UNIVERSITÄT OSNABRÜCK

Conference on
"Combinatorial Structures in Geometry"

Osnabrück
August 8th – 12th, 2016

The Graduiertenkolleg 'Combinatorial Structures in Geometry' at the University of Osnabrück is a project funded by the German Research Foundation (DFG). It enables research and scientific education within and between algebra/discrete mathematics, applied analysis, stochastics and topology/geometry and combinatorial optimisation. In order to celebrate the first three years of its existence and the completion of the first eight PhD-thesis supervisioned in this project we organize an international conference on Combinatorial Structures in Geometry.

Organizing Committee

- Holger Brenner
- Winfried Bruns
- Lars Diening
- Hanna Döring
- Martina Juhnke-Kubitzke
- Sigrid Knust
- Stefan Kunis
- Matthias Reitzner
- Tim Römer
- Oliver Röndigs
- Markus Spitzweck

Extras and social events

Tuesday, August 9th

- 16:30 - 19:30 Workshop for women on presentation skills (Dinner afterwards)

Wednesday, August 10th

- 14:00 - 18:00 Excursion to the Piesberg
  The participation is free of charge. The meeting point for the bus will be Barbarastraße.
- 19:00 Conference Dinner at the Hausbrauerei Rampendahl, Hasestraße 35, 49074 Osnabrück
  The price will be ***24,50 EURO*** (drinks not included).

If you would like to attend the excursion or conference dinner, please let us know until Monday evening!

Thursday, August 11th

- 16:00 - 17:00 Heidemarie Bräsel: Introduction to the exhibition
- 17:00 - 19:00 Exhibition on mathematical patterns

Local Information

Lecture Rooms

⌂ Building 93
Room E31
Barbarastraße 22c

Exhibition:

⌂ Building 96
Rooms E16
Nelson-Mandela-Platz 1

Public Transport

The campus can be reached by the bus number 21/22, which will take you to the bus stop "Hochschulen Westerberg". For more information please visit www.vos.info.

Wi-Fi

If you have an eduroam account you can connect to the eduroam network to get free wireless internet access. Otherwise please contact one of the organizers.

Website

http://www.grako.uni-osnabrueck.de/

Schedule

	Monday, August 8	**Tuesday, August 9**	**Wednesday, August 10**	**Thursday, August 11**	**Friday, August 12**
09:00 – 10:00	Registration & Welcome	**Alberto Fernández Boix** On some local cohomology filtrations	**Rashid Zaare-Nahandi** Linearity of resolution of monomials and the role of characteristic of the base field	**09:20 -10:00** **Xuan Thanh Le** Storage loading problems under uncertainty	**Martin Frankland** Higher distributivity via cubes and their faces
10:00 – 11:00	**Rolf Schneider** Typical polytopes in random hyperplane mosaics: from first to second moments	**Emanuele Delucchi** An attempt at equivariant matroid theory	**Inna Zakharevich** Analyzing geometric invariants with K-theory	**Horst W. Hamacher** Networks Flows and Variation	**Ieke Moerdijk** Dendroidal sets and Gamma-spaces
11:00 – 11:30	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:30 – 12:10	**Gilles Bonnet** Cells with many facets in a random hyperplane mosaic	**Davide Alberelli** Local Picard Group of Binoids	**Ulrich von der Ohe** A multivariate generalization of Prony's method	**Sabrina Syed** Motivic cohomology of toric varieties	**Alejo López Ávila** Hermitian K-theory of infinity categories with duality
12:10 – 12:50	**Benjamin Reichenwallner** Volumes of convex hulls of n ≤ d+1 points in d-dimensional convex bodies	**Thi Van Anh Nguyen** On monomial preorders and partial regularities	**Richard Sieg** Understanding Subdivisions of Simplicial Complexes via Local h-Vectors	**Hongyi Chu** Enriched infinity operads	**Hadrian Heine** A monadic approach to higher Lie theory
12:50 – 14:30	Lunch	Lunch	Lunch	Lunch	Lunch
14:30 – 15:30	**Alessio Caminata** Cohomological dimension and arithmetical rank of some determinantal ideals	**Sara Saeedi Madani** Cut ideals of graphs	Excursion to the Piesberg	**Sean Tilson** Motivic cohomology of toric varieties	
15:30 – 16:00	Coffee Break	Coffee Break		Coffee Break	
16:00 – 16:40		Workshop for women on presentation skills (Dinner afterwards)		**Heidemarie Bräsel** Introduction to the exhibition "Fascination of Mathematics - Paintings and	
16:40 – 17:20					
19:00			Dinner at Rampendahl		

Abstracts

Monday, August 8th

10:00 – 11:00

Typical polytopes in random hyperplane mosaics: from first to second moments

Rolf Schneider (University of Freiburg, Germany)

The vertex number of the typical cell of a stationary random hyperplane tessellation in $\mathbb{R}^d$ has, under some mild conditions, an expectation equal to 2^d, independent of the underlying distribution. The variance of this vertex number can vary widely. Under Poisson assumptions we give sharp bounds, showing, in particular that its maximum is attained if the hyperplane system is isotropic. We expand this observation, giving more examples, also in spherical space, where first moments of basic geometric functionals of typical cells are essentially combinatorial in character and hence independent of the distribution, whereas information on second moments depends heavily on the distribution

11:30 – 12:10

Cells with many facets in a random hyperplane mosaic

Gilles Bonnet (University of Osnabrück, Germany)

We consider a Poisson hyperplane process η in $\mathbb{R}^d$ with directional distribution φ. The closures of the connected components of $\mathbb{R}^d \setminus \bigcup_{H\in\eta} H$ are polytopes. The mosaic X_η is the collection of these polytopes, and we call the polytopes the cells of X_η. Almost surely one cell contains the origin in its interior, we call it the zero cell and denote it by Z_0. We investigate the distribution of the random polytope Z_0. In particular we prove (under a weak assumption on φ) that there exist positive constants c_1 and c_2 such that for n big enough we have

$$(c_1 n)^{-2n/(d-1)} < \mathbb{P}(Z_0 \text{ has } n \text{ facets}) < (c_2 n)^{-2n/(d-1)}.$$

It extends similar results of Calka and Hilhorst [1] who gave a more precise asymptotic expansion of the above probability but only in the two dimensional and isotropic case.

[1] H. J. Hilhorst and P. Calka. em J. Stat. Phys., ***132***(4):627–647, 2008.

12:10 – 12:50

Volumes of convex hulls of $n \leq d+1$ points in d-dimensional convex bodies

Benjamin Reichenwallner (University of Salzburg, Austria)

The convex hull of $n \leq d+1$ points randomly chosen from a d-dimensional convex body K according to the uniform distribution in K forms an $(n-1)$-dimensional simplex with probability 1. We denote its volume by $V_{K[n]}$ and ask if for two d-dimensional convex bodies K and L and $k > 0$, $K \subseteq L$ implies $\mathbb{E}V_{K[n]}^k \leq \mathbb{E}V_{L[n]}^k$.

In 2006, M. Meckes raised the question whether $K \subseteq L$ would imply $\mathbb{E}V_{K[d+1]} \leq \mathbb{E}V_{L[d+1]}$. L. Rademacher gave an answer for the case $n = d+1$ and $k = 1$, when $d \neq 3$. Higher moments were investigated by Rademacher and Reichenwallner & Reitzner, only leaving the expected volume of a random tetrahedron in dimension three as an open task.

We give a similar result for $n < d+1$, showing that for $k > 0$ there exist two d-dimensional convex bodies K and L satisfying $K \subseteq L$, but $\mathbb{E}V_{K[n]}^k > \mathbb{E}V_{L[n]}^k$, unless $n \in \{3, 4\}$ and $k = 1$.

14:30 – 15:30

Cohomological dimension and arithmetical rank of some determinantal ideals

Alessio Caminata (University of Neuchâtel, Switzerland)

The arithmetical rank of an algebraic variety X in a projective space is the minimum number r such that there exist r hypersurfaces $F_1, \ldots, F_r$ which cut out X set-theoretically. The arithmetical rank is strictly related to the cohomological dimension of X, that is the minimum integer n such that the sheaf cohomology module $H^i(X, \mathcal{F}) = 0$ for every $i > n$ and every coherent sheaf $\mathcal{F}$. In this talk, I will recall some classical results about these two invariants and I will study them for some classes of determinantal varieties. These are defined as zero loci of ideals of minors of a matrix whose entries are linear forms in a polynomial ring. This is a joint work with D. Bolognini, A. Macchia, and M. Mostafazadehfard.

Tuesday, August 9th

09:00 – 10:00

On some local cohomology filtrations

Alberto Fernández Boix, University Pompeu Fabra,

The goal of this talk is to construct certain filtrations of local cohomology modules, and to explain how to use them to obtain interesting information about such local cohomology modules. More precisely, on one hand, carrying over a Mayer Vietoris type spectral sequence, we recover and extend the filtration produced by Álvarez Montaner, Garcá López and Zarzuela used to produce a closed formula for the computation of characteristic cycles of local cohomology modules supported on an arrangement of linear varieties; moreover, we also use this kind of filtrations to produce a closed formula for the socalled generalized Lyubeznik numbers recently introduced by NuñezBetancourt and Witt. On the other hand, building upon another completely different spectral sequence, we obtain filtrations of local cohomology supported on a maximal ideal, and we explain how to use them to provide several Hochster's type formulas, including the classical one for Stanley Reisner rings, the recent one for Stanley toric face rings obtained by Brun, Bruns and Römer, and another new one for central arrangements of linear varieties. The content of this talk is based on a joint work in progress with Josep Álvarez Montaner and Santiago Zarzuela.

10:00 – 11:00

An attempt at equivariant matroid theory

Emanuele Delucchi (University of Fribourg, Switzerland)

Matroid theory is a sprawling branch of combinatorics with pervasive connections with geometry, topology and algebra. Recent progresses (e.g. De Concini, Procesi and Vergne's theory of toric arrangements and partition functions, Moci's arithmetic Tutte Polynomials etc.) have called for a new structure playing the role of matroids in new contexts.
In this talk I will introduce an approach to "equivariant matroid theory" via group actions on semimatroids, outlining its structure theory as well as, time permitting, some of its ramifications in combinatorial topology, enumerative combinatorics and commutative algebra.

11:30 – 12:10

Local Picard Group of Binoids

Davide Alberelli (University of Osnabrück, Germany)

Binoids, also known as pointed monoids, are combinatorial objects that allow us to unify the description of two apparently very distant worlds, namely Toric Varieties and Monomial Ideals. In this talk I will introduce the concept of local Picard group, both in the combinatorial and algebraic setting, and present some explicit results about simplicial binoids and Stanley-Reisner rings.

12:10 – 12:50

On monomial preorders and partial regularities

Thi Van Anh Nguyen (University of Osnabrück, Germany)

Robbiano has 1985 proved that any monomial preorder can be approximated by the lexicographic order defined by a real matrix. We applied this method of Robbiano to consider the construction of monomial preorders and corresponding initial ideals. For this we proved some basic related results based on our study about recent works of Trung on the subject. Also focused in our project is a study of the socalled partial regularities of a finitely generated graded module over the polynomial ring. The definition and many properties of these new invariants are considered via the notion and proven results of Caltelnuovo-Mumford regularity. In particular, we provided an upper bound for the partial regularities.

14:30 – 15:30

Cut ideals of graphs

Sara Saeedi Madani (University of Osnabrück, Germany)

Let $G = (V, E)$ be a finite simple graph. To a partition of the vertex set $V = A \cup B$, denoted by $A|B$, we associate a variable $q_{A|B}$. We consider two polynomial rings over a field $\mathbb{K}$ defined as follows:

$$S_G := \mathbb{K}[q_{A|B} : A \cup B = V, A \cap B = \emptyset],$$

$$R_G := \mathbb{K}[s_{ij}, t_{ij} : \{i, j\} \in E].$$

Each partition $A|B$ of V defines a subset $\mathrm{Cut}(A|B)$ of the edge set E which is

$$\mathrm{Cut}(A|B) := \big\{\{i, j\} \in E : i \in A, j \in B \text{ or } i \in B, j \in A\big\}.$$

Then we consider the following homogeneous homomorphism of $\mathbb{K}$-algebras:

$$\begin{aligned} \phi_G : S_G &\to R_G \\ q_{A|B} &\mapsto \prod_{\{i,j\}\in \mathrm{Cut}(A|B)} s_{ij} \prod_{\{i,j\}\in E\setminus \mathrm{Cut}(A|B)} t_{ij}, \end{aligned}$$

The kernel I_G of the map ϕ_G is a graded toric ideal which is called the cut ideal of G and introduced by Sturmfels and Sullivant.
In this talk, we discuss different algebraic properties of those algebras. Among them, we discuss the relationship between some graphical operations on a graph, the cut algebra and a corresponding polytope called cut polytope.
(This is joint work with Tim Römer).

Wednesday, August 10th

09:00 – 10:00

Linearity of resolution of monomials and the role of characteristic of the base field

Rashid Zaare-Nahandi (Institute for Advanced Studies in Basic Sciences, Zanj$\bar{a}$n, Iran)

Let I be an ideal generated by monomials of degree d in the polynomial ring over a field K. A clutter C can be corresponded to I in a natural way. The aim of this talk is to present some combinatorial conditions on the clutter C which push the resolution of the corresponding ideal to be linear over any field. Also we present some examples which have a linear resolution over any field except fields of characteristic p for a given prime p.

10:00 – 11:00

Linearity of resolution of monomials and the role of characteristic of the base field

Inna Zakharevich (University of Chicago, USA)

Classical scissors congruence analyzes invariants of polytopes under decomposition. However, similar decomposition problems appear in many contexts beyond classical geometry. In this talk we will discuss how to use algebraic K-theory to construct topological spaces that encode the invariants of ßcissors congruence"problems. We will also give some examples of contexts outside of classical scissors congruence where these methods apply.

11:30 – 12:10

A multivariate generalization of Prony's method

Ulrich von der Ohe (University of Osnabrück, Germany)

Motivated by a physical problem, in 1795 de Prony proposed a reconstruction method for the parameters of a complex exponential sum given an adequate set of samples. Variants and generalizations of Prony's method have been studied recently. This talk is about a generalization to the case of multivariate exponential sums. We formulate this in an algebraic framework that includes additional cases of interest.
This talk is based on joint work with Stefan Kunis, H. Michael Möller, Thomas Peter, and Tim Römer.

12:10 – 12:50

Understanding Subdivisions of Simplicial Complexes via Local h-Vectors

Richard Sieg (University of Osnabrück, Germany)

In the early 90's, Richard Stanley introduced the notion of/local h h-vectors/in order to understand the behavior of the usual h-vector under subdividing a simplicial complex. In particular

this allowed him to prove that the coordinates of the h-vector increase in nearly all cases. We will review the most common types of subdivisions and their relationships. We will then focus on results and open problems concerning possible characterizations of the local h-vector in each of these types. This is joint work with Martina Juhnke-Kubitzke and Lukas Katthän.

Thursday, August 11th

09:20 -10:00

Storage loading problems under uncertainty

Xuan Thanh Le (University of Osnabrück, Germany)

We consider storage loading problems under uncertainty where the storage area is organized in fixed stacks with a limited height. Such problems appear in several practical applications, e.g. when loading container terminals, container ships or warehouses. Incoming items arriving at a partly filled storage area have to be assigned to stacks regarding that not every item may be stacked on top of every other item and taking into account that some items with uncertain data will arrive later. Following the robust optimization paradigm, we propose different MIP formulations for the strictly and adjustable robust counterparts of the uncertain problem. Furthermore, we show that in the case of interval uncertainties the computational effort to find adjustable robust solutions can be reduced. Computational results are presented for randomly generated instances with up to 480 items. The results show that instances of this size can be solved in reasonable time and that including robustness improves solutions where uncertainty is not taken into account.

10:00 – 11:00

Networks Flows and Variation

Horst W. Hamacher (University of Kaiserslautern, Germany)

Within mathematical optimization, network flow theory plays a prominent role: On the one hand it is explicitly used as mathematical model in numerous real-world problems, on the other hand it is a hidden part in every efficient software to tackle linear and integer optimization problems.

In this presentation, I will present network flow theory from scratch and discuss some of its variants, for instance, algebraic flows, flows on matroids, combinations of flows with location problems and of k-best flows with robust optimization.

The presentation ought to be intelligible to everyone with a basic mathematical training - hopefully without being too boring for the optimization specialist.

11:30 – 12:10

Motivic cohomology of toric varieties

Sabrina Syed (University of Osnabrück, Germany)

In general, it is difficult to compute motivic cohomology. But in the case of toric varieties their structure supplies us with combinatorial data enabling us to give a nice description of motivic cohomology. In my talk I will give a short introduction to motivic cohomology and toric varieties and explain the description mentioned above.

12:10 – 12:50

Enriched infinity operads

Hongyi Chu (University of Osnabrück, Germany)

The concept of operads has seen ongoing development since its inception by Bordman, Vogt and May in the 70s. In particular, Jacob Lurie and Ieke Moerdijk introduced different approaches to infinity operads, which have now become an indispensable tool in modern algebraic topology. Despite these developments, certain techniques such as the enrichment of operads have up to now been missing for their infitiny-counterparts. In this talk I will introduce different approaches to enriched infinity operads and provide comparison results. At the end of the talk I will show how the long expected fact that all models for infinity operads are equivalent follows from the general theory of enriched infinity operads.

14:30 – 15:30

Commutative Algebra in Stable Homotopy theory

Sean Tilson (University of Osnabrück, Germany)

It has been a popular practice in stable homotopy theory to adopt and mimic classical tools from classical algebra. When we enlarge the collection of objects we wish to do commutative algebra with we gain many new examples, such as cochains on spaces. In this talk I will present recent work of Lukas Katthaen and myself on the mod p homology of conective Morava E-theory. Morava E-theory is a commutative algebra object which is constructed from number theoretic information. It also is very important in understanding the stable homotopy groups of spheres, a central object of study in stable homotopy theory. I will explain this computation and if time permits relate it to ongoing work on spectral algebraic geometry.

Friday, August 12th

09:00 – 10:00

Higher distributivity via cubes and their faces

Martin Frankland (University of Osnabrück, Germany)

Primary cohomology operations form an algebra, called the Steenrod algebra. In particular, composition of such operations is bilinear. When studying secondary and higher order operations, we run into a composition that is strictly linear in one variable, but linear up to coherent homotopy in the other variable. In joint work with Hans-Joachim Baues, we introduce a framework that encodes this structure. The higher distributivity laws are parametrized by higher-dimensional cubes. This is analogous to higher associativity laws being parametrized by associahedra, convex polytopes studied by Stasheff in the 1960s.

10:00 – 11:00

Dendroidal sets and Gamma-spaces

Ieke Moerdijk Ieke (University of Utrecht, The Netherlands)

Segal's theory of Gamma-spaces is one of the standard combinatorial ways of modelling the homotopy theory of connective spectra or infinite loop spaces. Dendroidal sets form a combinatorial approach to modelling topological operads and their algebras, in particular E-infinity algebras and hence infinite loop spaces. So it is natural to ask what (if any) the most natural and direct way is to relate dendroidal sets and Gamma-spaces. I will try to explain one answer to this question. (This talk is based on joint work with Pedro Boavida).

11:30 – 12:10

Hermitian K-theory of infinity categories with duality

Alejo López Ávila (University of Osnabrück, Germany)

We discuss infinity categories with duality, direct sum K-theory thereof and hermitian infinity loop space machines. We will also talk about multiplicative structures in these machines and present a recognition principle.

12:10 – 12:50

A monadic approach to higher Lie theory

Hadrian Heine (University of Osnabrück, Germany)

In "On the Structure of Hopf Algebras" Milnor and Moore proved that the category of Lie algebras arises as the category of algebras of the monad associated to the adjunction tensor algebra $/$ primitive elements. Moreover they showed that this characterization also holds for restricted Lie algebras in positive characteristic. I take this description of the category of Lie algebras as a definition and show that this definition makes sense in every preadditive presentable symmetric monoidal infinity

category, whose tensor product preserves colimits component-wise. Comparison results to L-infinity algebras are in vision and applications to deformation theory, representation theory and the concept of tangent Lie algebras of derived Artin stacks are expected.

Participants

Last name	*First name*	*Affiliation*
Alberelli	Davide	University of Osnabrück, Germany
Bagheri	Amir	University of Tabriz, Iran
Betken	Carina	University of Osnabrück, Germany
Boardman	John Michael	Johns Hopkins University Baltimore,USA
Bonnet	Gilles	University of Osnabrück, Germany
Brenner	Holger	University of Osnabrück, Germany
Brunink	Jan-Marten	University of Osnabrück, Germany
Bruns	Winfried	University of Osnabrück, Germany
Caminata	Alessio	University of Neuchâtel, Switzerland
Chu	Hongyi	University of Osnabrück, Germany
Delucchi	Emanuele	University of Fribourg, Switzerland
Diening	Lars	University of Osnabrück, Germany
Döring	Hanna	University of Osnabrück, Germany
Fernandez Boix	Alberto	University of Pompeu Fabra, Spain
Frankland	Martin	University of Osnabrück, Germany
Galassi	Eleonora	University of Bremen, Germany
Götz	Daniela	University of Osnabrück, Germany
Grosdos Koutsoumpelias	Alexandros	Aristotle University of Thessaloniki, Greece
Grygierek	Jens	University of Osnabrück, Germany
Hamacher	Horst W.	University of Kaiserslautern, Germany
Hanke	Erik	University of Bremen, Germany
Heine	Hadrian	University of Osnabrück, Germany
Homs Pons	Roser	University of Barcelona, Spain
Jensen	Solveig	University of Osnabrück, Germany
Juhnke-Kubitzke	Martina	University of Osnabrück, Germany
Knust	Sigrid	University of Osnabrück, Germany
Kunis	Stefan	University of Osnabrück, Germany
Lindemann	Tim	University of Bremen, Germany
Le	Xuan Thanh	University of Osnabrück, Germany
López Ávila	Alejo	University of Osnabrück, Germany
Melzer	Ines	University of Osnabrück, Germany
Moerdijk	Ieke	University of Utrecht, Netherlands
Moyano-Fernández	Julio-José	Universitat Jaume I de Castellón, Spain
Nagel	Dominik	University of Osnabrück, Germany
Nguyen	Manh Toan	University of Duisburg-Essen, Germany
Nguyen	Thi Van Anh	University of Osnabrück, Germany
Nowinska	Edyta	University of Osnabrück, Germany

Pegel	Christoph	University of Bremen, Germany
Plümer	Judith	University of Osnabrück, Germany
Reichenwallner	Benjamin	University of Salzburg, Austria
Reitzner	Matthias	University of Osnabrück, Germany
Römer	Tim	University of Osnabrück, Germany
Röndigs	Oliver	University of Osnabrück, Germany
Schmitz	Kirsten	University of Bremen, Germany
Saeedi Madani	Sara	University of Osnabrück, Germany
Schneider	Rolf	University of Freiburg, Germany
Schumacher	Stefanie	University of Osnabrück, Germany
Sepehr	Jafari	University of Genova, Italy
Sieg	Richard	University of Osnabrück, Germany
Souderes	Ismael	University of Osnabrück, Germany
Spitzweck	Markus	University of Osnabrück, Germany
Steinbuch	Jonathan	University of Osnabrück, Germany
Stelzer	Manfred	University of Osnabrück, Germany
Syed	Sabrina	University of Osnabrück, Germany
Tilson	Sean	University of Osnabrück, Germany
Verdugo	Paula	University of Paris XIII, France
von der Ohe	Ulrich	University of Osnabrück, Germany
Wageringel	Markus	University of Osnabrück, Germany
Wank	Maximilian	University of Osnabrück, Germany
Yamoul	Hicham	Faculty of Science Ain Chock-Casablanca, Marokko
Zaare-Nahandi	Rashid	Institute for Advanced Studies in Basic Sciences, Iran
Zakharevich	Inna	University of Chicago, USA