Dear combinatorialists,

the Colloquium on Combinatorics was established in 1981 and has since been held annually in seven cities throughout Germany. It has grown to an established conference that covers all areas of Combinatorics and Discrete Mathematics in a broad sense, including combinatorial aspects in Algebra, Geometry, Optimization and Computer Science.

It is our great pleasure to host the 37th Colloquium on Combinatorics. This year we welcome 91 participants. The program includes 60 contributed talks, organised in four parallel sessions, and five invited talks on a broad range of combinatorial topics.

Please note that we have allocated 25-minute slots for the contributed talks, which includes 20 minutes for the presentation, two minutes for discussion, and three minutes for room change.

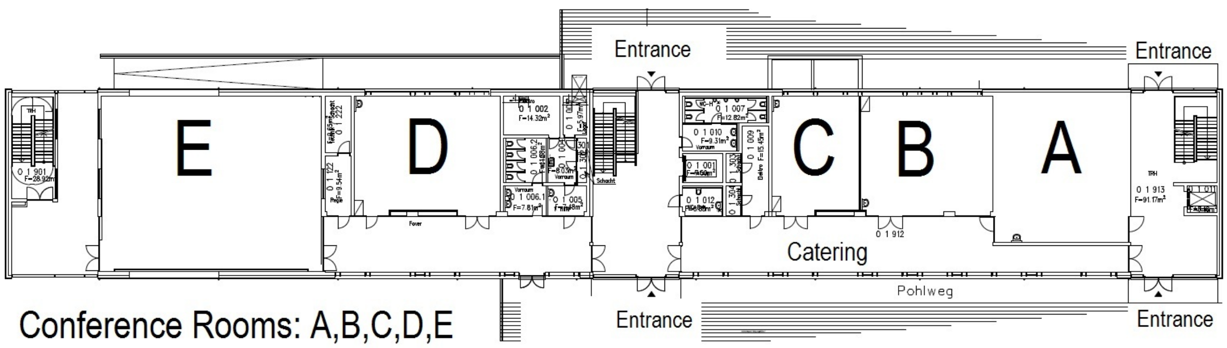
We sincerely thank our sponsors *Paderborn University* and the *Collaborative Research Centre (Sonderforschungsbereich 901) On-the-fly computing*.

We hope you enjoy the conference.

Kai-Uwe Schmidt
Eckhard Steffen

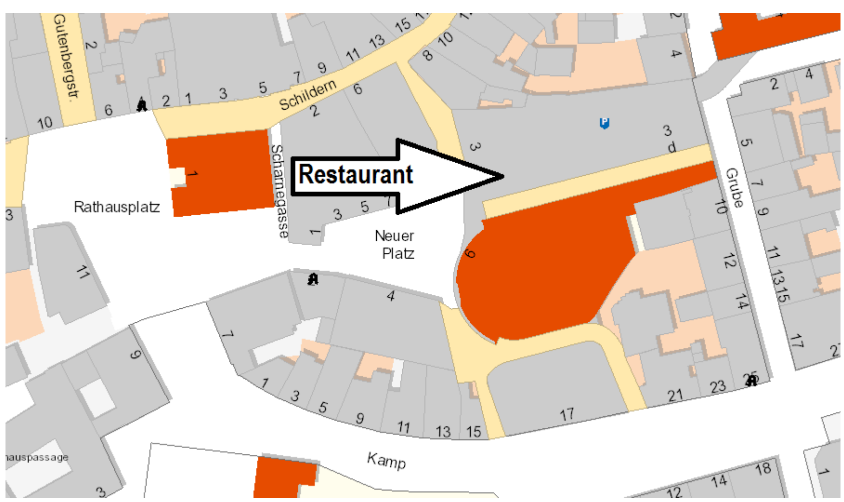
All **talks** will be in Building-O on the Main Campus (Pohlweg 51, 33098 Paderborn)

Invited talks	:	Room E
Contributed talks	:	Rooms A, B, C, D
Coffee and snacks	:	Foyer
Registration desk	:	Foyer
Library	:	Building-BI on the main campus



The **registration desk** is open on Friday from 8:00 to 18:00 and on Saturday from 8:00 to 17:00. The **library** is open on Friday from 7:30 to 24:00 and on Saturday from 9:00 to 21:00.

The **dinner** will take place at the restaurant *Bobberts* (Neuer Platz 3, Downtown Paderborn) on Friday at 19:00.



Bus lines 4 (to Heinz-Nixdorf Wendeschleife) and 9 (to Hauptbahnhof) run from the university to the restaurant. The bus stops nearest to Bobberts are: *Kamp* and *Rathausplatz*.

Busses leave at bus stop *Uni/Südring* at 17:29 (Line 9), 17:46 (Line 4), 17:59 (Line 9), 18:16 (Line 4), 18:29 (Line 9). It takes about 10 minutes to the restaurant.

(The complete bus schedule is available at `www.padersprinter.de`.)

Food options on campus

Location	Hours	Choice	Payment
Mensa Academica	11:15 – 13:30 (**only Friday**)	large variety	cash / DeliCard
Mensa Forum	11:15 – 13:30 (**only Friday**)	vegan/regular	**only DeliCard**
Grill/ Café	08:00 – 15:00 (**only Friday**)	burgers/steaks/salads	cash / DeliCard
One Way Snack	11:00 – 14:30 (**only Friday**)	sandwiches	**only DeliCard**
Caféte	08:00 – 15:45 on Friday 10:00 – 14:00 on Saturday	some variety	cash / DeliCard

More information: `http://www.studentenwerk-pb.de/en/food-services/`

Notice that **no cash payment** in the Mensa Forum (vegan Food) and One Way Snack is possible. You need a DeliCard. You can get a guest DeliCard at the DeliCard device, which is located in the entrance area of the Mensa.

Cost of the guest DeliCard: A deposit of 5 EUR plus the amount you top up.

Restitution of the unused amount: Use the same device to get back the unused money and the deposit.

(In case that the money return capacity is too low, a voucher will be issued. To get your money back, return this voucher to the staff in the Caféte before 14:00 on Saturday.)

Thursday, 22 November 2018

18:00 *Get together and registration* at **Bobberts** (Neuer Platz 3, Downtown Paderborn)

Friday, 23 November 2018

08:30 *Registration*

09:00 - 09:05 *Opening*

09:05 - 10:00 **Bill Jackson (London)**
"Rigidity of graphs and frameworks"

10:00 - 10:30 *Coffee break*

10:30 - 12:05 **Parallel sessions**

12:05 - 13:15 *Lunch*

13:15 - 14:50 **Parallel sessions**

14:50 - 15:20 *Coffee break*

15:20 - 16:15 **Karen Meagher (Regina)**
"Erdős-Ko-Rado theorems for permutations"

16:15 - 16:25 *Short break*

16:25 - 17:20 **Dion Gijswijt (Delft)**
"Cap sets and new applications of the polynomial method"

19:00 *Dinner* at **Bobberts** (Neuer Platz 3, Downtown Paderborn)

Saturday, 24 November 2018

08:50 - 10:00 **Parallel sessions**

10:00 - 10:30 *Coffee break*

10:30 - 12:05 **Parallel sessions**

12:05 - 13:15 *Lunch*

13:15 - 14:10 **Bernd Sturmfels (Leipzig)**
"The geometry of SDP-exactness in quadratic optimization"

14:10 - 14:40 *Coffee break*

14:40 - 15:35 **Paul Seymour (Princeton)**
"Gyárfás-Sumner meets Erdős-Hajnal"

15:35 - 15:40 *Farewell*

Detailed program on Friday morning

23 November 2018

Time	Section I	Section II	Section III	Section IV
	Room: A	**Room: B**	**Room: C**	**Room: D**
09:00 - 09:05	*Opening* **Room: E**			
09:05 - 10:00	**Bill Jackson** Rigidity of graphs and frameworks **Room: E**			
10:00 - 10:30	*Coffee break*			
10:30 - 10:50	**H. Harborth 1** Numbers of crossings in drawings of the cycle graph	**I. Beckenbach 2** The tight cut decomposition of matching covered hypergraphs	**S. Li 3** Constructions of primitive formally dual pairs having subsets with unequal sizes	**M.V. Sangaranar. 4** Partition functions for two-dimensional nearest neighbor Ising models and applications in chemistry
10:55 - 11:15	**K. S. Lyngsie 5** A 3-decomposition theorem	**M. Sonntag 6** Edge intersection hypergraphs	**H. Zerdoum 7** Zero-sum problems in finite abelian groups	**W. Hochstättler 8** The Varchenko determinant of an oriented matroid
11:20 - 11:40	**C. T. Zamfirescu 9** Grinberg's criterion	**S. Wiederrecht 10** On perfect matchings in uniform balanced hypergraphs	**K. Tabak 11** Viergruppen as Hamiltonian graphs	**S. Gharibian 12** On efficiently solvable cases of Quantum k-SAT
11:45 - 12:05	**I. Schiermeyer 13** Gallai Ramsey numbers of complete graphs and odd cycles	**M. Hiller 14** Gallai-Edmonds-decompositions for balanced hypergraphs	**Y. Stanchescu 15** Additive combinatorics in ordered nilpotent groups	**M. Hatzel 16** Perfect matching width, grids and directed cycles
12:05 - 13:15	*Lunch*			

Detailed program on Friday afternoon

23 November 2018

Time	Section I Room: A	Section II Room: B	Section III Room: C	Section IV Room: D
13:15 - 13:35	**J. P. Zerafa 17** An equivalent formulation of the Fan-Raspaud Conjecture and related problems	**D. Frettlöh 18** Perfect colourings of regular graphs	**F. Szöllősi 19** New constructions of few-distance sets	**Schrezenmaier 20** Equiangular polygon contact representations
13:40 - 14:00	**J. Goedgebeur 21** Generation of hypohamiltonian graphs	**D. Offner 22** Polychromatic colorings on the hypercube	**M. Ganzhinov 23** Largest sets of biangular lines in low-dimensional Euclidean spaces	**M. Pankov 24** Zigzags in embedded graphs. Z-knotted triangulations of surfaces
14:05 - 14:25	**M. Schubert 25** Flows on signed graphs without long barbells	**R. Steiner 26** Metric colourings of graphs	**A. A. Polujan 27** Homogeneous cubic bent functions: new from old	**M. Scheucher 28** Arrangements of pseudocircles: On circularizability
14:30 - 14:50	**D. Mattiolo 29** On the circular flow number of graphs	**S. D. Andres 30** The orthogonal graph colouring game	**L. Kölsch 31** Optimal implementations of matrix multiplication in finite fields	**C. Kolb 32** Compact competitive polygonal routing: The case of pairwise intersecting convex hulls
14:50 - 15:20	*Coffee break*			
15:20 - 16:15	**Karen Meagher** Erdős-Ko-Rado theorems for permutations **Room: E**			
16:15 - 16:25	*Short break*			
16:25 - 17:20	**Dion Gijswijt** Cap sets and new applications of the polynomial method **Room: E**			

Detailed program on Saturday

24 November 2018

Time	Section I Room: A	Section II Room: B	Section III Room: C	Section IV Room: D
08:50 - 09:10	**Van Cleemput 33** Shortness coefficient of cyclically 4-edge-connected cubic graphs	**A. Klopp 34** Path-factors of edge-chromatic critical graphs	**M. Kiermaier 35** On the lengths of divisible codes	**Ch. Josten 36** Twin Partitions: trying to count every second real number
09:15 - 09:35	**I. Allie 37** Oddness to resistance ratios in cubic graphs	**A. Lozano 38** Caterpillars are antimagic	**C. Deppe 39** Coding and decoding algorithms for Q-ary error-correcting codes with feedback	**M. Walter 40** Extended formulations for radial cones
09:40 - 10:00	**E. Dahlhaus 41** Even cycles of cubic planar graphs	**T. Schweser 42** DP-colorings of hypergraphs	**L. Nölke 43** Packing anchored rectangles with resource augmentation	**H. Bergold 44** A combinatorial extension of the colorful carathéodory
10:00 - 10:30	*Coffee break*			
10:30 - 10:50	**O. Parczyk 45** Universality in randomly perturbed graphs	**S. Mohr 46** Kempe chains and rooted minors	**F. Ihringer 47** Regular intersecting families	**J. Syrovátková 48** Finding automaton maximizing score in prisoner's dilemma tournament
10:55 - 11:15	**J. Alvarado 49** Constrained graphons of maximum entropy	**A. Erey 50** Maximizing the number of colorings and independent sets	**M. Kwiatkowski 51** The graphs of projective codes	**Kantarcı Oğuz 52** A connection between peak and descent polynomials
11:20 - 11:40	**T. Laihonen 53** About a conjecture on identification in Hamming graphs	**J. Wiehe 54** Computing the NL-flow polynomial	**Vlahović Kruc 55** Some new quasi-symmetric designs on 56 points	**A. Haupt 56** Enumeration of S-omino towers
11:45 - 12:05	**J. Rollin 57** Induced arboricity	**M. Alipour 58** Graph operations and neighborhood polynomials	**L. A. Pham 59** Latin cubes with forbidden entries	**R. Bachmann 60** Binomial transforms and zeta series
12:05 - 13:15	*Lunch*			
13:15 - 14:10	**Bernd Sturmfels** The geometry of SDP-exactness in quadratic optimization **Room: E**			
14:10 - 14:40	*Coffee break*			
14:40 - 15:35	**Paul Seymour** Gyárfás-Sumner meets Erdős-Hajnal **Room: E**			
15:35 - 15:40	*Farewell*			

Invited talks

Bill Jackson (London)	: Rigidity of graphs and frameworks
Karen Meagher (Regina)	: Erdős-Ko-Rado theorems for permutations
Dion Gijswijt (Delft)	: Cap sets and new applications of the polynomial method
Bernd Sturmfels (Leipzig)	: The geometry of SDP-exactness in quadratic optimization
Paul Seymour (Princeton)	: Gyárfás-Sumner meets Erdős-Hajnal

Contributed talks

Maryam Alipour (Mittweida)	: Graph operations and neighborhood polynomials
Imran Allie (Cape Town)	: Oddness to resistance ratios in cubic graphs
Juan Alvarado (Leuven)	: Constrained graphons of maximum entropy
Stephan Dominique Andres (Hagen)	: The orthogonal graph colouring game
Rolf Bachmann (Bergisch Gladbach)	: Binomial transforms and zeta series
Isabel Beckenbach (Berlin)	: The tight cut decomposition of matching covered hypergraphs
Helena Bergold (Hagen)	: A combinatorial extension of the colorful carathéodory
Elias Dahlhaus (Darmstadt)	: Even cycles of cubic planar graphs
Christian Deppe (München)	: Coding and decoding algorithms for Q-ary error-correcting codes with feedback
Aysel Erey (Gebze)	: Maximizing the number of colorings and independent sets
Dirk Frettlöh (Bielefeld)	: Perfect colourings of regular graphs
Mikhail Ganzhinov (Helsinki)	: Largest sets of biangular lines in low-dimensional Euclidean spaces
Sevag Gharibian (Paderborn)	: On efficiently solvable cases of Quantum k-SAT
Jan Goedgebeur (Ghent)	: Generation of hypohamiltonian graphs
Heiko Harborth (Braunschweig)	: Numbers of crossings in drawings of the cycle graph
Meike Hatzel (Berlin)	: Perfect matching width, grids and directed cycles
Alexander Haupt (Hamburg)	: Enumeration of S-omino towers
Michaela Hiller (Aachen)	: Gallai-Edmonds-decompositions for balanced hypergraphs
Winfried Hochstättler (Hagen)	: The Varchenko determinant of an oriented matroid
Ferdinand Ihringer (Ghent)	: Regular intersecting families
Christoph Josten (Frankfurt a.M.)	: Twin Partitions: trying to count every second real number
Michael Kiermaier (Bayreuth)	: On the lengths of divisible codes
Antje Klopp (Paderborn)	: Path-factors of edge-chromatic critical graphs
Lukas Kölsch (Rostock)	: Optimal implementations of matrix multiplication in finite fields
Christina Kolb (Paderborn)	: Compact competitive polygonal routing: The case of pairwise intersecting convex hulls
Renata Vlahović Kruc (Zagreb)	: Some new quasi-symmetric designs on 56 points
Mariusz Kwiatkowski (Olsztyn)	: The graphs of projective codes

Tero Laihonen (Turku)	: About a conjecture on identification in Hamming graphs
Shuxing Li (Magdeburg)	: Constructions of primitive formally dual pairs having subsets with unequal sizes
Antoni Lozano (Barcelona)	: Caterpillars are antimagic
Kasper Szabo Lyngsie (Lyngby)	: A 3-decomposition theorem
Davide Mattiolo (Modena)	: On the circular flow number of graphs
Samuel Mohr (Ilmenau)	: Kempe chains and rooted minors
Lukas Nölke (Bremen)	: Packing anchored rectangles with resource augmentation
David Offner (Westminster)	: Polychromatic colorings on the hypercube
Ezgİ Kantarcı Oğuz (Istanbul)	: A connection between peak and descent polynomials
Mark Pankov (Olsztyn)	: Zigzags in embedded graphs. Z-knotted triangulations of surfaces
Olaf Parczyk (Ilmenau)	: Universality in randomly perturbed graphs
Lan Anh Pham (Umeå)	: Latin cubes with forbidden entries
Alexandr A. Polujan (Magdeburg)	: Homogeneous cubic bent functions: new from old
Jonathan Rollin (Hagen)	: Induced arboricity
M.V. Sangaranarayanan (Chennai)	: Partition functions for two-dimensional nearest neighbor Ising models and applications in chemistry
Manfred Scheucher (Berlin)	: Arrangements of pseudocircles: On circularizability
Ingo Schiermeyer (Freiberg)	: Gallai Ramsey numbers of complete graphs and odd cycles
Hendrik Schrezenmaier (Berlin)	: Equiangular polygon contact representations
Michael Schubert (Paderborn)	: Flows on signed graphs without long barbells
Thomas Schweser (Ilmenau)	: DP-colorings of hypergraphs
Martin Sonntag (Freiberg)	: Edge intersection hypergraphs
Yonutz Stanchescu (Tel Aviv)	: Additive combinatorics in ordered nilpotent groups
Raphael Steiner (Berlin)	: Metric colourings of graphs
Jana Syrovátková (Prague)	: Finding automaton maximizing score in prisoner's dilemma tournament
Ferenc Szöllősi (Helsinki)	: New constructions of few-distance sets
Kristijan Tabak (Zagreb)	: Viergruppen as Hamiltonian graphs
Nico Van Cleemput (Ghent)	: Shortness coefficient of cyclically 4-edge-connected cubic graphs
Matthias Walter (Aachen)	: Extended formulations for radial cones
Johanna Wiehe (Hagen)	: Computing the NL-flow polynomial
Sebastian Wiederrecht (Berlin)	: On perfect matchings in uniform balanced hypergraphs
Carol T. Zamfirescu (Ghent)	: Grinberg's criterion
Jean Paul Zerafa (Modena)	: An equivalent formulation of the Fan-Raspaud Conjecture and related problems
Hanane Zerdoum (Paris)	: Zero-sum problems in finite abelian groups

Further participants

Manuel Berkemeier (Paderborn)
Thomas Böhme (Ilmenau)
Chiara Cappello (Paderborn)
Alena Ernst (Paderborn)
Jonas Frede (Magdeburg)
Jan Gausemeier (Paderborn)
Maximilian Geißer (Freiberg)
Christian Günther (Paderborn)
Pranshu Gupta (Hamburg)
Ligang Jin (Jinhua)
Lars Kleinemeier (Paderborn)
Domenico Labbate (Potenza)
Giuseppe Mazzuoccolo (Verona)
Seyedfakhredin Musavishavazi (Mittweida)
Alexander Pott (Magdeburg)
Marco Ricci (Hagen)
Robert Scheidweiler (Paderborn)
Kai-Uwe Schmidt (Paderborn)
Qays Shakir (Galway)
Eckhard Steffen (Paderborn)
Michael Stiebitz (Ilmenau)
Ulrich Tamm (Bielefeld)
Carsten Thomassen (Lyngby)
Charlene Weiß (Paderborn)

Friday, 23 Nov. 2018 — Time: 09:05 - 10:00 — Room: E

Rigidity of graphs and frameworks

BILL JACKSON (London)

The first reference to the rigidity of frameworks in the mathematical literature occurs in a problem posed by Euler in 1776. Consider a polyhedron P in 3-space. We view P as a 'panel-and-hinge framework' in which the faces are 2-dimensional panels and the edges are 1-dimensional hinges. The panels are free to move continuously in 3-space, subject to the constraints that the shapes of the panels and the adjacencies between them are preserved, and that the relative motion between pairs of adjacent panels is a rotation about their common hinge. The polyhedron P is rigid if every such motion results in a polyhedron which is congruent to P. Euler conjectured that every polyhedron is rigid. The conjecture was verified for the case when P is convex by Cauchy in 1813. Gluck showed in 1975 that it is true when P is 'generic' i.e. there are no algebraic dependencies between the coordinates of the vertices of P. Connelly finally disproved Euler's conjecture in 1982 by constructing a polyhedron which is not rigid. I will describe results and open problems concerning the rigidity of various other types of frameworks. I will be mostly concerned with the generic case for which the problem of characterizing rigidity usually reduces to pure graph theory.

Friday, 23 Nov. 2018 — Time: 15:20 - 16:15 — Room: E

Erdős-Ko-Rado theorems for permutations

KAREN MEAGHER (Regina)

In 1964 Erdős, Ko and Rado determined the size and structure of the largest collection of intersecting sets. This result has become a cornerstone of extremal set theory and has been extended to many other objects. In this talk I will focus on versions of the Erdős-Ko-Rado Theorem for permutations.
Two permutations are intersecting if they both map some i to the same point (so σ and π are intersecting if and only if $\pi^{-1}\sigma$ has a fixed point). In 1977, Deza and Frankl proved that the size of a set of intersecting permutations is at most $(n-1)!$. It wasn't until 2003 that the sets of intersecting permutations that meet this bound were characterized. In fact, between 2003 and 2009 four different proofs of the characterization were published.
Since then, this area has developed greatly. One focus has been to determine the largest set of intersecting permutations in a group, rather than considering all the permutations in the symmetric group. Versions of the EKR theorem have been proven for specific groups. Recently the size of the maximum intersecting set of permutations from any 2-transitive group was determined using an algebriac approach. I will discuss this result and explore the feasibility of using this approach with transitive groups.

Friday, 23 Nov. 2018 — Time: 16:25 - 17:20 — Room: E

Cap sets and new applications of the polynomial method

DION GIJSWIJT (Delft)

A cap set is a subset of the space $GF(3)^n$ that does not contain an affine line. In dimension four, this relates to the famous card game SET: a cap set corresponds to a collection of cards without a SET. The cap set problem is concerned with upper bounds on the size of cap sets. The central question (raised by Frankl, Graham and Rödl) is: do cap sets have exponentially small density? In 2016, this 'cap set problem' was (very unexpectedly) resolved using the polynomial method. The proof is surprisingly short and simple. In this talk, I will explain the proof and discuss some generalisations and connections to other problems such as 'fast matrix multiplication'.

Saturday, 24 Nov. 2018 — Time: 13:15 - 14:10 — Room: E

The geometry of SDP-exactness in quadratic optimization

BERND STURMFELS (Leipzig)

Consider the problem of minimizing a quadratic objective subject to quadratic equations. We study the objective functions for which this problem is solved by its semidefinite relaxation. We characterize the boundary of this region and we derive a formula for its degree. This is joint work with Diego Cifuentes and Corey Harris.

Saturday, 24 Nov. 2018 — Time: 14:40 - 15:35 — Room: E

Gyárfás-Sumner meets Erdős-Hajnal

PAUL SEYMOUR (Princeton)

The Gyárfás-Sumner conjecture says that every graph with huge (enough) chromatic number and bounded clique number contains any given tree as an induced subgraph. The Erdős-Hajnal conjecture says that for every graph H, all graphs not containing H as an induced subgraph have a clique or stable set of polynomial size. This talk is about a third problem related to both of these, the following. Say an n-vertex graph is "c-coherent" if every vertex has degree $< cn$, and every two disjoint vertex subsets of size at least cn have an edge between them. To prove a given graph H satisfies the Erdős-Hajnal conjecture, it is enough to prove that H satisfies the conjecture in all c-coherent graphs and their complements, for $c > 0$ as small as we like. But for some graphs H, all c-coherent graphs contain H if c is small enough, so half of the task is done for free.
Which graphs H have this property? Paths do (proved by Bousquet, Lagoutte, and Thomassé, 2013), and non-forests don't. Liebenau and Pilipczuk conjectured that all forests do; and recently we have proved this (joint with Chudnovsky, Scott and Spirkl).
This follows from a result that for every forest H, all graphs not containing H or its complement as an induced subgraph have two disjoint linear sets of vertices, either with no edges between them ("anticomplete") or completely joined to one another ("complete"). Only forests and their complements have this property, but there is a conjecture of Conlon, Fox and Sudakov that for every graph H, every graph not containing H as an induced subgraph has two disjoint sets of vertices, either anticomplete or complete, where one is linear and the other is just polynomial-sized. We discuss some progress on this last conjecture (joint with Chudnovsky, Fox, Scott and Spirkl).

Friday, 23 Nov. 2018 — Time: 10:30 - 10:50

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1 — Section I — Room A — 10:30 - 10:50

Numbers of crossings in drawings of the cycle graph

HEIKO HARBORTH (Braunschweig)

For general drawings, rectilinear drawings, convex drawings, unit edge drawings, and convex unit edge drawings of the cycle graph C_n it is asked for the set of all possible numbers of crossings.

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2 — Section II — Room B — 10:30 - 10:50

The tight cut decomposition of matching covered hypergraphs

ISABEL BECKENBACH (Berlin)

We investigate the structure of hypergraphs that admit a perfect matching using ideas from the theory of matching covered graphs. First, we generalize the notions of a tight cut, a tight cut contraction, and a tight cut decomposition to hypergraphs and examine their properties. In particular, every tight cut decomposition of a hypergraph leads to a decomposition of its perfect matching polytope.
A graph might have distinct tight cut decompositions. However, Lovász showed that the indecomposable graphs, so-called bricks and braces, are always the same (up to multiplicity of edges) independent from the concrete decomposition. We prove that this remarkable result also holds for a slight generalization of uniform hypergraphs. Moreover, we show that the outcome of the tight cut decomposition on general hypergraphs is no longer unique.
This is joint work with Meike Hatzel and Sebastian Wiederrecht.

3 — Section III — Room C — 10:30 - 10:50

Constructions of primitive formally dual pairs having subsets with unequal sizes

SHUXING LI (Magdeburg)

The concept of formal duality was proposed by Cohn, Kumar and Schürmann, which reflects an unexpected symmetry among energy-minimizing periodic configurations. This formal duality was later on translated into a purely combinatorial property by Cohn, Kumar, Reiher and Schürmann, where the corresponding combinatorial object was called formally dual pair. Except one example, almost all known primitive formally dual pairs satisfy that the two subsets have the same size. In this talk, we propose a lifting construction framework and a recursive construction framework, which generate new primitive formally dual pairs from known ones. As an application, for $m \geq 2$, we obtain $m+1$ pairwise inequivalent primitive formally dual pairs in $\mathbb{Z}_2 \times \mathbb{Z}_4^{2m}$, which have subsets with unequal sizes.
This is a joint work with Alexander Pott.

4 — Section IV — Room D — 10:30 - 10:50

Partition functions for two-dimensional nearest neighbor Ising models and applications in chemistry

M.V. SANGARANARAYANAN (Chennai)

The exact solution of two-dimensional nearest neighbor Ising models in a non-zero magnetic field has remained elusive for the past six decades. For finite square lattices, the counting of black-white edges is shown to yield the partition function as well as other thermodynamic quantities such as magnetization, susceptibility and specific heat.
For the following Hamiltonian viz

$$H_T = -J \sum_{<ij>} \left(\sigma_{i,j}\sigma_{i,j+1} + \sigma_{i,j}\sigma_{i+1,j}\right) - H \sum \sigma_{i,j}$$

where J denotes the nearest neighbor interaction energy and H is the external magnetic field, the canonical partition function is defined as

$$Q\left(H,T\right) = \sum_{i=1}^{2^N} e^{-\frac{(H_T)_i}{kT}}$$

for to a square lattice of 16 sites will be computed using black-white edges. The significance of the results in chemistry will also be indicated.

Friday, 23 Nov. 2018 — Time: 10:55 - 11:15

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5 — Section I — Room A — 10:55 - 11:15

A 3-decomposition theorem

KASPER SZABO LYNGSIE (Lyngby)

The 3-Decomposition Conjecture by Hoffmann-Ostenhof states that every connected cubic graph has a decomposition into a spanning tree, a collection of cycles, and a matching. In this talk I will present a general 3-decomposition theorem which states that every connected graph can be decomposed into a spanning tree, an even graph, and a star forest. This result implies that every connected cubic graph has a decomposition into a spanning tree, a collection of cycles, and a forest in which each component is a path of length at most 2.
Joint work with Martin Merker.

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6 — Section II — Room B — 10:55 - 11:15

Edge intersection hypergraphs

MARTIN SONNTAG (Freiberg)

If $\mathcal{H} = (V, \mathcal{E})$ is a hypergraph, its *edge intersection hypergraph* $EI(\mathcal{H}) = (V, \mathcal{E}^{EI})$ has the edge set $\mathcal{E}^{EI} = \{e_1 \cap e_2 \mid e_1, e_2 \in \mathcal{E} \ \wedge \ e_1 \neq e_2 \ \wedge \ |e_1 \cap e_2| \geq 2\}$.
For some classes of hypergraphs $\mathcal{H}$, we investigate the structure of $EI^k(\mathcal{H})$, where $EI^k(\mathcal{H})$ is the hypergraph being obtained from $\mathcal{H}$ by applying the EI-operator k times to $\mathcal{H}$.
For $n \geq 24$, we prove that there is a 3-regular hypergraph $\mathcal{H} = (V, \mathcal{E})$ (which is 6-uniform for n even) with $\lceil \frac{n}{2} \rceil$ hyperedges and $EI(\mathcal{H}) = C_n$.
Note that there is a significant difference to the known notions of the *intersection graph* or *edge intersection graph* $G = (V(G), E(G))$ *of (linear) hypergraphs* $\mathcal{H} = (V(\mathcal{H}), \mathcal{E}(\mathcal{H}))$, since there we have $V(G) = \mathcal{E}(\mathcal{H})$. An analog remark holds for the notion of the *edge intersection graph of paths* and for intersection graphs in the sense of T.A. MCKEE, F.R. MCMORRIS: *Intersection graph theory*.
(joint work with HANNS-MARTIN TEICHERT (Universität zu Lübeck))

7 — Section III — Room C — 10:55 - 11:15

Zero-sum problems in finite abelian groups

HANANE ZERDOUM (Paris)

Let $(G, +, 0)$ be a finite abelian group and $S = g_1 g_2 \dots g_n$ a collection of elements of G. Does S contain a zero-sum subsequence?
Numerous variants of this problem exist; e.g., imposing a restriction on the length of the subsequence or considering sets instead of sequences (Harborth; Erdős-Ginzburg-Ziv).
I will concentrate on the Harborth constant denoted by $\mathrm{g}(G)$ and defined as the smallest integer k such that each square-free sequence over G of length at least k (equivalently each subset of cardinality at least k) has a subsequence of length $\exp(G)$ whose terms sum to 0 .
This constant was introduced by Harborth [Ein Extremalproblem für Gitterpunkte, J. Reine Angew. Math., 262/263 (1973)]; it is a variant of the Erdős-Ginzburg-Ziv constant. Its value is so far only known for a few types of groups.
We focus on groups of the form $C_3 \oplus C_{3n}$. As our main result we determine the exact value in case n is a prime number; concretely we show that $\mathrm{g}(G) = 3n + 3$ for prime $n \neq 3$ and $\mathrm{g}(C_3 \oplus C_9) = 13$.
In this talk, I will explain the two approaches that we followed to determine the value of the Harborth constant for the groups $C_3 \oplus C_{3n}$: a computational approach and a theoretical approach..

8 — Section IV — Room D — 10:55 - 11:15

The Varchenko determinant of an oriented matroid

WINFRIED HOCHSTÄTTLER (Hagen)

The *Varchenko matrix* M of a hyperplane arrangement is a symmetric square matrix indexed by the full dimensional regions of the arrangement, where M_{ij} equals the formal product of the indices of those hyperplanes separating the cells i and j. Varchenko proved in 1993 that the determinant of this matrix has a nice factorization. Using a proof strategy suggested by Denham and Henlon in 1999 we show that the same factorization works in the abstract setting of oriented matroids. For that purpose we show that every T-convex region of the set of topes, considered as a subcomplex of the Edelman poset, has a contractible order complex, which might be of independent interest.
This is joint work with Volkmar Welker.

Friday, 23 Nov. 2018 — Time: 11:20 - 11:40

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9 — Section I — Room A — 11:20 - 11:40

Grinberg's criterion

CAROL T. ZAMFIRESCU (Ghent)

Grinberg's hamiltonicity criterion states that given a plane graph G, a hamiltonian cycle S in G, and f_k (f'_k) k-gons inside (outside) of S,

$$\sum_{k\geq 3}(k-2)(f_k - f'_k) = 0$$

holds. We present a generalisation of this theorem and derive some consequences. In particular, we extend Zaks' version of the criterion, which encompasses results of Gehner and Shimamoto.
This talk is based on joint work with Gunnar Brinkmann.

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10 — Section II — Room B — 11:20 - 11:40

On perfect matchings in uniform balanced hypergraphs

SEBASTIAN WIEDERRECHT (Berlin)

A graph is called matching covered if it is connected and every edge is contained in a perfect matching, it is k-extendable if every matching of size at most k can be extended to a perfect matching. Especially for bipartite graphs these two properties are well understood and, especially due to Lovász and Plummer, many characerisations for these properties are known.
We generalise some of these characterisations of matching covered bipartite graphs to the class of uniform balanced hypergraphs. With a slight generalisation of the idea of matching covered we are able to draw parallels between matching covered uniform balanced hypergraphs and their duals which leads to the central observation: A connection between minimum vertex covers and maximum stable sets. With this observation we are able to lift our results from matching covered to k-extendability.

11 — Section III — Room C — 11:20 - 11:40

Viergruppen as Hamiltonian graphs

KRISTIJAN TABAK (Zagreb)

An elementary abelian group E_{2^k} is a group of order 2^k and exponent 2. We will say that two Klein groups are connected with an edge if and only if they have common involution. We investigate under what conditions collection of all Klein Viergrupen that are contained in E_{2^k} (where $k > 2$) make a Hamiltonian graph. For some small k answer is trivial. For example, a classical results from graph theory are not applicable for $k = 5$. However, for the case $k = 5$ we menage to construct Hamiltonian cycle using purely algebraic tools.

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12 — Section IV — Room D — 11:20 - 11:40

On efficiently solvable cases of Quantum k-SAT

SEVAG GHARIBIAN (Paderborn)

The constraint satisfaction problems k-SAT and Quantum k-SAT (k-QSAT) are canonical NP-complete and QMA_1-complete problems (for $k \geq 3$), respectively, where QMA_1 is a quantum generalization of NP with one-sided error. Whereas k-SAT has been well-studied for special tractable cases, as well as from a parameterized complexity perspective, much less is known in similar settings for k-QSAT. Here, we study the open problem of computing satisfying assignments to k-QSAT instances which have a "matching" or *system of distinct representatives*; this is an NP problem whose decision variant is trivial, but whose search complexity remains open.

Among other results, our main contribution is a parameterized algorithm for k-QSAT instances from a certain non-trivial class, which allows us to obtain exponential speedups over brute force methods in some cases. This is, to our knowledge, the first known such parameterized algorithm. The techniques behind our work stem from algebraic geometry, although no background in the topic is required for this presentation. Along the way, we will require the new concept of *transfer filtrations* on hypergraphs, for which we leave certain complexity theoretic questions open.

Joint work with Marco Aldi (Virginia Commonwealth University), Niel de Beaudrap (University of Oxford), and Seyran Saeedi (Virginia Commonwealth University)

Friday, 23 Nov. 2018 — Time: 11:45 - 12:05

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13 — Section I — Room A — 11:45 - 12:05

Gallai Ramsey numbers of complete graphs and odd cycles

INGO SCHIERMEYER (Freiberg)

Given a graph H, the k-coloured Gallai Ramsey number $gr_k(K_3 : H)$ is defined to be the minimum integer n such that every k-colouring (using all k colours) of the complete graph on n vertices contains either a rainbow triangle or a monochromatic copy of H. In 2015, Fox, Grinshpun, and Pach conjectured the value of the Gallai Ramsey numbers for complete graphs. We verify this conjecture for the first open case when $H = K_4$. For the case $H = K_5$ we will show that the validity of the conjecture depends on the exact value of the (unknown) Ramsey number $r(K_5, K_5)$. We also present the Gallai Ramsey numbers $gr_k(K_3 : C_{2p+1})$ for all odd cycles C_{2p+1}.
This joint work with Akira Saito, Zhao Wang, Yaping Mao, Colton Magnant, and Jinyu Zou.

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14 — Section II — Room B — 11:45 - 12:05

Gallai-Edmonds-decompositions for balanced hypergraphs

MICHAELA HILLER (Aachen)

The class of balanced hypergraphs was defined by Claude Berge in the 70s and studied as one possible generalisation of bipartite graphs. Indeed, bipartite graphs and balanced hypergraphs share many important combinatorial features, e.g., strong coloring properties. Moreover, there exist Kőnig- and Hall-type theorems for this hypergraph class.
We present a Gallai-Edmonds-Decomposition for balanced hypergraphs. Additionally, we introduce a slight relaxation of matchings in hypergraphs for which we investigate relations to the vertex cover problem and discuss a generalisation of our Gallai-Edmonds-Decomposition.

This is joint work with Robert Scheidweiler and Eberhard Triesch.

15 — Section III — Room C — 11:45 - 12:05

Additive combinatorics in ordered nilpotent groups

YONUTZ STANCHESCU (Tel Aviv)

We will discuss several recent results in additive combinatorics. More precisely, we will describe some structural results for finite subsets S with small doubling property in ordered (nilpotent) groups. Joint work with G. A. Freiman, M. Herzog, P. Longobardi and M. Maj.

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16 — Section IV — Room D — 11:45 - 12:05

Perfect matching width, grids and directed cycles

MEIKE HATZEL (Berlin)

A graph G is called *matching covered* if it is connected and every edge of G is contained in a perfect matching. *Perfect matching width* is a width parameter for matching covered graphs based on a branch decomposition. It was introduced by Norine and intended as a tool for the structural study of matching covered graphs, especially in the context of Pfaffian orientations. Norine conjectured that graphs of high perfect matching width would contain a large grid as a matching minor, similar to the result on treewidth by Robertson and Seymour.

In this talk I want to present that the bipartite case of Norines conjecture is equivalent to the Directed Grid Theorem by Kawarabayashi and Kreutzer for directed treewidth. This settles the first part of the conjecture and also implies that perfect matching width generalises both (undirected) treewidth and directed treewidth.

An important tool is the *cyclewidth* which is a width measure for directed graphs based on a branch decomposition. This measure in itself provides a nice new tool to understand the connection between directed graphs and bipartite graphs.

Friday, 23 Nov. 2018 — Time: 13:15 - 13:35

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17 — Section I — Room A — 13:15 - 13:35

An equivalent formulation of the Fan-Raspaud Conjecture and related problems

JEAN PAUL ZERAFA (Modena)

In 1994, it was conjectured by Fan and Raspaud that every simple bridgeless cubic graph has three perfect matchings whose intersection is empty. In this talk we solve a problem recently proposed by Mkrtchyan and Vardanyan by giving an equivalent formulation of the Fan-Raspaud Conjecture. We also study a possible weaker conjecture which states that in every simple bridgeless cubic graph there exist two perfect matchings such that the complement of their union is a bipartite graph. We here show that this conjecture can be equivalently stated using H-colourings, we prove it for graphs having oddness at most four and extend it to bridgeless cubic multigraphs and certain cubic graphs having bridges.

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18 — Section II — Room B — 13:15 - 13:35

Perfect colourings of regular graphs

DIRK FRETTLÖH (Bielefeld)

A vertex colouring of some graph G is called *perfect* if each vertex of colour i has exactly a_{ij} neighbours of colour j. E.g., if one red vertex is adjacent to one black vertex, one red vertex and two green vertices, then each red vertex in G is adjacent to one black vertex, one red vertex and two green vertices. Being perfect imposes several restrictions on the colour incidence matrix (a_{ij}). This talk surveys several (old and new) necessary conditions for a matrix to be the colour incidence matrix of a perfect colouring. As an application we determine all perfect colourings of the edge graphs of the Platonic solids with two, three and four colours, respectively.

19 — Section III — Room C — 13:15 - 13:35

New constructions of few-distance sets

FERENC SZÖLLŐSI (Helsinki)

Let $d \geq 1, n \geq 2, s \geq 2$ be integers, and let R^d denote the d-dimensional Euclidean space equipped with the usual Euclidean metric μ. An n-element set of vectors $\mathcal{X} := \{x_1, \dots, x_n\} \subset R^d$ is called an s-distance set, if the cardinality of the set of distances $A(\mathcal{X}) := \{\mu(x_i, x_j)\colon 1 \leq i < j \leq n\}$ is exactly s. In this talk I will report on a new computer-aided approach towards the construction and classification of s-distance sets. I will discuss some new results in R^3 and R^4.

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20 — Section IV — Room D — 13:15 - 13:35

Equiangular polygon contact representations

HENDRIK SCHREZENMAIER (Berlin)

Planar graphs are known to have contact representations of various types. The most prominent example is Koebe?s 'kissing coins theorem'. Its rediscovery by Thurston lead to effective versions of the Riemann Mapping Theorem and motivated Schramm's Monster Packing Theorem. Monster Packing implies the existence of contact representations of planar triangulations where each vertex v is represented by a homothetic copy of a given smooth strictly-convex prototype P_v.
In this talk I will present results concerning computable approximations of Schramm representations. For fixed K, approximate P_v by an equiangular K-gon Q_v with horizontal basis. From Schramm's work it follows that the given triangulation also has a contact representation with homothetic copies of these K-gons. Our approach starts by guessing a K-contact-structure, i.e., the combinatorial structure of a contact representation. From the combinatorial data, we build a system of linear equations whose variables correspond to lengths of boundary segments of the K-gons. If the system has a non-negative solution, this yields the intended contact representation. If the solution of the system contains negative variables, these can be used as sign-posts indicating how to change the K-contact-structure for another try.
The procedure has been implemented. It always computed the solution with few iterations. I will present statistical data of the experiments and visualizations of the procedure leading to the conjecture that the procedure always terminates with a solution. Nevertheless, a proof is still missing.
This is joint work with Stefan Felsner and Raphael Steiner.

Friday, 23 Nov. 2018 — Time: 13:40 - 14:00

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21 — Section I — Room A — 13:40 - 14:00

Generation of hypohamiltonian graphs

JAN GOEDGEBEUR (Ghent)

We will present a new algorithm to generate all non-isomorphic hypohamiltonian graphs of a given order. (A graph G is *hypohamiltonian* if G is non-hamiltonian and $G - v$ is hamiltonian for every $v \in V(G)$).
Using this algorithm, we were able to generate complete lists of hypohamiltonian graphs of much larger orders than what was previously possible. This allowed us amongst others to find the smallest hypohamiltonian graph of girth 6 and to show that the smallest planar hypohamiltonian graph has order at least 23.
This is joint work with Carol Zamfirescu.

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22 — Section II — Room B — 13:40 - 14:00

Polychromatic colorings on the hypercube

DAVID OFFNER (Westminster)

Let G be a fixed subgraph of the hypercube. If an edge-coloring of the hypercube has the property that every copy of G contains an edge of every color, this coloring is called *G-polychromatic*. Denote by $p(G)$ the maximum number of colors with which it is possible to G-polychromatically color the edges of *any* hypercube. This parameter was originally introduced by Alon, Krech and Szabó in 2007 as a way to prove bounds for Turán type problems on the hypercube. This talk will survey our current understanding of polychromatic colorings on the hypercube, as well as some natural generalizations and open problems.

23 — Section III — Room C — 13:40 - 14:00

Largest sets of biangular lines in low-dimensional Euclidean spaces

MIKHAIL GANZHINOV (Helsinki)

A set of lines in Euclidean space is called biangular if the angle between each pair of lines can have only two values. In this computer-aided work we use a combined approach of isomorph-free exhaustive generation of Gram matrices with indeterminate angles and Gröbner basis computation to classify the largest biangular sets of nonorthogonal lines. Classification up to dimension 5 is obtained. This is joint work with Ferenc Szöllősi and Patric Östergård.

24 — Section IV — Room D — 13:40 - 14:00

Zigzags in embedded graphs. Z-knotted triangulations of surfaces

MARK PANKOV (Olsztyn)

Zigzags (known also as Petrie paths) was first considered by Coxeter. Latter, they were investigated in other objects, in particular, in graphs embedded in surfaces. An object is called z-knotted if it has a single zigzag. We show that every triangulation of any closed 2-dimensional surface admits a z-knotted shredding. The construction is based on the concept of z-monodromy. This is a joint work with my Ph.D student Adam Tyc (Institute of Mathematics, Polish Academy of Science). The talk is dedicated to the memory of my friend and mentor Michel Marie Deza who revealed me the zigzag world.

Friday, 23 Nov. 2018 — Time: 14:05 - 14:25

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25 — Section I — Room A — 14:05 - 14:25

Flows on signed graphs without long barbells

MICHAEL SCHUBERT (Paderborn)

In general, flows on signed graphs do not maintain most of the properties of Tutte's flow theory for unsigned graphs. However, for the class of signed graphs without long barbells many properties that hold for unsigned graphs remain valid. Let $\mathcal{B}$ be the class of flow-admissible signed graphs that do not contain a long barbell. We verify Bouchet's 6-flow conjecture for the class $\mathcal{B}$. Furthermore, for $k \geq 3$ and $k \neq 4$ we show that a signed graph $(G, \sigma) \in \mathcal{B}$ admits a nowhere-zero modulo k-flow if and only if (G, σ) admits a nowhere-zero integer k-flow. This is joint work with You Lu, Rong Luo, Eckhard Steffen, and Cun-Quan Zhang.

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26 — Section II — Room B — 14:05 - 14:25

Metric colourings of graphs

RAPHAEL STEINER (Berlin)

We introduce a notion of *metric colourings* for graphs which comes as a natural generalization of the *circular chromatic number* introduced by Vince and studied in numerous papers since then. Given a graph G and a metric space (X, d), such colourings are maps $c : V(G) \to X$ with the property that $d(c(u), c(w)) \geq m$ for any edge uw and a constant $m \in \mathbb{R}_+$. This notion includes standard graph colourings and circular colourings as subcases. Among many others, one may consider metric colourings on various bounded sets in the plane, d-dimensional spheres equipped with the orthodromic distance or of d-dimensional tori equipped with an adapted maximum metric. Natural questions that arise ask for the densest embedding of a graph in the sense of the maximum size of m or the minimal "size" of the metric space according to some measure for which a colouring of a fixed graph exists. We study the relations of the obtained graph colouring parameters with the standard (fractional and circular) chromatic number. It turns out that finding upper and lower bounds on these numbers is closely related to packings and coverings with unit balls in metric spaces. Considering the case of multidimensional tori, we deal with a minimization problem for products of circular chromatic numbers in graph unions.

27 — Section III — Room C — 14:05 - 14:25

Homogeneous cubic bent functions: new from old

ALEXANDR A. POLUJAN (Magdeburg)

The problem of constructing homogeneous bent functions arises from efficient evaluation of certain cryptographic algorithms. In this talk we explain how one can construct many new homogeneous cubic bent functions from just a single one. Based on our approach, we constructed more than 2^{20} homogeneous cubic bent functions in $n = 12$ variables, which is much greater than the number of previously known examples of such functions.

Although there are many examples of bent functions, it is in general difficult to show whether bent functions are equivalent or not. Further nontrivial analysis of our examples shows the existence of homogeneous cubic bent functions inequivalent to any of the previously known ones.

This is joint work with Alexander Pott.

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28 — Section IV — Room D — 14:05 - 14:25

Arrangements of pseudocircles: On circularizability

MANFRED SCHEUCHER (Berlin)

An arrangement of pseudocircles is a collection of simple closed curves on the sphere or in the plane such that any two of the curves are either disjoint or intersect in exactly two crossing points. We call an arrangement intersecting if every pair of pseudocircles intersects twice. An arrangement is circularizable if there is a combinatorially equivalent arrangement of circles.
We present the results of the first thorough study of circularizability. We show that there are exactly four non-circularizable arrangements of 5 pseudocircles (one of them was known before). In the set of 2131 digon-free intersecting arrangements of 6 pseudocircles we identify the three non-circularizable examples.
Most of our non-circularizability proofs depend on incidence theorems like Miquel's. In other cases we contradict circularizability by considering a continuous deformation where the circles of an assumed circle representation grow or shrink in a controlled way.
The claims that we have all non-circularizable arrangements with the given properties are based on a program that generated all arrangements up to a certain size. Given the complete lists of arrangements, we used heuristics to find circle representations. Examples where the heuristics failed were examined by hand.

Friday, 23 Nov. 2018 — Time: 14:30 - 14:50

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29 — Section I — Room A — 14:30 - 14:50

On the circular flow number of graphs

DAVIDE MATTIOLO (Modena)

Given a real number $r \geq 2$, a *circular nowhere-zero r-flow*, or r-CNZF, in a graph $G = (V, E)$ is an assignment $f\colon E \to [1, r-1]$ and an orientation D of G, such that, at every $x \in V$, the sum of incoming flow values equals the sum of outgoing ones in the orientation D. The *circular flow number* $\Phi_c(G)$ of G is the least r such that G admits an r-CNZF. It is known that the study of many flow problems can be reduced to cubic graphs. When dealing with such graphs, an equivalent formulation of the circular flow number can be given by using bisections. In the first part of this talk we present some remarks about 2-bisections of cubic graphs, needed to compute the circular flow number of cubic graphs. Afterwards we improve the best known upper bound for $\Phi_c(G_{2t+1})$, where G_{2t+1} is the Goldberg snark on $8(2t+1)$ vertices. Finally we show a result that certificates the circular flow number of a graph to be 5 whenever the circular flow number of some of its expansions is 5.

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30 — Section II — Room B — 14:30 - 14:50

The orthogonal graph colouring game

STEPHAN DOMINIQUE ANDRES (Hagen)

In the *m-colour mutually orthogonal Latin squares game* two players alternately fill entries of two $(n \times n)$-squares with one of m colours, so that the partial colourings obey the rules for orthogonal Latin squares. In each move the players may choose the square, however, each square belongs to one of the players. At the end, if no move is possible, the player who owns the square with the most filled entries wins, otherwise, i.e. if the number of entries are equal, there is a tie. We present a strategy of the second player to force a tie. This result can be generalised to a game using orthogonal proper colourings of a pair of isomorphic graphs with a *strictly matched involution*.
This is joint work with Melissa Huggan, Fionn Mc Inerney, and Richard Nowakowski.

31 — Section III — Room C — 14:30 - 14:50

Optimal implementations of matrix multiplication in finite fields

LUKAS KÖLSCH (Rostock)

In the past, two different metrics for the implementation cost of matrix multiplications have been introduced. Roughly speaking, the first one measures the number of nonzeros in the matrix while the second one measures the number of Gauss-steps it takes to transform the matrix into the identity matrix. Using purely combinatorical ideas, we are able to find families of matrices with certain extremal properties with respect to these two metrics. We also present results about upper bounds of implementation costs for matrices that correspond to mappings $x \mapsto \alpha x$ with $\alpha \in \mathbb{F}_{2^n}$.

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32 — Section IV — Room D — 14:30 - 14:50

Compact competitive polygonal routing: The case of pairwise intersecting convex hulls

CHRISTINA KOLB (Paderborn)

Consider a set S of nodes with geographic positions in the Euclidean plane $\mathbb{R}^2$ and outside of a set P of non-intersecting polygons in $\mathbb{R}^2$. Our goal is to come up with a compact representation of P so that c-competitive paths can be found between all source-destination pairs $s, t \in S$ that avoid the polygons in P. A path from s to t is called c-competitive if its length is at most c times the shortest path length of a path from s to t avoiding P, where by *avoid* we mean that the path does not use any inner part of a polygon in P. In a global setting, where all nodes in S know all polygons of P, it is trivial to compute 1-competitive paths. However, our aim is to find a compact representation of P in a distributed setting that still allows us to find c-competitive paths for some constant c. In this talk, we present our first ideas, where we consider the case that the convex hulls of polygons of P are at most pairwise overlapping.

Saturday, 24 Nov. 2018 — Time: 08:50 - 09:10

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33 — Section I — Room A — 08:50 - 09:10

Shortness coefficient of cyclically 4-edge-connected cubic graphs

NICO VAN CLEEMPUT (Ghent)

The shortness coefficient of a class of graphs is the limit of the infimum over all graphs in the class of the ratio of the length of the longest cycle in such a graph and the number of vertices in that graph.
Grünbaum and Malkevitch proved that the shortness coefficient of cyclically 4-edge-connected cubic planar graphs is at most $\frac{76}{77}$. Recently, this was improved to $\frac{359}{366}(< \frac{52}{53})$ and the question was raised whether this can be strengthened to $\frac{41}{42}$, a natural bound inferred from one of the Faulkner-Younger graphs. We prove that the shortness coefficient of cyclically 4-edge-connected cubic planar graphs is at most $\frac{37}{38}$. We also show that $\frac{45}{46}$ is an upper bound for the shortness coefficient of cyclically 4-edge-connected cubic graphs that are (i) planar with face lengths bounded above by some constant larger than 22, or (ii) of genus g for any prescribed $g \geq 0$. Finally, for the shortness coefficient of general cyclically 4-edge-connected cubic graphs we prove a theorem that implies the recently given upper bound $\frac{7}{8}$ of Máčajová and Mazák.
This is joint work with On-Hei S. Lo, Jens M. Schmidt, and Carol T. Zamfirescu.

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34 — Section II — Room B — 08:50 - 09:10

Path-factors of edge-chromatic critical graphs

ANTJE KLOPP (Paderborn)

In 1968 Vizing conjectured that every edge-chromatic critical graph has a 2-factor. A 2-factor of a graph G is a spanning subgraph, whose components are cycles. Instead of cycles we look at factors of G, whose components are paths or cycles, so-called [1,2]-factors. We show, that every edge-chromatic critical graph has a [1,2]-factor. Further we characterize all [1,2]-factors of edge-chromatic critical graphs. Especially we give a characterization for maximum [1,2]-factors.
This is joint work with Eckhard Steffen.

35 — Section III — Room C — 08:50 - 09:10

On the lengths of divisible codes

MICHAEL KIERMAIER (Bayreuth)

A linear code C is said to be Δ-*divisible* if all its Hamming weights are multiples of Δ. The main case of interest is that Δ is a power of the characteristic of the base field. Divisible codes have been introduced by Ward in 1981. His *divisible code bound* restricts the dimension of divisible codes. In this talk, we focus on the lengths of q^r-divisible $\mathbb{F}_q$-linear codes, without any restriction on the dimension.
As the length of a divisible can always be increased by adding an arbitrary number of all-zero coordinates, it is natural to look at the *effective length*, which is the number of coordinates which are not all-zero. For that purpose, the $S_q(r)$-adic expansion of an integer n is introduced. It is shown that there exists a q^r-divisible $\mathbb{F}_q$-linear code of effective length n if and only if the leading coefficient of the $S_q(r)$-adic expansion of n is non-negative.
This result has applications in the field of q-analog combinatorics. We get an improvement of the Johnson bound for constant dimension subspace codes. Furthermore, a recent theorem of Năstase and Sissokho on the maximum sizes of partial spreads follows as a corollary.
This is joint work with Sascha Kurz.

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36 — Section IV — Room D — 08:50 - 09:10

Twin Partitions: trying to count every second real number

CHRISTOPH JOSTEN (Frankfurt a.M.)

The integers can be partitioned – quite trivially – into two congruent subsets (even and odd) of the same order type in an interwoven way (so that between each two elements of one of the subsets there is one of the other). This can be done for the rational numbers relatively easy as well. For which linear orderings do such twin partitions exist? We examine the rather delicate case of the real numbers (where there are certain negative results by Holland and Lebesgue) that amounts to the question of convergence of the 'every-second-interval' sequence (in two dimensions: the 'chessboard' sequence) within the Cantor space. This leads to ultrafilter subsets. Most of the results are long – but perhaps not too well – known.

Saturday, 24 Nov. 2018 — Time: 09:15 - 09:35

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37 — Section I — Room A — 09:15 - 09:35

Oddness to resistance ratios in cubic graphs

IMRAN ALLIE (Cape Town)

Let G be a bridgeless cubic graph. Oddness (weak oddness) is defined as the minimum number of odd components in a 2-factor (an even factor) of G, denoted as $\omega(G)$ ($\omega'(G)$). Oddness and weak oddness have been referred to as *measurements of uncolourability*, due to the fact that $\omega(G) = 0$ and $\omega'(G) = 0$ if and only if G is 3-edge-colourable. Another so-called measurement of uncolourability is resistance, defined as the minimum number of edges that can be removed from G such that the resulting graph is 3-edge-colourable, denoted as $r(G)$. It is easily shown that $\omega(G) \geq \omega'(G) \geq r(G)$. While it has been shown that the difference between any two of these measures can be arbitrarily large, it has been conjectured that $\omega'(G) \leq 2r(G)$, and that if G is a snark then $\omega(G) \leq 2r(G)$. In this talk, we disprove the latter by showing that the ratio of oddness to weak oddness can be arbitrarily large. We also offer some insights into the former conjecture by defining what we call *resistance reducibility*, and conjecturing that $r(G) > 2$ implies that G is such resistance reducible. A conjecture which if true, implies that indeed $\omega'(G) \leq 2r(G)$.

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38 — Section II — Room B — 09:15 - 09:35

Caterpillars are antimagic

ANTONI LOZANO (Barcelona)

An *antimagic labeling* of a graph G is an injection from $E(G)$ to $\{1, 2, \ldots, |E(G)|\}$ such that all vertex sums are pairwise distinct, where the *vertex sum* at vertex u is the sum of the labels assigned to edges incident to u. A graph is called *antimagic* when it has an antimagic labeling. Hartsfield and Ringel conjectured that every simple connected graph other than K_2 is antimagic and the conjecture remains open even for trees. Here we prove that caterpillars are antimagic by means of an $O(n \log n)$ algorithm.
This is joint work with Mercè Mora and Carlos Seara.

39 — Section III — Room C — 09:15 - 09:35

Coding and decoding algorithms for Q-ary error-correcting codes with feedback

CHRISTIAN DEPPE (München)

It is still an unsolved problem to determine the capacity-error-function for q-ary error-correcting codes with feedback if $q > 2$. For big error fractions ($\tau \geq \frac{1}{q}$) we introduce new algorithms. We give optimal strategies for which it is not necessary to give feedback after every symbol and show that we can achieve the same rate as with full feedback for big error fractions. For small error fraction ($\tau < \frac{1}{q}$) we analyze Lebedev's algorithm. Furthermore, we consider special q-ary asymmetric error-correcting codes with feedback and give a coding algorithm. We give the capacity-error-function for these channels. The channels we consider are generalizations of the Z-channel and are special cases of q-ary Varshamov channels. This coding algorithm is also a search algorithm for an extension of the Renyi-Ulam-Berlekamp game.
Joint work with Vladimir Lebedev (Kharkevich Institute for Information Transmission Problems.

40 — Section IV — Room D — 09:15 - 09:35

Extended formulations for radial cones

MATTHIAS WALTER (Aachen)

In this talk we discuss extended formulations for radial cones at vertices of polyhedra, where the radial cone of a polyhedron P at a vertex $v \in P$ is the polyhedron defined by the constraints of P that are active at v. Given an extended formulation for P, it is easy to obtain an extended formulation of the same for each its radial cones. On the contrary, it is possible that radial cones of P admit much smaller extended formulations than P itself. A prominent example of this type is the perfect-matching polytope, which cannot be described by subexponential-size extended formulations (Rothvoß 2014). However, Ventura & Eisenbrand (2003) showed that its radial cones can be described by polynomial-size extended formulations. Moreover, they generalized their construction to V-join polyhedra. In the same paper, the authors asked whether the same holds for the odd-cut polyhedron, the blocker of the V-join polyhedron. We answer this question negatively. Precisely, we show that radial cones of odd-cut polyhedra cannot be described by subexponential-size extended formulations. To obtain our result, for a polyhedron P of blocking type, we establish a general relationship between its radial cones and certain faces of the blocker of P.

Saturday, 24 Nov. 2018 — Time: 09:40 - 10:00

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41 — Section I — Room A — 09:40 - 10:00

Even cycles of cubic planar graphs

ELIAS DAHLHAUS (Darmstadt)

We consider any cycle of a cubic planar graph of even length. The question is, for which such cycles, the inner vertices and edges can be replaced in such a way such that all faces have even length. We label the vertices of such a cycle alternately by +1 and -1. Vertices of the cycle with an edge in the outside direction are called outer vertices, vertices of the cycle with an edge in direction inside the cycle are called inner vertices. We will find out that the inner vertices and edges of a cycle of even length of a cubic planar graph can be replaced in such a way that all faces are of even length if an only if the sum of labels of inner vertices is 0 modulo 3.

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42 — Section II — Room B — 09:40 - 10:00

DP-colorings of hypergraphs

THOMAS SCHWESER (Ilmenau)

In order to solve a question on list coloring of planar graphs, Dvořák and Postle introduced the concept of DP-coloring, which shifts the problem of finding a coloring of a graph G from a given list L to finding an independent transversal in an auxiliary cover-graph H with vertex set $\{(v,c) \mid v \in V(G), c \in L(v)\}$. This leads to a new graph parameter, called the DP-chromatic number $\chi_{\mathrm{DP}}(G)$ of G, which is an upper bound for the list-chromatic number $\chi_\ell(G)$ of G. The DP-coloring concept was anaylized in detail by Bernshteyn, Kostochka, and Pron for graphs and multigraphs; they characterized DP-degree colorable multigraphs and deduced a Brooks' type result from this. In this talk, we will extend the concept of DP-colorings to hypergraphs having multiple (hyper-)edges. We characterize the DP-degree colorable hypergraphs and, furthermore, the corresponding 'bad' covers. This gives a Brooks' type result for the DP-chromatic number of a hypergraph.

43 — Section III — Room C — 09:40 - 10:00

Packing anchored rectangles with resource augmentation

LUKAS NÖLKE (Bremen)

The problem of packing anchored rectangles is defined as follows. Given a set P of n points in the unit square, including the origin, we are tasked with finding a set of disjoint, axis-aligned rectangles, each rooted at their lower-left corner in a point of P, that maximizes the total area of the square covered by the rectangles. Allen Freedman conjectured 50 years ago, that, independent of P, there is an anchored rectangle packing covering an area of at least $1/2$. In this talk, we investigate the optimization problem with two types of resource augmentation. In the first, we allow each point in P to be moved by a small amount $\varepsilon > 0$ within the unit square. For this setting, we give a polynomial time algorithm that finds a set of rectangles that covers an area at least as big as the optimal solution to the original problem. In the second, we allow the rectangles to overlap by a strip of width at most $\varepsilon > 0$. Here, we give a polynomial time algorithm that finds a set of rectangles that covers at least a $(1 - \varepsilon)$-fraction of the area that the optimal solution to the original problem does.

This is joint work with Antonios Antoniadis, Andrés Cristi, and Ruben Hoeksma.

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44 — Section IV — Room D — 09:40 - 10:00

A combinatorial extension of the colorful carathéodory

HELENA BERGOLD (Hagen)

Carathéodorys Theorem of convex hulls plays an important role in the convex geometry. In 1982, Bárány formulated and proved a more general version, called the Colorful Carathéodory. This colorful version was even more generalized by Andreas F. Holmsen in 2016. He formulated a combinatorial extension using the terms of matroids and oriented matroids. Taking a dual point of view we gain an equivalent formulation of Holmsen's result that has a more geometric meaning. (Joint work with Winfried Hochstättler)

Saturday, 24 Nov. 2018 — Time: 10:30 - 10:50

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45 — Section I — Room A — 10:30 - 10:50

Universality in randomly perturbed graphs

OLAF PARCZYK (Ilmenau)

We denote by $\mathcal{F}(n,\Delta)$ the family of all graphs on n vertices with maximum degree Δ and call a graph $\mathcal{F}(n,\Delta)$-universal if it contains all graphs from the family simultaneously. It is belived, that the threshold for $\mathcal{F}(n,\Delta)$-universality in the binomial random graph $G(n,p)$ is determined by the $K_{\Delta+1}$-factor, which gives $(n^{-1}\log^{1/\Delta} n)^{2/(\Delta+1)}$. This was confirmed by Ferber, Kronenberg, and Luh for $\Delta = 2$, while for larger Δ already the single containment problem is open.
We study the model of randomly perturbed dense graphs, that is, for any constant $\alpha > 0$, the union of some n-vertex graph G_α with minimum degree at least αn and $G(n,p)$. Together with Böttcher, Montgomery, and Person we resolved the single containment problem for $\mathcal{F}(n,\Delta)$ in $G_\alpha \cup G(n,p)$, showing that $n^{-2/(\Delta+1)}$ is sufficient. This $\log$-term difference in comparison to the threshold in $G(n,p)$ is optimal and typical for this model. We believe that $n^{-2/(\Delta+1)}$ also gives the threshold for $\mathcal{F}(n,\Delta)$-universality in $G_\alpha \cup G(n,p)$ and present a proof for $\Delta = 2$.

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46 — Section II — Room B — 10:30 - 10:50

Kempe chains and rooted minors

SAMUEL MOHR (Ilmenau)

A transversal of a partition is a set which contains exactly one member from each member of the partition and nothing else. We study the following problem. Given a transversal T of a proper colouring C of order k of some graph G, is there a partition H of a subset of $V(G)$ into connected sets such that T is a transversal of H and such that two sets of H are adjacent if their corresponding vertices from T are connected by a path using only two colours?
This is open for each $k \geq 5$; here we consider some positive results if $k = 5$ and disprove it for $k = 7$.

47 — Section III — Room C — 10:30 - 10:50

Regular intersecting families

FERDINAND IHRINGER (Ghent)

Erdős, Ko and Rado showed that an intersecting family $\mathcal{F}$ of k-sets of $\{1,\ldots,n\}$, $n \geq 2k$, has at most size $\binom{n-1}{k-1}$. For $n > 2k$ equality occurs if and only if $\mathcal{F}$ consists of all k-sets which contain one fixed element. Let $\delta(x)$ denote the degree of an element $x \in \{1,\ldots,n\}$, that is the number of members of $\mathcal{F}$ which contain x. The higher moments of $\delta(x)$ are large whenever $|\mathcal{F}|$ is close to $\binom{n-1}{k-1}$, so it is natural to consider restrictions on $\delta(x)$. In our talk we discuss bounds and constructions for *regular intersecting families*: $\mathcal{F}$ for which $\delta(x)$ is constant.

48 — Section IV — Room D — 10:30 - 10:50

Finding automaton maximizing score in prisoner's dilemma tournament

JANA SYROVÁTKOVÁ (Prague)

Prisoner's dilemma is a well-known concept. Robert Axelrod initiated the study of tournaments of finite automata playing repeated prisoner's dilemma. Similar tournaments have appeared afterwards. The strategy is written in the form of a finite automaton, the number of rounds is given by a random geometric distribution. In the tournament every automaton plays with every other one. Our goal was to create an automaton that will maximize the score earned in the tournament for a given set of opponents.

In the first stage, we convert the opponent's finite automaton into an oriented graph describing the possible iterations of repeated play. In the second phase, we search the walk in this graph that maximizes the score. To play against one automaton, the best combination consists of a path and a cycle sharing one common vertex. Finding the best automaton can be done in time $O(n^3)$, where n is the number of states of the opponent's automaton.

When playing against multiple automata, a graph with states from the Cartesian product of the states of the original automata is created. The states are also merged into groups according to the automata responses during the game. Within them, the solution is again the combination of path and cycle. If n is the number of states of the opponent's automaton with the most states and m the product of the number of states of all the automata, the search can be performed in time $O(mn)$.

Saturday, 24 Nov. 2018 — Time: 10:55 - 11:15

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49 — Section I — Room A — 10:55 - 11:15

Constrained graphons of maximum entropy

JUAN ALVARADO (Leuven)

This work proves a conjecture raised by Charles Radin of the most typical infinite graph satisfying subgraph density constraints. The conjecture states that the limit of Erdős-Rényi random graphs $G(n, 1/2)$ satisfying given subgraph density constraints is a m stepfunction with the minimum number of steps. The proof of this conjeture enables to compute the most typical infinite graph as the solution of a non-linear optimization problem on a finite dimensional space.
Our proof is based on an approximation of the constrained graphon space by stepfunction spaces. For each stepfunction space, we associate the space of stepfunctions that are local maxima for the entropy function for all possible combination of the prescribed sugraph densities. We prove the dimension of such space of local maxima is equal to the number of sufficient statistics and any further increment on the number of the steps does not change the shape of the space of local maxima.

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50 — Section II — Room B — 10:55 - 11:15

Maximizing the number of colorings and independent sets

AYSEL EREY (Gebze)

We discuss some extremal problems of maximizing the number of colorings and independent sets over families of graphs with fixed chromatic number and various different connectivity conditions.

51 — Section III — Room C — 10:55 - 11:15

The graphs of projective codes

MARIUSZ KWIATKOWSKI (Olsztyn)

Consider the Grassmann graph formed by k-dimensional subspaces of an n-dimensional vector space over the field of q elements ($1 < k < n-1$), two subspaces are adjacent if their intersection is k-1 dimensional. Denote by $\Pi(n,k)_q$ the restriction of this graph to the set of projective $[n,k]_q$ codes, i.e. linear codes whose generator matrices do not contain proportional columns. In the case when $q \geq \binom{n}{2}$, we show that the graph $\Pi(n,k)_q$ is connected, its diameter is equal to the diameter of the Grassmann graph and the distance between any two vertices coincides with the distance between these vertices in the Grassmann graph. Also, we give some observations concerning the graphs of simplex codes. For example, binary simplex codes of dimension 3 are precisely maximal singular subspaces of a non-degenerate quadratic form.

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52 — Section IV — Room D — 10:55 - 11:15

A connection between peak and descent polynomials

EZGİ KANTARCI OĞUZ (Istanbul)

A permutation $\sigma = \sigma_1\sigma_2\cdots\sigma_n$ has a descent at i if $\sigma_i > \sigma_{i+1}$. A descent i is called a peak if $i > 1$ and $i-1$ is not a descent. The size of the set of all permutations of n with a given descent set is a polynomials in n, called the descent polynomial. Similarly, the size of the set of all permutations of n with a given peak set, adjusted by a power of 2 gives a polynomial in n, called the peak polynomial. In this work we give a unitary expansion of descent polynomials in terms of peak polynomials. Then we use this expansion to give a combinatorial interpretation of the coefficients of the peak polynomial in a binomial basis, thus giving a new proof of the peak polynomial positivity conjecture.

Saturday, 24 Nov. 2018 — Time: 11:20 - 11:40

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53 — Section I — Room A — 11:20 - 11:40

About a conjecture on identification in Hamming graphs

TERO LAIHONEN (Turku)

In this talk, we consider a special class of dominating sets in graphs, namely, identifying codes. Let $G = (V, E)$ be an undirected and finite graph. For $C \subseteq V$, we denote $I(u) = N[u] \cap C$ where $N[u]$ is the closed neighbourhood of u. If $I(u) \neq \emptyset$ for all $u \in V$, then C is a dominating set. If, in addition, $I(u) \neq I(v)$ for all distinct vertices $u, v \in V$, then C is an *identifying code*. We denote the smallest cardinality of an identifying code in G by $\gamma^{ID}(G)$.
Identifying codes in graphs have been widely studied since their introduction by Karpovsky, Chakrabarty and Levitin in 1998. In particular, there are a lot of results regarding the binary hypercubes, that is, the Hamming graphs K_2^n. In 2008, Gravier *et al.* started investigating identification in K_q^2, $q \geq 3$. Goddard and Wash, in 2013, studied identifying codes in general Hamming graphs K_q^n. They stated, for instance, that $\gamma^{ID}(K_q^n) \leq q^{n-1}$ for any q and $n \geq 3$. Moreover, they conjectured that $\gamma^{ID}(K_q^3) = q^2$. In this talk, we show that $\gamma^{ID}(K_q^3) \leq q^2 - q/4$ when q is a power of four, disproving the conjecture. Goddard and Wash also gave the following lower bound $\gamma^{ID}(K_q^3) \geq q^2 - q\sqrt{q}$. We improve this bound to $\gamma^{ID}(K_q^3) \geq q^2 - \frac{3}{2}q$. Moreover, we improve the above mentioned bound $\gamma^{ID}(K_q^n) \leq q^{n-1}$ to $\gamma^{ID}(K_q^n) \leq q^{n-k}$ for $n = 3\frac{q^k-1}{q-1}$ when q is a prime power. For this bound, we utilize suitable linear codes over finite fields.
This is a joint work with Ville Junnila and Tuomo Lehtilä.

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54 — Section II — Room B — 11:20 - 11:40

Computing the NL-flow polynomial

JOHANNA WIEHE (Hagen)

In 1982 V. Neumann-Lara introduced the dichromatic number of a digraph D as the smallest integer k such that the vertices V of D can be colored with k colors and each color class induces an acyclic digraph.
W. Hochstättler developed a flow theory for the dichromatic number transferring Tutte's theory of nowhere-zero flows (NZ-flows) from classic graph colorings. Later B. Altenbokum and W. Hochstättler pursued this analogy by introducing algebraic Neumann-Lara-flows (NL-flows) as well as a polynomial counting these flows.
In this talk we will present another way for defining NL-flows and a closed formula for their polynomial. Finally we discuss computational aspects of computing the NL-flow polynomial for orientations of complete digraphs and obtain a closed formula in the acyclic case.
(joint work with W. Hochstättler)

55 — Section III — Room C — 11:20 - 11:40

Some new quasi-symmetric designs on 56 points

RENATA VLAHOVIĆ KRUC (Zagreb)

A t-(v, k, λ) design is quasi-symmetric if any two blocks intersect either in x or in y points, for non-negative integers $x < y$. It is known that there exist two 2-$(56, 16, 6)$ designs (A. Munemasa and V.D. Tonchev, 2004.) and three 2-$(56, 16, 18)$ designs (V. Krčadinac and R. Vlahović, 2016.). We construct some new quasi-symmetric designs with these parameters.
This is joint work with Vedran Krčadinac.

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56 — Section IV — Room D — 11:20 - 11:40

Enumeration of S-omino towers

ALEXANDER HAUPT (Hamburg)

The original problem of counting domino towers was first studied by G. Viennot in 1985, see also D. Zeilberger (*The Amazing* 3^n *Theorem*). We analyse a generalisation of domino towers that was proposed by T. M. Brown (J. Integer Seq. 20.3 (2017), Art. 17.3.1), which we call S-omino towers. After establishing an equation that the generating function must satisfy and applying the Lagrange Inversion Formula, we find a closed formula for the number of towers.

Saturday, 24 Nov. 2018 — Time: 11:45 - 12:05

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57 — Section I — Room A — 11:45 - 12:05

Induced arboricity

JONATHAN ROLLIN (Hagen)

The induced arboricity of a graph G is the smallest integer k such that there are k induced forests in G together covering all the edges of G. It turns out that this parameter depends on the structure of the graph and not only on its density. This is in contrast to the well known arboricity, where the forests are not necessarily induced.
We discuss some relations between induced arboricity and other graph parameters. This leads to a classification of families of graphs with bounded induced arboricity. In particular the induced arboricity is bounded for any family of graphs with bounded expansion. Specifically the largest induced arboricity among all planar graphs lies between 8 and 10.
From an algorithmic point of view we show that deciding whether a graph has induced arboricity at most k is NP-complete for each $k \geq 2$. The problem stays NP-complete for planar graphs in case $2 \leq k \leq 4$.
By varying the requirements on the forests many variants of induced arboricty can be defined. We consider two variants, one with weaker and one with stronger requirements.
This is joint work with Maria Axenovich, Philip Dörr, Daniel Gonçalves, and Torsten Ueckerdt.

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58 — Section II — Room B — 11:45 - 12:05

Graph operations and neighborhood polynomials

MARYAM ALIPOUR (Mittweida)

The neighborhood polynomial of graph G is the generating function for the number of vertex subsets of G of which the vertices have a common neighbor in G. In this talk, we investigate the behavior of this polynomial under several graph operations. Specifically, we provide an explicit formula for the neighborhood polynomial of the graph obtained from a given graph G by vertex attachment. We use this result to propose a recursive algorithm for the calculation of the neighborhood polynomial. Finally, we prove that the neighborhood polynomial can be found in polynomial-time in the class of k-degenerate graphs.

This is a joint work with Peter Tittmann (Hochschule Mittweida)

59 — Section III — Room C — 11:45 - 12:05

Latin cubes with forbidden entries

LAN ANH PHAM (Umeå)

We consider the problem of constructing Latin cubes subject to the condition that some symbols may not appear in certain cells. We prove that there is a constant $\gamma > 0$ such that if $n = 2^k$ and A is 3-dimensional $n \times n \times n$ array where every cell contains at most γn symbols, and every symbol occurs at most γn times in every line of A, then A is *avoidable*; that is, there is a Latin cube L of order n such that for every $1 \leq i, j, k \leq n$, the symbol in position (i, j, k) of L does not appear in the corresponding cell of A.

60 — Section IV — Room D — 11:45 - 12:05

Binomial transforms and zeta series

ROLF BACHMANN (Bergisch Gladbach)

This presentation establishes a link between the Binomial Transform of a series and ßeta seriesk-ontaining values of the Riemann zeta function $\zeta(z)$ as coefficients, which readily allows obtaining closed form solutions of zeta series. Examples will be given and the transformation of Laurent series into zeta series will be demonstrated. The main result is the formal relation:

$$\sum_{n=0}^{\infty}(-1)^n f_n = \sum_{k=1}^{\infty}(\zeta(k+d+1)-1)c_k(d) \tag{1}$$

with $c_k(d) = \sum_{j=0}^{k} \binom{k+d}{j+d}(-1)^j f_j - (-1)^k f_k$. From the c_k coefficients f_n can be obtained by the inverse relation (with the Bernoulli numbers B_k):

$$f_n = \frac{(-1)^n}{n+1+d} \sum_{k=1}^{n+1} B_{n+1-k} \binom{n+1+d}{k+d} c_k. \tag{2}$$

The combinatorial identity: $(n+1)S_2(j, n+1) = \sum_{k=0}^{j-1} \binom{j}{k} S_2(k, n)$ of Stirling numbers of the second kind provides a nice example (generalizing to the Hurwitz zeta function: $\zeta(z, m) = \sum_{k=0}^{\infty} \frac{1}{(k+m)^z}$, $m > n$ to ensure convergence)

$$\sum_{k=1}^{\infty} \zeta(k+1, m+1) S_2(k, n) = \frac{(m-n)!}{n * m!}. \tag{3}$$

Starting with the f_n the form of the c_k leads to two zeta series which cannot in general be separated. Exceptions are series invariant or inverse invariant under the Binomial Transform. Corresponding examples will be presented involving e.g. Fibonacci and Lucas polynomials, Stirling numbers of the first and second kind. Of yet different types are the following closed forms:

$$\sum_{j=1}^{\infty} \frac{1}{j} \sum_{k=0}^{j-1} \binom{j}{k} B_k \zeta(k+d) = \sum_{k=1}^{\infty} \frac{H_k}{k^d} \tag{4}$$

with the hamonic numbers H_k and

$$\sum_{k=1}^{\infty} \binom{k+d}{d} (-1)^{k+1} \zeta'(k+d+1) = \sum_{k=1}^{\infty} \frac{\zeta(k+d+1)-1}{k}. \tag{5}$$

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