# Conference 2017

European Women in Mathematics — German Chapter

9–10 June 2017

Department of Mathematics
University of Bielefeld
Room V2–210/216

Organizers: Barbara Baumeister (Bielefeld), Christine Bessenrodt (Hannover), Barbara Gentz (Bielefeld), Initiative *Young Women in the CRC 701*

This workshop is part of the conference programme of the DFG-funded CRC 701 *Spectral Structures and Topological Methods in Mathematics* at the Faculty of Mathematics, University of Bielefeld.

SFB 701
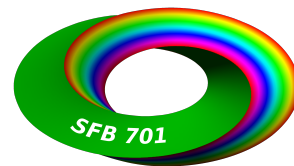
Programme

Friday, 9 June 2017

09:45 – 10:20	*Registration and coffee in V3–201*
10:20 – 10:30	*Opening of the workshop*
10:30 – 11:30	**Anita Winter** (Universität Duisburg-Essen) Real trees versus algebraic trees as states of stochastic processes
11:30 – 12:30	**Katharina Habermann** (SUB Göttingen) The Protestant Reformation and women's entry into universities
12:30 – 14:00	*Lunch*
14:00 – 16:00	*Focus group discussion* *Women in Mathematics: challenges and opportunities in Germany* organized by Maria Infusino (Konstanz) and Andrea Nickel (Bielefeld)
16:00 – 16:15	*Coffee in V3–201*
16:15 – 16:45	**Elena E. Berdysheva** (Justus-Liebig-Universität Gießen) Problems of Turán and Delsarte in locally compact abelian groups
16:45 – 17:15	**Kyung-Youn Kim** (Universität Bielefeld) Estimates of Dirichlet heat kernel for symmetric Markov processes
17:15 – 17:45	**Christine Scharlach** (Freie Universität Berlin) Beweisen auf Grundschulniveau – einige Beispiele
19:30 –	*Joint dinner in the city centre* Wernings Weinstube Alter Markt 1, 33602 Bielefeld, ☎ +49 521 136 51 51 http://www.wernings-weinstube.de Please note: For the dinner, prior registration is required.

The focus group discussion "Women in Mathematics: challenges and opportunities in Germany", organized by Maria Infusino (Konstanz) and Andrea Nickel (Bielefeld), will consist of an informal discussion about the state of women in mathematics in Germany with a particular focus on the challenges they are experiencing in their career paths and on the concrete actions which are or might be taken towards gender equality in mathematics. After some special contributions by Sara Azzali (Potsdam), Salma Kuhlmann (Konstanz) and Maria Rupprecht (Heidelberg) the discussion will be run in groups of participants at the same academic stage and then proceed in a collective debate.

All talks and the discussion will take place in V2–210/216.

Saturday, 10 June 2017

9:00 – 9:15   *Coffee in V3–201*

9:15 – 10:15   **Martina Juhnke-Kubitzke** (Universität Osnabrück)
Lefschetz properties for balanced 3-polytopes

10:15 – 10:45   **Maria Infusino** (Universität Konstanz)
The realizability problem for point processes

10:45 – 11:00   *Opening of the exhibition*
Women of Mathematics throughout Europe — A gallery of portraits
`http://womeninmath.net`

11:00 – 11:30   *Coffee in V3–201*

11:30 – 12:30   **Kathrin Bringmann** (Universität zu Köln)
Higher depth quantum modular forms

12:30 – 13:30   *Lunch*

13:30 – 14:00   **Emily King** (Universität Bremen)
Difference Ssts and Grassmannian packings

14:00 – 15:00   **Gitta Kutyniok** (TU Berlin)
Approximation theory meets deep learning

all day   *Exhibition in V2–213*
Women of Mathematics throughout Europe — A gallery of portraits
`http://womeninmath.net`

All talks will take place in V2–210/216.

Abstracts

Elena E. Berdysheva (Justus-Liebig-Universität Gießen)

Problems of Turán and Delsarte in locally compact abelian groups

Let G be a locally compact abelian group, and let Ω_+, Ω_- be two open sets in G. We investigate the constant

$$\mathcal{C}(\Omega_+, \Omega_-) := \sup \left\{ \int_G f : f \in \mathcal{F}(\Omega_+, \Omega_-) \right\},$$

where $\mathcal{F}(\Omega_+, \Omega_-)$ is the class of positive definite functions f on G such that $f(0) = 1$, the positive part f_+ of f is supported in Ω_+, and its negative part f_- is supported in Ω_-. In the case when $\Omega_+ = \Omega_- =: \Omega$, the problem is exactly the so-called Turán problem for the set Ω. When $\Omega_- = G$, i.e., there is a restriction only on the set of positivity of f, we obtain the Delsarte problem. In the cases when $G = \mathbb{R}^d$ or $\mathbb{Z}^d$, both problems are known in the harmonic analysis and have been studied by a number of authors. Especially, problems of Delsarte type in various settings play an important role in estimates for the density of spherical packings, the kissing numbers, the cardinality of spherical codes, etc.

For the Turán problem on locally compact abelian groups, Szilárd Révész has shown that structural properties of the set Ω — in particular, tiling or packing with a certain translational set Λ — yield estimates of the constant $\mathcal{C}(\Omega, \Omega)$. A critical role in these estimates is played by a generalized notion if size: asymptotic uniform upper density of sets in locally compact abelian groups. We extend these results to the more general case of $\mathcal{C}(\Omega_+, \Omega_-)$ that includes Delsarte's problem as a particular case and obtain estimates of $\mathcal{C}(\Omega_+, \Omega_-)$ in the situation when the set Ω_+ satisfies a certain packing type condition.

Joint work with Szilárd Gy. Révész (Alfréd Rényi Institute of Mathematics, Budapest, Hungary).

Kathrin Bringmann (Universität zu Köln)

Higher depth quantum modular forms

Modular forms are functions which are functions on the upper half plane which satisfy certain transformation laws. Such modul forms have many applications. Recently Don Zagier introduced quantum modular forms which instead just live on the rationals and spit out a simpler function when applying modular transformations. In this talk I will speak about a generalization of such functions.

Katharina Habermann (Georg-August-Universität Göttingen)

The Protestant Reformation and women's entry into universities

This year, 2017, marks the 500th anniversary of the Protestant Reformation. The Reformation profoundly affected the lives of women and changed women's position in society. Moreover, the Reformation brought a concept of marriage that rejected clerical celibacy and particularly implied a new marriage policy especially in academia. As a consequence women started to enter the university environment, first as wives and daughters of university professors.

This talk aims to challenge the view that this phenomenon can be considered as an initial point of women's university education and aims to spot some women in the natural sciences.

Maria Infusino (Universität Konstanz)

The realizability problem for point processes

The realizability problem is an infinite dimensional version of the classical truncated moment problem which naturally arises from applied fields dealing with the analysis of complex systems, and which is still open in many of its aspects. In this talk I will focus on a particular instance of this problem, namely, on the question of establishing whether two given functions $\rho_1(i)$ and $\rho_2(i,j)$ non-negative and symmetric on $\mathbb{Z}^d$ ($d \in \mathbb{N}$) are the first two correlation functions of a translation invariant point process on $\mathbb{Z}^d$. In a recent joint work with Emanuele Caglioti and Tobias Kuna we provide an explicit construction of such a realizing process for any $d \geq 2$ when $\rho_1(i) = \rho \in \mathbb{R}^+$ and $\rho_2(i,j) = \rho^2 g(i-j)$ with $g : \mathbb{Z}^d \to \mathbb{R}^+$ having a specific form particularly relevant for the study of heterogenous materials in chemistry (iso-g processes). The main challenge in this case is to find the maximal value of the uniform density ρ for which realizability can be established for a specified g. Our construction is the first to produce for any $d \geq 2$ a lower bound for the maximal realizable density which improves the general lower bounds already known in literature and so provides a better approximation of the feasibility region for this class of realizability problems.

Martina Juhnke-Kubitzke (Universität Osnabrück)

Lefschetz properties for balanced 3-polytopes

In this talk, we study Lefschetz properties of Artinian reductions of Stanley–Reisner rings of balanced simplicial 3-polytopes. A $(d-1)$-dimensional simplicial complex is said to be *balanced* if its graph is d-colorable, i.e., there exists a coloring of its vertices without monochromatic edges. If a simplicial complex is balanced, then its Stanley–Reisner ring has a special system of parameters induced by the coloring. We prove that the Artinian reduction of the Stanley–Reisner ring of a balanced simplicial 3-polytope with respect to this special system of parameters has the strong Lefschetz property if the characteristic of the base field is not two or three. Moreover, we characterize $(2,1)$-balanced simplicial polytopes, i.e., polytopes with exactly one red vertex and two blue vertices in each facet, such that an analogous property holds. In fact, we show that this is the case if and only if the induced graph on the blue vertices satisfies a Laman-type combinatorial condition. All necessary notions will be explained during this talk.

This is joint work with David Cook II, Satoshi Murai and Eran Nevo.

Kyung-Youn Kim (Universität Bielefeld)

Estimates of Dirichlet heat kernel for symmetric Markov processes

We consider a large class of symmetric pure jump Markov processes dominated by isotropic unimodal Lévy processes with weak scaling conditions. We first establish sharp two-sided heat kernel estimates for these processes in $\mathcal{C}^{1,\rho}$ open sets, $\rho \in (\bar{\alpha}/2, 1]$ where $\bar{\alpha}$ is the upper scaling parameter in the weak scaling conditions. As a corollary of our main result, we obtain a sharp two-sided Green function estimates and a scale invariant boundary Harnack inequality with explicit decay rates in $\mathcal{C}^{1,\rho}$ open sets.

This is joint work with Tomasz Grzywny and Panki Kim.

Emily King (Universität Bremen)

Difference sets and Grassmannian packings

It is often of interest to find subspaces which are optimally spread apart. For example, if one wants a set of vectors (representing one dimensional subspaces) which have similar properties to orthonormal bases, the vectors should as non-parallel as possible. Such collections yield optimally robust representations of certain classes of data and are referred to as Grassmannian (fusion) frames. There are a number of constructions possible using tools from combinatorial design theory: difference sets and their generalizations. In this talk, the connection between algebraic combinatorics and geometric packings will be presented, including brand new constructions of packings.

Gitta Kutyniok (TU Berlin)

Approximation theory meets deep learning

Despite the outstanding success of deep neural networks in real-world applications, most of the related research is empirically driven and a mathematical foundation is almost completely missing. One central task of a neural network is to approximate a function, which for instance encodes a classification task. In this talk, we will be concerned with the question, how well a function can be approximated by a neural network with sparse connectivity. Using methods from approximation theory and applied harmonic analysis, we will derive a fundamental lower bound on the sparsity of a neural network. By explicitly constructing neural networks based on certain representation systems, so-called α-shearlets, we will then demonstrate that this lower bound can in fact be attained. Finally, we present numerical experiments, which surprisingly show that already the standard backpropagation algorithm generates deep neural networks obeying those optimal approximation rates.

This is joint work with H. Bölcskei (ETH Zurich), P. Grohs (Uni Vienna), and P. Petersen (TU Berlin).

Christine Scharlach (FU Berlin)

Beweisen auf Grundschulniveau – einige Beispiele

Das Argumentieren und Begründen gehört zu den allgemeinen mathematischen Kompetenzen, deren Grundlagen in der Grundschule erworben werden (sollen). Dazu können wir uns nicht der formalen mathematischen Sprache bedienen, sondern müssen mit Beispielen (handelnd oder auf Zahlenebene) arbeiten.

Ohne großen theoretischen Unterbau wollen wir einige Beispiele demonstrieren, welche u.a. den werdenden Grundschullehrkräften die Angst vor mathematischen Beweisen nehmen können. Inspiriert sind die Beispiele häufig historisch, von „den alten Griechen".

Anita Winter (Universität Duisburg-Essen)

Real trees versus algebraic trees as states of stochastic processes

In this talk we are interested in continuum trees as limit objects of graph-theoretic trees when the number of vertices goes to infinity. Depending on which notion of convergence we choose, different objects are obtained. A notion of convergence with many applications in different areas is based on encoding trees as metric measure spaces and then using the Gromov-weak topology. Apparently such an encoding is not suitable in all applications. Problems arise in the construction of scaling limits of Markov chains taking values in graph-theoretic trees whenever the metric and the measure have a different scaling regime. We therefore introduce algebraic trees which have a nice encoding as triangulations of the circle and which can be seen as metric measure trees where we have forgotten the metric.

We will carefully explain the two approaches and illustrate them with the example of Aldous chain on cladograms.

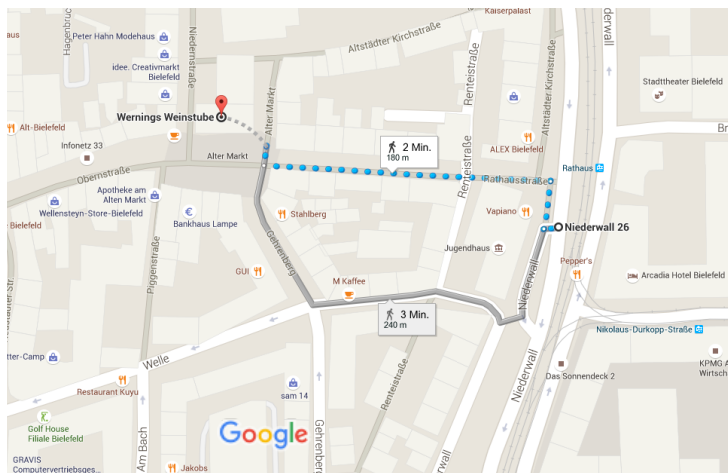**Workshop dinner**   (Friday, 9 June 2017, starting at 19:30 h)

Wernings Weinstube

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Please note: For the dinner, prior registration is required.

Registered participants

Sara Azzali	Universität Potsdam
Barbara Baumeister	Universität Bielefeld
Elena E. Berdysheva	Justus-Liebig-Universität Gießen
Christine Bessenrodt	Leibniz-Universität Hannover
Kathrin Bringmann	Universität zu Köln
Barbara Gentz	Universität Bielefeld
Katharina Habermann	Georg-August-Universität Göttingen
Maria Infusino	Universität Konstanz
Martina Juhnke-Kubitzke	Universität Osnabrück
Diana Kämpfe	Universität Bielefeld
Kyung-Youn Kim	Universität Bielefeld
Emily King	Universität Bremen
Claudia Köhler	Universität Bielefeld
Salma Kuhlmann	Universität Konstanz
Gitta Kutyniok	TU Berlin
Chengcheng Ling	Universität Bielefeld
Katharina von der Lühe	Universität Bielefeld
Nora Müller	Universität Bielefeld
Andrea Nickel	Universität Bielefeld
Rebecca Reischuk	Universität Bielefeld
Maria Rupprecht	Ruprecht-Karls-Universität Heidelberg
Christine Scharlach	FU Berlin
Yumi Takenaka	Leibniz-Universität Hannover
Victor Vinnikov	Ben-Gurion University of the Negev, Beer Sheva
Anita Winter	Universität Duisburg-Essen
Eva Zerz	RWTH Aachen

(as of 8 June 2017)