr anschauliche Figuren bringt"’.

Es werden vom Referenten entwickelte GeoGebra-Lernumgebungen vorgestellt, die in einem GeoGebra-Book im Web zusammengestellt sind. Wenn Sie ein mobiles Internet fähiges Gerät (Laptop, Tablet) mitbringen, können Sie die Beispiele auch alle parallel selbst bearbeiten.

Peter Ullrich (Universität Koblenz-Landau, Campus Koblenz, Deutschland)
"Man muß, m. E. bei Weierstraß Dasjenige, was er wirklich gemacht hat, von dem Mÿthus unterscheiden […]*" – Some remarks on the mathematics of Karl Weierstraß 125 years after his death*

The quote above is from a letter that Georg Cantor (1845–1918) wrote on December 8, 1895 to Felix Klein (1849–1925) and in which he criticized the students of Karl Weierstraß (1815–1897) for misusing their teacher's fame in order to enlarge their own.
Therefore, in order to get an objective assessment of the mathematics of Weierstraß at the time of his death, it seems advisable to take the perspective of a person who was not his direct student: In his obituary for Weierstraß David Hilbert (1862–1943) naturally mentions his solution of the Jacobi inversion problem for hyperelliptic functions and the generalization of this result to general Abelian functions. But even more he praises the contributions to the foundations of the theory of analytic functions and the fact that Weierstraß based them on his critique of the traditional contents. As to the methods, Hilbert stresses the algebraic foundations on which Weierstraß built up his theory and even mentions the latter's articles on algebra proper and on linear algebra. Furthermore, Hilbert points at the contributions that Weierstraß made to the calculus of variations, including the question of the mere existence of a minimizing function.
But even Hilbert's broad exposition omits some aspects: In particular, Weierstraß was by no means as averse to geometry, in particular geometrical imagination, as the common gossip likes to tell: In his "Mathematische Seminar", for example, lectures were given on the possibility to represent the graph of a complex valued function of one complex variable in the real three dimensional space. He was even interested in technical details of realizing minimal surfaces by means of liquid films. Even more important is the influence via some of his students who are usually not considered as representatives of his mathematics: Wilhelm Killing (1847–1923), for example, who later on became influential by his classification of Lie algebras, had written a doctoral dissertation on the application of algebraic methods to the theory of surfaces under the supervision of Weierstraß. And Hermann Schubert (1848–1911) was led to his calculus of enumerative geometry via his own lecture in the seminar of Weierstraß and by the guidance and support with which the latter provided him.

Eva Kaufholz-Soldat (Universität Koblenz-Landau, Germany)

Mathematical schools, dissected brains and the nature of women:
The reception of Sofya Kovalevskaya at the end of the long 19th century

As one of the first female professors, Sofja Kovlevskaya (1850–1891) is considerably more famous than most mathematicians and is often portrayed as a pioneer whose life is considered as evidence that women can excel in all academic domains. While she was seen in a similar vein during her lifetime, publications appearing in the years following her untimely death present a more pluralistic picture that will be explored in this talk. To this end, I will discuss three different contexts in which her life was discussed, beginning with the assesment of her mathematical work, by Gösta Mittag-Leffler and Felix Klein. I will show that their diverging appraisals are due to their vastly different assessments of the Weiestrassian School of mathematics, of which Kovalevskaya is generally considered to be a member, as Weierstrass' declared favourite pupil.

That Kovaylevskaya's life was mainly understood as an opportunity to propagate respective opinions becomes even more evident when considering her instrumentalization in the various agendas against the background of the then virulent discussions women's ability to pursue higher education. For this purpose, I will first discuss the biographies of Anna Charlotte Leffler and Laura Marholm, who painted Kovalevskaya as the sad mathematician in the vain search for love, who consequently died of a broken heart. Due to this image, Kovalevskaya was now only rarely seen as a role model, but rather as an exception or even a warning example for women who might consider taking a path deemed unnatural for their sex. As a particularly interesting representative of the latter category, I will conclude by discussing the physician Paul Möbius. I will first discuss his scientifically questionable attempts to refute the speculations about a cerebral mathematical centre published by Gustaf Retizus after the autopsy of Kovalevskaya's brain, before moving on to his debate with Otto Weininger. Here Möbius attempted to classify Kovalevskaya as a result of degeneration, in order to discredit Weininger's likewise misogynistic theories. All in all, not only the different contexts in which Kovalevskaya was instrumentalised will become become apparent, but also how motifs introduced a century ago helped shape the way pioneering women are portrayed today. Therefore, this lecture is not only a contribution to the cultural history of mathematics the 19th century, but also to the emergence of modern, supposedly more objective, views of women in science.

MINISYMPOSIA

MINISYMPOSIUM
MS 01 Mathematical Analysis of Complex Quantum Systems

Organized by Heinz Siedentop and Konstantin Merz

This Minisymposium is geared towards the analytic and stochastic methods relevant for the description of interacting quantum systems, in particular with realistic interactions like Coulomb potentials. This is motivated by applications in quantum field theory, condensed matter physics, and atomic and molecular physics. These are static problems treated by spectral theoretic and stochastic methods as well as dynamic problems like the derivation of effective one-particle equations retaining bounds on the errors. Typically a controlled approximation of a high dimensional linear system like the *N*-particle Schrödinger equation by a low dimensional, possibly nonlinear, equation is in the center of investigation. Simple examples are the Thomas–Fermi equation. Both the derivation of such equations as well as their analysis are of interest.

SESSION 1 _ Tuesday, September 13 _ 10.30–12.30 _ Takustraße 9: SR 049
Chair: Heinz Siedentop

10.30 Marcel Griesemer (University of Stuttgart, Germany)
▷ *Many-body quantum systems with short-range interactions*

11.30 Arnaud Triay (LMU Munich, Germany)
▷ *The Scott correction in Dirac-–Fock theory*

12.00 Konstantin Merz (TU Braunschweig, Germany)
▷ *Random Schrödinger operators with complex decaying potentials*

SESSION 2 _ Wednesday, September 14 _ 10.30–12.30 _ Takustraße 9: SR 049
Chair: Konstantin Merz

10.30 Sabiha Tokus (Universität Tübingen)
▷ *Ground state energy for one-dimensional interacting Bose gases*

11.00 Simone Rademacher (Institute of Science and Technology Austria, Austria)
▷ *Large deviation estimates for weakly interacting bosons*

11.30 Jinyeop Lee (LMU München, Germany)
▷ *A mixed-norm estimate of two-particle reduced density matrix of many-body Schrödinger dynamics*

12.00 Andreas Deuchert (University of Zurich, Switzerland)
▷ *Dynamics of mean-field bosons at positive temperature*

SESSION 3 _ Wednesday, September 14 _ 15.30–17.30 _ Takustraße 9: SR 049
Chair: Heinz Siedentop

15.30 Marcin Napiórkowski (University of Warsaw, Poland)
▷ *Friedrichs model approach to Beliaev damping*

16.30 Benjamin Hinrichs (Friedrich-Schiller-Universität Jena, Germany)
▷ *The qubit and the infared catastrophe*

17.00 Dirk-André Deckert (LMU Munich, Germany)
▷ *Dynamics of the quantum vacuum in external fields*

SESSION 4 _ Thursday, September 15 _ 10.30–12.30 _ Takustraße 9: SR 049
Chair: Konstantin Merz

10.30 Jacob Schach Møller (Aarhus University, Denmark)
▷ *Renormalization of a toy model*

11.30 Enno Lenzmann (Universität Basel, Switzerland)
▷ *Classical counterparts of quantum Haldane–Shastry spin systems*

ABSTRACTS

Marcel Griesemer (University of Stuttgart, Germany)
Many-body quantum systems with short-range interactions

In this talk, I will review recent progress in the analysis of many-body Schrödinger operators with short-range interactions that are controlled by a single physical parameter such as the binding energy or the scattering length. In the zero range limit, these Schrödinger operators converge to Hamiltonians describing contact interactions of TMS-type, which are popular nowadays in the description of ultracold quantum gases. The rate of convergence depends on the regularity of Sobolev functions and the space dimension. This talk will also address the characterization of zero-range Hamiltonians as self-adjoint extensions of the Laplacian a la Birman–Krein–Vishik. – Joint work with Michael Hofacker.

Arnaud Triay (LMU Munich, Germany)

The Scott correction in Dirac-–Fock theory

The Scott correction is the name of second order in the expansion of the ground state energy of heavy atoms. For large atomic numbers, relativistic effects play a significant role in the chemical properties of atoms, and in particular create a shift in the ground state energy at the second order compared to the non-relativistic theory. We compute this correction in the Dirac–Fock theory, which is the relativistic counterpart of the well-known Hartree–Fock theory. – Joint work with Fournais, Søren (Aarhus University, Denmark) and Mathieu Lewin (Université Paris-Dauphine, France).

Konstantin Merz (TU Braunschweig, Germany)

Random Schrödinger operators with complex decaying potentials

We prove that the eigenvalues of a continuum random Schrödinger operator $-\Delta + V_\omega$ of Anderson type, with complex decaying potential, can be bounded (with high probability) in terms of an L^q norm of the potential for all $q \leq d+1$. This shows that in the random setting, the exponent q can be essentially doubled compared to the deterministic bounds of Frank (*Bull. Lond. Math. Soc.*, 2011). This improvement is based on ideas of Bourgain (*Discrete Contin. Dyn. Syst.*, 2002) related to almost sure scattering for lattice Schrödinger operators. – The talk is based on joint work with Jean-Claude Cuenin.

Sabiha Tokus (Universität Tübingen)

Ground state energy for one-dimensional interacting Bose gases

This talk presents an approach for a computation of the ground state energy of one-dimensional Bose gases with two-particle interaction in the limit of high density. The method is based on the variational principle for the free energy functional for quasi-free states. As a first application, I will consider the derivation of a high-density expansion of the ground state energy for the well-known one dimensional boson model with delta interaction, the Lieb–Liniger Hamiltonian.

Simone Rademacher (Institute of Science and Technology Austria, Austria)

Large deviation estimates for weakly interacting bosons

We consider the many-body quantum dynamics of weakly interacting bosons. For factorized initial data, exhibiting Bose-Einstein condensation, we show that fluctuations around the condensate satisfy large deviation estimates and determine the rate function up to quadratic order. These results are consistent with central limit theorems that have been established in the last years. – This is joint work with Kay Kirkpatrick (University of Illinois Urbana-Champaign, USA), Benjamin Schlein (University of Zurich, Switzerland) and Robert Seiringer (Institute of Science and Technology Austria, Austria).

Jinyeop Lee (LMU München, Germany)

A mixed-norm estimate of two-particle reduced density matrix of many-body Schrödinger dynamics

We provide a mixed-norm estimate of two-particle reduced density matrix of the solution of N-body Schrödinger equation. Using that we present a new approach to obtain the Vlasov dynamics from the Schrödinger equation through Hartree–Fock dynamics with $\hbar = N^{-1/3}$ as the re-scaled Plank constant. Furthermore, we provide that, in the sense of distribution, the mean-field residue term has higher rate than the semi-classical residue. – Joint work with Li Chen (Universität Mannheim, Germany) and Matthew Liew (Universität Mannheim, Germany).

Andreas Deuchert (University of Zurich, Switzerland)

Dynamics of mean-field bosons at positive temperature

We study the time-evolution of an initially trapped weakly interacting Bose gas at positive temperature, after the trapping potential has been switched off. It has been recently shown in arXiv:2009.00992 that the one-particle density matrix of Gibbs states of the interacting trapped gas is given, to leading order in N, as $N \to \infty$, by the one of the ideal gas, with the condensate wave function replaced by the minimizer of the Hartree energy functional. We show that this structure is stable with respect to the many-body evolution in the following sense: the dynamics can be approximated in terms of the time-dependent Hartree equation for the condensate wave function and in terms of the free evolution for the thermally excited particles. The main technical novelty of our work is the use of the Hartree–Fock–Bogoliubov equations to define a fluctuation dynamics. – Joint work with Benjamin Schlein (University of Zurich, Switzerland).

Marcin Napiórkowski (University of Warsaw, Poland)

Friedrichs model approach to Beliaev damping

We consider the Bose gas at zero temperature. According to Bogoliubov theory the low energy behaviour of the system is described by non-interacting bosonic quasiparticles called phonons. In my talk I will present how the phenomenon of Beliaev damping – the decay of phonons due to interactions between them – can be explained using an effective theory based on a Friedrichs model approach. This allows us to compute in a clear and transparent way the damping ratio of phonons – a result first derived by S. T. Beliaev using diagrammatic techniques. – Based on a joint work (in progress) with Jan Dereziński and Ben Li.

Benjamin Hinrichs (Friedrich-Schiller-Universität Jena, Germany)

The qubit and the infrared catastrophe

In models describing the interaction of a quantum mechanical particle with a quantum field of massless bosons, one observes the infrared catastrophe. From the physical perspective, this is attributed to the fact that even tiny energy fluctuations can lead to the creation of an infinite cloud of low-energy bosons. Mathematically, this reflects in the absence of ground states of the Hamilton operator describing the system. In this talk, we consider the infrared problem for the spin boson model in which the particle is a qubit, i.e., a two-state quantum system. Due to the so-called spin-flip symmetry, the infrared catastrophe is not present if the coupling is sufficiently small, which can heuristically be explained by a cancellation of infared-divergences. We discuss a recent non-perturbative proof for the existence of ground states, which allows us to give a simple explicit bound on the absolute value of the coupling constant. We further argue towards the conjecture that there exists no ground state for coupling constants with absolute value larger than a critical value. – The talk is based on joint work with David Hasler and Oliver Siebert.

Dirk-André Deckert (LMU Munich, Germany)

Dynamics of the quantum vacuum in external fields

I will review a series of joint works with co-authors Dürr, Merkl, Nöth, and Schottenloher on the mathematical difficulties in defining the dynamics of the electrodynamic quantum vacuum subject to external fields and report on recent progress regarding a non-perturbative construction of the polarization current.

Jacob Schach Møller (Aarhus University, Denmark)

Renormalization of a toy model

We investigate a method of ultraviolet renormalization through resolvent resummation, a method going back to Epstein, in the context of a Hamiltonian model for a fermion field interacting with a boson field without particle conservation. – The talk is based on joint work with Benjamin Alvarez.

Enno Lenzmann (Universität Basel, Switzerland)

Classical counterparts of quantum Haldane–Shastry spin systems

In the 1980s, Haldane and Shastry indepedently found an exactly solvable quantum spin system with long-range interactions with $1/r^2$ dependence (opposed to the Heisenberg chain with only nearest neighbor interactions). In this talk, we make a link to a classical counterpart involving classical spins. These are Hamiltonian systems of so-called

Calogero–Moser–Sutherland type. Furthermore, we discuss the continuum limit leading to a partial differential equations with completely integrable structures (e.g., Lax pairs, multi-solitons, etc.) This talk is based on joint work with P. Gérard (Paris-Orsay) and A. Schikorra (Pittsburgh).

MINISYMPOSIUM
MS 02 Global Analysis and Geometry

Organized by Ilka Agricola, George Marinescu and Guofang Wang

This minisymposium is devoted to recent developments in global analysis and differential geometry as well as to the interactions between these fields and their application to problems of mathematical physics.

SESSION 1 _ Thursday, September 15 _ 15.30–17.30 _ Takustraße 9: SR 005
Chair: Guofang Wang

15.30 Stefan Ivanov (Sofia University "St. Kl. Ohridski", Bulgaria)
▷ *Para Sasaki-like Riemannian manifolds and new Einstein metrics*

16.30 Giulia Dileo (Università degli Studi di Bari Aldo Moro, Bari, Italy)
▷ *On the geometry of 3-(α, δ)-Sasaki manifolds*

SESSION 2 _ Friday, September 16 _ 10.30–12.30 _ Arnimallee 7: SR 031
Chair: Stefan Ivanov

10.30 George Marinescu (Universität Köln, Germany)
▷ *Bergman kernels on punctured Riemann surfaces*

11.30 Christina Tønnesen-Friedman (Union College, USA)
▷ *CSC Sasaki metrics on Admissible Sasaki manifolds*

SESSION 3 _ Friday, September 16 _ 15.30–17.30 _ Arnimallee 7: SR 031
Chair: Christina Tønnesen-Friedman

15.30 Guofang Wang (Albert-Ludwigs-Universität Freiburg, Germany)
▷ *Optimal geometric inequalities*

ABSTRACTS

Stefan Ivanov (Sofia University “St. Kl. Ohridski”, Bulgaria)

Para Sasaki-like Riemannian manifolds and new Einstein metrics

We determine a new class of paracontact paracomplex Riemannian manifolds derived from certain cone construction, called para-Sasaki-like Riemannian manifolds, and give explicit examples. We define a hyperbolic extension of a paraholomorphic paracomplex Riemannian manifold, which is a local product of two Riemannian spaces of equal dimension, and show that it is a para-Sasaki-like Riemannian manifold. If the original paraholomorphic paracom-plex Riemannian manifold is a complete Einstein space of negative scalar curvature, then its hyperbolic extension is a complete Einstein para-Sasaki-like Riemannian manifold of negative scalar curvature. Thus, we present new examples of complete Einstein Riemannian manifolds of negative scalar curvature.

Giulia Dileo (Università degli Studi di Bari Aldo Moro, Bari, Italy)

On the geometry of 3-(α, δ)-Sasaki manifolds

We consider 3-(α, δ)-Sasaki manifolds, a special class of manifolds generalizing 3-Sasaki manifolds, and locally fibering over a quaternionic Kähler manifold of vanishing, positive or negative scalar curvature, according to $\delta = 0$, $\alpha\delta > 0$, or $\alpha\delta < 0$. We describe homogeneous models, providing a complete classification in the positive case, where the base space of the fibration is a symmetric Wolf space. A central role in the geometry of these manifolds is played by a canonical metric connection with skew torsion. We investigate both the Riemannian curvature and the curvature of the canonical connection, with special attention to conditions of strongly positive curvature. – Joint work with Ilka Agricola (Philipps-Universität Marburg, Germany) and Leander Stecker (Universität Hamburg, Germany).

George Marinescu (Universität Köln, Germany)

Bergman kernels on punctured Riemann surfaces

We show that the Bergman kernel of a punctured Riemann surface endowed with the Poincaré metric can be localized around the singularities and its local model is the Bergman kernel of the punctured unit disc endowed with the standard Poincaré metric. As a consequence, we obtain an optimal uniform estimate of the supremum norm of the Bergman kernel, involving a fractional growth order of the tensor power. This holds in particular for the Bergman kernel of cusp forms of high weight of non-cocompact geometrically finite Fuchsian groups of first kind without elliptic elements.

Christina Tønnesen-Friedman (Union College, USA)

CSC Sasaki metrics on Admissible Sasaki manifolds

If a Sasakian manifold is obtained by a Boothby–Wang construction over a polarized admissible Kähler manifold, we say that the Sasaki manifold is admissible. For such a Sasaki manifold there is a natural 2-dim sub cone of the Sasaki-Reeb cone. We will show that when the base of the admissible Kähler manifold is a local product of non-negative CSC (Constant Scalar Curvature) Kähler metrics, this sub cone always has at least one CSC Sasaki ray. Time permitting we might also discuss related examples and results. – The talk is based on joint work with C. P. Boyer, H. Huang, and E. Legendre.

Guofang Wang (Albert-Ludwigs-Universität Freiburg, Germany)

Optimal geometric inequalities

I will talk about optimal geometric inequalities for hypersurfaces with or without boundary.

MINISYMPOSIUM
MS 03 Mathematics and Arts

Organized by Martin Skrodzki and Milena Damrau

This Minisymposium aims to bring together researchers interested in the connection of mathematics and arts. The talks present artistic objects that include mathematical components and put a focus on the imparting of this underlying mathematics. Furthermore, they explore mathematical themes that invite discussions of their illustrations and the embodied artistic value. A variety of topics centred around the inclusion of mathematics in different art forms like painting, sculpture, architecture, textiles, and music are covered. Moreover, we discuss uses of these combinations for example in high school and university teaching or in outreach projects directed at the general public.

SESSION 1 _ Thursday, September 15 _ 15.30–17.30 _ Takustraße 9: SR 049
Chair: Jürgen Richter-Gebert

15.30 Benjamin Himpel (Reutlingen University, Germany)
▷ *Differential geometry of music perception*

16.00 Dario Alatorre (Instituto de Matemáticas, UNAM, Mexico) and Lobato, Jaime (Seminario Semimúticas, Mexico)
▷ *An advance on a math sonification program*

16.30 Jürgen Richter-Gebert (TU München, Germany)
▷ *The challenge of real time symmetry drawing*

17.00 Discussion

SESSION 2 _ Friday, September 16 _ 10.30–12.30 _ Takustraße 9: SR 049
Chair: Martin Skrodzki

10.30 Timea Tihanyi (Slip Rabbit Studio/University of Washington,USA)
▷ *Making and breaking rules with clay and code: Iteration, glitch, and mathematical thinking*

11.00 Renate Quehenberger (QC:L, Austria)
▷ *The art of 3D digital animated geometry – a visual access to higher dimensions*

11.30 Graham Horton (University of Magdeburg, Germany)
▷ *Simulation of paper marbling*

12.00 Dominic Hopkinson (ACE funded Artist in Residence)
▷ *The mathematics of form. Aperiodic systems from a sculptor's perspective*

SESSION 3 _ Friday, September 16 _ 15.30–17.30 _ Takustraße 9: SR 049
Chair: Milena Damrau

15.30 Henriette-Sophie Lipschütz (FU Berlin, Germany) and Reitebuch, Ulrich (FU Berlin, Germany)
▷ *Visualisation of the Kolakoski sequence*

16.00 Helena Verrill (University of Warwick, UK)
▷ *The boundary of fractal dragon Truchet curves*

16.30 Joshua Holden (Rose-Hulman Institute of Technology, United States of America)
▷ *From Sierpinski's Carpet to Fractal Tapestries: Weaving Fractals on a Computer-Controlled Loom*

17.00 Discussion and Show-and-Tell: Presentation of further MathArt projects

ABSTRACTS

Benjamin Himpel (Reutlingen University, Germany)
Differential geometry of music perception

In response to the question "Why does music theory sound good to our ears" on Wired.com Tech Support (May 26, 2021) musical prodigy Jacob Collier answers "Music theory doesn't really sound like anything. It sounds like parchment. Music sounds like stuff though, and the truth is no one knows. It's a bit of a mystery." We will describe what other musicians and neuroscientists think about this "stuff" and go on a scientific journey in order to analyze it. Mathematics allows us to use neuroscientific theories and psychoacoustic discoveries in order to systematically solve the mystery of why music sounds good. The ultimate goal is to translate music into measurable entities which can be analysed within a holistic model, and that we can deduce good music based on the manipulation of formal objects. To this end we develop some of the mathematical theory suitable for describing the way humans perceive music.
First we give an overview of some of the foundations of music perception, with a focus on prevalent neuroscientific theories, in particular, logarithmic perception of signals, pattern recognition and signal detection theory. Next we introduce the mathematical concepts necessary for modeling music perception. In particular, we show that the space C of musical chords is a stratifold, which is a generalization of a differentiable manifold invented by Matthias Kreck. Its Riemannian metric naturally yields a geodesic distance function suitable for voice-leading. This voice-leading distance naturally satisfies the triangle inequality across different strata of C, which is a suprising observation in view of previous work on voice-leading

by Dmitri Tymoczko. The stratifold structure on C allows us to study the shape of melodies as well as chord progressions as paths in C and the perception thereof by differentiating psychoacoustic lifts of the paths in C. In particular, we analyse quantities like roughness and harmonicity that describe musical qualities of chords. Lastly, we discuss musical expectation, which involves recognizing and predicting patterns in sound and time. We elaborate on its relationship to harmonicity, roughness and voice-leading. We finish by showing how we can analyze a periodicity approach to tension and release using differential geometry.

Dario Alatorre (Instituto de Matemáticas, UNAM, Mexico) and Lobato, Jaime (Seminario Semimúticas, Mexico)

An advance on a math sonification program

In last year's minisymposium, we presented the very beginnings of "a math sonification program". We talked about our motivations and objectives, and showed our first examples. The idea for this year is to give an update of how this project has developed during this timespan.
We will talk about how some of those examples have been used. This involves our conversations with teachers for blind people and the feedback of both artistic and mathematical communities. We will also present new examples and discuss different techniques (like synthesis and localization) for conveying information auditively. We would like to open the conversation with the minisymposium participants towards an integration of a framework for communicating mathematics through sound.

Jürgen Richter-Gebert (TU München, Germany)

The challenge of real time symmetry drawing

Symmetric patterns and ornamental structures are a great topic to communicate about the beauty of mathematics. The topic even attracts laypersons. it becomes even more interesting if people can create such patterns themselves by drawing on a tablet computer, or similar device. This talk will report about the mathematical and computer science challenges behind the project iOrnament (iornament.com), a symmetry drawing app for iOS that is used by many people worldwide. Besides the underlying theory of the overall system that covers topics, like symmetry, crystallographic groups, non-euclidean geometries and conformal mappings we will focus on the following topics:

– overall system architecture
– fast stroke drawing
– implementation of effects like glitter and gold pens
– deformation algorithms for hyperbolic tesselations
– the special role of the GPU (graphical processing unit) for fast rendering

– real time requirements

Since each of the topics might easily fill the entire talk, I will give flashlights about several highlights.

Timea Tihanyi (Slip Rabbit Studio/University of Washington,USA)

Making and breaking rules with clay and code: Iteration, glitch, and mathematical thinking

The talk introduces 3D printing from the perspective of a visual artist's practice. It considers mathematical ideas, from basic geometry and trigonometry to computational theory for the creation of forms and textures, which otherwise would not be possible to create. 3D printing with clay is a recent development within a repertoire of available additive technologies. In ceramic craft, the process of building up a form coil by coil is one of the most ancient techniques. Clay printers revisit this process with unprecedented granularity, accessibility, and transparency. The digital-to-physical workflow creates limitless entry points for using mathematics in creating a design from scratch or hacking an existing design. I will introduce several of my recent projects and collaborations with mathematicians and design researchers at Slip Rabbit Studio. The projects using Rhinoceros/Grasshopper software for form giving, as well as data physicalization, low-tech coding and machine manipulations.

Renate Quehenberger (QC:L, Austria)

The art of 3D digital animated geometry – a visual access to higher dimensions

"The geometry of n dimensions has a real object. [...] and if we cannot represent it we have to conceive and study it." (Henri Poincaré) Finally Henri Poincaré's quest for a hyper-Euclidean geometry, or what he called l'Hypergéométrie, could be fulfilled based on his original ideas of interconnected spaces by means of digital arts with the development of a dynamic 3D digital animated geometry (during the Quantum Cinema-project, 2010–13). Some examples of the visualization of higher dimensional space configurations and a dynamic spatial continuum by means of a newly (re-)discovered heptahedron, the 3-dimensional representation of the Penrose kites & darts tiling named epitahedron ($E\pm$), shall be presented in different contexts: It could be identified as solution to Plato's riddle about "the 5th element" as "composition of triangles" that turned out to be the composition of unit cells of 5-dimensional space ($E\pm$). They are not only composing the 5th regular solid, the well known 3-dimensional dodecahedron, but also a 4-dimensional dodecahedron which can only be presented by means of digital 3D animated geometry, namely in motion. Its visualisation was designed according to the description of the Poincaré dodecahedral space which gives rise to a new answer to the Poincaré conjecture. A short overview about the scientific implications of this re-discovery related to Plato's Theory of Everything (TOE) and its relevance in terms of quantum geometry as well as in regard to biology, genetics and cosmology shall be given.

Graham Horton (University of Magdeburg, Germany)

Simulation of paper marbling

Up until the era of mass production, bookbinders used manually decorated paper for the endpapers and covers of books. In the decoration technique known as marbling, pigments were distributed on the surface of a water bath, and a pattern was induced in them with a needle or a comb. This pattern was then "printed" by carefully laying a sheet of paper onto the surface of the liquid. Using a very simple mathematical model, many traditional marbling patterns can be recreated by simulating the effect of dragging a needle or comb through the liquid. The resulting images can be quite spectacular, especially when printed at high resolution on an A2-sized sheet of paper. The focus of the presentation will be to show various patterns generated by the simulator. These will include direct comparisons with real 19th and 20th century books that show how accurate the simple model can be. Finally, original, digitally marbled patterns will be presented which – although physically feasible - have yet to be created by traditional craftspeople.

Dominic Hopkinson (ACE funded Artist in Residence)

The mathematics of form. Aperiodic systems from a sculptor's perspective

How does a 2 dimensional aperiodic tiling translate into a 3 dimensional structure? What are the connections between the "artistic" concept of the Golden ratio and aperiodic tiling, X-ray crystallography and quasicrystals? How does one visualise, and then communicate, complex ideas to a non specialist audience via abstract art. This presentation will introduce artwork by sculptor Dominic Hopkinson who will discuss his mathematical research which utilises methods he describes as "pattern recognition and frequency analysis". This work led to Hopkinson receiving Arts Council England funding to complete an 18 month residency with Prof. Alastair Rucklidge and Dr. Priya Subramanian at the School of Mathematics at University of Leeds. The residency and associated conferences enabled Hopkinson to further expand his knowledge and understanding of the subject, leading to exhibitions at the 2018 Venice Architecture Biennale, and Leeds.

Henriette-Sophie Lipschütz (FU Berlin, Germany) and Reitebuch, Ulrich (FU Berlin, Germany)

Visualisation of the Kolakoski sequence

The OEIS defines the self-describing Kolakoski sequence (A000002) by listing the number of consecutive repetitions of an element. It consists of 1's and 2's only and starts with 1. Both, 1 and 2, occur in a sequence of equal elements of either one or two consecutive terms. A common way to depict this sequence consists of distributing the elements on a spiral. Based on the conjecture that the share of 1's corresponds to the share of 2's, the elements are distributed such that the angle density of the elements on the spiral increases exponentially. Next to the consecutive elements on the spiral, each element is related to another element which already appeared on the spiral. This element predicts the repetition of the considered one. Depending on whether the considered element is a 1 or a 2, it is connected to the one or two elements it predicts. By connecting each 1 to the predicted element occuring on the next winding by a straight line segment and each 2 to the two predicted elements by straight line segments, resulting locally in a Y shape, this procedure results in a tree-like fractal structure in the plane.

Helena Verrill (University of Warwick, UK)

The boundary of fractal dragon Truchet curves

Fractals are ubiquitous in nature, and very popular in abstract mathematics, and works of generative art. The Truchet tiling, especially in the form of Smith's quarter circles design, is also a familiar motif in generative art. I bring these two concepts together in mathematical generative art. This is a new construction of the well known fractal dragon curves, giving new insights into their properties. I will explain the hinged Truchet tiling method, and how a choice of path through a binary tree gives rise to fractals with different shapes and differing fractal dimension of their boundary. I will explain the concept of fractal dimension, illustrated by fractals constructed by the hinged Truchet tiling method. By using plenty of images I hope to make this concept clear for the non-specialist. I will give an outline of how to compute this dimension for these curves. The talk will be illustrated with images of the construction, including animations of the fractal process, and use of the construction as an image filter. I will give a demonstration of using my online fractal hinged tiling JavaScript program.

Joshua Holden (Rose-Hulman Institute of Technology, United States of America)

From Sierpinski's Carpet to Fractal Tapestries: Weaving Fractals on a Computer-Controlled Loom

Weaving is possibly the earliest artistic medium to divide pictures up into pixels. Many weaving techniques involve a rectangular grid of horizontal and vertical threads, where each intersection can be thought of as a pixel. The color of the pixel is determined by whether the horizontal or the vertical thread is on top. Modern hobbyist weaving looms generally use frames called shafts to select which threads are going to be raised and lowered in the weaving process. Each shaft controls a set of vertical threads, and therefore the color pattern of each column of pixels is determined by a specific set of shafts. The number of distinct vertical color patterns, known as blocks, in a design is thus bounded by a function of the number of shafts. Because of constraints necessary to keep the fabric from falling apart, it is not normally

possible to weave n blocks with only n shafts. Rather, between $n + 2$ to $4n$ or more shafts are required, depending on the exact structure of the weaving.
The author recently purchased through his institution a 32-shaft computer-controlled loom, and started looking for mathematical patterns which could be woven on it. Fractals seemed like the obvious answer, leading to the question of how complicated a fractal could be produced with 30 blocks? A variation on the Sierpinski carpet can be designed using a number of blocks which is a power of three, which so far appears to be the fractal leaving the fewest number of unused shafts.

MINISYMPOSIUM
MS 04 Nonlinear Algebra in the Sciences

Organized by Simon Telen and Paul Breiding

Nonlinear algebra is the application driven study of nonlinear equations, with a view towards computations. It goes beyond the well-developed tools from linear algebra and allows scientists to effectively compute with nonlinear models. Recent advances in the field have manifested its importance in real world problems. Application areas include computer vision, chemistry, robotics, statistics and data science, to name a few. This Minisymposium features new theoretical and methodological developments in nonlinear algebra, as well as computational and applied aspects.

SESSION 1 _ Monday, September 12 _ 11.00–13.00 _ Takustraße 9: SR 005
Chair: Paul Breiding

11.00 Boulos El Hilany (TU Braunschweig, Germany)
▷ *The tropical bifurcation set of polynomial maps on a plane*

11.30 Irem Portakal (Technische Universität München, Germany)
▷ *Geometry of dependency equilibria*

12.00 Nick Dewaele (KU Leuven, Belgium)
▷ *Computing the condition number of tensor decompositions by compression*

12.30 Carlos Améndola (Technische Universität Berlin, Germany)
▷ *Likelihood geometry of correlation models*

SESSION 2 _ Monday, September 12 _ 15.30–17.30 _ Takustraße 9: SR 005
Chair: Simon Telen

15.30 Elima Shehu (MPI MiS Leipzig, Germany)
▷ *Line multiview varieties*

16.00 Mara Belotti (Technische Universität Berlin, Germany)
▷ *On the Cox ring of the blow up of 7 points in projective 3-space*

16.30 Paul Breiding (MPI MiS Leipzig and University of Osnabrück, Germany)
▷ *Curvature of algebraic surfaces in three-space*

17.00 Bernd Sturmfels (MPI MiS Leipzig, Germany)
▷ *Subspaces fixed by a nilpotent matrix*

ABSTRACTS

Boulos El Hilany (TU Braunschweig, Germany)

The tropical bifurcation set of polynomial maps on a plane

The bifurcation set, $B(f)$, of a polynomial map $f : X \to Y$ between two smooth affine varieties is the smallest set of points in Y outside of which the map is a locally trivial smooth fibration. Understanding the geometrical properties of $B(f)$ is key for describing the topology of f, yet standard methods for characterizing it rely on elimination techniques that can often be inefficient. As polynomial maps are central objects in singularity theory, affine geometry, and applied mathematics, the necessity for developing tools for computing the bifurcation set becomes apparent. This talk concerns polynomial maps on the two-dimensional torus defined over the field of generalized Puiseux series with complex coefficients. I will present a combinatorial procedure for computing the tropical curve of the bifurcation set of general polynomial maps with given support. This allows to use tools from polyhedral geometry for characterizing the bifurcation set of polynomial maps on the plane. I will also show how to use this new description to compute the Newton polytope of $B(f)$ whenever $X = Y = \mathbb{C}^2$.

Irem Portakal (Technische Universität München, Germany)

Geometry of dependency equilibria

An n-person game is specified by n tensors of the same format. We view its equilibria as points in that tensor space. Dependency equilibria are defined by linear constraints on conditional probabilities, and thus by determinantal quadrics in the tensor entries. These equations cut out the Spohn variety, named after the philosopher who introduced dependency equilibria. The Nash equilibria among these are the tensors of rank one. We study the real algebraic geometry of the Spohn variety. This variety is rational, except for 2×2 games, when it is an elliptic curve. For 3×2 games, it is a del Pezzo surface of degree two. We characterize the payoff regions and their boundaries using oriented matroids, and we develop the connection to Bayesian networks in statistics. – Joint work with Bernd Sturmfels (MPI MiS Leipzig, Germany).

Nick Dewaele (KU Leuven, Belgium)

Computing the condition number of tensor decompositions by compression

Tensor decompositions are an important class of systems of equations found in nonlinear algebra. Examples include the tensor rank and block term decomposition. These decompositions are often used as low-rank models in data analysis and engineering. In order to interpret the solution, however, it is essential to measure its sensitivity to the data or parameters. The condition number is a classic way to do exactly this. In this talk, we discuss how a condition number can be defined for tensor decompositions from a geometric point of view. Furthermore, we study the impact of Tucker compression, a common dimensionality reduction technique for this kind of systems. We compare the sensitivity of the original and reduced problem and conclude with a compression-based algorithm to compute the condition number. – Joint work with Paul Breiding (MPI MiS Leipzig and University of Osnabrück, Germany).

Carlos Améndola (Technische Universität Berlin, Germany)
Likelihood geometry of correlation models

We present a problem where nonlinear algebra appears naturally in statistics. Concretely, we study the geometry of maximum likelihood estimation for correlation matrices, which form an affine space of symmetric matrices defined by setting the diagonal entries to one. We also consider minimizing two closely related functions of the covariance matrix: the Stein's loss and the symmetrized Stein's loss. Studying the critical points in all three settings leads to systems of nonlinear equations, and we compute some of these degree invariants. – Joint work with Piotr Zwiernik (University of Toronto, Canada).

Elima Shehu (MPI MiS Leipzig, Germany)
Line multiview varieties

Consider taking m images of a line in three-dimensional projective space using m pinhole cameras, where pinhole cameras are projective linear maps given by full rank 3×4 matrices. In this way, we obtain a line correspondence consisting of an arrangement of m lines in two-space. The purpose of this presentation is to discuss line correspondences from the perspective of algebraic geometry. We define the line multiview variety as the Zariski closure of the set of all line correspondences with m fixed cameras. In the case of camera matrices in general position, we show that the line multiview variety is characterized by a natural determinantal variety and provide a complete description of any camera arrangement. Basic properties of this variety, such as dimension, smoothness, and multidegree, are explored. – Joint work with Paul Breiding, Felix Rydell, and Angelica Torres.

Mara Belotti (Technische Universität Berlin, Germany)
On the Cox ring of the blow up of 7 points in projective 3-space

We prove quadratic generation for the ideal of the Cox ring of the blow up of 7 points in projective 3-space. To do this we find special Khovanskii bases, implementing techniques which proved successful in the case of Del Pezzo surfaces. Such bases give us toric degenerations which allow us to get geometric informations about the Cox ring from a family of lattice polytopes. In particular, we focus on the f-vector of such polytopes and we define the Mukai edge graph. – Joint work with Marta Panizzut (TU Berlin).

Paul Breiding (MPI MiS Leipzig and University of Osnabrück, Germany)
Curvature of algebraic surfaces in three-space

We consider the problem of counting points on a real algebraic surface in three-space that exhibit special curvature properties. More specifically, we study the number of umbilics and critical curvature points using methods from complex algebraic geometry. – Joint work with Kristian Ranestad and Maddie Weinstein.

Bernd Sturmfels (MPI MiS Leipzig, Germany)
Subspaces fixed by a nilpotent matrix

The linear spaces that are fixed by a given nilpotent matrix form a subvariety of the Grassmannian. We classify these varieties. Mutiah, Weekes and Yacobi conjectured that their radical ideals are generated by certain linear forms known as shuffle equations. We disprove this conjecture, and we examine circumstances where it holds. – Joint work with Marvin Hahn, Gabriele Nebe, and Mima Stanojkovski.

MINISYMPOSIUM

MS 05 Nonlinear Evolution Equations and Applications

Organized by Bogdan Matioc and Christoph Walker

Nonlinear evolution equations arise as models for many processes in natural sciences and technology, in particular in the fields of solid and fluid mechanics and material science. The challenging mathematical difficulties encountered by researchers have led to the development of innovative and sophisticated methods and techniques in this area of pure and applied mathematics. One of the main goals of this Minisymposium is to bring together experts and young scientists in nonlinear evolution equations of parabolic or hyperbolic type in order to stimulate the transfer of ideas, results, and techniques among them.

SESSION 1 _ Thursday, September 15 _ 10.30–12.30 _ Takustraße 9: SR 055
Chair: Christoph Walker

10.30 Helmut Abels (Universität Regensburg, Germany)
▷ *Regularity and convergence to equilibrium for a Navier–Stokes–Cahn–Hilliard system with unmatched densities*

11.00 Johannes Lankeit (Leibniz Universität Hannover, Germany)
▷ *Blow-up in a fully parabolic attraction-repulsion chemotaxis system*

11.30 Katerina Nik (TU Wien, Austria)
▷ *Some variational problem in morphoelasticity*

12.00 Christian Zillinger (Karlsruher Institut für Technologie, Germany)
▷ *On traveling waves and echo chains in the Boussinesq equations*

SESSION 2 _ Thursday, September 15 _ 15.30–17.30 _ Takustraße 9: SR 055
Chair: Bogdan Matioc

15.30 Petra Wittbold (University of Duisburg-Essen, Germany)
▷ *Bounded weak solutions of time-fractional porous medium type equations*

16.00 Patrik Knopf (Universität Regensburg, Germany)
▷ *Two-phase flows with bulk-surface interaction: A Navier–Stokes–Cahn–Hilliard model with dynamic boundary conditions*

16.30 David Henry (University College Cork, Ireland)
▷ *On the energy of nonlinear water waves*

17.00 Mathias Wilke (Martin-Luther-Universität Halle-Wittenberg, Germany)
▷ *Lp-Lq-theory for a quasilinear non-isothermal Westervelt equation*

ABSTRACTS

Helmut Abels (Universität Regensburg, Germany)

Regularity and convergence to equilibrium for a Navier–Stokes–Cahn–Hilliard system with unmatched densities

We study the initial-boundary value problem for an incompressible Navier–Stokes–Cahn–Hilliard system with non-constant density proposed by Abels, Garcke and Grün in 2012. This model arises in the diffuse interface theory for binary mixtures of viscous incompressible fluids. This system is a generalization of the well-known model H in the case of fluids with unmatched densities. In three dimensions, we prove that any global weak solution (for which uniqueness is not known) exhibits a propagation of regularity in time and stabilizes towards an equilibrium state as time tends to infinity. Our analysis hinges upon the following key points: a novel global regularity result (with explicit bounds) for the Cahn–Hilliard equation with divergence-free velocity belonging only to the Leray–Hopf class, the energy dissipation of the system, the separation property for large times, a weak strong uniqueness type result, and the Lojasiewicz–Simon inequality. – Joint work with Harald Garcke (Universität Regensburg, Germany) and Andrea Giorgini (Imperial College London, UK).

Johannes Lankeit (Leibniz Universität Hannover, Germany)

Blow-up in a fully parabolic attraction-repulsion chemotaxis system

In this talk we will deal with solutions of a chemotaxis system with two signals – one acting as attractant, one as repellent. After reviewing some classical methods for proving blow-up in Keller–Segel type systems, we will capitalize on a simple observation to carry over one of these ideas to the system with two signals.

Katerina Nik (TU Wien, Austria)

Some variational problem in morphoelasticity

I will present some recent work on a three-dimensional quasistatic morphoelastic model. The mechanical response of the body and its growth are modeled by the interplay of hyperelastic energy minimization and growth dynamics. An existence result is obtained by regularization and time-discretization, also taking advantage of an exponential-update scheme. – Joint work with Elisa Davoli (TU Wien, Austria) and Ulisse Stefanelli (University of Vienna, Austria).

Christian Zillinger (Karlsruher Institut für Technologie, Germany)

On traveling waves and echo chains in the Boussinesq equations

The 2D Boussinesq equations describe the evolution of a heat conducting viscous fluid. In this talk I show that in the setting without thermal dissipation there exist explicit non-trivial traveling wave solutions near shear flows and hydrostatic balance. Moreover, the linearized equations around these waves exhibit resonances, called echoes, despite viscous dissipation of the velocity. There is a critical Gevrey 3 regularity class for which infinitely many resonances cause the temperature and vorticity to diverge to infinity in Sobolev regularity as $t \to \infty$. Yet, convergence of the velocity may persist despite this blow-up.

Petra Wittbold (University of Duisburg-Essen, Germany)

Bounded weak solutions of time-fractional porous medium type equations

We prove existence of bounded weak solutions to degenerate nonlinear subdiffusion problems of the following form

$$\begin{aligned} \partial_t(k*(u-u_0)) - \operatorname{div}(A(t,x)\nabla\varphi(u)) &= f && \text{on } (0,T)\times\Omega \\ u &= 0 && \text{on } (0,T)\times\partial\Omega \\ u_{|t=0} &= u_0 && \text{on } \Omega, \end{aligned}$$

where $T>0$, Ω is a bounded open subset of $\mathbb{R}^d$ ($d\in\mathbb{N}$), k is a so-called $\mathcal{PC}$-kernel (in particular, the case of a fractional time derivative of order less than 1 is included), the coefficient matrix $A(\cdot,\cdot)\in L^\infty((0,T)\times\Omega;\mathbb{R}^{d\times d})$ is supposed to satisfy a coerciveness condition and the nonlinearity $\varphi\in C^1(\mathbb{R})$ some appropriate assumptions which are, in particular, satisfied by the nonlinearity $\varphi(r)=|r|^{m-1}r$, $r\in\mathbb{R}$, with $m>1$ (porous-medium type nonlinearity).
Due to the time-dependence of the coefficients we can not rely on the classical theory by Gripenberg for evolutionary integro-differential equations with accretive nonlinearity.
A key ingredient in our proof of existence is a new compactness criterion of Aubin–Lions type which involves function spaces defined in terms of the integro-differential operator in time.
Boundedness of the solutions is obtained by a De Giorgi iteration technique.
Sufficiently regular solutions are shown to be unique by means of an L^1-contraction principle.
An extension of these results for time-fractional porous medium type equations with unbounded data is discussed.
This work is partially based on the article “Bounded weak solutions of time-fractional porous medium type and more general nonlinear and degenerate evolutionary integro-differential equations” by Wittbod, P.; Wolejko,P.; Zacher, R. published in JMAA in 2021. – Joint work with Rico Zacher (University of Ulm, Germany).

Patrik Knopf (Universität Regensburg, Germany)

Two-phase flows with bulk-surface interaction: A Navier–Stokes–Cahn–Hilliard model with dynamic boundary conditions

We derive a novel thermodynamically consistent Navier–Stokes–Cahn–Hilliard system with dynamic boundary conditions. This model describes the motion of viscous incompressible binary fluids with different densities. In contrast to previous models in the literature, our new model allows for surface diffusion, a variable contact angle between the diffuse interface and the boundary, and mass transfer between bulk and surface. In particular, this transfer of material is subject to a mass conservation law including a bulk and a surface contribution. The derivation is carried out by means of local energy dissipation laws and the Lagrange multiplier approach. Next, in the case of fluids with matched densities, we show the existence of global weak solutions in two and three dimensions as well as the uniqueness of weak solutions in two dimensions. – Joint work with Andrea Giorgini (Imperial College London, UK).

David Henry (University College Cork, Ireland)

On the energy of nonlinear water waves

The mathematical analysis of water waves is an intriguing and challenging subject spanning a number of scientific disciplines. Even in the setting of a perfect fluid (incompressible and inviscid) the governing equations are highly intractable, primarily due to strong nonlinearities, compounded by the presence of an unknown free-boundary. This talk presents recent results concerning excess energy densities for exact nonlinear water waves.

Mathias Wilke (Martin-Luther-Universität Halle-Wittenberg, Germany)

Lp-Lq-theory for a quasilinear non-isothermal Westervelt equation

We investigate a quasilinear system consisting of the Westervelt equation from nonlinear acoustics and Pennes bioheat equation, subject to Dirichlet or Neumann boundary conditions. The concept of maximal regularity of type Lp-Lq is applied to prove local and global well-posedness. Moreover, we compute the equilibria of the system and investigate the long-time behaviour of solutions starting close to equilibria.

MINISYMPOSIUM
MS 06 Translation Surfaces

Organized by Samantha Fairchild

Translation surfaces are a collection of polygons in the plane with parallel sides identified by translation to form a Riemann surface with a singular Euclidean structure. Understanding the geometry and behaviour of flows on translation surfaces and their moduli spaces led to the development of many new and revolutionary techniques. This session will focus on results on translation surfaces and other closely related structures.

SESSION 1 _ Thursday, September 15 _ 15.30–17.30 _ Arnimallee 6: SR 007–008
Chair: Samantha Fairchild

15.30 Gabriela Weitze-Schmithuesen (Saarland University, Germany)
▷ *Systoles of translation surfaces*

16.00 Christian Weiss (Ruhr West University of Applied Sciences, Mülheim an der Ruhr, Germany)
▷ *Quantitative equidistribution of billard flows on the unit square*

16.30 Anja Randecker (Universität Heidelberg, Germany)
▷ *Periodic directions on translation surfaces in genus 2*

17.00 Peter Kaiser (Karlsruher Institut für Technologie, Germany)
▷ *Finite local complexity in model sets*

SESSION 2 _ Friday, September 16 _ 10.30–12.30 _ Arnimallee 6: SR 007–008
Chair: Samantha Fairchild

10.30 Diaaeldin Taha (Heidelberg University, Germany)
▷ *On the limiting distribution of free path lengths for translation surfaces with circular obstacles*

11.00 Andrea Thevis (Goethe University Frankfurt, Germany)
▷ *On the geometry of p-origamis and beyond*

11.30 Frank Herrlich (Karlsruher Institut für Technologie, Germany)
▷ *Qwirkle origamis*

12.00 Jan Kohlmüller (Karlsruher Institut für Technologie, Germany)
▷ *Topologies on the space of all translation surfaces*

ABSTRACTS

Gabriela Weitze-Schmithuesen (Saarland University, Germany)

Systoles of translation surfaces

We study systoles of translation surfaces, i.e., shortest geodesics. How long can systoles be in a given stratum? We use origamis to obtain estimates.

Christian Weiss (Ruhr West University of Applied Sciences, Mülheim an der Ruhr, Germany)

Quantitative equidistribution of billard flows on the unit square

The distributional properties of the translation flow on the unit square have been studied in different fields of mathematics, including algebraic geometry and discrepancy theory. One method to quantify equidistribution is to compare the error between the actual time the translation flow spent in specific sets $E \subset [0,1]^2$ to the expected time. In this talk, we discuss error terms for different types of sets and show new results for the so-called algebra of convex sets. Amongst others, we will also see how the number theoretic properties of the direction govern the order of the error termn. This is joint work with Max Goering.

Anja Randecker (Universität Heidelberg, Germany)

Periodic directions on translation surfaces in genus 2

The Veech groups of translation surfaces are closely related to the behaviour of the geodesic flow – whereas the geodesic flows again are closely related to interval exchange transformations. In this talk, I will use interval exchange transformations to give a description of the potential sets of directions in which the geodesic flow is periodic for a translation surface in $\mathcal{H}(2)$. – This is based on an ongoing project with Binbin Xu which has the goal to explicitely determine all Veech groups of translation surfaces of genus 2. – Joint work with Binbin Xu (Nankai University, China).

Peter Kaiser (Karlsruher Institut für Technologie, Germany)

Finite local complexity in model sets

We consider discrete locally finite subsets of groups which are equipped with a metric. For such a subset Λ we can consider for each $\lambda \in \Lambda$ the r-patch $B_r(\lambda) \cap \Lambda$. The patches induce an equivalence relation on Λ for each r. Our interest is in the function which counts the number of equivalence classes in dependence of r, the patch-counting function $p(r)$, sometimes also called the complexity function. The asymptotic behaviour of p is a good measure for how 'complicated' the set Λ is. Lattices have a complexity function constantly 1, which means that lattices are highly structured. We are interested in sets where $p(r) < \infty$ for all $r > 0$. From this perspective these sets are a natural generalisation of lattices. One says these sets have *finite local complexity (FLC)*. We consider a certain class of FLC sets, which is constructed by the so called *cut and project method*. For this construction one considers a lattice in a product of two groups and projects in a certain way to one of the factors. Under some extra conditions these sets are called *Model sets*. For Model sets which fulfil certain geometric properties it is possible to determine the asymptotic behaviour of p. In the euclidean set-up this is done by Koivusalo and Walton. We extend their ideas to the non-abelian case.

Diaaeldin Taha (Heidelberg University, Germany)

On the limiting distribution of free path lengths for translation surfaces with circular obstacles

In this talk, we prove the existence of a limiting distribution of the free path lengths on translation surfaces with circular obstacles as the radius of the obstacles goes to zero. Moreover, we relate this distribution to the distribution of the heights of zippered rectangle decompositions of flat surfaces, and to the distribution of gap lengths for particular interval exchange transformations. This is work in progress.

Andrea Thevis (Goethe University Frankfurt, Germany)

On the geometry of p-origamis and beyond

In this talk, we study a special class of translation surfaces called normal origamis. Normal origamis are surfaces with a maximal symmetry group and induce normal covers of the torus. We focus on p-origamis, where the deck transformation groups of the torus covers are p-groups, and answer the questions: Which strata contain p-origamis? Does already the deck transformation group determine the stratum? We then turn toward the study of Veech groups of certain normal origamis. These groups are the stabilizer groups of an origami under an $SL(2, Z)$-action. We are especially interested in the question, whether the occurring Veech groups are congruence groups. Lastly, we consider cylinder decompositions of so-called geminal origamis. These origamis exhibit very special cylinder decompositions. Apisa and Wright asked whether geminal origamis are cyclic covers of the surface (2×2)-torus. We use methods from group theory to answer this question partially. This talk is partially based on joint work with Johannes Flake.

Frank Herrlich (Karlsruher Institut für Technologie, Germany)

Qwirkle origamis

We call a regular origami consisting of d squares a qwirkle origami if we can assign to each square a color and a shape in such a way that in each horizontal cylinder all squares have the same color, but mutually different shapes, and vice versa for the vertical cylinders. The existence of such an assignment is reflected by certain properties of the automorphism group of the origami. In the talk I shall characterize these “qwirkle groups” and present some examples.

Jan Kohlmüller (Karlsruher Institut für Technologie, Germany)

Topologies on the space of all translation surfaces

The Moduli spaces of finite translation surfaces have been thoroughly studied in the past. In contrast, not much is known about the space of all (finite and infinite) translation surfaces, but some attempts have been made to establish a topology on this space. In this talk, we will take a look at the immersive topology on this space, which has been established by Patrick Hooper, and examine the topological properties of some families of infinite translation surfaces. In addition, we will introduce a slightly stronger topology and show some advantages it has over the immersive topology by looking at some concrete examples.

MINISYMPOSIUM
MS 07 Extremal and Probabilistic Combinatorics

Organized by Julia Böttcher, Olaf Parczyk, Yury Person and Tibor Szabo

This Minisymposium will focus on extremal and probabilistic combinatorics. We expect lectures on topics such as random discrete structures, Ramsey theory, structural graph theory, extremal problems in combinatorics and a mix thereof. The lectures will highlight recent advances and modern developments and we expect fruitful discussions.

SESSION 1 _ Monday, September 12 _ 15.30–17.30 _ Arnimallee 6: SR 032
Chair: Olaf Parczyk

15.30 Mathias Schacht (Universität Hamburg, Germany)
▷ *Extremal problems in hypergraphs with quasirandom links*

16.00 Shoham Letzter (University College London, UK)
▷ *Ascending subgraph decomposition*

16.30 Mykhaylo Tyomkyn (Charles University, Czech Republic)
▷ *Weakly saturated hypergraphs and a conjecture of Tuza*

17.00 Diana Piguet (Czech Academy of Sciences, Czech Republik)
▷ *Perfect packing of D-degenerate graphs*

SESSION 2 _ Tuesday, September 13 _ 10.30–12.30 _ Arnimallee 6: SR 032
Chair: Tibor Szabó

10.30 Gal Kronenberg (University of Oxford, UK)
▷ *Erdős–Renyi shotgun reconstruction*

11.00 Nina Kamčev (University of Zagreb, Croatia)
▷ *Canonical colourings in random graphs*

11.30 Patrick Morris (Universitat Politècnica de Catalunya, Barcelona, Spain)
▷ *Two round Ramsey games on random graphs*

12.00 Ross Kang (University of Amsterdam, The Netherlands)
▷ *On a conjecture of Reed*

ABSTRACTS

Mathias Schacht (Universität Hamburg, Germany)

Extremal problems in hypergraphs with quasirandom links

Extremal problems for 3-uniform hypergraphs concern the maximum cardinality of a set E of 3-element subsets of a given n-element set V such that for any l elements of V at least one triple is missing in E. This innocent looking problem is still open, despite a great deal of effort over the last 80 years. We consider a variant of the problem by imposing additional restrictions on the distribution of the 3-element subsets in E, which are motivated by the theory of quasirandom hypergraphs. These additional assumptions yield a finer control over the corresponding extremal problem. In fact, this leads to many interesting and more manageable subproblems, some of which were already considered by Erdős and Sós in the 1980ies. In this talk we consider hypergraphs whose vertices have quasirandom link graphs. – Joint work with Sören Berger (Universität Hamburg, Germany), Simon Piga (University of Birmingham, UK), Christian Reiher (Universität Hamburg, Germany) and Vojtech Rödl (Emory University, USA).

Shoham Letzter (University College London, UK)

Ascending subgraph decomposition

A conjecture of Alavi–Boals–Chartrand-Erdős–Oellermann (1987) asserts that every graph on ($m + 1$ choose 2) edges can be decomposed into graphs $G_1, \ldots, G_m$, where G_i has exactly i edges and is isomorphic to a subgraph of G_{i+1}; such a decomposition is called an ascending subgraph decomposition. We prove the conjecture for all large enough m. — This is joint work with Kyriakos Katsamaktsis, Alexey Pokrovskiy and Benny Sudakov.

Mykhaylo Tyomkyn (Charles University, Czech Republic)

Weakly saturated hypergraphs and a conjecture of Tuza

For two r-uniform hypergraphs G and H we say that G is weakly H-saturated if the missing edges in G can be filled one by one, creating a new copy of H at every step. The quantity $wsat(n, H)$ measures the smallest size of a weakly H-saturated r-graph of order n. For $r = 2$ a short argument due to Alon (1985) shows that for any graph H, $wsat(n, H)/n$ tends to a limit as n increases. Tuza conjectured in 1992 that for arbitrary r the quantity $wsat(n, H)/n^{r-1}$ similarly has a limit $c(H)$. I will present a recent proof of Tuza's conjecture. – Joint work with Asaf Shapira.

Diana Piguet (Czech Academy of Sciences, Czech Republik)

Perfect packing of D-degenerate graphs

We say that a family of graphs G packs into a graph H if there are edge disjoint copies of each member of G into H, and it packs perfectly, when the total number of edges in G equals the number of edges in H. We present a result about perfectly packing D-degenerate graphs of maximum degree $cn/\log n$ into a complete graph on n vertices. – Joint work with Peter Allen (London School of Economics and Political Science, UK), Julia Böttcher (London School of Economics and Political Science, UK), Dennis Clemens (Hamburg University of Technology, Germany), and Jan Hladký (Czech Academy of Sciences, Czech Republik).

Gal Kronenberg (University of Oxford, UK)

Erdős–Renyi shotgun reconstruction

We say that a graph G is reconstructible from its r-neighbourhoods if all graphs H having the same collection of r-balls as G up to isomorphism, are isomorphic to G. We are interested in the reconstruction of the Erdős–Renyi graph $G(n,p)$ for a wide range of values of r, aiming to determine the values of p for which $G(n,p)$ is r-reconstructible with high probability. Mossel and Ross considered this problem in the sparse case where $p = C/n$, and they also considered reconstruction in the dense case where $p \gg 1/n$, and showed that the the graph $G(n,p)$ can be reconstructed from its 3-neighbourhoods with high probability provided that $p \gg \log_2(n)/n$. Later, Gaudio and Mossel studied reconstruction from the 1- and 2-neighbourhoods, giving bounds on the values of p for which $G(n,p)$ is reconsructible. For 1-neighbourhoods, this was improved very recently by Huang and Tikhomirov who determined the correct threshold up to logarithmic factors, around $n^{-1/2}$. In this talk we will show new bounds on p for the r-reconstructibility problem in $G(n,p)$. We improve the bounds for 2-neighbourhoods given by Gaudio and Mossel by polynomial factors. We also improve the result of Huang and Tikhomirov for 1-neighbourhoods, showing that the logarithmic factor is necessary. Finally, we determine the exact thresholds for r-reconstructibility for $r \geq 3$. – This is a joint work with Tom Johnston, Alexander Roberts, and Alex Scott.

Nina Kamčev (University of Zagreb, Croatia)

Canonical colourings in random graphs

Rödl and Ruciński have extended Ramsey's Theorem to random graphs, showing that there is a constant C such that with high probability, any two-colouring of the edges of $G(n,p)$ with edge probability $p = Cn^{-2/(t+1)}$ contains a monochromatic copy of K_t (the complete t-vertex graph). We investigate how this statement extends to arbitrary colourings of $G(n,p)$. Namely, when no assumptions are made on the edge colouring, one can only hope to find one of the four canonical colourings of K_t, as in the well-known canonical version of Ramsey's Theorem due to Erdős and Rado. We show that indeed, any colouring of $G(n, p)$ with $p = Cn^{-2/(t+1)}$ contains a canonically coloured copy of K_t. A crucial tool in the proof is the transference principle due to Conlon and Gowers. – Joint work with Mathias Schacht (Universität Hamburg, Germany).

Patrick Morris (Universitat Politècnica de Catalunya, Barcelona, Spain)

Two round Ramsey games on random graphs

In this talk, we discuss the following one-player Ramsey game. Given some $p = p(n)$ and $q = q(n)$, the player is first shown $G(n, p)$ and must 2-colour the edges avoiding monochromatic triangles. The second random graph $G(n, q)$ is then revealed and the player is asked to extend their colouring of $G(n, p)$ to the new edges in $G(n, q)$ without creating any monochromatic triangles. For what p and q can the player succeed? This game was introduced by Friedgut, Kohayakawa, Rödl, Ruciński and Tetali in 2003, where they showed that when $p = \epsilon n^{-1/2}$ is just slightly below the triangle Ramsey threshold, if $G(n, q)$ contains a super-constant number of edges, the player will already fail. In this talk, we discuss the situation for smaller p, determining the optimal dependence of q on p for which the player can win in the range $n^{-2/3} \ll p \ll n^{-1/2}$, where we see two different behaviours either side of $n^{-3/5}$. – Joint work with Yahav Alon (Tel-Aviv University, Israel) and Wojciech Samotij (Tel-Aviv University, Israel).

Ross Kang (University of Amsterdam, The Netherlands)

On a conjecture of Reed

The interplay between local structure (e.g., having independent neighbourhoods or having bounded clique number) and global structure (e.g., having a large independent set or a good colouring) has long played a central role in combinatorics, especially in probabilistic and extremal combinatorics. We will take one view on this paradigm from the perspective of chromatic graph theory. The talk is centred around a conjecture of Reed, as well as a related conjecture of Alon, Krivelevich and Sudakov, both of which are about finding good colourings in graphs of prescribed clique number. We will discuss how progress on these problems seems to depend on progress related to finding good colourings in graphs of prescribed local edge density. If time permits, we may present some open problems. – This work touches on joint works with Davies, de Joannis de Verclos, Hurley, Pirot, Sereni.

MINISYMPOSIUM
MS 08 Advances in K-Theory, Symmetry, and Periodicity

Organized by Gabriel Angelini-Knoll

Interactions between the fields of algebraic K-theory, equivariant homotopy theory, and chromatic homotopy theory, have led to exciting new results with applications to number theory and geometric topology. Classically, equivariant homotopy theory is an integral part of a modern approach to algebraic K-theory, known as trace methods where one uses Hochschild homology to approximate algebraic K-theory. The trace methods approach to K-theory combined with tools from chromatic homotopy theory has led to advances in our understanding of the arithmetic of ring spectra. Additionally, the relatively recent theory of Real cyclotomic spectra combines topological Hochschild homology and equivariant homotopy theory to produce new tools for computing Grothendieck–Witt groups and L-theory groups. The goal of this Minisymposium is to highlight recent advances in Hochschild homology, algebraic K-theory, equivariant homotopy theory, and chromatic homotopy theory that combine tools from several of these fields, as well as bring together researchers from these different areas to promote future interactions between these fields.

SESSION 1 _ Friday, September 16 _ 10.30–12.30 _ Takustraße 9: SR 055
Chair: Gabriel Angelini-Knoll

10.30 Mikala Jansen (University of Copenhagen, Denmark)
▷ *Unstable algebraic K-theory*

11.30 J. D. Quigley (MPIM, University of Oregon, USA)
▷ *Bredon homological stability*

SESSION 2 _ Friday, September 16 _ 15.30–17.30 _ Takustraße 9: SR 055
Chair: Gabriel Angelini-Knoll

15.30 Jack Davies (Utrecht University, The Netherlands)
▷ *Stable operations in elliptic cohomology*

16.30 Eva Höning (Radboud University, The Netherlands)
▷ *Algebraic K-theory of the second truncated Brown–Peterson spectrum*

ABSTRACTS

Mikala Jansen (University of Copenhagen, Denmark)

Unstable algebraic K-theory

Let R by a ring. The term unstable algebraic K-theory will refer to any (family of) anima $K(R,n)$ built entirely out of linear algebra internal to R^n through which the canonical maps $BGL_n(R) \to K(R)$ factorise. A classical example is Quillen's plus-construction $BGL_n(R)^+$. Ideally, we want a model for unstable algebraic K-theory to be closer to $K(R)$ than $BGL_n(R)$ is in terms of its nature and properties; for example the fundamental group of the plus-construction is closer to $K_1(R)$ than $GL_n(R)$ is. The term unstable algebraic K-theory was used in the 1970's by Dennis and Stein in a survey of the functor K_2, and classically unstable algebraic K-theory has been used to derive many important computational results about "stable" algebraic K-theory. We introduce a new model for unstable algebraic K-theory inspired by a detailed study of the so-called reductive Borel–Serre compactification of locally symmetric spaces. In this talk I will mention the main results and calculations of this work and also attempt to shed light on the geometric origins of the model, as this is an important and very interesting aspect of the story. – This is joint work with Dustin Clausen.

J. D. Quigley (MPIM, University of Oregon, USA)

Bredon homological stability

Homological stability is a well-studied phenomenon with applications to stable homotopy theory and algebraic K-theory. In this talk, I will introduce Bredon homological stability, an equivariant refinement of homological stability, and discuss some examples. – This is joint work with Eva Belmont.

Jack Davies (Utrecht University, The Netherlands)

Stable operations in elliptic cohomology

Many famous results in topology can be proven using operations on various cohomology theories. In this talk, we will discuss two families of stable operations on elliptic cohomology and topological modular forms. These include stable Adams operations, analogous to those on topological K-theory, and stable Hecke operators, inspired by operations in number theory. We will see in some small examples how homotopy theoretic techniques can be used to perform number theoretic calculations.

Eva Höning (Radboud University, The Netherlands)

Algebraic K-theory of the second truncated Brown–Peterson spectrum

I will explain how to prove a strong form of the redshift conjecture for $BP\langle 2\rangle$ by explicitly computing the mod (p, v_1, v_2) homotopy of its topological cyclic homology. – This is a report on joint work with G. Angelini-Knoll, Ch. Ausoni, D. Culver and J. Rognes.

MINISYMPOSIUM

MS 09 The Future of Digital Infrastructures for Mathematical Research

Organized by Tabea Bacher, Moritz Schubotz, Karsten Tabelow, Olaf Teschke and Thomas Koprucki

As mathematics becomes more and more digital and algorithms, proof assistants, and digital databases become more and more involved in mathematical research, the question arises how to handle this mathematical research data that accumulates alongside a publication; how it can be stored, made accessible, and reused. How can a certain quality be ensured?
These are not easy questions, since mathematical research data is very diverse and infrastructure is just developing. But there are many great ideas and visions in the community that will be highlighted in this Minisymposium. Next generation peer review, the Mathematical Knowledge Graph, repositories for mathematical research data, benchmark services, … to name a few.
Speakers will share their experience with already existing solutions and their visions and plans for how a well-developed integrated infrastructure can further facilitate mathematical research. A focus will be on the Mathematical Research Data Initiative (MaRDI), the NFDI consortium of the mathematical community, that will develop a portal for mathematical research data with many services in the next years.

SESSION 1 _ Tuesday, September 13 _ 10.30–12.30 _ Takustraße 9: SR 005
Chair: Karsten Tabelow

10.30 Moritz Schubotz and Olaf Teschke (FIZ Karlsruhe – Leibniz Institute for Information Infrastructure, Berlin, Germany)
▷ *zbMATH Open as a research data resource*

11.00 Jeroen Hanselman (TU Kaiserslautern and MaRDI, Germany)
▷ *Next generation peer reviewing and MaRDI*

11.30 Joaquin Vanschoren (OpenML)
▷ *Democratizing machine learning research with OpenML*

12.00 Stefan Schmeja (Technische Informationsbibliothek (TIB), Germany)
▷ *No time like the present! TIB's support for mathematics' publishing demands: Open access, affordable, community-owned*

SESSION 2 _ Wednesday, September 14 _ 10.30–12.30 _ Takustraße 9: SR 005
Chair: Tabea Bacher

10.30 Matti Stöhr (TIB – Leibniz Information Centre for Science and Technology and University Library, Germany)
▷ *Mathematical knowledge in videos – experience the TIB's AV-portal for maths*

11.00 Christiane Görgen (Universität Leipzig, Germany)
▷ *MathRepo as an example of a mathematical research-data repository*

11.30 Christian Himpe (University of Münster, Germany)
▷ *The algorithm knowledge graph – a seed for linked math*

12.00 Jens Saak (Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany)
▷ *The benchmark framework – one path to standardized comparison of numerical methods*

ABSTRACTS

Moritz Schubotz and Olaf Teschke (FIZ Karlsruhe – Leibniz Institute for Information Infrastructure, Berlin, Germany)
zbMATH Open as a research data resource

For some time, data from zbMATH Open have been made available through APIs. While there are some limitations, e.g., due to restrictions by licenses imposed by publishers, there are already several projects which successfully employ zbMATH Open data for historical, sociological, or bibliometrics research, as well as a building block of research infrastructures. Moreover, we describe how zbMATH open data will contribute to the broader vision of open and FAIR research data in the context of the National Research Data initiative as well as the European Open Science Cloud. We also discuss how the particularities of mathematics require special treatment and how we design crosswalks to map our custom specifications to standardized data schemata.

Jeroen Hanselman (TU Kaiserslautern and MaRDI, Germany)
Next generation peer reviewing and MaRDI

It is important that results published in papers are understandable and verifiable by other mathematicians. Even if they read them a hundred years from now. If a paper is highly dependent on a software component this may often be difficult. The software could be out of date, very difficult to install or contain bugs that were never checked for. Computed results might not be available anymore or stored in a datatype which no one other than the authors are able to comprehend. As part of the Mathematical Research Data Initiative (MaRDI) I am tasked with developing a peer reviewing system that aims to improve the reusability and reproducibilty of the software component of publications. In this talk I will about recent developments and experiences pertaining this topic.

Joaquin Vanschoren (OpenML)

Democratizing machine learning research with OpenML

Is massively collaborative machine learning possible? Can we share and organize our collective knowledge of machine learning to solve ever more challenging problems? As a community, we are already successful at developing high-quality open-source libraries, thanks to frictionless collaboration platforms for software development. However, code is only one aspect. The answer is much less clear when we also consider the data that goes into these algorithms and the exact models that are produced. A tremendous amount of work and experience goes into the collection, cleaning, and preprocessing of data and the design, evaluation, and finetuning of models, yet very little of this is shared and organized in a way so that others can easily build on it. Suppose one had a global platform for sharing machine learning datasets, models, and reproducible experiments in a frictionless way. OpenML is an open-source initiative to create such a platform. It allows anyone to share datasets, machine learning pipelines, and full experiments, organizes all of it online with rich metadata, and enables anyone to reuse and build on them in novel and unexpected ways. All data is open and accessible through APIs, and it is readily integrated into popular machine learning tools to allow easy sharing of models and experiments. This openness also allows a budding ecosystem of automated processes to scale up machine learning further, such as discovering similar datasets, creating systematic benchmarks, or learning from all collected results how to build the best machine learning models and even automatically doing so for any new dataset. We welcome all of you to become a part of it.

Stefan Schmeja (Technische Informationsbibliothek (TIB), Germany)

No time like the present! TIB's support for mathematics' publishing demands: Open access, affordable, community-owned

Technische Informationsbibliothek (TIB) as the German central library for science and technology offers publishing services for research output in various formats, tailored to the needs of researchers in science and technology. Services include (a) a disciplinary repository for publishing and archiving papers, (b) a portal for publishing scientific videos and (c) a modern publishing platform for journals and conference proceedings. All of these infrastructures are governed by the research community, fulfil open-access demands of funders, operate on a not-for-profit basis and are in line with data protection and privacy legislation. All content is digitally preserved. TIB is also involved in consortial funding models for open-access resources,

enabling sustainable funding for open access infrastructures (e.g., by supporting arXiv) and journals that are free to readers and do not take article processing charges (APC).
We will present different publishing options and also show how researchers – in their role as authors and editors – can easily use these infrastructures according to their needs. We will also address how journals can be "flipped" from a paywalled journal or a journal that takes APCs to an APC-free open-access resource. At TIB we believe that there is no time like the present to support mathematicians in their efforts to publish in a way that serves the community best.

Matti Stöhr (TIB – Leibniz Information Centre for Science and Technology and University Library, Germany)
Mathematical knowledge in videos – experience the TIB's AV-portal for maths

The TIB AV-Portal is a portal for scientific videos from the realms of technology/engineering and sciences, especially mathematics with in this subject at present over 4400 contributions, from over 37 000 videos all in all. Especially in the mathematical context, the following contents could be very interesting for a broader audience of mathematicians – wether if they're researchers or students: (1) visual demonstrations of numerical simulations, (2) video recordings of conference talks, (3) video abtracts for journal submissions, and (4) lecture videos. In this contribution the main features and advantages of finding and using, as well publishing mathematical videos in the TIB AV-Portal are shown, by giving certain examples and demonstrating use cases and workflows. Especially to be emphazised: the opportunities of persistent identifier, content linking as well various automatic video analysis and its values for effective searching and finding relevant content.

Christiane Görgen (Universität Leipzig, Germany)
MathRepo as an example of a mathematical research-data repository

MathRepo, located at `https://mathrepo.mis.mpg.de`, was establish in 2017 at the Max Planck Institute for Mathematics in the Sciences in Leipzig. In this talk I trace its development from the early stages as an ad-hoc solution for code used in the computational Nonlinear Algebra group to the role MathRepo plays in a MaRDI context in 2022. This talk is based on the article "The mathematical research-data repository MathRepo" written by the maintainers of the repository, Claudia Fevola and myself, in 2022. It's been published in the *Computer Algebra Rundbrief*, Nummer 70, with a preprint available here arXiv:2202.04022.

Christian Himpe (University of Münster, Germany)
The algorithm knowledge graph – a seed for linked math

Already for millennia mathematicians construct and document recipes to perform computations, and given the previous centuries and decades, this activity seems to increase exponentially. While this immense wealth of mathematical knowledge is gathered, it is hardly organized and hence barely discoverable. Practically, the following questions become ever more pressing:

- How do research mathematicians keep up with their field?
- How do researcher from other fields find algorithms for their problems?
- How do new PhD students get familiar with the state of the art?

The algorithm knowledge graph demonstrates how this discoverability problem could be overcome, using the semantic technology of linked data. A knowledge graph encodes relations (edges) between objects (nodes). Particularly, the algorithm knowledge graph connects mathematical algorithms with the problems they solve and publications they are documented in. This means, for example, given a numerical problem, all suitable algorithms can be queried; a task that is tedious at best using a full text search. We present the state of the algorithm knowledge graph – a project of the scientific computing task area in the MaRDI NFDI consortium – and discuss long-term sustainability as a community project. – Joint work with René Fritze, Hendrik Kleikamp, Mario Ohlberger, and Stephan Rave.

Jens Saak (Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany)

The benchmark framework – one path to standardized comparison of numerical methods

As computer systems have become more widespread and powerful in recent decades, computer-based experiments have also become increasingly important throughout the sciences. While in computational science and engineering (CSE) it is often the goal to make something formerly inaccessible actually computable, other areas of applied mathematics have opened races for the fastest, most accurate, most simple methods to solve a specific problem. In this, principally, fruitful competition there seems to be a basic agreement of which components have to enter a certain comparison to make it scientifically sound. At the same time, there appears to be little standardization of the actual process. Also, the documentation of the experiments is often patchy at best. Our research attempts to create a general framework consisting of simple modules, describing the required core components of these comparison-experiments in an easy to adapt or extend way. The targeted standard features five basics building blocks:

- the basic loader module fetching the example, or model data from a curated database
- the methods module implementing the interface to the available software for the investigated task
- the driver or executor that, given sets of models and methods, runs the actual experiments
- an evaluation module that compares the results by the desired measures and verifies self assessments of the methods

- the result browser and report generator for post-processing and human interaction with the result data.

We start from simple tasks like the solution of linear systems, advance to the methods of model order reduction for dynamical systems and move to more general settings from there. Our presentation reports on the latest developments. – Joint work with Peter Benner and Kathryn Lund.

MINISYMPOSIUM
MS 10 Locally Convex Methods in Analysis

Organized by Jochen Wengenroth and Thomas Kalmes

Modern aspects of the theory of locally convex spaces provide powerful tools to treat various problems from different fields of analysis such as Complex Analysis, Analysis of Partial Differential Operators, Spaces of (generalized) Functions, (Systems of) Partial Differential Equations, and Harmonic Analysis. The aim of the minisymposium is to present recent results based on abstract functional analytic methods as well as to discuss new trends and topics in locally convex spaces.

SESSION 1 _ Tuesday, September 13 _ 10.30–12.30 _ Arnimallee 6: SR 007–008
Chair: Thomas Kalmes

10.30 Jasson Vindas (Ghent University, Belgium)
▷ *Factorization theorems in Denjoy–Carleman classes associated to representations of* $(\mathbb{R}^d, +)$

11.00 Lenny Neyt (Ghent University, Belgium)
▷ *Weighted (PLB)-spaces of ultradifferentiable functions and multiplier spaces*

11.30 Tomasz Ciaś (Adam Mickiewicz University, Poznań, Poland)
▷ *Structure, classification and representation of Köthe sequence algebras*

12.00 Christian Bargetz (Universität Innsbruck, Austria)
▷ *Sequence space representations of spaces of distributions via Wilson bases*

SESSION 2 _ Wednesday, September 14 _ 10.30–12.30 _ Arnimallee 6: SR 007–008
Chair: Jochen Wengenroth

10.30 Enrique Jordá (Universitat Politècnica de València, CIF-ESQ4618002B, Spain)
▷ *Uniformly ergodic and completely mixing measures*

11.00 Adam Przestacki (Adam Mickiewicz University, Poznań, Poland)
▷ *The invariant subspace problem for the space of smooth functions on the real line*

11.30 Sven-Ake Wegner (Universität Hamburg, Germany)
▷ *The heart of the Banach spaces*

12.00 Andreas Debrouwere (Vrije Universiteit Brussel, Belgium)
▷ *Linear topological invariants for kernels of convolution and differential operators*

ABSTRACTS

Jasson Vindas (Ghent University, Belgium)

Factorization theorems in Denjoy–Carleman classes associated to representations of $(\mathbb{R}^d, +)$

The purpose of this talk is to discuss a strong factorization theorem of Dixmier–Malliavin type for ultradifferentiable vectors associated to broad classes of representations of $(\mathbb{R}^d, +)$ on sequentially complete locally convex Hausdorff spaces. We employ our results to show that various convolution algebras and modules of ultradifferentiable functions commonly occurring in analysis satisfy the strong factorization property. In general, a module $\mathcal{M}$ over a non-unital algebra $\mathcal{A}$ is said to have the *strong* factorization property if $\mathcal{M} = \{a \cdot m \,|\, a \in \mathcal{A}, m \in \mathcal{M}\}$. – The talk is based on collaborative work with Andreas Debrouwere and Bojan Prangoski.

Lenny Neyt (Ghent University, Belgium)

Weighted (PLB)-spaces of ultradifferentiable functions and multiplier spaces

(PLB)-spaces, i.e., countable intersections of countable unions of Banach spaces, arise naturally in functional analysis. Classical examples are the space of distributions, the space of real analytic functions and the space of multipliers of the Schwartz space. In order to be able to apply functional analytic tools such as De Wilde's open mapping and closed graph theorems or the theory of the derived projective limit functor, it is important to determine when such spaces are ultrabornological. Note that this is a non-trivial matter as the projective limit of a spectrum of ultrabornological spaces is not necessarily again ultrabornological. In a series of two papers we showed a full characterization of when weighted (PLB)-spaces of ultradifferentiable functions are ultrabornological in terms of the defining weight system by using tools from time-frequency analysis. This generalizes Grothendieck's classical result that the space of slowly increasing smooth functions is ultrabornological to the context of ultradifferentiable functions. Furthermore, we determined the multiplier spaces of the Gelfand-Shilov spaces and, by using the above result, characterized when such spaces are ultrabornological. In particular, we obtained that the multiplier space of the Gelfand–Shilov space $\Sigma^r_s(\mathbb{R}^d)$ of Beurling type is ultrabornological, whereas the one of the Gelfand-Shilov space $\mathcal{S}^r_s(\mathbb{R}^d)$ of Roumieu type is not. In this talk we will give an overview of these results. – The talk is based on collaborative works with Andreas Debrouwere.

Tomasz Ciaś (Adam Mickiewicz University, Poznań, Poland)

Structure, classification and representation of Köthe sequence algebras

It turns out that many Köthe sequence spaces $\lambda_p(A)$ – when endowed with pointwise multiplication – are Fréchet algebras. Although Köthe sequence algebras has been investigated in various contexts by, for example, Subbash J. Bhatt and Alexei Yu. Pirkovskii, there was a lack of comprehensive study of these algebras. In the preliminary part of this talk, we characterize those Köthe matrices for which the corresponding Köthe algebra shares "good" properties such as m-convexity or the Q-property. Closed ideals and subalgebras are described. We also show connections of nuclear m-convex biprojective Köthe algebras with the algebra of smoothing operators and with the quasi-equivalence problem for bases in nuclear Fréchet spaces. – The talk is based on the joint work with Krzysztof Piszczek.

Christian Bargetz (Universität Innsbruck, Austria)

Sequence space representations of spaces of distributions via Wilson bases

We present a common unconditional Schauder bases for many spaces of smooth functions and distributions. This basis is a Wilson basis generated by a compactly supported smooth window. Using this basis we are able to show that the Valdivia–Vogt tables of sequence space representations of spaces of smooth functions and distributions can be interpreted as one large commutative diagram. – This is joint work with Andreas Debrouwere and Eduard Nigsch.

Enrique Jordá (Universitat Politècnica de València, CIF-ESQ4618002B, Spain)

Uniformly ergodic and completely mixing measures

Let G be a locally compact group. A probabilty measure on G is said to be:
(a) ergodic: if $\sum_{k=1}^{n} mu^k * f/n$ converges to 0 in $L_1(F)$ for all $f \in L_1(G)$ such that $\int f dm_G = 0$;
(b) completely mixing: if $mu^n * f$ is convergent to 0 for all $f \in L_1(G)$ such that $\int f dm_G = 0$.
Motivated by these classical definitions, we investigate when the convolution operator defined on $L_1^0(G) := \{f \in L_1(G) : \int f dm_G = 0\}$ is uniformly mean ergodic and when it posseses a norm convergent sequence of iterates, relating this with the behaviour of the corresponding operator on $L_1(G)$. We characterize completely when this happens in case G is abelian. – We report on ongoing joint work with J. Galindo and A. Rodríguez-Arenas.

Adam Przestacki (Adam Mickiewicz University, Poznań, Poland)

The invariant subspace problem for the space of smooth functions on the real line

Let X be a locally convex space. The invariant subspace problem is the question if every continuous linear operator $T : X \to X$ has a non-trivial invariant subspace, i.e., if there exists a closed subspace $0 \subsetneq H \subsetneq X$ such that $T(H) \subset H$.The case of the separable Hilbert space has been studied by multiple authors and is one of the most important open problems in operator theory. In the Banach space setting the first counterexamples to the invariant subspace problem were constructed by P. Enflo and C. Read in the 1980s. A. Atzmon constructed an operator on a nuclear Fréchet space (with a continuous norm) without non-trivial invariant subspaces. M. Goliński was able to modify Read's construction in order to obtain such operators for many classical Fréchet spaces including the space of holomorphic functions on the unit disc and the space of rapidly decreasing sequences s. The construction required the existence of a continuous norm on the underlying space. During the talk I will describe how to construct an operator without a non-trivial invariant subspace acting on the space of smooth functions on the real line. This is a first example of such an operator acting on a natural Fréchet space without a continuous norm. – The results presented during the talk were obtained jointly with M. Goliński.

Sven-Ake Wegner (Universität Hamburg, Germany)

The heart of the Banach spaces

Let X be a Banach space and let Y be a subspace. If Y is closed in X then X/Y is a Banach space in the quotient norm. If Y is not closed, then this is wrong, even if Y is a Banach space in a stronger norm (example: $X = c_0$ and $Y = l^1$). The fact, that there is no reasonable Banach space X/Y in the setting above, motivated Waelbroeck in the 1960s to consider 'formal quotients' instead. In 1982 Beilinson, Bernstein, Deligne defined 'hearts of t-structures' on triangulated categories. It turns out that in the special case of Banach spaces, their heart is precisely the category of formal quotients considered by Waelbroeck.
In the talk we sketch an explicit approach to the heart and discuss generalizations beyond the case of Banach spaces, namely to several categories of locally convex spaces. The results are based on [1, 2, 3].

References

[1] R. Henrard, S. Kvamme, A-C. van Roosmalen and S.-A. Wegner, The left heart and exact hull of an additive regular category. To appear in *Rev. Mat. Iberoam.*, arXiv:2105.11483.

[2] M. Lawson and S.-A. Wegner, The category of Silva spaces is not integral. To appear in *Homology, Homotopy and Applications*, arXiv:2107.13901.

[3] S.-A. Wegner, The heart of the Banach spaces. *J. Pure Appl. Algebra* 221 (2017), no. 11, 2880–2909.

Andreas Debrouwere (Vrije Universiteit Brussel, Belgium)

Linear topological invariants for kernels of convolution and differential operators

We give an overview of known results and open problems concerning linear topological invariants for smooth and distributional kernels of convolution and differential operators. Furthermore, we explain the intimate connection of this topic with the problem of parameter dependence of solutions of such operators.

MINISYMPOSIUM
MS 11 Algebra and Low-Dimensional Topology

Organized by Paul Wedrich and Claudius Zibrowius

The aim of this minisymposium is two-fold. First and foremost, we want to bring talented young researchers into contact with more experienced mathematicians from Germany and abroad in order to facilitate a direct exchange of ideas between different generations. The second goal is to advertise some of the very exciting recent developments at the interface of algebra and low-dimensional topology, especially in the area of link homology theories and categorification, to the wider German mathematical community. We believe that this minisymposium would complement the planned sections very well and would be of interest also to a wider audience of researchers in pure mathematics.

SESSION 1 _ Friday, September 16 _ 10.30–12.30 _ Takustraße 9: SR 046
Chair: Claudius Zibrowius

10.30 Catharina Stroppel (Universität Bonn, Germany)
▷ *Fukaya categories from representation theory*

11.00 Isaac Sundberg (Max Planck Institute for Mathematics, Bonn, Germany)
▷ *Khovanov homology and uniqueness of surfaces in the 4-ball*

11.30 Laura Marino (University Paris Cité, France)
▷ *Khovanov homology and rational unknotting*

12.00 Dirk Schütz (Durham University, United Kingdom)
▷ *Second Steenrod squares for odd Khovanov homology*

SESSION 2 _ Friday, September 16 _ 15.30–17.30 _ Takustraße 9: SR 046
Chair: Paul Wedrich

15.30 Ikshu Neithalath (University of Southern Denmark, Denmark)
▷ *Skein lasagna modules*

16.00 Paula Truöl (ETH Zürich, Switzerland)
▷ *Strongly quasipositive knots are concordant to infinitely many strongly quasipositive knots*

16.30 David Reutter (Universität Hamburg, Germany)
▷ *Semisimple topological quantum field theories detect stable diffeomorphism*

ABSTRACTS

Stroppel, Catharina (Universität Bonn, Germany)

Fukaya categories from representation theory

Khovanov homology can be constructed using quite different tools. In particularl there exists representation theoretic and symplectic geometric constructions involving Fukaya categories associated with nilpotent slices. I will briefly recall some of this, but then focus on giving a representation theoretic approach to these Fukaya categories. The talk will be a combination of a short summary and new joint results with Jens Eberhardt connecting Floer homology with cohomology of Richardson varieties which I will explain in detail.

Isaac Sundberg (Max Planck Institute for Mathematics, Bonn, Germany)

Khovanov homology and uniqueness of surfaces in the 4-ball

Khovanov homology produces an invariant of links in 3-space and surfaces in 4-space. In this talk, we discuss recently developed techniques that use Khovanov homology to distinguish non-isotopic families of surfaces in the 4-ball, including families of exotic slice disks and (pushed in) Seifert surfaces. – Joint work with Kyle Hayden (Columbia University, USA), Maggie Miller (Stanford University and Clay Mathematics Institute, USA), Seungwon Kim (Seoul National University, Korea), and JungHwan Park (Korea Advanced Institute of Science and Technology).

Laura Marino (University Paris Cité, France)

Khovanov homology and rational unknotting

Khovanov homology is a powerful link invariant introduced around 2000 as a categorification of the Jones polynomial. Although combinatorially defined, it contains significant topological information about the links it is associated to. In this talk, we use a universal version of Khovanov homology to extract a new knot invariant λ. We show that λ is a lower bound for the proper rational unknotting number, the minimal number of connectivity preserving rational tangle replacements needed to make a knot trivial. In particular, *lambda* is a lower bound for the unknotting number. – This is joint work with Damian Iltgen and Lukas Lewark (University of Regensburg, Germany).

Dirk Schütz (Durham University, United Kingdom)

Second Steenrod squares for odd Khovanov homology

We use a simplification of framed flow categories to define second Steenrod squares on odd Khovanov homology and make explicit calculations. We also obtain a refinement of the mod 2

Rasmussen invariant following work of Lipshitz–Sarkar. We also conjecture a close relationship to the stable homotopy type for odd Khovanov homology recently constructed by Sarkar–Scaduto–Stoffregen.

Ikshu Neithalath (University of Southern Denmark, Denmark)

Skein lasagna modules

Morrison, Walker and Wedrich defined a generalization of Khovanov–Rozansky homology to links in the boundary of a 4-manifold. We will discuss joint work with Ciprian Manolescu on the "skein lasagna module", a basic part of MWW's invariant, for a certain class of 4-manifolds. We will also discuss work in progress, joint with Paul Wedrich, on calculations of the invariant.

Paula Truöl (ETH Zürich, Switzerland)

Strongly quasipositive knots are concordant to infinitely many strongly quasipositive knots

We show that every non-trivial strongly quasipositive knot is smoothly concordant to infinitely many pairwise non-isotopic, strongly quasipositive knots. In contrast to our result, Baader, Dehornoy and Liechti showed that every (topologically locally-flat) concordance class contains at most finitely many positive knots. Moreover, it was conjectured by Baker that smoothly concordant strongly quasipositive and fibered knots are isotopic. Our construction uses a satellite operation with companion a slice knot with maximal Thurston–Bennequin number -1.

David Reutter (Universität Hamburg, Germany)

Semisimple topological quantum field theories detect stable diffeomorphism

A major open problem in quantum topology is the construction of an oriented 4-dimensional topological quantum field theory (TQFT) in the sense of Atiyah–Segal which is sensitive to exotic smooth structure. More generally, how much manifold topology can a TQFT see?
In this talk, I will answer this question for even-dimensional field theories fulfilling a certain algebraic condition – semisimplicity. This includes all currently known examples of linear algebraic TQFTs, including "unitary field theories" and "once-extended field theories", which also assign algebras, or linear categories, to codimension 2 corners. The representation-theoretic property "semisimplicity" turns out to be surprisingly closely related to the topological notion of "stable diffeomorphism": I will outline a proof that semisimple theories can at most see the stable diffeomorphism type of a manifold and conversely, that if two sufficiently finite manifolds are not stably diffeomorphic, then they can be distinguished by semisimple field theories. I will discuss implications, such as the fact that in four dimensions, oriented semisimple field theories cannot see smooth structure, while unoriented ones

sometimes can. This is based on arXiv:2001.02288 and arXiv:2206.10031. – Joint work with Christopher Schommer-Pries (University of Notre Dame, IN, USA).

MINISYMPOSIUM
MS 12 Higher Differential Geometry

Organized by Matthias Ludewig and Konrad Waldorf

Higher Differential Geometry is a relatively new area of mathematics, which investigates differential-geometric structures of a higher-categorical flavor. Examples are stacks, bundle gerbes, Lie groupoids or principal bundles for categorical groups. The higher-categorical nature of these objects shows up by the fact that their automorphisms themselves have automorphisms, and that these higher-order automorphisms encode important information. In the last decades, it turned out that such objects naturally appear in various areas of geometry, such as index theory, gauge theory, tangential structures, loop spaces, as well as in mathematical physics. In particular, Higher Differential Geometry is a key ingredient of Functorial Field Theory, a recent new approach to understand quantum field theories from a general foundational point of view. This minisymposium aims at bringing together researchers working on different aspects of Higher Differential Geometry and Functorial Field Theory.

SESSION 1 _ Thursday, September 15 _ 15.30–17.30 _ Takustraße 9: SR 006
Chair: Matthias Ludewig

15.30 Gerd Laures (Ruhr-University Bochum, Germany)
▷ *Infitesimal loop bundles, lattice algebras and elliptic objects*

16.30 Christian Blohmann (Max-Planck-Institut für Mathematik, Bonn, Germany)
▷ *Differentiation of higher diffeological groupoids*

17.00 Severin Bunk (University of Oxford, UK)
▷ *Moduli of connections on gerbes and Courant algebroids*

SESSION 2 _ Friday, September 16 _ 15.30–17.30 _ Takustraße 9: SR 006
Chair: Konrad Waldorf

15.30 Bas Janssens (Technische Universiteit Delft, The Netherlands)
▷ *Localization for positive energy representations of gauge groups*

16.00 Lukas Müller (Max Planck Institute for Mathematics, Bonn, Germany)
▷ *Higher differential geometric aspects of anomalies in quantum field theories*

ABSTRACTS

Gerd Laures (Ruhr-University Bochum, Germany)

Infitesimal loop bundles, lattice algebras and elliptic objects

We construct an infitesimal version of the ring of smooth functions on the free loop space. The chiral de Rham complex provides an example for the associated bundles. When taking into acount the action of a vertex algebra associated to a certain lattice, these objects may give models for the cocycles in elliptic cohomology.

Christian Blohmann (Max-Planck-Institut für Mathematik, Bonn, Germany)

Differentiation of higher diffeological groupoids

Higher diffeological groupoids appear in various areas of mathematics, such as infinite-dimensional Lie theory, field theory, deformation theory, and moduli spaces. The category of diffeological spaces, however, is not equipped with the differential calculus needed for the differentiation of groupoids. In a first step, I will identify the largest category of diffeological spaces, called elastic, on which the left Kan extension of the tangent functor is an abstract tangent structure in the sense of Rosicky. Then I will reformulate the idea of Severa to differentiate higher groupoids and generalize it to this setting. This yields the construction of a kind of higher Lie algebroid which can be expressed concisely as a categorical end over the simplex category. – This is joint work with Lory Kadiyan.

Bunk, Severin (University of Oxford, UK)

Moduli of connections on gerbes and Courant algebroids

Gerbes and higher gerbes are categorified versions of line bundles. They provide geometric models for the higher (differential) cohomology groups of the manifold they live on. Connections on a gerbe consist of pairs (A, B) of locally defined 1- and 2-forms. In higher geometry, this is widely seen as a model for the B-field in string theory. The 2-group of automorphisms of the gerbe acts on the pairs (A, B) as gauge transformations, giving rise to a moduli stack of B-fields. In generalised geometry, however, the B-field is modelled using splittings of a Courant algebroid, cosntructed from the gerbe G and a fixed choice of local 1-forms A. The 2-group of automorphisms of (G, A) acts on these splittings, giving rise to another candidate for the moduli stack of B-fields. In the above two set-ups, the 'B-fields' as well as their gauge transformations are genuinely different. Nevertheless, in this talk I will present comparison results for the resulting moduli stacks. – This is joint work with Carlos Shahbazi.

Bas Janssens (Technische Universiteit Delft, The Netherlands)

Localization for positive energy representations of gauge groups

We study projective unitary representations of the (infinite dimensional) group of gauge transformations that are equivariant under a specified group of space-time symmetries. We show that if every timelike translation gives rise to a Hamilton operator with nonnegative spectrum (the positive energy condition), then the gauge group representation localizes at fixed points and 1-dimensional orbits of the group of space-time symmetries. In particular, positive energy representations over compactified Minkowski space automatically localize at conformal infinity.– This is joint work with Karl-Hermann Neeb (FAU Erlangen-Nürnberg, Germany).

Lukas Müller (Max Planck Institute for Mathematics, Bonn, Germany)

Higher differential geometric aspects of anomalies in quantum field theories

Anomalies are a feature of quantum field theories with deep connections to differential geometry and in particular index theory. In my talk, I will discus the higher geometric aspects of their description, new higher geometric tools to study them, and some open questions. – The talk is partially based on joint work with Severin Bunk and Richard Szabo.

MINISYMPOSIUM

MS 13 What are Lectures in Mathematics and What Should They Be?

Organized by Thomas Skill

The borrowing of the title, which is based on Dedekind, shows the direction of the minisymposium. Only the format of a classical lecture is now in question. First, after an input presentation, the participants should work out in groups what they understand by lectures and their objectives. The respective results are presented and discussed in the plenum. The past online-semesters have made it clear that while face-to-face teaching is necessary, it should also be used in a special way. Therefore, ideas and concepts will be presented in input presentations on inverted classrooms and digital teaching. Following this, groups of participants should analyze which parts actually require presence, with which goals and how this part can then be designed. But it should also be developed how and with which purpose the “digital” part and can be implemented.

SESSION 1 _ Tuesday, September 13 _ 10.30–12.30 _ Arnimallee 6: SR 025–026

Chair: Thomas Skill

The talks in this minisymposium will be given in German, and the organisers would expect that the participants are present for the entire duration of the minisymposium.

10.30 Frank Feudel and Luise Fehlinger (Humboldt-Universität zu Berlin, Germany)
▷ *Using a lecture-oriented flipped classroom in a proof-oriented Analysis I course*

10.50 Martin Pohl (OTH Regensburg, Deutschland)
▷ *Vergleich des Lernfortschritts bei traditionellen und aktivierenden Lehrmethoden*

11.10 Reflexions-/Arbeitsphase

11.30 Daniel Grieser (Carl von Ossietzky Universität Oldenburg, Germany)
▷ *Forschendes Lernen in der Vorlesung: Geht das?*

11.50 Reflexions-/Arbeitsphase

12.10 Diskussion

ABSTRACTS

Frank Feudel and Luise Fehlinger (Humboldt-Universität zu Berlin, Germany)

Using a lecture-oriented flipped classroom in a proof-oriented Analysis I course

The didactic literature suggests that many students might benefit from a flipped classroom in undergraduate mathematics courses. In this format, students' first contact with new content takes place before class, for example on the basis of videos or a script. The lecture time is then used for activities that should help students to make sense of this content, for example in group discussions. In proof-oriented courses, however, the content is often so difficult that it is hard for students to elaborate the content in class without a strong input from the lecturer. We therefore implemented a lecture-oriented version of the flipped classroom into an Analysis I course. This adaption tried to combine advantages of the flipped classroom and a classical lecture given by an expert in mathematics, who is able to bring out the core ideas behind the formal content. In the talk, we want to discuss potentials of this flipped classroom adaption, illustrate our implementation, and show some empirical results concerning the question to what extent this approach was actually useful to address typical problems that occur in traditional mathematics lectures.

Martin Pohl (OTH Regensburg, Deutschland)

Vergleich des Lernfortschritts bei traditionellen und aktivierenden Lehrmethoden

Meine Analysis-Lehrveranstaltungen führte ich früher im traditionellen Stil durch. Im Laufe der Zeit habe ich vermehrt verschiedene aktivierende Lehrmethoden eingesetzt – von hands-on Aktivitäten und 5-Minute Papers bis hin zu Just-in-Time-Teaching und Peer Instruction. Zur Beurteilung der Wirksamkeit der verschiedenen Lehrmethoden habe ich den Lernfortschritt der Studierenden mit dem Calculus Concept Inventory (CCI) ermittelt.

Die Ergebnisse der Daten aus fünf Semestern liefern ein starkes Indiz dafür, dass in Lehrveranstaltungen mit aktivierenden Lehrmethoden ein höherer Lernzuwachs erzielt wird als in traditionellen durchgeführten Lehrveranstaltungen. Darüber hinaus zeigt sich, dass die Art der Hochschulzugangsberechtigung der Studierenden einen starken Einfluss auf den erzielten Lernzuwachs hat.

I used to lecture calculus classes in a traditional way. Over time I have introduces different activating teaching methods – from hands-on activities and 5-minute papers to just-in-time teaching and peer instruction. To compare the outcome of these teaching methods, I determined the learning progress of the students using the Calculus Concept Inventory (CCI).

The evaluation of the collected data provides strong evidence that active learning environments result in higher student performance compared with traditional teaching methods. In addition, it turns out that the type of university entrance qualification of the students has a strong influence on the learning gain.

Daniel Grieser (Carl von Ossietzky Universität Oldenburg, Germany)
Forschendes Lernen in der Vorlesung: Geht das?

Das Schlagwort ‚Forschendes Lernen' (Inquiry based learning) erfährt seit einigen Jahren eine hohe Aufmerksamkeit, und Lehrende an Hochschulen sind angehalten, hier Angebote zu machen. Gleichzeitig ist die Vorlesung im Mathematik-Studium nach wie vor die vorherrschende Lehrform, und dafür gibt es gute Gründe. Kann das zusammenpassen, oder muss des ‚forschende Lernen' ausschließlich außerhalb der Vorlesungen stattfinden? In diesem Kurzvortrag werde ich einige persönliche Versuche und Erfahrungen mit diesem Thema vorstellen, die hoffentlich zu einer interessanten Diskussion während des Minisymposiums beitragen.


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