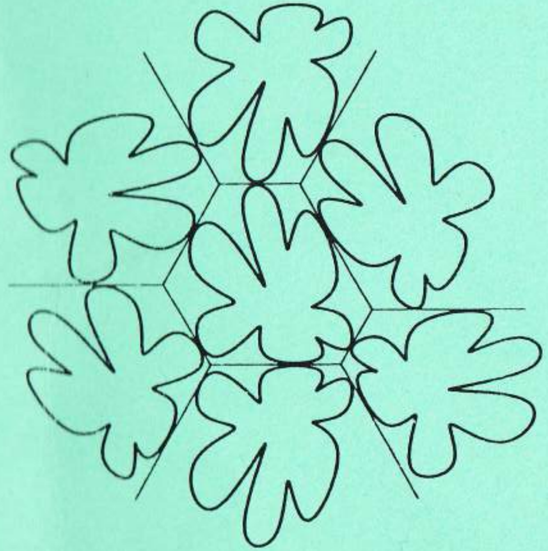
# KOLLOQUIUM
## ÜBER
# KOMBINATORIK

12.-13. November 1999



Diskrete Mathematik

TECHNISCHE UNIVERSITÄT
BRAUNSCHWEIG

# Freitag, 12.11.1999 — Zeit: 14.00

6 — Sektion I — Raum PK 14.3 — 14.00

## The game Trik on hypergraphs

DRAGO BOKAL, Ljubljana, Slovenia

There exist several games among two players in which they are coloring the objects (points, circles, squares, etc.) avoiding to color specific pattern. If one of the players produces this pattern with the objects all of his color, he loses the game.
The talk presents a general model for studying such games, where the playing board is replaced by two hypergraphs on the same set of points, each presenting dangerous subsets for one of the players. The model is used to show some properties of the generalized game and to study winning strategies on some simple playing boards.

7 — Sektion II — Raum PK 14.4 — 14.00

## Zur chromatischen Zahl des $\mathbb{R}^d$

BERNULF WEISSBACH, Magdeburg

Im $\mathbb{R}^d$ seien Punkte mit dem euklidischen Abstand 1 durch eine Strecke verbunden. Der entstehende unendliche Graph wird üblicherweise wieder mit $\mathbb{R}^d$ bezeichnet. Für seine chromatische Zahl gewannen P. Frankl und R. M. Wilson 1981 die Abschätzung

$$\chi(\mathbb{R}^d) \geq \frac{\binom{d}{2q-1}}{\binom{d}{q-1}}$$

gültig für jede Primzahlpotenz $q := p^\alpha$, $\alpha \in \mathbb{N}$, mit $2q \leq d+1$, woraus auf

$$\chi(\mathbb{R}^d) \geq 1,2^d(1+o(1)), d \to \infty$$

geschlossen werden kann.
Wesentlich leichter als die Abschätzung von Frankl und Wilson kann man (wie im Vortrag gezeigt wird) die geringfügig schlechtere Abschätzung

$$\chi(\mathbb{R}^d) \geq \frac{\sum_{\nu=0}^{q-1}\binom{d}{2\nu+1}}{\sum_{\nu=0}^{q-1}\binom{d}{\nu}}$$

erhalten, die aber die gleiche asymptotische Schranke liefert.
Literatur:

P. Frankl - R. M. Wilson: Intersection theorems with geometric consequences. Combinatorica 1 (1981); 357 - 368.

8 — Sektion III — Raum PK 14.6 — 14.00

## On a degree property of cross-intersecting families

GOHAR M. KYUREGHYAN, Bielefeld

To give a complexity estimation for DNFs, Razborov and Vereshchagin proved a degree bound for cross-intersecting families in [RA]. We sharpen this result and show that our bound is best possible by constructing appropriate families. We also consider the case of cross-$t$-intersecting families.
**References** [RA] A.A.Razborov and N.K.Vereshchagin, A property of cross-intersecting families, Research Communications, Conf."Paul Erdös and his Mathematics",Budapest,1999,218-220.

9 — Sektion IV — Raum PK 14.7 — 14.00

## Orthogonal double covers of complete graphs

UWE LECK, Rostock

An orthogonal double cover (ODC) of the complete graph $K_n$ by some graph $G$ is a collection of spanning subgraphs $G_1, G_2, \ldots, G_n$ such that:
(1) $G_i$ is isomorphic to $G$ for $i = 1, \ldots, n$.
(2) Every edge of $K_n$ is contained in exactly two of the graphs $G_1, \ldots, G_n$.
(3) $G_i$ and $G_j$ share exactly one edge for $1 \leq i < j \leq n$.
We present a number of new results on the existence of ODCs of $K_n$ by hamiltonian paths and by almost-hamiltonian cycles, i.e. the cases $G = P_n$ and $G = C_{n-1}$.

10 — Sektion V — Raum PK 14.8 — 14.00

## Some news about oblique graphs

JENS SCHREYER AND HANSJOACHIM WALTHER, Ilmenau

Let $G = G(V,E,F)$ be a polyhedral graph with $v = v(G) = |V(G)|$ vertices, $e = e(G) = |E(G)|$ edges and $f = f(G) = |F(G)|$ faces. $M = \{m_1, m_2, ..., m_k : m_1 < m_2 < ... < m_k\}$ is called the *degree set of* $G$ if for each $i = 1, 2, ..., k$ there is a vertex $x_i \in V(G)$ : $deg_G(x_i) = m_i$ and $deg_G(x) \in M$ $\forall x \in V(G)$. $v_i = v_i(G)$ is the number of vertices of degree $i$ in $G$. $\alpha \in F(G)$ is an $\langle a_1, a_2, ..., a_l\rangle$-face if $\alpha$ is a $l$-gon, $a_i \in M, i = 1, 2, ..., l$ and the valencies $deg_G(x_i)$ of the vertices $x_i, i = 1, 2, ..., k$ incident with $\alpha$ in the cyclic order are $a_1, a_2, ..., a_l$, resp. Obviously, $\alpha$ is also an $\langle a_2, a_3, ..., a_l, a_1\rangle$-face, an $\langle a_3, a_4, ..., a_l, a_1, a_2\rangle$-face,... and an $\langle a_l, a_{l-1}, ..., a_2, a_1\rangle$-face, too. The lexicographic minimum $\langle b_1, b_2, ..., b_l\rangle$ : $\alpha$ is a $\langle b_1, b_2, ..., b_l\rangle$ – face is called the *type* of $\alpha$. A polyhedral graph $G$ is called *oblique* if all its faces are of different type. It is known that the set of all oblique graphs is finite but not empty. The set of oblique triangulations is not empty, too.
Among others we can prove

1. Let $G$ be an oblique graph with minimum number of faces. Then we have $f(G) = 8$, but $G$ is not unique.
2. The minimum degree of an oblique graph is 3.
3. The minimum number of faces of an oblique triangulation is 16.
4. There is a polyhedral graphs $G$ (so far we know two of them) which is as well oblique as its dual.

Some open problems are discussed.

# Freitag, 12.11.1999 — Zeit: 14.30

11 — Sektion I — Raum PK 14.3 — 14.30

## Realizations and drawings of configurations

TOMAŽ PISANSKI, Ljubljana, Slovenija

We define a *drawing* and a *realization* of an arbitrary incidence structure $I$ in another incidence structure $P$. Furthermore we introduce the *drawing defect* $\delta(I,P)$ and the *realization defect* $\rho(I,P)$ as the minimum number of lines that have to be deleted from $I$ in order to admit a drawing (respectively: a realization) of the corresponding modified incidence structure in $P$. We consider the $\delta$ and $\rho$ for some configurations $I$ when $P$ is a projective plane or the Euclidean plane.
This is a joint work with Marko Boben (Ljubljana, `Marko.Boben@fmf.uni-lj.si`) and Harald Gropp (Heidelberg, `d12@ix.urz.uni-heidelberg.de`).

12 — Sektion II — Raum PK 14.4 — 14.30

## Listenchromatische Zahlen ganzzahliger Distanzgraphen

MASSIMILIANO MARANGIO, Braunschweig

Ein ganzzahliger Distanzgraph $G(D)$ mit $D \subseteq \mathbb{N}$ ist ein Graph mit den ganzen Zahlen $\mathbb{Z}$ als Knotenmenge und Kanten zwischen allen Knoten $u$ und $v$, für die $|u-v| \in D$ gilt.
Mit $\chi(G)$ wird die chromatische Zahl eines Graphen $G$ bezeichnet, mit $\chi'(G)$ die kantenchromatische Zahl, mit $\chi''(G)$ die totalchromatische Zahl und mit $\chi_l(G)$, $\chi'_l(G)$, $\chi''_l(G)$ die entsprechenden listenchromatischen Zahlen.
In diesem Vortrag werden $\chi'(G(D))$, $\chi'_l(G(D))$, $\chi''(G(D))$ und $\chi''_l(G(D))$ für beliebige ganzzahlige Distanzgraphen $G(D)$ bestimmt, und für $\chi(G(D))$ und $\chi_l(G(D))$ werden Teilergebnisse vorgestellt.

13 — Sektion III — Raum PK 14.6 — 14.30

## Intersecting families in chain- and star products

CHRISTIAN BEY, Bielefeld

We discuss intersection problems in star products and chain products. For example, we determine the maximum size of an $k$-uniform $t$-intersecting family in the partially ordered set (star product)

$$([0,\alpha_1] \times \cdots \times [0,\alpha_n], \leq)$$
$$(a_1,\ldots,a_n) \leq (b_1,\ldots,b_n) \Leftrightarrow \forall i: a_i \in \{0,b_i\}$$

if $t=1$ or if $\alpha_1 = \cdots = \alpha_n \geq 3$ and $n$ is large.

14 — Sektion IV — Raum PK 14.7 — 14.30

## Classes of hypergraphs with sum number one

HANNS-MARTIN TEICHERT, Lübeck

A hypergraph $\mathcal{H}$ is a *sum hypergraph* iff there are a finite $S \subseteq \mathbb{N}^+$ and $\underline{d}, \overline{d} \in \mathbb{N}^+$ with $1 < \underline{d} \leq \overline{d}$ such that $\mathcal{H}$ is isomorphic to the hypergraph $\mathcal{H}_{\underline{d},\overline{d}}(S) = (V,\mathcal{E})$ where $V = S$ and $\mathcal{E} = \{e \subseteq S : \underline{d} \leq |e| \leq \overline{d} \wedge \sum_{v \in e} v \in S\}$. For an arbitrary hypergraph $\mathcal{H}$ the sum number $\sigma = \sigma(\mathcal{H})$ is defined to be the minimum number of isolated vertices $w_1,\ldots,w_\sigma \notin V$ such that $\mathcal{H} \cup \{w_1,\ldots,w_\sigma\}$ is a sum hypergraph.
For graphs it is known that cycles $C_n$ and wheels $W_n$ have sum numbers greater than one. Generalizing these graphs we prove for the hypergraphs $\mathcal{C}_n$ and $\mathcal{W}_n$ that under a certain condition for the edge cardinalities $\sigma(\mathcal{C}_n) = \sigma(\mathcal{W}_n) = 1$ is fulfilled.

15 — Sektion V — Raum PK 14.8 — 14.30

## Long cycles vs. removable links in critically 2-connected graphs

MATTHIAS KRIESELL, Hannover

A vertex $x$ of a finite undirected simple graph $G$ is called *removable*, if $G-x$ is 2-connected. A *link* in $G$ is a nonempty subpath $P$ of $G$ where all vertices have degree 2 in $G$, and it is called *removable* if $G - V(P)$ is 2-connected.
We show that for natural numbers $m,k$ there exists a number $c(m,k)$ such that any 2-connected graph having at least $c(m,k)$ vertices of degree exceeding 2 has either a removable vertex, or more than $m$ removable links, or a substructure consisting of two disjoint chordless $a_i,b_i$-paths, $i \in \{1,2\}$, whose lengths sum up to at least $k$ and which separate the graph into parts whose neighborhood equals either $\{a_1,a_2\}$ or $\{b_1,b_2\}$.

# Freitag, 12.11.1999 — Zeit: 15.00

16 — Sektion I — Raum PK 14.3 — 15.00

## Does a small portion determine a unique picture?

ULRIKE VON NATHUSIUS, Bielefeld

A **periodic tiling of the plane** can be informally described as a regular pattern covering the plane. Examples for such tilings are cutplanes through theoretical models of crystalline structures. But in fact no real crystall occuring in nature is perfectly regular and some very important physical or chemical properties turned out to be caused by disorders of the lattice.
This was the reason for extending the theory of periodic tilings to **disordered periodic tilings**. One property of periodic tilings is that it is possible to represent the infinite tiling by a finite portion of it. But does this hold for disordered tilings, too? Is it possible to determine a unique infinite tiling by giving the disordered patch and a "rule for extension"? And in case it does which are the characteristics the patch must have?
In my talk I will discuss this problem and give an answer for a special form of disorder.

17 — Sektion II — Raum PK 14.4 — 15.00

## Forbidden subgraphs and 3-colourability

BERT RANDERATH, INGO SCHIERMEYER AND MEIKE TEWES, Freiberg

The 3-colourability problem is a well-known NP-complete problem. It remains NP-complete for triangle-free graphs of maximum degree 4 and for claw-free graphs.
Sumner has shown that triangle-free and $P_5$-free or triangle-free, $P_6$-free and $C_6$-free graphs are 3-colourable.
In this talk we will present the following results:
**Main Theorem:** The 3-colourability problem can be decided and a corresponding 3-colouring can be determined in polynomial time for the class of
(i) triangle-free and $P_6$-free graphs,
(ii) $P_5$-free graphs,
(iii) claw-free and hourglass-free graphs $(K_1 + 2K_2)$,
(iv) claw-free and $t$-spider-free graphs (a $K_{1,t}$ with each edge subdivided).

18 — Sektion III — Raum PK 14.6 — 15.00

## Order embedding structures

MARCEL ERNÉ, JÜRGEN REINHOLD, Hannover

For any quasiordered set (qoset), topological space or other structure $S$, the collection $SubS$ of all nonempty subqosets, subspaces, or generally subobjects, is quasiordered by embeddability. Let $p_n$ and $q_n$ denote the smallest size of qosets (equivalently, of topological spaces) $S$ such that every partially ordered set (poset), respectively qoset, with $n$ points is embeddable in $SubS$. Similarly, let $b_n$ and $c_n$ denote the smallest size of posets $S$ such that $SubS$ contains an $n$-dimensional Boolean cube as a filter or as a subposet, respectively. The relations $p_n \leq c_n \leq b_n$ and $n < p_n \leq q_n$ are obvious. Recently, McCluskey and McMaster obtained the inequality $p_n \leq n^2$. This upper bound may be improved considerably:

$$b_n \leq n + l(n) + l(l(n)) + 2 \quad \text{with} \quad l(n) = \min\{k : n \leq 2^k\},$$
$$q_n \leq p_n + l(n) + l(l(n)) \leq n + 2l(n) + 2l(l(n)) + 2.$$

The case of infinite cardinals $n$ is settled entirely: here we have $b_n = c_n = p_n = q_n = n$.

19 — Sektion IV — Raum PK 14.7 — 15.00

## Antimagic and supermagic labellings of hypergraphs

MARTIN SONNTAG, Freiberg

It is known that uniform cacti and linear $(d_1, d_2)$–uniform wheels are antimagic.
Composing $d_1$–uniform stars and $d_2$–uniform strong cycles (which are proved to be (almost) supermagic and antimagic, respectively) we verify that a large class of non–linear $(d_1, d_2)$–uniform wheels is antimagic, too.
Moreover, we construct antimagic vertex–labellings for linear non–uniform grid hypergraphs.

20 — Sektion V — Raum PK 14.8 — 15.00

## Supersimple decompositions of complete multigraphs

SVEN HARTMANN, Rostock

A family $\mathcal{G}$ of subgraphs of the complete graph $K_n$ forms a supersimple decomposition of $\lambda K_n$, if every edge of $K_n$ belongs to exactly $\lambda$ members of $\mathcal{G}$, and any two of the subgraphs share at most one edge.
We present new results on the existence of supersimple decompositions applying Weil's theorem on the absolute value of character sums in finite fields. Moreover, we discuss related structures such as pure digraph designs and orthogonal double covers by flowers.

# Freitag, 12.11.1999 — Zeit: 15.30

21 — Sektion I — Raum PK 14.3 — 15.30

## The Penrose polynomial and the Fano matroid

MARTIN AIGNER, HANS MIELKE, Berlin

The Penrose polynomial is a polynomial for plane graphs with a couple of astonishing properties. It is based on ideas of R. Penrose and can be generalized to binary matroids. For a plane graph $G$, its Penrose polynomial $P_G$ vanishes if and only if $G$ contains a bridge. With binary matroids this is not true any more: For the dual Fano matroid $F^*$, the Penrose polynomial $P_{F^*} = 0$. It turns out that this is essentially the only counterexample: If a binary matroid $M$ is bridgeless and $P_M = 0$, then $M$ contains the dual Fano matroid as a minor.
In this talk, we introduce the Penrose polynomial for binary matroids and show how to obtain the just mentioned result. As a corollary, we derive a statement not involving the Penrose polynomial, namely a necessary condition for a binary matroid to have the property that every circuit is also a cocircuit.

22 — Sektion II — Raum PK 14.4 — 15.30

## Closure and forbidden pairs for hamiltonicity

ZDENĚK RYJÁČEK, Pilsen, Czech Republic

Let $C$ be the claw $K_{1,3}$ and $N$ the net, i.e. the only connected graph with degree sequence 333111. It is known [Bedrossian 1991; Faudree and Gould 1997] that if $X, Y$ is a pair of connected graphs such that, for any 2-connected graph $G$, $G$ being $XY$-free implies $G$ is hamiltonian, then $X$ is the claw $C$ and $Y$ belongs to a finite list of graphs, one of them being the net $N$.
For any such pair $XY$, we show that the closures of all 2-connected $XY$-free graphs form a subclass of the class of $CN$-free graphs, and we fully describe their structure.

23 — Sektion III — Raum PK 14.6 — 15.30

## Ultrahomogeneous semilinear spaces

ALICE DEVILLERS, Brussels, Belgium

A relational structure $S$ is said to be ultrahomogeneous whenever every isomorphism between two finite substructures of $S$ can be extended into an automorphism of $S$. All the finite, respectively countable, ultrahomogeneous undirected graphs have been classified by Gardiner (1976), respectively Lachlan and Woodrow (1980). Devillers and Doyen have classified in 1998 the ultrahomogeneous linear spaces without any finiteness assumption: the only non trivial ones are $PG(2,2)$ and $PG(2,3)$. Semilinear (=partial linear) spaces are a natural generalization of undirected graphs and of linear spaces. I have classified (with as few finiteness assumptions as possible) the ultrahomogeneous semilinear spaces.

24 — Sektion IV — Raum PK 14.7 — 15.30

## Computing minimum spanning trees in hypergraphs

STEFAN HOUGARDY, Berlin

The Minimum Spanning Tree Problem is one of the classical problems in algorithmic graph theory. It is well known that an optimum solution can be found in polynomial time by a greedy algorithm (e.g. Kruskal's or Prim's algorithm). For hypergraphs the corresponding minimum spanning subgraph problem is NP-hard, already for the case of unweighted 4-uniform hypergraphs. We present an algorithm that finds approximate solutions for the minimum spanning subgraph problem in $k$-uniform hypergraphs and discuss its connection to the Steiner Tree Problem in networks.

25 — Sektion V — Raum PK 14.8 — 15.30

## New explicit Ramsey graph constructions

VINCE GROLMUSZ, Budapest, Hungary

We present an explicit construction for multi-colored Ramsey graphs, which uses certain modulo 6 polynomials of *Barrington, Beigel* and *Rudich*. This construction gives the same logarithmic order of magnitude for two colors as the best known construction of *Frankl* and *Wilson* (1981).
We also present an improvement of this construction, which is a joint work with *László Babai* (1999). This explicit construction has the same order of magnitude as the Frankl-Wilson construction for two colors. This latter result uses an inequality proved by *Babai, Snevily,* and *Wilson* (1995) for $q$-ary codes.

# Freitag, 12.11.1999 — Zeit: 16.30

26 — Sektion I — Raum PK 14.3 — 16.30

## Dominating a sequence by two sequences

PER WILLENIUS, Magdeburg

Let $G$ be an undirected graph where each node has a given weight. The maximal path weight of an orientatation $G_o$ of $G$ is denoted by $C_{\max}(G_o)$. The orientation $G_o$ is domitated by a set of orientations $M$, if for each positive vertice weight of $G$ there exists a $G'_o$ in $M$ such that $C_{\max}(G_o)$ is not smaller than $C_{\max}(G'_o)$. We show that if $M$ contains at most two elements, this dominance relation can be tested by a small set of forbidden substructures.

27 — Sektion II — Raum PK 14.4 — 16.30

## Finite circle packings and extremal polygons

FERENC FODOR, Cookeville, TN, U.S.A.

New results in the theory of finite circle packings will be presented. In particular, the densest packings of 12, 13 and 19 congruent circles in a circle will be exhibited. To prove the optimality of these packings a general technique was used which may enable us to handle more cases. Also, the connection between the circle packing problem and finding the largest perimeter n-gon of unit diameter is to be presented.

28 — Sektion III — Raum PK 14.6 — 16.30

## On difference matrices

ARNE WINTERHOF, Vienna, Austria

A new construction method for difference matrices based on character sums of polynomials over finite fields is given. For example the existence of a $(15,16,8)$-difference matrix is shown. Moreover, some nonexistence results are presented.

29 — Sektion IV — Raum PK 14.7 — 16.30

## Längenminimale Netze

DIETMAR CIESLIK, Greifswald

Eine der zentralen Aufgaben des Network Design ist die Bestimmung kürzester Netze, die Punkte eines metrischen Raumes verbinden. Hierbei sind oft Nebenbedingungen - z.B. durch Einschränkungen an die kombinatorische Struktur des Netzes oder an die geometrische Struktur des Raumes - zu beachten. Viele Probleme dieser Art sind $\mathcal{NP}$-vollständig. Es wird in einem Überblick aufgezeigt wie - in Abhängigkeit von den Einschränkungen - die Probleme einfache oder große Komplexität aufweisen.

30 — Sektion V — Raum PK 14.8 — 16.30

## Size measures for chordal graphs and related fill-in problems

ELIAS DAHLHAUS, Berlin

Observe for example that the time complexity of a Gauss elimination on a positive definite matrix that has a chordal nonzero-entry graph is the sum of squares of the number of "greater" neighbors *with respect to a particular perfect elimination ordering*. It will be shown that this sum of squares of the number of greater neighbors is independent on the particular perfect elimination ordering.

There is a stronger result in behind. For an ordering $<$ on the vertices of $G$, let $d_<(x)$ be the number of greater neighbors of the vertex $x$ with respect to $<$. For a graph $G=(V,E)$ and an ordering $<$, the *greater degree multiset* $D_{G,<}$ is defined as the multiset of $d_<(x)$ with $x \in V$ where $d$ appears exactly $r$ times if there are $r$ vertices $x$ of $G$ with $d_<(x)=d$.

**Theorem:** For any chordal graph $G$ with a perfect elimination ordering $<$, the corresponding greater degree multiset $D_{G,<}$ depends only on $G$, not on the particular perfect elimination ordering $<$.

# Freitag, 12.11.1999 — Zeit: 17.00

31 — Sektion I — Raum PK 14.3 — 17.00

## Some results on domination in graphs

BOHDAN ZELINKA, Liberec, Czech Republic

A subset $D$ of the vertex set $V(G)$ of a graph $G$ is called point-set dominating, if for each subset $S \subseteq V(G) - D$ there exists a vertex $v \in D$ such that the subgraph of $G$ induced by $S \cup \{v\}$ is connected.The maximum number of classes of a partition of $V(G)$, all of whose classes are point-set dominating sets, id the point-domatic number of $G$. It $E(G)$ is the edge set of $G$ and $f$ is a mapping of $E(G)$ into $\{-1, 1\}$ such that the sum of $f(e)$ taken over any closed neighbourhood of an adge of $G$ is at least 1, then $f$ is a signed edge dominating function on $G$. The minimum of $\sum_{e \in E(G)} f(e)$ taken over all signed edge dominating functions $f$ on $G$ is the signed edge domination number of $G$. These concepts are studied.

32 — Sektion II — Raum PK 14.4 — 17.00

## On finite zero-one-sequences

PETER BUNDSCHUH, Köln

We investigate the following problem. Let $n$ and $k$ be positive integers, and consider all sequences of length $n$, consisting only of zeros and ones such that there are at least $k-1$ ones between any two zeros, or at least $k-1$ zeros between any two ones. We shall show that the mean value of the number of ones in such 0-1-sequences exists, and we will determine this mean value in terms of $k$. Our proof uses some classical fundamentals from the theory of homogeneous linear recurrence sequences with constant coefficients.

33 — Sektion III — Raum PK 14.6 — 17.00

## Partielle Differenzengleichungen als Verallgemeinerung gewöhnlicher Differenzengleichungen

HELWIG HASSENPFLUG, Aachen

Partielle Differenzengleichungen werden u. a. durch Verallgemeinerung gewonnen. So verallgemeinert man z. B. in der Warteschlangentheorie Geburts-Todesprozesse, die im Gleichgewicht typischer Weise gewöhnliche Differenzengleichungen erfüllen, zu Quasi-Geburts-Todesprozessen, die im Gleichgewicht typischer Weise partielle Differenzengleichungen erfüllen. Ich stelle z. B. die Frage, wie man die Gleichung

$$\begin{pmatrix} F_n \\ F_{n+1} \end{pmatrix} = \begin{pmatrix} 0 & 1 \\ 1 & 1 \end{pmatrix} \begin{pmatrix} F_{n-1} \\ F_n \end{pmatrix}$$

für die Fibonaccizahlen auf den Fall partieller Differenzengleichungen verallgemeinern soll.

34 — Sektion IV — Raum PK 14.7 — 17.00

## Hyperebenen-Separation der Eckenmenge des $n$-Würfels

NIHAT AY, FRANK PASEMANN AND WALTER WENZEL, Chemnitz

Im Rahmen einer Theorie der "Feedforward Netzwerke" stellt sich folgendes Problem:

Gegeben sei eine Partition der Vertexmenge $W_n$ des $n$-dimensionalen Würfels in eine Menge $C$ und ihr Komplement $C'$. Gesucht ist ein Hyperebenen-Arrangement $(H_1, \cdots, H_d)$ von $d$ affinen und zu $W_n$ disjunkten Hyperebenen für möglichst kleines $d$, das die Menge $C$ in folgendem Sinne von $C'$ separiert:
Jede der $d$ Hyperebenen bestimmt – bis auf die Reihenfolge eindeutig – einen positiven offenen Halbraum $H_i^+$ und einen negativen offenen Halbraum $H_i^-$. Definiere die Abbildung $\varphi = (\varphi_1, \cdots, \varphi_d) : W_n \longrightarrow W_d$ durch

$$\varphi_i(x) := \begin{cases} 1 & \text{für} \quad x \in H_i^+ \\ -1 & \text{für} \quad x \in H_i^- . \end{cases}$$

Dann sagen wir, daß das Hyperebenen-Arrangement $(H_1, \cdots, H_d)$ die Menge $C$ von der Menge $C'$ separiert, falls die beiden Mengen $\varphi(C)$ und $\varphi(C')$ in $\mathbb{R}^d$ durch eine affine Hyperebene getrennt werden können. Es wird aufgezeigt, daßdie Zahl $d$ – für großes $n$ und gewisse $C, C'$ – exponentiell mit $n$ wächst, und zwar gilt genauer:

$$2^{\frac{n}{2}} - \frac{n^2}{2} \leq d \leq \frac{3}{n+2} \cdot 2^n .$$

35 — Sektion V — Raum PK 14.8 — 17.00

## Longest paths and longest cycles in graphs with large degree sums

MEIKE TEWES, Freiberg

Let $p(G)$ and $c(G)$ be the order of a longest path and a longest cycle in a graph $G$, respectively. Define $\sigma_4(G) = \min\{\sum_{i=1}^4 d(x_i) \mid \{x_1, x_2, x_3, x_4\}$ is an independent set of vertices of $G\}$. We show that if $G$ is a 2-connected graph with $\sigma_4(G) \geq |V(G)| + 3$, then either $p(G) - c(G) \leq 1$ or for every longest path $P$, the subgraph $G - P$ consists of a collection of $K_1$'s and $K_2$'s. Examples showing the sharpness of this result are presented.

# Freitag, 12.11.1999 — Zeit: 17.30

36 — Sektion I — Raum PK 14.3 — 17.30

## An enumeration problem

GERHARD WESP, Salzburg

For a sign vector $X \in \{+,-,0\}^n$, by its *weight* we mean the number of plus signs it contains. For an oriented matroid given by its covector set $\mathcal{L}$, we denote by $g_{s,k}(\mathcal{L})$ the number of covectors with rank $s$ and weight at most $k$ in $\mathcal{L}$. We give an explicit formula for $g_{s,k}(C(n,r))$, where $C(n,r)$ is the alternating oriented matroid of rank $r$ on $n$ elements. The Upper Bound Conjecture for oriented matroids (Eckhoff 1993, Linhart 1994, W. 1999) claims that for any rank $r$ oriented matroid $\mathcal{L}$ on $n$ elements we have $g_{s,k}(\mathcal{L}) \leq g_{s,k}(C(n,r))$ for all $s$ and all $k < (n-(r-s))/2$. The role the alternating oriented matroid plays in this conjecture is analogous to the role the cyclic polytope plays in the Upper Bound Theorem for convex polytopes proved by McMullen in 1970.

37 — Sektion II — Raum PK 14.4 — 17.30

## On long minimal zero sequences in finite abelian groups

ALFRED GEROLDINGER, Graz, Austria

Let $G$ be a finite abelian group and $\mathcal{D}(G)$ Davenport's constant of $G$ which is defined as the maximal length of a minimal zero sequence in $G$. In order to describe the structure of minimal zero sequences with length $\mathcal{D}(G)$, we study the order of elements occuring in such sequences. We concentrate on the following question: does a minimal zero sequence with length $\mathcal{D}(G)$ contain elements whose order equals the exponent of $G$?

38 — Sektion III — Raum PK 14.6 — 17.30

## A constructive upper bound on matrix rigidity

CARSTEN DAMM, Trier

The *rigidity* $\mathcal{R}_A^K(r)$ of a matrix $A$ with respect to a field $K$ is the minimal number of entries that must be changed to obtain a matrix $B$ with $\mathrm{rank}_K(B) \leq r$. The *Boolean rank* $\mathrm{rank}_{\mathbb{B}}(A)$ of a 0/1-matrix $A$ is the smallest number of 1-colored submatrices whose union is the set $A^{-1}(1)$ of of 1-entries of $A$.
Non-constructively it was proved in [?], that if $\mathrm{rank}_{\mathbb{B}}(A)$ is "small", then also $\mathcal{R}_A^K(r)$ is "small": only "few" entries in $A$ have to be changed in order to obtain a "small rank" matrix $B$. Here we present an algorithm, that given an $n \times n$ 0/1-matrix $A$ and a cover of $A^{-1}(1)$ by 1-colored submatrices $A_1, \ldots, A_t$ finds a matrix $B$ as above in time polynomial in $n$ and $t$. The algorithm makes use of polynomial time encodable *good* error-correcting codes.

39 — Sektion IV — Raum PK 14.7 — 17.30

## Equilateral dimension of the rectilinear space

JACK KOOLEN, MONIQUE LAURENT AND ALEXANDER SCHRIJVER, Bielefeld

A subset $X$ of a metric space $M$ is called *equilateral* if any two distinct points of $X$ are at the same distance. The *equilateral dimension* $e(M)$ of $M$ is defined as the minimal cardinality of an equilateral set in $M$.
Equilateral sets are well understood in the Euclidean, spherical and hyperbolic spaces, but little is known in the elliptic $k$-space ($k > 5$) and in the rectilinear $k$-space, i.e. $(\mathbf{R}^k, l_1)$.
In this talk we will concentrate on the case of the rectilinear space. Guy conjectured:

**Conjecture.** $e(\mathbf{R}^k, l_1) = 2k$ for $k \geq 1$.

We showed that $e(\mathbf{R}^k, l_1) = 2k$ for $k \leq 4$. In this talk we will discuss related problems and conjectures, such as the antichain problem for designs.

40 — Sektion V — Raum PK 14.8 — 17.30

## On $F(j)$-graphs and their applications

NARONG PUNNIM, Bangkok, Thailand

Erdös and Gallai (1963) showed that any $r$-regular graph of order $n$, with $r < n-1$, has chromatic number at most $3n/5$, and this bound is achieved precisely for those graphs with complement equal to a disjoint union of 5-cycles.
We are able to generalize this result by considering the problem of determining a $(j-1)$-regular graph $G$ of minimum order $f(j)$ such that the chromatic number of the complement of $G$ exceeds $f(j)/2$. Such a graph will be called an *$F(j)$-graph*. We produce an $F(j)$-graph for all positive odd integers $j$, showing that $f(j) = 3D5(j-1)/2$ if $j \equiv= 3 \pmod 4$, and $f(j) = 3D1 + 5(j-1)/2$ if $j \equiv 1 \pmod 4$.

# Sonnabend, 13.11.1999 — Zeit: 13.30

41 — Sektion I — Raum PK 14.3 — 13.30

## Tilings of convex $m$-gons into $n$-gons

ROSWITHA BLIND, Stuttgart

A convex $m$-gon $Q$ is *tiled* by convex $n$-gons $P_1, \dots, P_r$ (the *tiles*) if the interiors of the $n$-gons $P_1, \dots, P_r$ are disjoint and if $Q$ is the union of $P_1, \dots, P_r$. We consider *edge-to-edge* tilings, that is, the intersection of any two $P_i$ is a side of each, and each side of $Q$ is a side of some $P_i$. Then, $r$ being the number of tiles, such a tiling is said to be of type $< m, n, r >$.
In a joint paper with G.C. Shephard we determine all possible types of such tilings. The results for $n \leq 5$ are quite different from those for $n \geq 6$. It is therefore curious that almost the same inequalities for $m, n, r$ hold in all cases. Even stranger is the fact that there is just one anomalous case: A tiling $< 3, 5, 13 >$ does not exist even though it satisfies the inequalities.

42 — Sektion II — Raum PK 14.4 — 13.30

## Turán-type theorems for convex geometric graphs

PETER BRASS, Berlin

Classical Turán theory investigates the maximum number of edges of a graph with $n$ vertices which does not contain some given forbidden subgraph. A similar question can be asked for other structures, but already for directed graphs the situation is more complicated, and for 3-uniform hypergraphs even the simplest case is a famous open problem (Turán's conjecture). In this talk we will study the Turán-type theory of convex geometric graphs, i.e. diagonal systems of convex $n$-gons. With a suitable definition of chromatic number (admitting only sets of consecutive vertices as color classes) this behaves very similar to the graph case for chromatic number at least three, but there are surprising differences in the bipartite case. E.g. there are tree drawings with a Turán function of order $\Theta(n \log n)$, an order which does not occur for any graph.

43 — Sektion III — Raum PK 14.6 — 13.30

## Hamiltonicity and coloring of arrangement graphs

STEFAN FELSNER, FERRAN HURTADO, MARC NOY AND ILEANA STREINU, Berlin

We study connectivity, Hamilton path and Hamilton cycle decomposition, 4-edge and 3-vertex coloring for geometric graphs arising from pseudoline (affine or projective) and pseudocircle (spherical) arrangements. While arrangements as geometric objects are well studied objects in discrete and computational geometry, their graph theoretical properties seem to have been ignored so far. We show that these graphs have interesting properties. Most prominently spherical arrangement graphs are planar graphs admiting a decompositions into two Hamiltonian cycles and 4-edge colorings. We also discuss results for the other classes of arrangement graphs. A number of conjectures and open questions accompany our results.

44 — Sektion IV — Raum PK 14.7 — 13.30

## $K$-alternative algorithms versus $K$-best algorithms in discrete optimization: models and exemplary results

INGO ALTHÖFER, Jena

In a "Multiple Choice System for Decision Support" the following happens. One or several computer programs propose(s) a clear handful of interesting candidate solutions, and a human controller makes the final choice amongst these alternatives. Such systems are very successful in certain fields of discrete decision making, for instance in chess under the name "3-Hirn".
A naive approach would use "k-best algorithms" to produce more than only a single best solution for an optimization problem. However, the k best solutions are often merely micro mutations of each other and not true alternatives (Ferrari with one ash-tray versus Ferrari with two ash-trays).
In the talk we want to discuss approaches to generate true alternatives. Examples from the shortest-path problem are presented, and a rather general monotonicity theorem is proved.

45 — Sektion V — Raum PK 14.8 — 13.30

## Divisible designs admitting special linear groups as automorphism groups

RALPH-HARDO SCHULZ, Berlin

One of the methods to construct divisible designs uses 2-$R$-homogeneous groups, that means permutation groups transitive on the set of (with respect to an equivalence relation $R$) transversal pairs of elements. It was introduced by A.G. Spera (cf. [Sp]).
The construction of such groups, originally applied to certain lines of translation planes, has been extended by Cinzia Cerroni and the author to sets of planes of the 3-dimensional affine space $\mathcal{A} = \mathrm{AG}(3, q)$ with parallelism relation $R$. In this way we get, for instance, divisible designs which admit a group $T \cdot G$ with translation group $T$ and $G \cong \mathrm{GL}(3, q)$ as an automorphism group. Here, the point set is the set of all planes of $\mathcal{A}$ and the block set is determined by a conic and an hermitian unital respectively of the ideal plane of $\mathcal{A}$.

[Sp] A. G. Spera, *t - Divisible designs from imprimitive permutation groups*, Europ. J. Comb. 13, (1992), 409 - 417.

# Sonnabend, 13.11.1999 — Zeit: 14.00

46 — Sektion I — Raum PK 14.3 — 14.00

## Zur Zerlegung des $2n$-dimensionalen Würfels in $n$ HAMILTONsche Kreise

GERHARD KOESTER, Elmshorn

Gerhard Ringel publizierte 1955 das folgende Resultat: Besitzt ein $2n$-dimensionaler Würfel eine Zerlegung seiner Kantenmenge in $n$ HAMILTONsche Kreise, so besitzt auch der $4n$-dimensionale Würfel eine Zerlegung seiner Kantenmenge in $2n$ HAMILTONsche Kreise. Daraus folgt, daßein $2n$-dimensionaler Würfel eine solche Zerlegung besitzt, wenn $n = 2^k$ $(k = 0, 1, 2, \ldots)$ ist. Ringel vermutete, daßes für andere $n$ eine solche Zerlegung nicht gibt. Es wird eine Zerlegung des 6-dimensionalen Würfels in 3 HAMILTONsche Kreise vorgestellt. Aus der Existenz dieser Zerlegung und dem Resultat von Ringel folgt die Zerlegbarkeit für $n = m2^k$ $(k = 0, 1, 2, \ldots; m = 1, 2, 3)$. Es wird erläutert, wie sich die Zerlegung des 6-dimensionalen Würfels aus der Ergänzung von drei disjunkten komplementärsymmetrischen Bahnenüberdeckungen des 6-dimensionalen Würfels ergibt.

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47 — Sektion II — Raum PK 14.4 — 14.00

## Pick, packing and covering

JOERG M. WILLS, Siegen

The most general theorem for packings of translates of an 0–symmetric convex body in the plane is by Folkman, Graham, Witsenhausen and Zassenhaus (1969/72). It generalizes an earlier theorem by Groemer and Oler (1960/61) and improves earlier results by Thue (1892), Segre, Mahler, L. Fejes Toth (1940) and Rogers (1952).
The result is tight for all convex bodies and it is formally closely related to Pick's lattice point theorem. The same holds for the general and optimal covering result by Bambah, Roger, Woods and Zassenhaus (1964/72).

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48 — Sektion III — Raum PK 14.6 — 14.00

## The binding number of $K_r$-free graphs

STEPHAN BRANDT, IRINA KALDRACK, Berlin

The binding number

$$\mathrm{bind}(G) = \min_{X \in S} \frac{|N(X)|}{|X|},$$

where $S$ consists of all subsets $X \subseteq V(G)$ with $N(X) \neq V(G)$ was introduced by Woodall in 1973. Basically, the binding number is a measure for the expansion of graphs with large minimum degree. For several extremal properties tight bounds on the binding number are known ensuring this property, e.g. (almost) perfect matching (bind $\geq \frac{4}{3}$) and hamiltonian cycle (bind $\geq \frac{3}{2}$). For complete graphs $K_r$ only rough estimates for the minimum binding number $b(r)$ are known ensuring a $K_r$-subgraph, namely $r - 2 \leq b(r) \leq r - \frac{4}{3}$, except for the case $r = 3$ where $b(3) = \frac{3}{2}$. We improve the upper bound significantly and show that the lower bound is asymptotically tight as $r \to \infty$. Moreover we present an improved lower bound for $r = 4$. Nevertheless, we conjecture that the lower bound is tight if $r$ is sufficiently large.

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49 — Sektion IV — Raum PK 14.7 — 14.00

## Computing the numbers of lattices on 18 and posets on 14 elements

JOBST HEITZIG AND JÜRGEN REINHOLD, Hannover

The correct values of the numbers of unlabeled/labeled posets/lattices on $n$ elements have been published up to $n = 13$ (unlabeled posets), $n = 15$ (labeled posets), and $n = 11$ (unlabeled lattices). Most of the authors generated those objects using an algorithm that required isomorphism tests (see J. Culberson and G. Rawlins: New results from an algorithm for counting posets, Order 7 (1991), 361–374).

Using a quite different method, we generated all unlabeled posets (equivalently: $T_0$ topologies) on up to 14 and all unlabeled lattices on up to 18 elements. This also gave the number of labeled posets on 16 elements (see M. Erné and K. Stege: Counting finite posets and topologies, Order 8 (1991), 247–265). Like other orderly algorithms (for example B. McKay: Isomorphism-free exhaustive generation, J. Algorithms 26 (1998), no. 2, 306–324) our method avoids isomorphism tests and can easily be parallelized.

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50 — Sektion V — Raum PK 14.8 — 14.00

## Existence criteria for PBDs which include block size 3

MARTIN GRÜTTMÜLLER, Rostock

A pairwise balanced design PBD$[v, K]$ of order $v$ with block sizes from $K$ is a pair $(V, \mathcal{B})$, where $V$ is a finite set (the point set) of cardinality $v$ and $\mathcal{B}$ is a family of subsets of $V$ called blocks such that every 2-subset of $V$ is contained in exactly one block of $\mathcal{B}$, and $|B| \in K$ for every block $B \in \mathcal{B}$.
Let $\alpha(K) = \gcd\{k-1 : k \in K\}$ and $\beta(K) = \gcd\{k(k-1) : k \in K\}$. Then the conditions $v - 1 \equiv 0 \pmod{\alpha(K)}$ and $v(v-1) \equiv 0 \pmod{\beta(K)}$ are easily seen to be necessary for the existence of a PBD$[v, K]$. R.M. Wilson has shown that they are also asymptotically sufficient, that is, there exists a constant $v_0 = v_0(K)$ such that if $v \geq v_0$ and these conditions are satisfied, then there exists a PBD$[v, K]$. The estimates of the constant $v_0$ as determined by Wilson's theory are extremely large, and in specific instances much stronger results are possible.
In this talk, we investigate upper bounds for $v_0(K)$ in the case that $K$ contains the element 3.

# Sonnabend, 13.11.1999 — Zeit: 14.30

51 — Sektion I — Raum PK 14.3 — 14.30

## Maximal number of constant weight vertices of the unit $n$-cube contained in a $k$-dimensional subspace

R. AHLSWEDE, HARUTYUN AYDINIAN, AND L. KHACHATRIAN, Bielefeld

We introduce and solve a seemingly basic geometrical extremal problem.For the set $E(n,w) = \{x^n \in \{0,1\}^n : x^n \text{ has } w \text{ ones}\}$ of vertices of weight $w$ in the unit cube of $R^n$ we determine $M(n,k,w) = \max\{|U_k^n \cap E(n,w)| : U_k^n \text{ is a } k\text{-dimensional subspace of } R^n\}$.We also present an extension to multi-sets and explain a connection to the (higher dimensional) Erdös-Moser problem.

52 — Sektion II — Raum PK 14.4 — 14.30

## Diameter graphs in classical geometries and full equi-intersectors

BERND WEGNER, Berlin

The estimates by Hopf-Pannwitz-Erdős for diameter graphs of finite sets are generalized from Euclidean to elliptic and hyperbolic geometry. A classification of these graphs is given which also holds in all of these three geometries. The same arguments give a similar classification for a class of graphs which are called full equi-intersectors.

In spherical geometry the diameter of the sets considered will have to be smaller than half of the interior diameter of the sphere, while such a restriction will not be necessary in the hyperbolic and in the Euclidean case. The reason for this is that we shall need the convexity of distance balls for several arguments and as a consequence the so-called Intersection Lemma, which is not satisfied for spherical distances above half of the interior diameter. Here counterexamples to the proposed inequalities and classifications can be obtained.

53 — Sektion III — Raum PK 14.6 — 14.30

## Self-avoiding walks and finite automata

PETER TITTMANN, Mittweida

Let $c_n^{(d)}$ be the number of self-avoiding walks of length $n$ in a hypercubic lattice $\mathbb{Z}^d$. The exact value of the *connective constant* $\mu^{(d)} = \lim_{n\to\infty} \sqrt[n]{c_n^{(d)}}$ is not known. Upper bounds for $\mu^{(d)}$ can be obtained by counting self-avoiding walks with finite memory, that is walks self-avoiding only within a prescript number of steps. The known upper bounds could be improved by using finite automata in order to count symmetry classes of walks containing cycles up to a given length. The corresponding ordinary generating function is always rational. Thus we obtain the asymptotic behavior by considering the roots of smallest modulus of the denominator polynomial. These roots correspond to the positive real dominating eigenvalue of the automaton matrix. The automaton itself is used to find this eigenvalue by power iteration. The new upper bounds in two and three dimensions are 2.6792 and 4.7387, respectively.

54 — Sektion IV — Raum PK 14.7 — 14.30

## New lower bounds for covering codes

ALAIN PLAGNE, Paris, France

We develop two methods for obtaining new lower bounds for the cardinality of covering codes. Both are based on the notion of linear inequality of a code. Indeed, every linear inequality of a code (defined on $F_q^n$) allows to obtain, using a classical formula $(*)$, a lower bound on $K_q(n,R)$, the minimum cardinality of a covering code with radius $R$. We first show how to get new linear inequalities (providing new lower bounds) from old ones. Then, we prove some formulae that improve on the classical formula $(*)$ for linear inequalities of some given types. Applying both methods to all the classical cases of the literature, we improve on nearly 20 % of the best lower bounds on $K_q(n,R)$. This is a joint work with Laurent Habsieger.

55 — Sektion V — Raum PK 14.8 — 14.30

## On existence problems of $(r,1)$-designs

HARALD GROPP, Heidelberg

After some historical remarks concerning 100 years of Hilbert's Grundlagen der Geometrie and 100 years of Steiner systems S(2,3,13) my talk will focus on existence problems of (r,1)-designs, mainly in a combinatorial sense rather than a geometrical sense.

A *linear space* is an incidence structure of $v$ points and $b$ lines such that through two different points there is exactly one line. *(r,1)-designs* are those linear spaces where through every point there are exactly $r$ lines. All linear spaces with at most 12 points and all $(r,1)$-designs with at most 13 points have been constructed. Important subclasses are configurations, regular graphs, and Steiner systems.

The emphasis will be on collecting numerical and structural conditions in order to obtain nonexistence results for suitable parameter sets which characterize certain $(r,1)$-designs. For small cases the obviously necessary conditions are already sufficient. This talk continues and complements earlier work on infinite series of $(r,1)$-designs.

Liebe Teilnehmerinnen und Teilnehmer:

Zum 19. "Kolloquium über Kombinatorik" begüßen wir Sie alle recht herzlich hier in unserer Technischen Universität Carolo-Wilhelmina.

Diese Tagung der Diskreten Mathematik im weitesten Sinne wurde 1981 von Walter Deuber in Bielefeld ins Leben gerufen. Nach zehn Jahren in Bielefeld findet sie seither, bis auf ein Jahr in Hamburg, immer in Braunschweig statt. Wir möchten dieses 19. Kolloquium über Kombinatorik dem Andenken an Walter Deuber (1942-1999) widmen.

Für die Hilfe von allen Freiwilligen, besonders aus der Studentenschaft, möchten wir uns vielmals bedanken.

Dem Präsidenten der Technischen Universität Braunschweig, Herrn Professor Dr. J. Litterst, danken wir für eine finanzielle Unterstützung.

Allen Teilnehmern wünschen wir eine erfolgreiche Tagung und einige schöne Tage in Braunschweig.

Heiko Harborth
Arnfried Kemnitz
Christian Thürmann
Hartmut Weiß

**Diskrete Mathematik**
**Technische Universität Braunschweig**

# Sonnabend, 13.11.1999 — Zeit: 15.30

56 — Sektion I — Raum PK 14.3 — 15.30

## Sets containing no three points on a line and the number of sums

YONUTZ STANCHESCU, Bordeaux, France

Let $A$ be a planar finite set of $n$ lattice points. We prove that if $A$ does not contain any three collinear points, then $|A+A| \gg n(\log n)^c$. Here $c$ can be every positive absolute constant $c < 0.125$. This lower bound provides an answer to an old question of G. A. Freiman. Some further related questions on non-averaging sets of integers are posed and discussed.

57 — Sektion II — Raum PK 14.4 — 15.30

## Consecutive binomial coefficients in Pythagorean triples

FLORIAN LUCA, Praha, Czech Republic

Various diophantine equations involving binomial coefficients have been previously investigated. For example, de Weger and Pinter have investigated the problem of determining all positive integers which can be represented as a nontrivial binomial coefficient more than once. In particular, they have solved equations such as

$$\binom{n}{2} = \binom{n}{3}$$

or

$$\binom{n}{2} = \binom{n}{4}$$

and so on.

In my talk, I will look at all consecutive triples of binomial coefficients

$$\binom{n}{k},\ \binom{n}{k+1},\ \binom{n}{k+2} \tag{1}$$

which form a Pythagorean triple. The result is:

**Theorem.**

*If the three numbers from list* (1) *form a Pythagorean triple, then* $n = 62$ *and* $k = 26$ *or* 34.

The proof uses results concerning occurrences of squares in the Fibonacci sequence.

58 — Sektion III — Raum PK 14.6 — 15.30

## Listing polycyclic chains

AMREY KRAUSE, Bielefeld

59 — Sektion IV — Raum PK 14.7 — 15.30

## Neue Bonferroni-Ungleichungen durch Abschluss- und Kernoperatoren

KLAUS DOHMEN, Berlin

Sei $(\Omega, \mathcal{A}, P)$ ein Wahrscheinlichkeitsraum und $\{A_v\}_{v\in V} \subseteq \mathcal{A}$ eine endliche Familie von Ereignissen. Aufgrund der klassischen Bonferroni-Ungleichungen gilt für jedes $r \in \mathbb{N}$

$$(-1)^{r-1} P\left(\bigcup_{v\in V} A_v\right) \leq (-1)^{r-1} \sum_{\substack{I\in\mathcal{P}^*(V)\\ |I|\leq r}} (-1)^{|I|-1} P\left(\bigcap_{i\in I} A_i\right),$$

wobei $\mathcal{P}^*(V)$ den abstrakten simplizialen Komplex der nichtleeren Teilmengen von $V$ bezeichnet. Wir zeigen, wie man unter gewissen Voraussetzungen den Komplex $\mathcal{P}^*(V)$ durch einen kleineren abstrakten simplizialen Komplex $\mathcal{S} \subseteq \mathcal{P}^*(V)$ ersetzen kann, so dass für alle $r \in \mathbb{N}$ gilt:

$$(-1)^{r-1} P\left(\bigcup_{v\in V} A_v\right) \leq (-1)^{r-1} \sum_{\substack{I\in\mathcal{S}\\ |I|\leq r}} (-1)^{|I|-1} P\left(\bigcap_{i\in I} A_i\right) \leq (-1)^{r-1} \sum_{\substack{I\in\mathcal{P}^*(V)\\ |I|\leq r}} (-1)^{|I|-1} P\left(\bigcap_{i\in I} A_i\right).$$

60 — Sektion V — Raum PK 14.8 — 15.30

## For every $t$, there is a $t$-design with arbitrarily large automorphism group

MICHEL SEBILLE, Bruxelles, Belgium

A $t-(v,k,\lambda)$ **design** (or simply $t$-**design**), denoted by $S_\lambda(t,k,v)$, is a pair $(X,\mathcal{B})$ where $X$ is a set of $v$ elements called **points** and $\mathcal{B}$ is a collection of $k$-subsets of $X$ (called **blocks**) such that every $t$-subset of $X$ is contained in $\lambda$ blocks of $\mathcal{B}$.

In 1987, Teirlinck proved that if $t$ and $v$ are two integers such that $v \equiv t \pmod{(t+1)!^{(2t+1)}}$ and $v \geq t+1 > 0$, then there exists a $t-(v, t+1, (t+1)!^{(2t+1)})$ design. We prove that if there exists a $(t+1)-(v,k,\lambda)$ design and a $t-(v-1, k-2, \lambda(k-t-1)/(v-k+1))$ design with $t \geq 2$, then there exists a $t-(v+1, k, \lambda(v-t+1)(v-t)/(v-k+1)(k-t))$ design. Using this recursive construction, we prove that for any pair $(t,n)$ of integers ($t \geq 2$ and $n \geq 0$), there exists a simple non trivial $t-(v,k,\lambda)$ design having an automorphism group isomorphic to $\mathbb{Z}_2^n$.

# Sonnabend, 13.11.1999 — Zeit: 16.00

61 — Sektion I — Raum PK 14.3 — 16.00

## The facets of $k$-factors polytope

RUSLAN SIMANCHEV, Omsk, Russia


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# Vortragende

# Freitag, 12. 11. 1999

9.30 **Eröffnung** (Hörsaal: PK 4.3)

9.45 **Hans Jürgen Prömel (Berlin)** (Hörsaal: PK 4.3)
"On the mathematical work of Walter Deuber"

10.40 **Kaffeepause**

10.55 **Marek Lassak (Berlin)** (Hörsaal: PK 4.3)
"Combinatorial and geometric problems
on approximation of a set by a triangle"

11.50–13.30 **Mittagspause**

| Zeit | Sektion I<br>Raum PK 14.3 | Sektion II<br>Raum PK 14.4 | Sektion III<br>Raum PK 14.6 | Sektion IV<br>Raum PK 14.7 | Sektion V<br>Raum PK 14.8 |
|---|---|---|---|---|---|
| **13.30** | **J.-P. Bode** 1<br>Independent chesspieces on euclidean boards | **H. Fleischner** 2<br>On maximum independent vertex sets in a special class of hamiltonian 4-regular graphs | **K. Engel** 3<br>$t$–intersecting and $s$–cointersecting families in the Boolean lattice | **F. Recker** 4<br>The search complexity in trees with a lying oracle | **E. Steffen** 5<br>Circular flow numbers of regular multigraphs |
| **14.00** | **D. Bokal** 6<br>The game Trik on hypergraphs | **B. Weißbach** 7<br>Zur chromatischen Zahl des $\mathbb{R}^d$ | **G. Kyureghyan** 8<br>On a degree property of cross-intersecting families | **U. Leck** 9<br>Orthogonal double covers of complete graphs | **J. Schreyer** 10<br>Some news about oblique graphs |
| **14.30** | **T. Pisanski** 11<br>Realizations and drawings of configurations | **M. Marangio** 12<br>Listenchromatische Zahlen ganzzahliger Distanzgraphen | **C. Bey** 13<br>Intersecting families in chain- and star products | **H.-M. Teichert** 14<br>Classes of hypergraphs with sum number one | **M. Kriesell** 15<br>Long cycles vs. removable links in critically 2-connected graphs |
| **15.00** | **U. v. Nathusius** 16<br>Does a small portion determine a unique picture? | **I. Schiermeyer** 17<br>Forbidden subgraphs and 3-colourability | **M. Erné** 18<br>Order embedding structures | **M. Sonntag** 19<br>Antimagic and supermagic labellings of hypergraphs | **S. Hartmann** 20<br>Supersimple decompositions of complete multigraphs |
| **15.30** | **H. Mielke** 21<br>The Penrose polynomial and the Fano matroid | **Z. Ryjáček** 22<br>Closure and forbidden pairs for hamiltonicity | **A. Devillers** 23<br>Ultrahomogeneous semilinear spaces | **S. Hougardy** 24<br>Computing minimum spanning trees in hypergraphs | **V. Grolmusz** 25<br>New explicit Ramsey graph constructions |
| **16.00** | **Kaffeepause** | | | | |
| **16.30** | **P. Willenius** 26<br>Dominating a sequence by two sequences | **F. Fodor** 27<br>Finite circle packings and extremal polygons | **A. Winterhof** 28<br>On difference matrices | **D. Cieslik** 29<br>Längenminimale Netze | **E. Dahlhaus** 30<br>Size measures for chordal graphs and related fill-in problems |
| **17.00** | **B. Zelinka** 31<br>Some results on domination in graphs | **P. Bundschuh** 32<br>On finite zero-one-sequences | **H. Hassenpflug** 33<br>Partielle Differenzengleichungen als Verallgemeinerung gewöhnlicher Differenzengleichungen | **W. Wenzel** 34<br>Hyperebenen-Separation der Eckenmenge des $n$-Würfels | **M. Tewes** 35<br>Longest paths and longest cycles in graphs with large degree sums |
| **17.30** | **G. Wesp** 36<br>An enumeration problem | **A. Geroldinger** 37<br>On long minimal zero sequences in finite abelian groups | **C. Damm** 38<br>A constructive upper bound on matrix rigidity | **J. Koolen** 39<br>Equilateral dimension of the rectilinear space | **N. Punnim** 40<br>On $F(j)$-graphs and their applications |

19.00 **Gemeinsames Abendessen** im Ristorante „da Paolo“, Lindenhof



# Sonnabend, 13. 11. 1999

9.45 **Dorothea Wagner (Konstanz)** (Hörsaal: PK 4.3)
"Flow methods for graph drawing"

10.40 **Kaffeepause**

10.55 **Alexander Rosa (Hamilton, Canada)** (Hörsaal: PK 4.3)
"Generalized orthogonal covers"

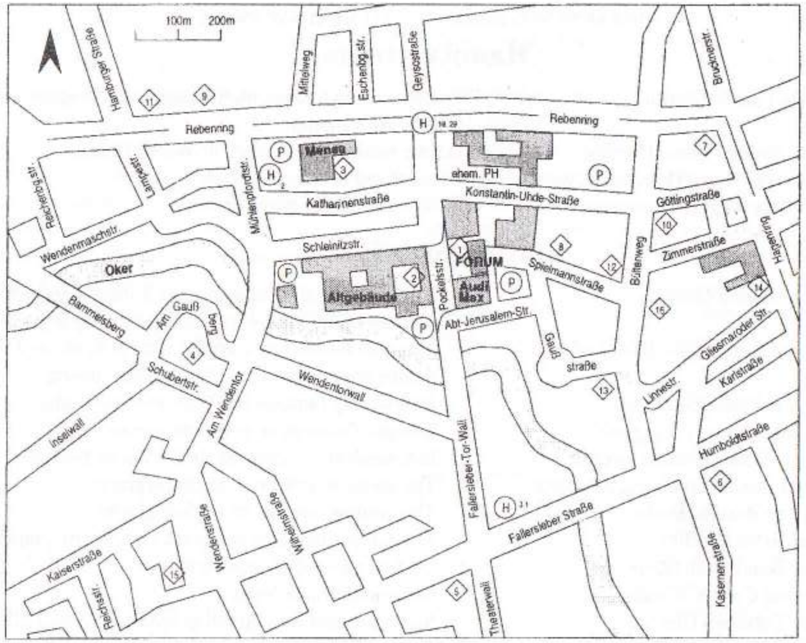
11.50–13.30 **Mittagspause**

| Zeit | Sektion I<br>Raum PK 14.3 | Sektion II<br>Raum PK 14.4 | Sektion III<br>Raum PK 14.6 | Sektion IV<br>Raum PK 14.7 | Sektion V<br>Raum PK 14.8 |
|---|---|---|---|---|---|
| **13.30** | **R. Blind** 41<br>Tilings of convex $m$-gons into $n$-gons | **P. Braß** 42<br>Turán-type theorems for convex geometric graphs | **S. Felsner** 43<br>Hamiltonicity and coloring of arrangement graphs | **I. Althöfer** 44<br>$K$-alternative algorithms versus $K$-best algorithms in discrete optimization: models and exemplary results | **R.-H. Schulz** 45<br>Divisible designs admitting special linear groups as automorphism groups |
| **14.00** | **G. Koester** 46<br>Zur Zerlegung des $2n$-dimensionalen Würfels in $n$ HAMILTONsche Kreise | **J. M. Wills** 47<br>Pick, packing and covering | **S. Brandt** 48<br>The binding number of $K_r$-free graphs | **J. Heitzig** 49<br>Computing the numbers of lattices on 18 and posets on 14 elements | **M. Grüttmüller** 50<br>Existence criteria for PBDs which include block size 3 |
| **14.30** | **H. Aydinian** 51<br>Maximal number of constant weight vertices of the unit $n$-cube contained in a $k$-dimensional subspace | **B. Wegner** 52<br>Diameter graphs in classical geometrics and full equi-intersectors | **P. Tittmann** 53<br>Self-avoiding walks and finite automata | **A. Plagne** 54<br>New lower bounds for covering codes | **H. Gropp** 55<br>On existence problems of $(r, 1)$-design |
| **15.00** | **Kaffeepause** | | | | |
| **15.30** | **Y. Stanchescu** 56<br>Sets containing no three points on a line and the number of sums | **F. Luca** 57<br>Consecutive binomial coefficients in Pythagorean triples | **A. Krause** 58<br>Listing polycyclic chains | **K. Dohmen** 59<br>Neue Bonferroni-Ungleichungen durch Abschluss- und Kernoperatoren | **M. Sebille** 60<br>For every $t$, there is a $t$-design with arbitrarily large automorphism group |
| **16.00** | **R. Simanchev** 61<br>The facets of $k$-factors polytope | 62 | 63 | 64 | 65 |

## Raumplan

| | | |
|---|---|---|
| **Hauptvorträge** | : | Hörsaal PK 4.3 (Altgebäude, Pockelsstraße 4) |
| **Sektionsvorträge** | : | Hörsäle PK 14.3 und PK 14.4 (Forum, 3. Stockwerk)<br>Hörsäle PK 14.6, PK 14.7 und PK 14.8 (Forum, 5. Stockwerk) |
| **Tagungsbüro** | : | F 314 (Forum, Pockelsstraße 14, 3. Stockwerk) |
| **Bibliothek** | : | F 416 (Forum, 4. Stockwerk) |
| **Cafeteria** | : | F 314/315 (Forum, 3. Stockwerk) |
| **Arbeitsraum** | : | F 507 (Forum, 5. Stockwerk) |
| **Fernsprecher** | : | Erdgeschoß des Forumsgebäudes;<br>Altgebäude, in der Nähe des Hörsaales PK 4.3;<br>Pockelsstraße, gegenüber der Universitätsbibliothek<br>(Münz– und Kartenfernsprecher) |

Öffnungszeiten von Tagungsbüro, Bibliothek, Cafeteria und Arbeitsraum:
Freitag, 9.00–18.30; Sonnabend, 9.00–16.30.




1 Forum, Pockelsstraße 14
2 Altgebäude, Pockelsstraße 4
3 Mensa, Katherinenstraße 1
4 Gaußdenkmal
5 Mephisto, Fallersleberstraße 35, 15.00–3.00
6 Ristorante "da Paolo" (Lindenhof), Kasernenstraße 20, 11.30–15.00, 18.00–23.00

7 Dialog (Bistro), Rebenring 48, 11.30–24.00
8 Eusebia (Bistro), Spielmannstraße 11, 9.00–2.00
9 Griechische Taverne, Rebenring 8a, 12.00–14.30, 17.30–0.00
10 Konfuzius (Chinesisch), Bültenweg 81, 11.30–15.00, 18.00–23.30
11 Ana (Türkisch), Hamburger Straße 287, 10.00–1.00
12 R. P. McMurphy (Irisch Pub), Bültenweg 10, 16.00–2.00
13 Pico's Bierladen (Türkisch), Bültenweg 6, 12.00–24.00
14 Choong Palast (Chinesisch), Gliesmaroderstraße 15, 11.30–15.00, 18.00–23.00
15 Teratai House (Indon.–Chin.), Wendenstraße 49/50, 12.00–15.00, 18.00–23.00
16 Viertel Nach (Bistro), Bültenweg 89, 9.00–2.00

## Hauptvorträge

Marek Lassak (Berlin) : Combinatorial and geometric problems on approximation of a set by a triangle
Hans Jürgen Prömel (Berlin) : On the mathematical work of Walter Deuber
Alexander Rosa (Hamilton, Canada) : Generalized orthogonal covers
Dorothea Wagner (Konstanz) : Flow methods for graph drawing

## Kurzvorträge

Ingo Althöfer (Jena) : $K$-alternative algorithms versus $K$-best algorithms in discrete optimization: models and exemplary results
Harutyun Aydinian (Bielefeld) : Maximal number of constant weight vertices of the unit $n$-cube contained in a $k$-dimensional subspace
Christian Bey (Bielefeld) : Intersecting families in chain- and starproducts
Roswitha Blind (Stuttgart) : Tilings of convex $m$-gons into $n$-gons
Jens-P. Bode (Braunschweig) : Independent chesspieces on Euclidean boards
Drago Bokal (Ljubljana, Slovenia) : The game of Trik on some hypergraphs
Stephan Brandt (Berlin) : The binding number of $K_r$-free graphs
Peter Brass (Berlin) : Turán-type theorems for convex geometric graphs
Peter Bundschuh (Köln) : On finite zero-one-sequences
Dietmar Cieslik (Greifswald) : Längenminimale Netze
Elias Dahlhaus (Berlin) : Size measures for chordal graphs and related fill-in problems
Carsten Damm (Trier) : A constructive upper bound on matrix rigidity
Alice Devillers (Brussels, Belgium) : Ultrahomogeneous semilinear spaces
Klaus Dohmen (Berlin) : Neue Bonferroni-Ungleichungen durch Abschluss- und Kernoperatoren
Konrad Engel (Rostock) : $t$-intersecting and $s$-cointersecting families in the Boolean lattice
Marcel Erné (Hannover) : Order embedding structures
Stefan Felsner (Berlin) : Hamiltonicity and coloring of arrangement graphs
Herbert Fleischner (Vienna, Austria) : On maximum independent vertex sets in a special class of Hamiltonian 4-regular graphs
Ferenc Fodor (Cookeville, TN, U.S.A.) : Finite circle packings and extremal polygons
Alfred Geroldinger (Graz, Austria) : On long minimal zero sequences in finite abelian groups
Vince Grolmusz (Budapest, Hungary) : New explicit Ramsey graph constructions
Harald Gropp (Heidelberg) : On existence problems of $(r,1)$-designs
Martin Grüttmüller (Rostock) : Existence criteria for PBDs which include block size 3
Sven Hartmann (Rostock) : Supersimple decompositions of complete multigraphs
Helwig Hassenpflug (Aachen) : Partielle Differenzengleichungen als Verallgemeinerung gewöhnlicher Differenzengleichungen
Jobst Heitzig (Hannover) : Computing the numbers of lattices on 18 and posets on 14 elements
Stefan Hougardy (Berlin) : Computing minimum spanning trees in hypergraphs
Gerhard Koester (Elmshorn) : Zur Zerlegung des $2n$-dimensionalen Würfels in $n$ Hamiltonsche Kreise
Jack Koolen (Bielefeld) : Equilateral dimension of the rectilinear space
Amrey Krause (Bielefeld) : Listing polycyclic chains
Matthias Kriesell (Hannover) : Long cycles vs. removable links in critically 2-connected graphs
Gohar Kyureghyan (Bielefeld) : On a degree property of cross-intersecting families
Uwe Leck (Rostock) : Orthogonal double covers of complete graphs
Florian Luca (Prague, Czech Republic) : Consecutive binomial coefficients in Pythagorean triples
Massimiliano Marangio (Braunschweig) : Listenchromatische Zahlen ganzzahliger Distanzgraphen
Hans Mielke (Berlin) : The Penrose Polynomial and the Fano Matroid
Ulrike von Nathusius (Bielefeld) : Does a small portion determine a unique picture?
Tomaz Pisanski (Ljubljana, Slovenia) : Realizations and drawings of configurations
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Narong Punnim (Bangkok, Thailand) : On $F(j)$-graphs and their applications
Frank Recker (Trier) : The search complexity in trees with a lying oracle
Zdeněk Ryjáček (Pilsen, Czech Republic) : Closure and forbidden pairs for hamiltonicity
Ingo Schiermeyer (Freiberg) : Forbidden subgraphs and 3-colourability
Jens Schreyer (Ilmenau) : Some news about oblique graphs
Ralph-Hardo Schulz (Berlin) : Divisible designs admitting special linear groups as automorphism groups
Michel Sebille (Bruxelles, Belgium) : For every $t$, there is a $t$-design with arbitrarily large automorphism group
Ruslan Simanchev (Omsk, Russia) : The facets of $k$-factors polytope
Martin Sonntag (Freiberg) : Antimagic and supermagic labellings of hypergraphs
Yonutz Stanchescu (Bordeaux, France) : On the doubling of sets of lattice points in the plane having no three points on a line
Eckhard Steffen (Bielefeld) : Circular flow number of some regular graphs
Hanns-Martin Teichert (Lübeck) : Classes of hypergraphs with sum number one
Meike Tewes (Freiberg) : Longest paths and longest cycles in graphs with large degree sums
Peter Tittmann (Mittweida) : Self-avoiding walks and finite automata
Bernd Wegner (Berlin) : Diameter graphs in classical geometries and full equi-intersectors
Bernulf Weißbach (Magdeburg) : Zur chromatischen Zahl des $R^d$
Walter Wenzel (Chemnitz) : Hyperebenen-Separation der Eckenmenge des $n$-Würfels
Gerhard Wesp (Salzburg) : An enumeration problem
Per Willenius (Magdeburg) : Dominating a sequence by two sequences
Joerg M. Wills (Siegen) : Pick, packing and covering
Arne Winterhof (Vienna, Austria) : On difference matrices
Bohdan Zelinka (Liberec, Czech Republic) : Some results on domination in graphs

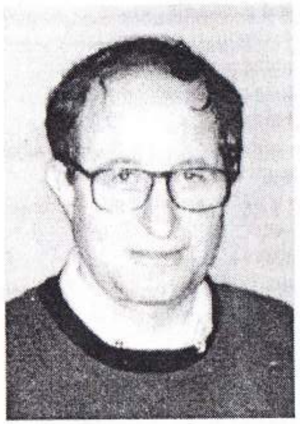
## Weitere Teilnehmer

Suren Arzumanyan (Bielefeld), Ulrike Baumann (Dresden), Gerd Blind (Stuttgart), Jean Doyen (Bruxelles, Belgium), Dieter Gernert (München), Eberhard Girlich (Magdeburg), Stefan Gruenewald (Bielefeld), Andrea Hackmann (Braunschweig), Jochen Harant (Ilmenau), Heiko Harborth (Braunschweig), Egbert Harzheim (Düsseldorf), Michael Hoeding (Magdeburg), Christoph Josten (Frankfurt), Heinz Adolf Jung (Berlin), Franz Kalhoff (Passau), Arnfried Kemnitz (Braunschweig), Ingrid Mengersen (Braunschweig), Meinhard Möller (Braunschweig), Nicole Morawe (Berlin), Annette Schelten (Freiberg), John Selfridge (DeKalb, IL, U.S.A.), Larry Somer (Prague, Czech Republic), Thomas Tautenhahn (Magdeburg), Christian Thürmann (Braunschweig), Hansjoachim Walther (Ilmenau), Ian Wanless (Oxford, England), Hartmut Weiß (Braunschweig), Aierken Wumaier (Berlin)

**Freitag, 12.11.1999 — Zeit: 9.45 — Hörsaal: PK 4.3**

# On the mathematical work of Walter Deuber

HANS JÜRGEN PRÖMEL, Berlin



**Walter Deuber 1942-1999**

Walter Deuber, Professor of Mathematics at the University of Bielefeld, died on 16th July 1999 at the age of 56 after a one and a half year struggle with cancer. He was born on 6th October 1942, in Bern, Switzerland, where he grew up, went to school, and spent the first twenty years of his life until he went to Zürich to study.

Walter was a mathematician with far-ranging interests, but his mathematical love was Ramsey theory. When I talked to him for the last time, about two weeks before his untimely death, he asked me "What is new in mathematics?". I started talking about some results in random graph theory which we had recently obtained. But he immediately interrupted me, saying "No, I meant in Ramsey theory, of course." Rota's dictum *Ramsey's theorem tells more about the nature of sets than all the axioms of set theory!* was spoken from the bottom of Walter's heart.

Walter studied mathematics and physics at the Eidgenössische Technische Hochschule (ETH) Zürich – originally, to become a high school teacher. He first came across Ramsey theory in his PhD-thesis, written under the guidance of Ernst Specker in Zürich, which in its core contains a remarkable extension of a famous result of Richard Rado. In his thesis *Studien zur Kombinatorik* from 1933, Rado had studied systems of homogeneous linear equations and had addressed the following question: which systems of homogeneous linear equations that have a solution in $\mathbb{N}$ do have the property that for every partition of $\mathbb{N}$ into finitely many classes at least one of these classes must contain a solution of this system of equations. Rado gave a complete characterization of these systems of equations and called them *partition regular systems*. Going one step further, one calls a set $X \subset \mathbb{N}$ *partition regular* if and only if it contains a solution of every partition regular system. Obviously, Rado's result then says that whenever $\mathbb{N}$ is partitioned into finitely many classes at least one of these classes is partition regular. Already in his thesis Rado conjectured that whenever *any* partition regular set is partitioned into finitely many classes, then at least one of these classes is partition regular *again*. This conjecture remained open for forty years until Walter settled it in his thesis. The tool that Walter invented in order to prove the conjecture has become even more popular than the result itself. He gave a description of the arithmetic structure of the sets of solutions of partition regular systems, calling them $(m, p, c)$*-sets*. Now *Deuber-sets* seems to be the proper name for them. He proved a general partition theorem for $(m, p, c)$-sets that in particular yields a proof of Rado's conjecture. The main results of his thesis are published in the paper *Partitionen und lineare Gleichungssysteme*[1]

Partition regular systems of equations and $(m, p, c)$-sets became a constant companion throughout his entire mathematical life. As with many mathematicians, he often came back to the results he proved in his PhD-thesis. An excellent account of the developments based on Rado's and on his dissertation – which is, to quote Graham, Rothschild and Spencer[2], on the shoulders of Rado – was given by Walter in the Surveys in Combinatorics 1989[3]. In spring 1998, already being aware of his deadly illness, he witnessed one of his last scientific satisfactions. Meike Schröder, his last PhD-student, was awarded the "Richard Rado Prize for Discrete Mathematics" for her outstanding thesis. In her thesis, Schröder used Walter's $(m, p, c)$-sets to prove an analogue of Rado's theorem for systems of homogeneous linear *inequalities*, showing once more the power of this concept.

Leaving the ETH Zürich in 1972 (one year before he formally obtained his PhD from there) Walter went on to become Oberassistent at the Technische Universität Hannover. At this time he started studying partition properties of finite graphs and wrote his probably most cited paper: *Generalizations of Ramsey's theorem*[4]. This paper, published in the proceedings volume dedicated to the 60th birthday of Paul Erdős contains a far-reaching generalization of Ramsey's theorem to coloring edges in finite graphs. This result, obtained independently by Rödl and by Erdős, Hajnal and Pósa, opened up new vistas in Ramsey theory. In his second thesis, his Habilitationsschrift, which Walter defended in 1974 in Hannover, he then extended the edge-coloring theorem for finite graphs to a coloring result for general cliques. This result was published in the paper *Partitionstheoreme für Graphen*[5]. His wife Kathy and his son François, who was three years old at the time joined him when he visited the University of California at Los Angeles in 1974/75. There he worked with Bruce Rothschild, among other problems, on the investigation of *Categories without the Ramsey property*[6]. It was during this stay in California that his daughter Odette was born.

In 1976, Walter became Professor of Mathematics in Bielefeld where he remained from then on. He liked to talk about mathematics, and he liked to work in company. So he often visited colleagues and friends around the world and many of them will remember an inspiring time enjoying his hospitality in Bielefeld. In 1981 he started organizing the "Colloquium on Combinatorics" a series of annual meetings which took place in Bielefeld for ten years. This meeting is by now in its nineteenth year, presently held in Braunschweig. During his time in Bielefeld, Walter also served his university and the mathematical community in many other respects: as chairman of the department of mathematics, as the speaker of a Sonderforschungsbereich, and as the coordinator of a European network on Discrete Mathematics, just to name a few of his many activities.

[1] W. Deuber, *Mathematische Zeitschrift* **133** (1973), 109-123.

[2] R.L. Graham, B.L. Rothschild, and J.H. Spencer, *Ramsey Theory*, John Wiley & Sons, New York, 2nd Edition, 1990.

[3] W. Deuber, in: *Surveys in Combinatorics, 1989* (J. Siemons, ed.), London Mathematical Society Lecture Notes Series 141, 52-74.

[4] W. Deuber, in: *Infinite and finite sets* (A. Hajnal, R. Rado, V.T. Sós, eds.), Colloq. Math. Soc. János Bolyai **10** (1975), 323-332.

[5] W. Deuber, *Comment. Math. Helvetici* **50** (1975), 311-320.

[6] W. Deuber and B.L. Rothschild, in: *Combinatorics*, Colloq. Math. Soc. János Bolyai **18** (1978), 225-249.

Mathematically, he always came back to Ramsey's theorem and he contributed substantially to shape modern Ramsey theory.

But his work has many facets besides Ramsey theory. I will, pars pro toto, mention only one area to which Walter contributed during the last years. He was always very interested in how combinatorics relates to other parts of mathematics, in particular to set theory, and how to bridge finite and infinite mathematics. In the beginning of the 90s, he got fascinated in Laczkovich's solution of the Tarski circle squaring problem, and started studying the combinatorial ideas behind the notion of uniformely spread sets which were used by Laczkovich in his proof. Walter investigated so-called wobbling mappings between metric spaces and paradoxical subsets. A wobbling mapping is, intuitively speaking, just a mapping on a metric space which does not move any point too far and a metric space $(M,d)$ is paradoxical if there exists a decomposition of $M$ into two parts $M_1$ and $M_2$ such that $M_1$, $M_2$ and $M$ are pairwise equivalent with respect to wobbling mappings. Considering these general notions led him to study analogues of the spectacular Banach-Tarski phenomenon in arbitrary metric spaces. Some results in this area which Walter obtained with co-authors are contained in "A note on paradoxical metric spaces"[7] and in the paper *Geometrical bijections in discrete lattices*[8].

Walter was a mathematician by passion, both as a researcher and teacher. But also outside mathematics Walter was an inspiring man of excellent taste. He liked art and he liked to cook and to eat well. He liked to enjoy a glass of good wine together with a stimulating conversation. I had the great privilege of first knowing him as a teacher then as a researcher and finally as a friend. His passing away undoubtedly leaves a large void for everybody who knew him.

[7] W. Deuber, M. Simonovits, and V.T. Sós, *Studia Scientiarium Mathematicarum Hungarica* **30** (1995), 17-23.
[8] H.-G. Carstens, W. Deuber, W. Thumser, and E. Koppenrade, *J. Comb. Probab. Comput.* **8** (1999), 109-129.

**Freitag, 12.11.1999 — Zeit: 10.55 — Hörsaal: PK 4.3**

# Combinatorial and geometric problems on approximation of a set by a triangle

MAREK LASSAK, Berlin

Our aim is to discuss miscellaneous methods of comparison of shapes of planar sets with shapes of triangles. For comparison of convex sets with triangles, first of all the Hausdorff metric and a generalized notion of the Banach-Mazur distance will be considered. But also other methods will be presented. Some methods take into account areas, diameters, perimeters and minimal widths. Also finite sets of points will be compared with triangles. In a few cases we will consider more general questions about approximation of sets of Euclidean $n$-space by simplices. The lecture will give a survey of results and open problems.

# Flow methods for graph drawing

DOROTHEA WAGNER, Konstanz

The construction of clear and readable drawings of graphs is a basic problem arising in many fields of applications. Well studied graph drawing models are straight-line drawings, orthogonal drawings or layered drawings. Criteria for the readability of drawings are e.g. the angle resolution in straight-line drawings or the number of bends in orthogonal drawings.
In this talk, we discuss flow methods for the angle resolution in straight-line drawings and for minimizing the number of bends in orthogonal drawings. We then address the dynamic graph drawing problem. When given a dynamic graph, i.e. a graph that changes over the time, one has to take into account not only static criteria as mentioned before, but also the effort users spend to regain familiarity with the drawing. We extend the flow methods for orthogonal drawings to dynamic graphs and show that optimal drawings can be computed efficiently.



# Generalized orthogonal covers

ALEXANDER ROSA, Hamilton, Canada

Generalized orthogonal covers (also known as symmetric graph designs) were introduced recently as a common generalization of symmetric balanced incomplete block designs, and of orthogonal double covers. We present some examples of these - in our opinion extremely interesting - objects, and discuss some recent results on the existence of various classes of generalized orthogonal covers, including those on friendship graphs, as well as Peter Cameron's characterization of doubly transitive symmetric graph designs.

# Freitag, 12.11.1999 — Zeit: 13.30

1 — Sektion I — Raum PK 14.3 — 13.30

## Independent chesspieces on euclidean boards

JENS-P. BODE, Braunschweig

Corresponding to chessboards we introduce game boards with triangles or hexagons as cells and chess-like pieces for these boards. The independence number $\beta$ is determined for many of these pieces. Common work with Heiko Harborth.

2 — Sektion II — Raum PK 14.4 — 13.30

## On maximum independent vertex sets in a special class of hamiltonian 4-regular graphs

HERBERT FLEISCHNER, Vienna, Austria

Let $G$ be a 4-regular graph decomposable into a hamiltonian cycle H and a 2-factor $Q$ such that a run through any component of $Q$ traverses the vertices in the same order in which they appear in $H$. We say the cycles of $Q$ are conformly inscribed in $H$. If every component of $Q$ is a triangle, then $G$ is a cycle-plus-triangles graph for which it was shown in joint work with M. Stiebitz (TU Illmenau) that they are 3-colourable.
In joint work with G. Sabidussi it was shown that in the general case described above, 3-colourability is an NP-complete problem, even if $Q$ is of uniform cycle length (i.e., every component of $Q$ has the same fixed length). It is even true that such graphs may not have an independent set of size $n/3$ or larger (again, even in the restricted case of uniform cycle length of $Q$). However, it is easy to show that

$$\alpha(G) \geq (n-r)/3$$

where $\alpha(G)$ is the independence number of $G$, $n$ is the order of $G$ and $r$ is the number of components of $Q$. This led us to write as a formal equation

$$\alpha(G) = (n-cr)/3 \quad \text{where} \quad 0 \leq c = c(G) \leq 1.$$

The graphs for which $c = 1$ are easily described as those for which $r = 2$ and $n = 2 \bmod 3$. We have found graphs for various other values of $c$. However, we have more open questions than answers.

3 — Sektion III — Raum PK 14.6 — 13.30

## $t$–intersecting and $s$–cointersecting families in the Boolean lattice

KONRAD ENGEL, Rostock

Let $[n] := \{1,\dots,n\}$ and let $2^{[n]}$ be the power set of $[n]$. A family $\mathcal{F} \subseteq 2^{[n]}$ is called *$t$–intersecting* (resp. *$s$–cointersecting*) if $|X \cap Y| \geq t$ (resp. $|X \cup Y| \leq n-s$) for all $X, Y \in \mathcal{F}$. Examples of $t$–intersecting and $s$–cointersecting families are the families

$$S(n,t,s,r) := \{X \in 2^{[n]} : |X \cap [t+2r]| \geq t+r \text{ and } |X \cap \{n-s-2q+1,\dots,n\}| \leq q\},$$

$r = 0,\dots,\lfloor \frac{n-t-s}{2} \rfloor$, where $q := \lfloor \frac{n-t-s}{2} \rfloor - r$. We present a result which proves an asymptotic variant of a conjecture of Frankl, Bang, Sharp, and Winkler: Let $t = \tau n + o(n), s = \sigma n + o(n), \tau, \sigma > 0, \tau + \sigma < 1$ and $n \to \infty$. Then the maximum size of a $t$–intersecting and $s$-cointersecting family in $2^{[n]}$ is asymptotically equal to $\max\{|S(n,t,s,r)| : r = 0,\dots,\lfloor \frac{n-t-s}{2} \rfloor\}$.
This is part of joint work with R. Ahlswede, C. Bey, and L. Khachatrian.

4 — Sektion IV — Raum PK 14.7 — 13.30

## The search complexity in trees with a lying oracle

FRANK RECKER, Trier

Let $n \in \mathbb{N}$ be given. The complete binary tree $T$ with depth $n$ has $2^n$ leaves and $2^n - 1$ inner nodes.
Alice and Bob play the following game: Alice has to find an unknown leave $x$. She chooses a node $u$ of $T$ and Bob answers, whether or not the leave is a descendant of $u$. After receiving the answers, Alice asks the next question and so on.
Alice can always find the leave after at most $n$ questions. On the other hand, $n-1$ questions might not suffice. $n$ is called the **search complexity** of this search process.
The search complexity increases, when Bob is allowed to lie. Some bounds for the search complexity with $e \in \mathbb{N}$ allowed lies will be presented.

5 — Sektion V — Raum PK 14.8 — 13.30

## Circular flow numbers of regular multigraphs

ECKHARD STEFFEN, Bielefeld

The circular flow number $F_c(G)$ of a graph $G = (V,E)$ is the minimum $r \in \mathbb{Q}$ such that $G$ admits a flow $\phi$ with $1 \leq \phi(e) \leq r-1$, for each $e \in E$.
We determine the circular flow number of some regular multigraphs. In particular, we characterize the bipartite $(2t+1)$-regular graphs ($t \geq 1$). Our results imply that there are gaps for possible circular flow numbers for $(2t+1)$-regular graphs, e.g. there is no cubic graph $G$ with $3 < F_c(G) < 4$.
We further show that there are snarks with circular flow number arbitrary close to 4, answering a question of X. Zhu.