MATH+

Opening Conference

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Varieties, Polyhedra, Computation

Freie Universität Berlin

Technische Universität Berlin

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Freie Universität Berlin

07th - 11th October 2019

Semester Organizers

Peter Bürgisser, Technische Universität Berlin
Gavril Farkas, Humboldt Universität zu Berlin
Christian Haase, Freie Universität Berlin

Conference Organizers

Mario Kummer, Technische Universität Berlin
Angela Ortega, Humboldt Universität zu Berlin
Andrea Petracci, Freie Universität Berlin
Karin Schaller, Freie Universität Berlin

Speakers

Daniele Agostini, HU Berlin
Omid Amini, École Polytechnipue
Alexander Bobenko, TU Berlin
Felipe Cucker, TU Berlin
Jan Draisma, U Bern
Mathias Drton, TU München
Michael Joswig, TU Berlin
Kaie Kubjas, Aalto U Helsinki
Pierre Lairez, INRIA
Laurent Manivel, U Toulouse
Francisco Santos, U de Cantabria
Reinhold Schneider, TU Berlin
Rainer Sinn, FU Berlin
Orsola Tommasi, U Padova
Timo de Wolff, TU Braunschweig

What is ...? Speakers

Carlos Amendola, TU München
Dominic Bunnett, TU Berlin
Janin Heuer, TU Braunschweig
Jean-Philippe Labbé, FU Berlin
Josué Tonelli-Cueto, TU Berlin

Schedule

	Monday 07.10.2019	**Tuesday** 08.10.2019	**Wednesday** 09.10.2019	**Thursday** 10.10.2019	**Friday** 11.10.2019
09 :00-09 :30	Registration				
09 :30 - 10 :00	What is ...? **J. Tonelli-Cueto**	What is ...? **Janin Heuer**	What is ...? **C. Amendola**	What is ...? **D. Bunnett**	What is ...? **J.-P. Labbé**
10 :00 - 10 :30	**Felipe Cucker**	**Jan Draisma**	**Daniele Agostini**	**Orsola Tommasi**	**Francisco Santos**
10 :30 - 11 :00					
11 :00 - 11 :30	Coffee Break				
11 :30 - 12 :00	**Reinhold Schneider**	**Rainer Sinn**	**Mathias Drton**	**Omid Amini**	**Laurent Manivel**
12 :00 - 12 :30					
12 :30 - 13 :30	Lunch				
13 :30 - 14 :30					
14 :30 - 15 :00	**Pierre Lairez**	**Timo de Wolff**		**Michael Joswig**	
15 :00 - 15 :30					
15 :30 - 16 :00	Poster Session and Finger Food	Coffee Break		Coffee Break	
16 :00 - 16 :30		**Kaje Kubjas**		**Alexander Bobenko**	
16 :30 - 17 :00					
17 :00 - 17 :30					
17 :30 - 18 :00					
19 :00				Conference Dinner	

Talks

09.10.
10:00

Daniele Agostini, HU Berlin
Moment Identifiability of Homoscedastic Gaussian Mixtures.

In this talk, we consider the problem of identifying a mixture of Gaussian distributions with same unknown covariance matrix by their sequence of moments up to certain order. Our approach rests on studying the moment varieties obtained by taking special secants to the Gaussian moment varieties, defined by their natural polynomial parametrization in terms of the model parameters. This is joint work with Carlos Améndola and Kristian Ranestad.

10.10.
11:30

Omid Amini, École Polytechnique
Hodge isomorphism for matroids.

We show that the cycle class map from the Chow ring of a matroid to the tropical cohomology groups of the wonderful compactification of the Bergman fan induces an isomorphism of rings. We then discuss connection to the work of Adiprasito, Huh and Katz on log-concavity of the coefficients of the characteristic polynomials. Joint work with Matthieu Piquerez.

10.10.
16:00

Alexander Bobenko, TU Berlin
Discrete Riemann Surfaces. Periods and Convergence.

We present a linear theory of discrete Riemann surfaces based on the notion of discrete holomorphicity. Discrete (multi-valued) harmonic and holomorphic functions and period matrices are defined.We prove that the discrete period matrices and the Abel map converge to their continuous counterparts. Numerical results are demonstrated for polyhedral surfaces, ramified coverings, and some classical Riemann surfaces.

07.10.
10:00

Felipe Cucker, TU Berlin
Condition and semialgebraic geometry.

We overview several geometric features of semialgebraic sets for which a quantitative aspect relates to the condition of the descriotion of the set.

08.10.
10:00

Jan Draisma, U Bern
The coarse structure of GL_∞***-varieties.***

A (n affine) GL_∞-variety over $\mathbb{C}$ is a closed, GL_∞-stable subset of the inverse limit P_∞ of the $P(\mathbb{C}^n)$, where P is a fixed Schur functor. For example, for $P = S^2$, P_∞ is the space of symmetric infinite-by-infinite matrices. In this example, a matrix either has finite rank k, in which case it lies in the image of the smaller Schur functor $(S^1)^k$ under the morphism $(v_1, ..., v_k) \to v_1^2 + ... + v_k^2$ of GL_∞-varieties; or else its orbit is dense in P_∞. In particular, every GL_∞-variety in S^2 is an orbit closure. In ongoing work with Arthur Bik, Rob Eggermont, and Andrew Snowden we generalise this dichotomy to other Schur functors. Among other things, we prove that any GL_∞-variety in any P_∞ is the closure of a finite-dimensional family of orbits. We also prove a

version of Chevalley's theorem on constructible sets, which implies that membership in the image of a fixed GL_∞-morphism can be tested deterministically in polynomial time.

09.10.
11:30

Mathias Drton, TU München
Maximum likelihood thresholds for covariance matrices with Kronecker product structure.

The matrix normal model is a statistical model that assumes multivariate data to be generated from a Gaussian distribution whose covariance matrix is the Kronecker product of two positive definite matrices. Prior work shows that maximum likelihood estimators (MLEs) in these models may exist for surprisingly small sample sizes. We formulate algebraic conditions for existence of the MLE and show that in special cases the normal form for matrix pencils can be leveraged to derive the precise sample size needed for almost sure existence. (joint work with Satoshi Kuriki)

10.10.
14:30

Michael Joswig, TU Berlin
The Schläfli Fan.

Smooth tropical cubic surfaces are parametrized by maximal cones in the unimodular secondary fan of the triple tetrahedron. There are 344843867 such cones, organized into a database of 14373645 symmetry classes. The Schläfli fan gives a further refinement of these cones. It reveals all possible patterns of the 27 or more lines on tropical cubic surfaces, thus serving as a combinatorial base space for the universal Fano variety. This article develops the relevant theory and offers a blueprint for the analysis of big data in tropical algebraic geometry. We conclude with a sparse model for cubic surfaces over a field with valuation. Joint work with Marta Panizzut and Bernd Sturmfels.

08.10.
16:00

Kaie Kubjas, Aalto U Helsinki
Maximum likelihood estimation of toric Fano varieties.

Maximum likelihood estimation aims to find a point of a statistical model that best explains observational data. We study the maximum likelihood (ML) estimation problem for toric Fano varieties. First we show that with one exception for all 2-dimensional Gorenstein toric Fano varieties the ML degree equals the degree of the variety and we provide expressions that allow to compute the maximum likelihood estimate in the closed form. We then explore the reasons for ML degree drop using A-discriminants and intersection theory. Finally we show that varieties associated to 3-valent phylogenetic trees and known from the work of Buczynska and Wisniewski have ML degree one. This follows from a more general result on the multiplicativity of ML degrees of codimension zero toric fiber products.

Pierre Lairez, INRIA 07.10. 14:30

Numerical periods in effective algebraic geometry.

Thanks to several recent progress, we can now compute the periods of quartic surfaces to arbitrary precision, and consequently many algebraic invariants: Picard group, endomorphism ring, number of embedded smooth rational curve of a given degree, etc. We start compiling a database of K3 surfaces with their invariants. This talk will aim at a hands-on presentation of the tools involved and a presentation of several examples of the database. Joint work with Emre Sertöz.

Laurent Manivel, U Toulouse 11.10. 11:30

On the geometry of skew-symmetric three-forms.

There has been a huge activity in the last decades around the geometry of tensors, with all kinds of potential applications. In this talk I will concentrate on skew-symmetric three-forms. In low dimensions, up to eight, there exist only finitely many types of such forms. The critical dimensions are nine and ten, for which extremely rich geometries emerge.

Francisco Santos, U de Cantabria 11.10. 10:00

Width of lattice polytope.

Hollow polytopes (that is, polytopes with no interior lattice points) are important both in algebraic geometry and integer optimization. One of their most important invariants is their lattice width which, by the "flatness theorem" is bounded in fixed dimension. We will review several recent results related to the width of lattice polytopes. Among them:

- we look at how to construct hollow polytopes of width larger than their dimension, trying to improve lower bounds on the flatness constant.
- we conjecture that the tight upper bound for the width of hollow convex bodies in dimension three is $2+\sqrt{2}$, attained by a certain tetrahedron.
- we show how width can be used as a tool to classify lattice polytopes. Eg: In dimension three there are finitely many (perhaps non-hollow) lattice polytopes of width larger than one for each number of lattice points. In dimension four, there are finitely many empty simplices of width larger than two, which has been used to completely classify empty 4-simplices (equivalently, to classify terminal quotient singularities of dimension four).

Reinhold Schneider, TU Berlin 07.10. 11:30
Variational Monte Carlo - theoretical bridge between numerics and statistical learning.

For solving high-dimensional PDE's numerically, we cast them into a variational framework. For computational purpose the objective functional is restricted to appropriate possibly nonlinear and even non-convex model classes. In Variational Monte Carlo the objective functional is replaced by an empirical (surrogate) functional, in a sim- ilar way as for risk minimization or loss functions in statistical learn- ing. We want to consider convergence in probability based on restricted isometry property (RIP).

Rainer Sinn, FU Berlin 08.10. 11:30
Sums of Squares and Projective Varieties.

Writing a real polynomial p as a sum of squares of polynomials is a certificate of positivity for p that is exploited in polynomial optimization because of its connections to the feasibility problem in semidefinite programming via the Gram map. The Gram map naturally generalizes to the context of real projective varieties, where sums of squares certify nonnegativity of homogeneous elements of even degree in the homogeneous coordinate rings. I will report on surprising connections between sums of squares and invariants of (embedded) projective varieties.

Orsola Tommasi, U Padova 10.10. 10:00
Local systems on M_2 and the top weight cohomology of $M_{2,n}$.

The moduli space $M_{g,n}$ of smooth n-pointed complex curves of genus g is a classical object of study in algebraic geometry. However, its topological invariants are still not well-known. If one looks at the cohomology of $M_{g,n}$, the best known part is the so-called tautological subring, which is generated by geometrically natural classes. However, recent work by Chan, Galatius and Payne highlighted the importance of a completely different part of cohomology: its top weight part, defined using mixed Hodge structures. This top weight part turns out to be quite combinatorial in nature because of its relationship with tropical geometry. In this talk, I would like to present an alternative approach to the study of the top weight cohomology for genus $g = 2$, using local systems. This is joint work (in progress) with Dan Petersen.

Timo de Wolff, TU Braunschweig 08.10. 14:30
Nonnegativity, Discriminants, and Tropical Geometry.

Certifying nonnegativity of real, multivariate polynomials is a key problem in real algebraic geom- etry since the 19th century. In the 21st century, the problem gained significant momentum due to its relevance in polynomial optimization.

Let $\mathbb{R}^A$ denote the space of all real polynomials with support $A \subset \mathbb{N}^n$. We study certficates called (sums of) nonnegative circuit polynomials (SONC) or agiforms, which can be obtained

from the inequality of arithmetic and geometric means. SONCs form a full dimensional subcone S of the cone of nonnegative polynomials in $\mathbb{R}^A$. In particular, S is not contained the cone of sums of squares.

We describe the boundary of the cone S as a space stratified in real semi-algebraic varieties. In order to describe the single strata, we will go on an exploration through the mathematical universe on which we will encounter discriminants, polytopes and their triangulations, and tropical geometry.

This is joint work with Jens Forsgård.

What is ...? Talks

09.10.
09:30

Carlos Amendola, TU München
What is estimation for Gaussian models?

The multivariate Gaussian distribution is fundamental in statistics. In this talk I will introduce two methods for estimating parameters: maximum likelihood and method of moments. Then I will present examples of how these apply to Gaussian covariance models and Gaussian mixture models.

10.10.
09:30

Dominic Bunnett, TU Berlin
What is $M_{g,n}$?

$M_{g,n}$ is an algebraic variety which parameterises isomorphism classes of smooth curves of genus g and n marked points. The study of $M_{g,n}$ goes back to Riemann in 1857 and has been an object of study ever since, although the first rigorous construction is due to Mumford in 1965. We give a gentle introduction to the construction of $M_{g,n}$ and the techniques used to study its geometry.

08.10.
09:30

Janin Heuer, TU Braunschweig
What is a Nonnegativity Certificate?

Mathematicians have been studying nonnegativity of real polynomials since as early as the 19th century. Nonnegativity certificates are an important tool in these investigations, giving easier to check, sufficient conditions for nonnegativity.
In this talk we will motivate the study of nonnegativity by relating it to polynomial optimization. Furthermore, we will define the nonnegativity certificates sums of squares (SOS) and sums of nonnegative circuit polynomials (SONC).

11.10.
09:30

Jean-Philippe Labbé, FU Berlin
What is a Toric Variety in the eye of a Discrete Geometer?

This talk will present a few translations from the Toric Geometry ↔ Discrete Geometry dictionary. Namely, we will see how to view a toric variety and its singularities using polyhedral cones and lattice polytopes and their properties.

07.10.
09:30

Josué Tonelli-Cueto, TU Berlin
What is the probabilistic analysis of a condition number?

For a given problem, a condition number is a quantity depending on the data that measure the numerical sensitivity of the data to perturbations. This parameter plays a fundamental role in the complexity analysis of numerical algorithms, both from a run-time and precision control perspective. However, because of this, numerical algorithms tend to have complexity estimates that do not depend solely on the input size. The main philosophy to solve this is to

perform a probabilistic analysis of the condition number assuming some reasonable probability distribution of the input. In this talk, we introduce the different ways in which such a probabilistic analysis can be done and the differences between the different approaches.

Poster Session

Mathew Aibinu, University of KwaZulu-Natal. *The implicit midpoint rule of nonexpansive mappings and applications in uniformly smooth Banach spaces.*

Carlos Amendola, TU München. *Autocovariance Varieties of Moving Average Random Fields.*

Laura Brustenga, Universitat Autònoma de Barcelona. *The blow up split section family.*

Weronika Buczynska, University of Warsaw. *tba.*

Daniel Corey, University of Wisconsin-Madison. *Tropical curves of hyperelliptic type.*

Oliver Gäfvert, KTH Stockholm. *tba.*

Giuliano Gagliardi, Universität Hannover. *Existence of equivariant models of spherical homogeneous spaces.*

Marina Garrote-López, Universitat Politècnica de Catalunya. *tba.*

Florian Kohl, Aalto University. *Transfer-Matrix Methods meet Ehrhart Theory.*

Khazhgali Kozhasov, TU Braunschweig. *Nonnegative forms with sublevel sets of minimal volume.*

Lukas Kühne, Hebrew University of Jerusalem. *On the generation of rank 3 simple matroids and Terao?s freeness conjecture.*

Miruna-Stefana Sorea, MPI Leipzig. *The Shapes of Level Curves of Real Polynomials Near Strict Local Minima.*

Mariel Supina, University of California, Berkeley. *tba.*

Simon Telen, KU Leuven. *Numerical Root Finding via Cox Rings.*

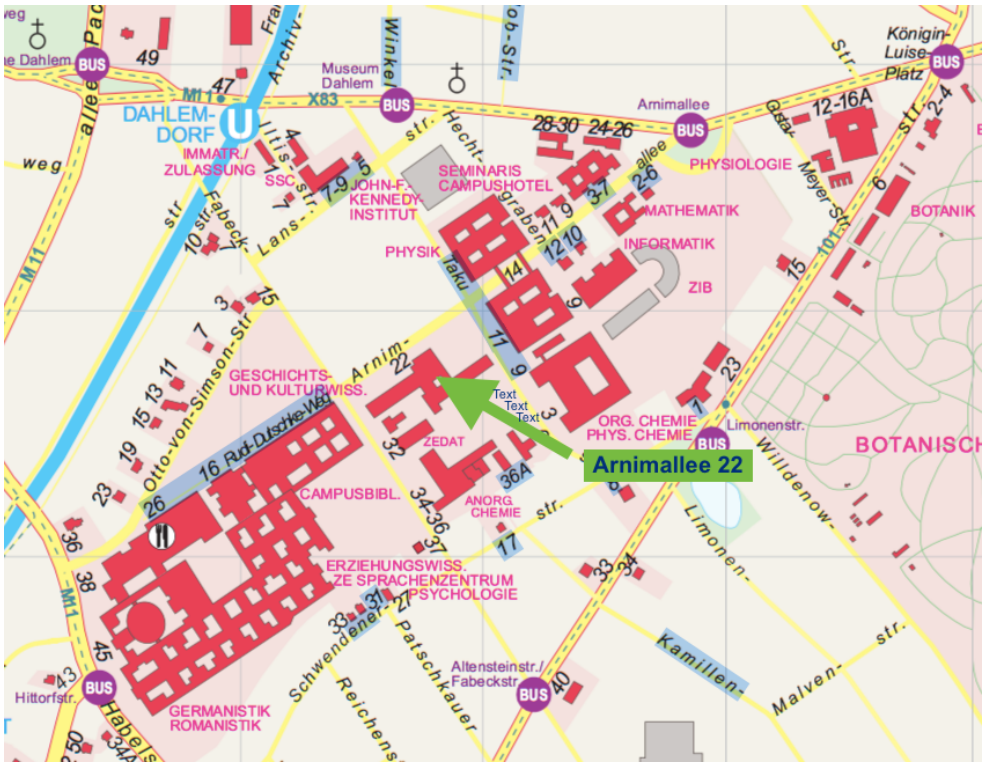
Josué Tonelli-Cueto, TU Berlin. *tba.*

Maddie Weinstein, University of California, Berkeley. *Voronoi Cells in Metric Algebraic Geometry of Plane Curve.*

Oguzhan Yürük, TU Braunschweig. *tba.*

Conference Venue

FU Berlin Campus
Hörsaal A (Lecture Hall A)
Arnimallee 22
14195 Berlin



Discussion Rooms

conference venue
seminar room **A.006** and **B-132** (signposted)

available daily 08:00 - 18:00 – except Wednesday 14:00 - 16:30

Conference Dinner – Thursday, 10 October 2019 at 19:00h

Alte Pumpe
Lützowstraße 42
10785 Berlin
www.altepumpe.de/EN/

The conference dinner will be a self-paid four-course buffet (buffet excluding beverages: 26.50€ regular, 15€ students with Student's Dinner Card).

Located near metro station Nollendorfplatz: metro line U1 and U2, bus line 341, 148, 100, and 129.

Public Transportation

Berlin has an efficent public transportation system. Online map services work perfectly well - for public transport as well as taxi services. The online tool of the Berlin transit system is available at www.bvg.de, where directions, ticket costs and schedules are indicated.

From Tegel Airport to FU Berlin (ca. 45 minutes)
Ticket: Single fare ticket Berlin AB costs 2.80€. It is recommended to get the 4-tickets option for 9€.

- Take the bus X9, direction S+U Zoologischer Garten and get off at U Jakob-Kaiser-Platz station.
- Take the U7 in direction Rudow and change in U Fehrbelliner Platz to U3, in direction Krumme Lanke.
- Get off U Bhf Dahlem-Dorf and walk 10 minutes.

From Schoenefeld Airport to FU Berlin (ca. 80 minutes)
Ticket: The needed ticket is ABC (Schoenefeld airport is in Zone C). Single ticket costs 3.40 euros.

- Take the bus X7, direction U Rudow and get off at that station.
- Take the subway U7, direction S+U Rathaus Spandau and get off at the station U Fehrbelliner Platz.
- Take the subway U3, direction U Krumme Lanke and get off at the station U Dahlem-Dorf and walk 10 minutes.

Internet Access

At FU Berlin, `eduroam` can be used to access the internet.

A Wi-Fi network will be set up specially for the opening conference and can be accessed via a general password. Information about the network name and password will be available at the registration desk in Arnimallee 22.

Restaurants in the Neighborhood

Cafeteria (Mensa) ⚠**No** cash and credit card payments! Need to buy a mensa card.
Otto-von-Simson-Straße 26
www.stw.berlin/mensen/mensa-fu-ii.html

Fast-food

- **Asia Snack Dahlem** | *Vietnamese*
  Königin-Luise-Straße 38

- **Really Good Life** | *Burger*
  Königin-Luise-Straße 44

- **Cantine of Julius Kühn Institute** | *German Cantine*
  Königin-Luise-Straße 19

- **Small "Döner" place at the subway station** | *Turkish*

Bio-cafe with vegetarian options

- **Baci's Coffee** | Coffee (with espresso machine)
  Königin-Luise-Straße 39

- **Cafeteria im Museum** | *Ethnological*
  Lansstraße 8

Sit-down restaurants

- **Alter Krug** | *German*
  Königin-Luise-Straße 52
  Phone: +49 30 832 700 0

- **Luise** | *German*
  Königin-Luise-Straße 40
  Phone: +49 30 841 888 0

- **Ristorante Piaggio** | *Italian*
  Königin-Luise-Straße 44
  Phone: +49 30 832 022 66

- **Restaurant Englers** | *German & French (Fancy)*
  Englerallee 42
  Phone: +49 30 303 642 36

List of Participants

Daniele Agostini	HU Berlin
Mathew Aibinu	University of KwaZulu-Natal
Carlos Améndola	TU München
Omid Amini	École Polytechnique
Matthias Beck	San Francisco State University
Matías Bender	TU Berlin
Valentina Beorchia	University of Trieste
Marko Berghoff	HU Berlin
Greg Blekherman	Georgia Tech
Alexander Bobenko	TU Berlin
Christopher Borger	Universität Magdeburg
Marie-Charlotte Brandenburg	FU Berlin
Laura Brustenga	Universitat Autònoma de Barcelona
Weronika Buczynska	University of Warsaw
Dominic Bunnett	TU Berlin
Peter Bürgisser	TU Berlin
Felicia Burtscher	TU Berlin
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Gang Chen	Queen Mary University of London
Giulia Codenotti	FU Berlin
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Jan Draisma	Universität Bern
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Gavril Farkas	HU Berlin
Oliver Gäfvert	KTH Stockholm
Giuliano Gagliardi	Universität Hannover
Marina Garrote-López	Universitat Politècnica de Catalunya
Noah Giessing	FU Berlin
Maksymilian Grab	University of Warsaw
Stefan Günther	None

Christian Haase	FU Berlin
Janin Heuer	TU Braunschweig
Matthias Himmelmann	FU Berlin
Max Hlavacek	UC Berkeley
Roser Homs Pons	TU Berlin
Michael Joswig	TU Berlin
Lars Kastner	TU Berlin
Hanieh Keneshlou	MPI Leipzig
Yeongrak Kim	Universität des Saarlandes
Jin Hong Kim	Chosun University
Florian Kohl	Aalto University
Hana Kourimska	TU Berlin
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Thomas Krämer	HU Berlin
Kaie Kubjas	Aalto University
Lukas Kühne	Hebrew University of Jerusalem
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Niklas Livchitz	FU Berlin
Davide Lofano	TU Berlin
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Antonio Macchia	FU Berlin
Anieza Maltsi	Weierstrass Institute
Laurent Manivel	Paul Sabatier University, Toulouse
Katharina Mölter	FU Berlin
Mandira Mondal	Chennai Mathematical Institute
Simone Naldi	Université de Limoges
Angela Ortega	HU Berlin
Mathias Oster	TU Berlin
Giorgio Ottaviani	University of Florence
Ashraf Owis	Cairo University
Marta Panizzut	TU Berlin
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Alexander Prasse	HU Berlin
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Marco Ramponi	HU Berlin
Laith Rastanawi	FU Berlin
Philipp Reichenbach	TU Berlin
Doreen Reuchsel	King's College London
Eleonora Anna Romano	University of Warsaw
Sybille Rosset	Universite Paris Saclay
Ferry Saavedra	FU Berlin
Francisco Santos	U de Cantabria
Karin Schaller	FU Berlin
Reinhold Schneider	TU Berlin
Irene Schwarz	HU Berlin
Büsra Sert	TU Berlin
Emre Sertöz	MPI Leipzig
Arsen Shebzukhov	University of Versailles and Saint-Quentin
Vladyslav Shram	Igor Sikorsky Kyiv Polytechnic Institute
Rainer Sinn	FU Berlin
Hannah Sjöberg	FU Berlin
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Johanna Steinmeyer	Hebrew University of Jerusalem
Mariel Supina	University of California, Berkeley
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Sascha Timme	TU Berlin
Zeinab Toghani	Queen Mary University of London
Orsola Tommasi	University of Padova
Josué Tonelli-Cueto	TU Berlin
Akiyoshi Tsuchiya	University of Tokyo
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Anna-Lena Winz	FU Berlin
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http://ehrhart.math.fu-berlin.de/agplus/conference.php