TWENTY FOURTH MIDWESTERN CONFERENCE ON COMBINATORICS, CRYPTOGRAPHY, AND COMPUTING
(Honoree: Roger B. Eggleton)

PLENARY TALKS

Three Hamilton decomposition problems
Brian Alspach, University of Newcastle, Australia
[Sat 2:00 139]

I shall give a brief survey on three problems dealing with Hamilton decompositions of graphs. One problem is Bermond's Conjecture that cartesian products of Hamilton-decomposable graphs themselves are Hamilton-decomposable. The second problem is my problem asking whether connected Cayley graphs on abelian groups are Hamilton-decomposable. The third problem is my problem with Moshe Rosenfeld asking which trivalent graphs have Hamilton-decomposable prisms.

Two problems concerning decompositions of complete graphs.
Darryn Bryant, University of Queensland, Australia
[F 2:00 139]

A decomposition of a graph is a set of edge-disjoint subgraphs which together contain all its edges. I will discuss two problems on decompositions of the complete graph. The first concerns decompositions of the complete graph on n vertices into n isomorphic subgraphs, and the second concerns decompositions of complete graphs into isomorphic regular spanning subgraphs.

Latin squares without proper subrectangles
Barbara Maenhaut, University of Queensland, Australia
[Sat 9:00 139]

A Latin square of order n is an $n \times n$ matrix in which each one of n symbols appears exactly once in each row and exactly once in each column. A subsquare of a Latin square L is a submatrix of L that is itself a Latin square. A subrectangle of a Latin square L is a rectangular submatrix of L in which the same symbols occur in each row. A subsquare or subrectangle of a Latin square L is proper if it has at least two rows and is not L itself.

A Latin square is subsquare-free if it has no proper subsquares and is row-Hamiltonian if it has no proper subrectangles. A survey of existence results on subsquare-free and row-Hamiltonian Latin squares will be presented.

The graph theoretic version of the secretary problem
Michal Morayne, Wroclaw University of Technology, Poland
[Sun 9:00 139]

In the classical secretary problem a selector deals with a random permutation of n linearly ordered elements. The selector does not know this permutation and examines the elements one by one, knowing at a given moment only the order formed by the hitherto examined candidates and the presently examined one. The selector can choose only the presently examined element and the goal is to maximize the probability that this element is the absolute best. (The name 'secretary problem' comes from an entertaining statement of the problem where the 'elements' are candidates for a job as a secretary and the 'selector' is an administrator who is to choose the best candidate.) The problem has a natural extension where the linearly ordered set is replaced by a poset. There have been several papers investigating various aspects of this problem. A further generalization consists in considering a graph (directed or not) whose vertices again show up in the order of a random permutation with the selector seeing at a given moment the graph induced by the vertices that have come so far. Again the selector can choose only the presently examined vertex aiming at choosing a vertex from a given set with the maximal possible probability. Some natural graph models where optimal or effective strategies have been found will be discussed.

Gregarious cycle system with two associate classes
Chris Rodger, Auburn University, USA
[F 9:00 139]

A G-decomposition of H is a partition of the edges of H into sets, each of which induces a copy of the graph G. A G-decomposition of H is said to be gregarious with respect to a partition P of the vertices of H if each copy of G contains vertices from as many different elements of P as possible. In this talk, gregarious cycle systems of H are discussed in the case where two vertices of H are joined by λ_1 edges if they occur in the same part of P, and by λ_2 edges if they occur in different parts of P; decompositions of this graph are said to have two associate classes.

CONTRIBUTED TALKS

(In alphabetical order of last names of speakers)

A public-key threshold cryptosystem based on finite Abelian groups

John Asplund, Michigan Technological University

[Sun 10:25 148]

A cryptosystem where a number of participants larger than the threshold is required to come together with their shared private key in order to decrypt the encrypted message is called a public-key threshold cryptosystem. The message was encrypted using the public key. We construct a variant of Pedersen's public-key threshold cryptosystem. While Pedersen's protocol relies on field properties of $\mathcal{Z}_p$, we generalize the protocol to include calculations that may be performed in finite abelian groups. This is joint work with Melissa Keranen and Ethan Smith.

Decompositions of graphs into cycles with chords

Paul Balister, University of Memphis

[Sun 10:25 147]

Our main result is that if G is a graph on at least $3r + 4s$ vertices with minimum degree at least $2r+3s$, then G contains $r+s$ vertex disjoint cycles, where each of s of these cycles either contain two chords, or are of order 4 and contain one chord. This strengthens a conjecture of Bialostochi, Finkel, and Gyárfás, which was proved by Gao, Li, and Yan. This is joint work with Hao Li and Richard Schelp.

On balance index sets of generalized book and ear expansion graphs

Dan Bouchard, Stonehill College

[F 3:55 147]

Let G be a simple graph with vertex set $V(G)$ and edge set $E(G)$, and let $\mathcal{Z}_2 = \{0, 1\}$. A labeling $f : V(G) \to \mathcal{Z}_2$ induces an edge partial labeling $f^* : E(G) \to \mathcal{Z}_2$ defined by $f^*(uv) = f(u)$ if and only if $f(u) = f(v)$. For $i \in \mathcal{Z}_2$, let $v_f(i) = |\{v \in V(G) : f(v) = i\}|$ and $e_f(i) = |\{e \in E(G) : f^*(e) = i\}|$. f is called a friendly labeling if $|v_f(0) - v_f(1)| \leq 1$. The BI(G), the balance index of G, is defined as $\{|e_f(0) - e_f(1)| :$ the vertex labeling f is friendly.$\}$. This paper focuses on the balance index sets of generalized book and ear expansion graphs. This is joint work with Hsin-hao Su and Patrick Clark.

On labeling the one-point union of two cycles
Ryan Bunge, Illinois State University

[F 4:25 147]

Let G be the one-point union of two cycles C_r and C_s and let $n = r + s > 7$. Using Rosa-type labelings on the vertices of G, we show that there is a cyclic G-decomposition of the complete graph K_{2nx+1} for all positive integers x. This is joint work with K. Brewington, L. J. Cross, C. K. Pawlak, J. L. Smith, and S. Zeppetello.

Ramsey-type numbers of degree sequences
Arthur Busch, University of Dayton

[Fri 11:55 148]

A (finite) sequence of non-negative integers is graphic if it is the degree sequence of some simple graph G. Given graphs G_1 and G_2, we define the *potential-Ramsey number*, $r_{pot}(G_1, G_2)$, as the smallest integer n such that for every n-term graphic sequence π, there is some graph G with degree sequence π with $G_1 \subseteq G$ or with $G_2 \subseteq \overline{G}$. Bounded above by the well-studied classical Ramsey number, we consider situations where equality holds, and give exact values for $r_{pot}(K_n, K_t), r_{pot}(C_n, K_t), r_{pot}(P_n, K_t)$. This is joint work with Michael Ferrara, Stephen Hartke, Michael Jacobson, and Hemanshu Kaul.

Subplanes of order 3 in Hughes planes
Cafer Caliskan, Michigan Technological University

[Sat 10:55 147]

In this study, the subplane structure of Hughes planes of some certain order is analyzed. Furthermore, the existence of subplanes of order 3 in Hughes planes of order q^2, where q is a prime power and $q \equiv 5$ $(mod\ 6)$, is shown.

The Computation of the Ramsey Number $R(K_5 - P_3, K_5)$
Jesse Calvert, Washington University in St. Louis

[Sat 4:25 147]

In 1989, Hendry compiled a table of Ramsey numbers $R(G, H)$ for connected graphs G and H on five vertices. For the Ramsey number $R(K_5 - P_3, K_5)$ he lists the bound $R(K_5 - P_3, K_5) \leq 28$; a lower bound is obtained from the well known result $R(K_4, K_5) = 25$. In 2009, Black, Leven and Radziszowski showed that the upper bound can be further reduced to $R(K_5 - P_3, K_5) \leq 26$. Here we prove that $R(K_5 - P_3, K_5) = 25$ using computer algorithms, which solves one of the three remaining open cases in Hendry's table, leaving only $R(K_5, K_5)$ and $R(K_5, K_5 - e)$ unknown. In addition, we show that there are no $(K_5 - P_3, K_5)$-good graphs containing a K_4 on 23 or 24 vertices. The unique $(K_5 - P_3, K_5)$-good graph with a K_4 on 22 vertices is presented. Finally, we use a result by Burr, Erdős, Faudree and Schelp to show that $R(K_5 - P_3, \widehat{K}_{5,2}) = 25$, where $\widehat{K}_{5,2}$ is the graph obtained by attaching a vertex to a K_5 using 2 edges. This is joint work with Michael Schuster and Stanisław P. Radziszowski.

Tutte polynomials and G-parking functions
Hungyung Chang, National Sun Yat-sen University, Taiwan

[Sat 3:25 148]

In this paper, we give a new expression for the Tutte polynomial of a general connected graph G in terms of statistics of G-parking functions. In particular, given a G-parking function f, let $cb_G(f)$ be the number of critical-bridge vertices of f and denote $w_G(f) = |E(G)| - |V(G)| - \sum_{v \in V(G)} f(v)$. We prove that $T_G(x, y) = \sum_{f \in \mathcal{P}_G} x^{cb_G(f)} y^{w_G(f)}$, where $\mathcal{P}_G$ is the set of G-parking functions. Our proof avoids any use of spanning trees and is independent of bijections between the set of G-parking functions and the set of spanning trees. This is joint work with J. Ma and Y. Yeh.

Using Steiner designs to construct entanglement-assisted quantum LDPC codes

David Clark, Michigan Technological University

[Sat 4:55 149]

Entanglement-assisted quantum error-correcting codes (EAQECCs) are a newly discovered category of quantum codes which are closely linked to classical binary codes. We present a general method for constructing EAQECCs which is based on Steiner designs and low-density parity check (LDPC) codes. This method creates EAQECCs with many desirable properties, including efficient decoding algorithms and very low error rates. The designs used in this construction are deeply linked to the best properties of the codes. This is joint work with Maarten De Boeck, Yuichiro Fujiwara, Vladimir Tonchev, and Peter Vandendriessche.

On the edge-balance-index sets of the L-product of cycle graphs with star graphs

Patrick Clark, Stonehill College

[F 4:55 147]

Let G be a graph with vertex set $V(G)$ and edge set $E(G)$, and let $\mathbb{Z}_2 = \{0,1\}$. A labeling $f : E(G) \to \mathbb{Z}_2$ of a graph G is said to be edge-friendly if $\{|e_f(0) - e_f(1)| \leq 1\}$. An edge-friendly labeling f induces a partial vertex labeling $f^+ : V(G) \to \mathbb{Z}_2$ defined by $f^+(x) = 0$ if the number of edges labeled by 0 incident on x is more than the number of edges labeled by 1 incident on x. Similarly, $f^+(x) = 1$ if the number of edges labeled by 1 incident on x is more than the number of edges labeled by 0 incident on x. $f^+(x)$ is not define if the number of edges labeled by 1 incident on x is equal to the number of edges labeled by 0 incident on x. For $i \in \mathbb{Z}_2$, let $v_f(i) = \text{card}\{v \in V(G) : f^+(v) = i\}$ and $e_f(i) = \text{card}\{e \in E(G) : f(e) = i\}$. The edge-balance index set of the graph G, EBI(G), is defined as $\{|v_f(0) - v_f(1)| : \text{the edge labeling } f \text{ is edge-friendly.}\}$. The edge-balance index sets of C_n x$_L$ $St(m)$ graphs where m is even and greater than 2 are presented in this paper. This is joint work with Dan Bouchard and Hsin Hao Su.

MOLS: Bachelors and monogamous mates

Peter Danziger, Ryerson University

[Sat 10:25 147]

Classically the study of Mutually Orthogonal Latin Squares (MOLS) has focused on the question of how many orthogonal mates it is possible to have for a given order. Recently Wanless and Webb and independently Evans have shown that it is almost always possible to have a Bachelor square, a Latin square which has no mate. In this talk we consider the question of whether there exists a Latin Square which has exactly one mate, called a Monogamous square, for each order. We prove that for any positive integer $n > 6$ there exists a Monogamous Latin Square of order n, except possibly when $n = 2p$ for some prime $p \geq 11$. This is joint work with Ian Wanless and Bridget Webb.

Existence of balanced arrays and the positive semi-definiteness of the moment matrix

Rose Dios, New Jersey Institute of Technology

[Sat 11:25 147]

A balanced array (B-array) of strength t with m ($\geq t$) rows (constraints), N columns, and with two symbols (say, 0 and 1) is a matrix T of size $(m \times N)$ and with elements 0 and 1 such that in every $(t \times N)$ submatrix T^* of T, every $(t \times 1)$ vector with i $(0 \leq i \leq t)$ 1s in it appears with the same frequency (say μ_i). The vector $(\mu_0, \mu_1, \ldots, \mu_t)$ is called the index set of the array. These arrays are generalizations of various other combinatorial structures, and have been extensively used in constructing fractional factorial designs. In this paper, we derive some existence conditions for some of these B-arrays by using the positive semi-definiteness of the moment matrix, and consequently obtain results on the maximum number of constraints of such arrays. This is joint work with D.V. Chopra and Richard M. Low.

On the connection between expander bipartite graphs, and degrees of freedom of the K-user Gaussian interference channel with transmitter cooperation

Aly El Gamal, University of Illinois at Urbana-Champaign

[Sat 4:25 149]

Aided by the information theoretic model for the k-user Gaussian interference channel, we pursue a study of the fundamental limits to the value of transmitter cooperation in a broad class of wireless networks. In order to well pose the problem, we bound the number of transmitters at which any given message is available. To simplify the problem, and identify the effect of cooperation on the structure of interfering signals, without considering the Gaussian noise, we only consider the sum rate at high signal to noise ratio (sum degrees of freedom) as a criterion. Insightful upper and inner bounds are derived. In particular, for any given distribution of messages, we draw an analogy between an upper bound on the sum degrees of freedom, and expansion properties of a bipartite graph where transmitters lie on one side and messages on the other; an edge is present whenever the selected message is available at the corresponding transmitter. This is joint work with V. Sreekanth Annapureddy and Venugopal Veeravalli.

Graceful and rosy labelings of kayak paddles

Dalibor Froncek, University of Minnesota Duluth

[F 10:55 147]

A *labeling* of a graph G with n edges is an injection ρ from $V(G)$, the vertex set of G, into a subset S of the set $\{0, 1, 2, \ldots, 2n\}$ of elements of the additive group Z_{2n+1}. The *length* of an edge $e = xy$ with endvertices x and y is defined as $\ell(xy) = \min\{\rho(x) - \rho(y), \rho(y) - \rho(x)\}$. The subtraction is performed in Z_{2n+1} and hence $1 \leq \ell(e) \leq n$. If the set of all lengths of the n edges is equal to $\{1, 2, \ldots, n\}$, then ρ is a *rosy labeling*; if in addition to it $S \subseteq \{0, 1, \ldots, n\}$, then ρ is a *graceful labeling*. Both labelings were first defined by A. Rosa who also proved that if G with n edges has a rosy (or graceful) labeling, then there exists a decomposition of K_{2n+1} into $2n + 1$ edge-disjoint copies of G. A *canoe paddle* (a.k.a. a *kite*, a *dragon*, or a *tadpole*) is a cycle with a path attached. A *kayak paddle* (or a *double kite* or a *double dragon*) is a pair of cycles joined by a path. It was shown by Truszczyński that all kites are graceful. We started looking at (rosy) labelings of kayak paddles first with Leah Tollefson as a part of her undergraduate research project. Later we accepted the graceful challenge and started investigating graceful labelings of kayak paddles with Ann Literski as a part of her Masters Thesis. We present a report on work in progress in this area. This is joint work with Ann Literski and Leah Tollefson.

t-cancellative families

Zoltán Füredi , University of Illinois at Urbana-Champaign

[F 3:25 139]

A family $\mathcal{F}$ of sets is called t-cancellative if for any distinct $t+2$ members $A_1, \ldots, A_t, B, C \in \mathcal{F}$

$$A_1 \cup A_2 \cup \cdots \cup A_t \cup B \neq A_1 \cup A_2 \cup \cdots \cup A_t \cup C.$$

Let $M_t(n)$ be the maximum size of a such an $\mathcal{F}$ on n elements. It is known that

$$1.5^n/n < M_1(n) < 1.5^n$$

(Tolhuizen, construction, Frankl and Furedi, upper bound). Korner and Simeniori showed

$$0.11 < \limsup M_2(n)/\log_2 n < 0.42$$

Here we give a slight improvement on the upper bound (0.4151) and also consider $M_t(n,k)$, the size of the largest t-cancellative k-uniform family on n vertices, thus answering a question of G. O. H. Katona.

On the purely logical solution of Sudoku

Sergey Gubin, Hewlett Packard

[F 4:55 148]

We use the compatibility matrix method and prove that Sudoku can be solved with pure logic, i.e. the puzzle can be solved without deployment of the trial and error method. Alongside, we discuss the compatibility matrix method itself and its applicability to other combinatorial problems.

Generalized Stirling numbers, Riordan arrays, and the Sheffer group
Tian Xiao He, Illinois Wesleyan University
[Sun 10:55 148]

The Sheffer group of all Sheffer-type polynomials and a pair of generalized Stirling numbers are defined. The isomorphism between the Sheffer group and the Riordan group is proved. An equivalence of the Riordan array pair and generalized Stirling number pair is also presented. Finally, we consider the characterization of Riordan arrays by means of the A- and Z-sequences. It corresponds to a horizontal construction of a Riordan array, whereas the traditional approach is through column generating functions. We show how the A- and Z-sequences of the product of two Riordan arrays are derived from those of the two factors; similar results are obtained for the inverse. We also show how the sequence characterization is applied to construct easily a Riordan array.

Langford-type difference sets for cycle systems
Tina Helms, Maggie Murray, and Stephanie Zeppetello, Illinois State University
[Sun 10:55 147]

A Langford-type m-type difference set of size t and defect d is a set of t m-tuples $\{(d_{i,1}, d_{i,2}, \ldots, d_{i,m}) \mid i = 1, 2, \ldots, t\}$ such that $d_{i,1} + d_{i,2} + \cdots + d_{i,m} = 0$ for $1 \leq i \leq t$ and $\{|d_{i,j}| \mid 1 \leq i \leq t, 1 \leq j \leq m\} = \{d, d+1, \ldots, d+mt-1\}$. In this paper, Langford-type 5-tuple difference sets are given for d even and $t \equiv 0, 1(\mod 4)$ with $d \leq \lfloor \frac{t}{2} \rfloor$, and d odd and $t \equiv 0, 3(\mod 4)$ with $d \leq \lfloor \frac{t-5}{2} \rfloor$. As a corollary, we obtain cyclic 5-cycle systems of the circulant graph $\langle \{d, d+1, \ldots, d+5t-1\} \rangle_n$ for all $n \geq 2d + 10t - 1$ with d and t satisfying the above conditions.

Modular edge colorings of graphs
Ryan Jones, Western Michigan University
[Sat 10:55 148]

A modular edge coloring of a graph gives rise to a proper vertex coloring of the graph. We investigate the relationship between this coloring and the standard vertex coloring. Some results and problems are presented. This is joint work with Kyle Kolasinski, Futabe Okamoto and Ping Zhang.

Large B_d-free subfamilies

Younjin Kim, University of Illinois at Urbana-Champaign

[Sat 11:25 148]

Let $f(\mathcal{F},\Gamma)$ denote the size of the largest subfamily of $\mathcal{F}$ having property Γ, $f(\mathcal{F},\Gamma) := \max\{|\mathcal{F}'| : \mathcal{F}' \subseteq \mathcal{F},\ \mathcal{F}' \text{ has property } \Gamma\}$. Let $f(m,\Gamma) := \min\{f(\mathcal{F},\Gamma) : |\mathcal{F}| = m\}$. First, we consider the case when Γ is the property that there are no four distinct sets in $\mathcal{F}$ satisfing $F_1 \cup F_2 = F_3$, $F_1 \cap F_2 = F_4$. Such families are called B_2-*free*. In 1972 Erdős and Shelah conjectured that $f(m, B_2\text{-}free) = \Theta(m^{2/3})$. We prove that Erdős and Shelah's conjecture is true and establish some general lower and upper bounds on $f(m, B_d\text{-}free)$, where B_d is the Boolean lattice of dimension d. This is a joint work with Zoltán Füredi, Janos Barat, Ida Kantor, and Balazs Patkos.

Degree Ramsey numbers for stars and double-stars

Bill Kinnersley, University of Illinois at Urbana-Champaign

[Sat 4:55 147]

The s-color Degree Ramsey number of a graph G, denoted $R_\Delta(G;s)$, is the minimum of $\Delta(H)$ over all graphs H for which any s-edge-coloring yields a monochromatic G. When G is a star, Burr, Erdős, and Lovász determined $R_\Delta(G;2)$; we determine $R_\Delta(G;s)$ for arbitrary s. When G is a double-star, we determine $R_\Delta(G;2)$ exactly and, by a probabilistic construction, give a lower bound for $R_\Delta(G,s)$. This lower bound asymptotically matches an upper bound due to Jiang for $R_\Delta(T;s)$, where T is any tree. This is joint work with Kevin Milans and Douglas B. West.

Distance-colored graphs

Kyle Kolasinski, Western Michigan University

[Sat 11:55 148]

We define an edge coloring of graphs in terms of distance in graphs and study the Hamiltonian properties on these distance-colored graphs. Results and problems are presented on this topic. This is joint work with Gary Chartrand, Ryan Jones, and Ping Zhang.

Graphical designs

Donald Kreher, Michigan Technological University

[Sat 11:55 147]

Given a graph Γ a collection of subgraphs $\mathcal{B}$ of Γ is said to be a Γ-Graphical t-design of index λ if

1. whenever $B \in \mathcal{B}$ and $\alpha \in \textsc{Aut}\ \Gamma$, then $\alpha(B) \in \mathcal{B}$;
2. every t-edge subgraph of Γ, is contained in exactly λ of the subgraphs in $\mathcal{B}$.

The Γ-graphical designs of index 1 with $\Gamma = K_n$, $K_{m,n}$ and $K_{\underbrace{n, n, n, \ldots, n}_{r}}$ will be presented.

Conflict free coloring of simple hypergraphs with few edges

Mohit Kumbhat, University of Illinois at Urbana-Champaign

[Sun 10:55 149]

A coloring of the vertices of a hypergraph $\mathcal{H}$ is called *conflict free* if each edge e of $\mathcal{H}$ contains a vertex whose color does not get repeated in e. The smallest number of colors required for such a coloring is called the conflict-free chromatic number of $\mathcal{H}$, and is denoted by $\chi_{CF}(\mathcal{H})$. Pach and Tardos studied this parameter for graphs and hypergraphs. Among other things, they proved that for an $(2r-1)$-uniform hypergraph $\mathcal{H}$ with m edges, $\chi_{CF}(\mathcal{H})$ is of the order of $m^{1/r} \log m$. They also raised the question whether the same result holds for r-uniform hypergraphs. In this talk we shall show that this is not necessarily true. Moreover, we provide lower and upper bounds on the minimum number of edges of an r-uniform simple hypergraph which is not conflict free k-colorable. This is a joint work with A. Kostochka and Tomasz Łuczak.

Group divisible designs with block size 6 and fixed block configuration
Melanie Laffin, Michigan Technological University

[F 11:55 147]

A group divisible design GDD$(n, m, k; \lambda_1, \lambda_2)$ is a collection of k element subsets of a set of $v = nm$ points called blocks. These points are partitioned into m groups of size n, and the blocks have the property that each pair of points from the same group appears in exactly λ_1 blocks and each pair from different groups is in exactly λ_2 blocks. If we require that each block contains s points from one group and t points from the other group, then it is called a (s, t) fixed block configuration. We present necessary and sufficient conditions about the existence of group divisible designs with 2 groups and block size 6 with a (3,3) configuration. We also give partial results on GDDs with a (4,2) or (5,1) block configuration. This is joint work with Melissa Keranen.

On union-closed collections of sets
Uwe Leck, University of Wisconsin-Superior

[Sat 4:55 148]

We study the following question: Given m, k, how to choose m k-sets such that their union-closure contains as few sets as possible? A conjecture of Roberts (1999) says that it is best to take the first m k-sets in a certain linear order which can be characterized as globally antilexicographic and locally lexicographic. We present some recent progress on this conjecture including the proof of a more general weighted version for $k = 2$ and some inequalities for cross-unions that are related to the Four Functions Theorem of Ahlswede and Daykin.

On distance-two domination of composition of graphs
Yung-Ling Lai, National Chiayi University, Taiwan

[F 10:55 148]

For a graph $G = (V, E)$, let $N_1(v)$ and $N_2(v)$ denote the set of vertices that are at distance one and two from v respectively. A subset $D \subseteq V(G)$ is said to be a $D_{3,2,1}$-dominating set of G if every vertex $v \in V$ satisfies $w_D(v) \geq 3$

where $w_D(v) = 3|\{v\} \cap D| + 2|N_1(v) \cap D| + |N_2(v) \cap D|$. The minimum cardinality of a $D_{3,2,1}$-dominating set of G, denoted as $\gamma_{3,2,1}(G)$, is called the $D_{3,2,1}$-domination number of G. In this paper we obtained the $D_{3,2,1}$-domination number of the composition of graphs G and H where G is a path or a cycle. This is joint work with Shou-Bo Jeng.

Removing edges from dense H-free graphs
Jeremy Lyle, The University of Southern Mississippi

[F 11:25 148]

Recently, Alon and Sudakov, and subsequently Allen, have considered the following problem: Determine bounds on the number of edges which need to be removed from an H-free graph G, with minimum degree at least $((3\chi(H)-7)/(3\chi(H)-4))|V(G)|$, so that the resulting graph has chromatic number at most $\chi(H)-1$. This extends a classical result of Andrásfai, Erdős, and Sós about K_r-free graphs with large minimum degree. In this paper, we consider extending other results about homomorphisms of dense K_r-free graphs in the same manner.

Longest cycles in k-connected graphs with given independence number
Suil O , University of Illinois at Urbana-Champaign

[F 10:25 148]

The Chvatal-Erdős Theorem states that every graph whose connectivity is at least its independence number has a spanning cycle. In 1976, Fouquet and Jolivet conjec- tured an extension: If G is an n-vertex k-connected graph with independence number a, and $a \geq k$, then G has a cycle with length at least $\frac{k(n+a-k)}{a}$. We prove this conjecture. This is joint work with Douglas B. West and Hehui Wu.

The Hamilton-Waterloo Problem with 4-cycles and a single factor of n-cycles
Sibel Ozkan , Michigan Technological Institute

[Sat 3:55 147]

A $\{C_m^r, C_n^s\}$-decomposition of K_v is a 2-factorization of K_v where r of the 2-factors consist of m-cycles and s of the 2-factors consist of n-cycles. In this paper, we are present results on $\{C_4^r, C_n\}$-decomposition of $K_v - F$ where F is a 1-factor of K_v. So, all the 2-factors except one consist of 4-cycles and a 1-factor is left since v has to be even. This is joint work with Melissa Keranen.

The feasible matching problem
Yuejian Peng, Indiana State University

[Sat 10:25 148]

Let G be a graph and let R be a subset of edges of G. We say that M is an R-*feasible matching* if for every pair of M-saturated vertices u and v, we have $uv \notin R$. We show that Hall's theorem generalizes to R-feasible matching. We also discuss some application of this concept to hypergraph matching and derive bounds for the maximum size of an R-feasible matching. This is joint work with Papa Sissokho.

Revolutionaries and spies
Gregory Puleo, University of Illinois at Urbana-Champaign

[F 4:25 148]

In the game of Revolutionaries and Spies, a number of revolutionaries move about the vertices of a graph while being pursued by spies. If some fixed number of revolutionaries can meet on the same vertex with no spy present, they stage a revolution and win. The spies win by preventing such a meeting indefinitely. We present some results about the behavior of this game on specific graphs, especially complete bipartite graphs. This is joint work with Jane Butterfield, Daniel Cranston, Douglas B. West, and Reza Zamani.

An intermediate value theorem for linear forest numbers
Narong Punnim, Srinakharinwirot University, Thailand

[Sat 3:25 147]

Let $G = (V, E)$ be a graph and $F \subseteq V$. Then F is called an induced forest of G if $\langle F \rangle$ is acyclic. An induced forest F is linear if $\langle F \rangle$ is a union of paths. The linear forest number of a graph G, denoted by $\ell f(G)$, is defined as follows:

$$\ell f(G) = \max\{|F| : F \text{ is an induced linear forest of } G\}.$$

We prove an intermediate value theorem for the linear forest number with the same degree sequence: If the degree sequence of two graphs G and H are the same, and if their linear forest numbers are a and b, then for every integer c between a and b, there is a third graph with the same degree sequence as G and H whose linear induced forest number is c. Let $\mathbf{d}$ be a graphic degree sequence and $\mathcal{R}(\mathbf{d})$ be the class of realizations of $\mathbf{d}$. Let $\mathcal{J} \subseteq \mathcal{R}(\mathbf{d})$. The range of linear forest number over $\mathcal{J}$ is defined by $\ell f(\mathcal{J}) = \{\ell f(G) : G \in \mathcal{J}\}$. We obtain $\ell f(\mathcal{J})$ for several classes of $\mathcal{J}$.

A game of toppling tokens
Benjamin Reiniger, University of Illinois at Urbana-Champaign

[F 3:55 148]

A game is played by two players, Red and Blue, on a graph. On Red's turn, he places a token either on an empty vertex, in which case it is turned red; or on a vertex which is already red. Blue plays the same way. When a vertex has as many tokens as its degree, it *topples*: it gives one token to each of its neighbors, AND all those neighbors become the same color as the toppled vertex. The player to claim all vertices with his color wins. We study this game on several classes of graphs. We also consider a nonpartisan version. This is joint work with David Hannasch, Immanuel McLaughlin, and Gregory Puleo.

1-designs: is there anything left
Dinesh Sarvate, College of Charleston

[Sun 11:25 149]

Solution to a number theory/set theory exercise, "Partition the set of integers $\{1, 2, \cdots, v\}$ into k subsets such that the sum of each subset is $\frac{v(v+1)}{2k}$ whenever $\frac{v(v+1)}{2k}$ is an integer" for positive integers v and k, gives a construction of a 1-SB design which is not simple. This raises a natural question of the existence of a simple 1-SB designs. We show that the necessary conditions for the existence of simple 1-SB designs for block size 2,3,4,5 and 6 are sufficient and even though the same pattern of the proof is applicable for higher block sizes, no satisfactory construction for all block sizes is available at present. Hence we ask a natural question, "can we obtain a construction for simple 1-SB-designs similar to the Billington's construction of simple 1-designs for any block size k?". Same question can also be asked for restricted simple 1-designs. It is well known that a simple 1-design BD(v, k, r) is a set of k-subsets of a v-set such that each element occurs in exactly r blocks. Another natural question can be asked: is it possible to obtain a simple 1-design BD(v, k, r) where the v-set is partitioned into m parts for some integer m and the blocks do not contain more than one element from each part. Such a simple design is called a restricted simple 1-design. We obtain several results for restricted simple 1-designs as well. This is joint work with W. Hemakul, C. Moolsombut, and H. Chan.

Symmetric Hamilton cycle decompositions of graphs
Michael Schroeder, University of Wisconsin-Madison
[F 10:25 147]

Let G be a graph on n vertices. A Hamilton cycle of G is a collection of n edges which form a cycle connecting all vertices. A Hamilton cycle decomposition of G is a partition of the edges of G into Hamilton cycles. Let ϕ be a vertex automorphism of G. We say a Hamilton cycle C is ϕ-symmetric if for each edge $xy \in C$, then $\phi(x)\phi(y) \in C$. A Hamilton cycle decomposition is ϕ-symmetric if each of its Hamilton cycles are ϕ-symmetric. We will discuss existence conditions for ϕ and the existence of ϕ-symmetric Hamilton cycle decompositions for K_m, $K_m - I$ and an appropriate generalization of these graphs. This is joint work with Richard Brualdi.

6-cycle system of $L(B)$ producing 2-path coverings of B
Nidhi Sehgal, Auburn University
[Sun 11:55 148]

In this talk we discuss the necessary and sufficient conditions required for the construction of the 6-cycle system of the line graph, $L(B)$ of a bipartite graph B. But we do so under the added condition that this 6-cycle system can be used to produce a covering of each 2-path in the original bipartite graph exactly once. This is joint work with Chris Rodger.

The fixed weight subset sum problem
Andrew Shallue, Illinois Wesleyan University

[Sat 3:25 149]

In the fixed weight subset sum problem, we are tasked to find a subset with a particular number of terms ℓ that sums to the target. Surprisingly, it has been difficult to find algorithms that improve upon the naive running time of $\binom{n}{\ell}$, and only recently was a method for applying the standard time-space tradeoff discovered. Generalizing the notion of a splitting system from Stinson and utilizing the k-tree algorithm of Wagner, I give a randomized algorithm for the problem that takes time $O(\ell^{(k-1)/2} \cdot \binom{n}{\ell}^{1/(\log k+1)})$ and space $O(\binom{n}{\ell}^{1/(\log k+1)})$. Finally, I will discuss an interesting open problem in the field of design theory.

On the complexity of counting cycles in sparse graphs using nilpotent adjacency matrices
George Stacey Staples, Southern Illinois University-Edwardsville

[Sun 11:55 147]

Nilpotent adjacency matrix methods are employed to enumerate k-cycles in simple graphs on n vertices for any $k \leq n$. The worst-case time complexity of counting k-cycles in an n-vertex simple graph is shown to be $\mathcal{O}(n^{\alpha+1}2^n)$, where $\alpha \leq 3$ is the exponent representing the complexity of matrix multiplication. When k is fixed, the enumeration of all k-cycles in an n-vertex graph is of time complexity $\mathcal{O}(n^{\alpha+k-1})$. Letting $\Omega = \binom{n}{2}$, the average-case time complexity of counting k-cycles in an n-vertex, e-edge graph where $e \leq q\left(\frac{\Omega}{k} - 1\right)$ for fixed $q < 1$ is found to be $\mathcal{O}(n^4(1+q)^n)$. The storage complexity of the approach detailed herein is $\mathcal{O}(n^2 2^n)$. For reference, experimental results detailing computation times (in seconds) are included alongside similar computations performed with algorithms based on the approaches of Bax and Tarjan. This is joint work with René Schott.

Acyclic colorings of graphs with bounded maximum degree
Christopher Stocker, University of Illinois at Urbana-Champaign

[Sat 3:55 148]

An acyclic coloring is a proper coloring with the additional property that any two color classes induce a forest. In 1973 Grünbaum conjectured that for every r, each graph G with $\Delta(G) \leq r$ has an acyclic $(r+1)$-coloring. The conjecture is know to be true for $r \leq 4$ and false for large values of r. We show that for $r = 5$, 7 colors suffice. We also give an efficient algorithm which produces an acyclic coloring using at most $(1 + \lfloor \frac{(r+1)^2}{4} \rfloor)$ colors. This is joint work with Alexandr V. Kostochka.

On mod(2)-edge-magic cubic graphss
Hsin-hao Su, Stonehill College

[Sat 10:55 149]

Let G be a (p, q)-graph where each edge of G is labeled by a number $1, 2, \ldots, q$. The vertex sum for a vertex v is the sum of the labels of edges that are incident to v. If the vertex sums equal to a constant $\pmod{k}$ where $k \geq 2$, then G is said to be Mod(k)-edge-magic. When $k = p$, the corresponding Mod(p)-edge-magic graph is the edge-magic graph introduced by Lee, Seah and Tan. In this paper, we investigate cubic graphs which are Mod(2)-edge-magic. This is joint work with Yung-Chin Wang and Sin-Min Lee.

Counting nilpotent elements in various semigroups of subpermutations
Abdullahi Umar, Sultan Qaboos University, Oman

[Sun 11:25 148]

Let $[n] = \{1, 2, \ldots, n\}$ be an n-chain and let $\alpha : \; Dom\, \alpha \subseteq [n] \rightarrow \; Im\, \alpha \subseteq [n]$ be a partial one-to-one transformation (or subpermutation) on $[n]$. The set of all subpermutations on $[n]$, denoted by I_n, is known as the *symmetric inverse semigroup* with the empty map serving as the *zero* element in this semigroup. The symmetric semigroup is the natural analogue of the symmetric group, in semigroup theory. In a semigroup with 0, an element a is said to be *nilpotent* if $a^k = 0$ for some natural number k. Products of nilpotents and nipotent ranks in I_n have been investigated by Gomes and Howie (1987) and Garba (1994) but the nilpotents of I_n were only counted in 2004, by Laradji and Umar (2004) and independently by Ganyushkin and Mazorchuk (2004). We shall give a summary of all the results and open problems concerning number of nilpotents in I_n and some of its notable subsemigroups.

On k-edge-magic cubic graphs

Yung-Chin Wang, Tzu-Hui Institute of Technology, Taiwan

[Sat 11:25 149]

Let G be a (p, q)-graph where each edge of G is labeled by a number $1, 2, \ldots, q$. The vertex sum for a vertex v is the sum of the labels of edges that are incident to v. If the vertex sums equal to a constant mod(k) where $k \geq 2$, then G is said to be Mod(k)-edge-magic. When $k = p$, the corresponding Mod(p)-edge-magic graph is the edge-magic graph introduced by Lee, Seah and Tan. In this paper, we investigate cubic graphs which are Mod(2)-edge-magic. This is joint work with Sin-Min Lee.

Decomposition of sparse graphs

Hehui Wu, University of Illinois at Urbana-Champaign

[F 11:25 147]

Say that a graph with maximum degree at most d is d-bounded. For dk, we prove a sharp sparseness condition for decomposability into k forests and a d-bounded graph. Consequences are that every graph with fractional arboricity at most $k + \frac{d}{k+d+1}$ has such a decomposition, and (for $k = 1$) every graph with maximum average degree less than $2 + \frac{2d}{d+2}$ decomposes into a forest and a d-bounded graph. When $d = k + 1$, and when $k = 1$ and d‘6, the d-bounded graph in the decomposition can also be required to be a forest. When $k = 1$ and $d = 2$, the d-bounded forest can also be required to have at most d edges in each component. This is joint work with Seog-Jin Kim, Alexandr V. Kostochka, Douglas West, and Xuding Zhu.

Constructing graphs that deviate from the lower bound function in the one-sided minimum crossing problem

Matthew Yancey, University of Illinois at Urbana-Champaign

[Sun 11:25 147]

Let G be a bipartite graph with parts V and W drawn in the plane R^2. The set of edges, $E(G)$, are straight-line immersions. Let $W = \{u_1, u_2, \ldots, u_w\}$. The vertices of W are placed on a straight line L_1 in order from left to right. The one-sided minimum crossing problem is to find the optimum order σ of the vertices of V to place on L_2, a line parallel to L_1, such that the number of crossings is minimized. For vertices $u, v \in V$, let $cr_{uv} = \{w_i w_j : w_i \in N(v), w_j \in N(u), i < j\}$. A well known lower bound function $LB(G)$ is achieved by summing $\min(cr_{uv}, cr_{vu})$ over all pairs of vertices in V. In 2005 Nagamochi gave an algorithm that would provide an approximate solution with no more than $1.4664LB(G)$ crossings and gave an example G', where the optimum drawing has $1.18LB(G)$ crossings. In this paper we will investigate the value of $sup_G \frac{opt(G)}{LB(G)}$ and construct an infinite family of graphs where $opt(G) \geq 1.209LB(G)$.

A note on Motzkin-Straus type results for r-uniform hypergraphs

Cheng Zhao, Indiana State University

[Sat 4:25 148]

In 1965, Motzkin and Straus established a remarkable connection between the maximum clique problem and the extrema of the Lagrangian of a graph. It is interesting to study a generalization of the Motzkin-Straus Theorem to hypergraphs. In this paper, we give some Motzkin-Straus type results. This is joint work with Yuejian Peng.