43rd Australasian Combinatorics Conference

13–17 December 2021

School of Mathematics and Statistics
University of Melbourne

Melbourne-Peking Virtual Research Hub
for Mathematics and Statistics (MPRHMS)

Contents

Conference Overview

Welcome to the 43rd Australasian Combinatorics Conference!

There are 80 talks, including 10 invited lectures.

There are timetables for the week and for each day on the following pages. Each day is broken into two halves (each with a short break). The contributed talks will run in two parallel sessions. Clicking on a talk title in a timetable will take you to the abstract for that talk.

All talks are live talks in Zoom meetings. The Zoom links are listed explicitly below and are also linked at appropriate places in the timetable and abstracts.

Invited talks will be 55 min long and contributed talks will be 25 min long, both including time for questions.

Times listed in the program use Australian Eastern Daylight Time (AEDT).

Links

Conference home page
Online timetable

Zoom Links

Opening/CMSA AGM/Student prize presentation
Invited talks
Session 1
Session 2

(Passcodes are available here.)

Organising Committee

Malwina Luczak, Charl Ras, Lawrence Reeves, Binzhou Xia, Sanming Zhou (Chair)

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Conference Timetable

Zoom links: Invited talks Session 1 Session 2

Time	Monday	Tuesday	Wednesday	Thursday	Friday
8:00					
8:30	Opening				
9:00	Moniri / Huang	Invited talk *Julia Böttcher*	Kingan / Rahim	Freschi / Conder	Lundqvist / Miska
9:30	Vilchis-Alfaro / Gill		Liebenau / Zheng	Bunjamin / McKay	Wood / Bailey
10:00	Hickingbotham / Gentle	Lesgourgues / Horsley	Chng / Huynh	Gowty / Wanless	Darijani / Verret
10:30	De Vas Gunasekara / Steinke	Hall / Imamura	Ohno / Makai	Allsop / Barton	Cavenagh / Qiao
11:00					
11:30	Invited talk *Nick Wormald*	Southwell / Enami	CMSA Annual General Meeting	Invited talk *Jeroen Schillewaert*	Satake / East
12:00		Zhang / Lu			Paleta / Glasby
12:30					Farr / Hawtin
13:00					
13:30					
14:00					
14:30					
15:00					Student prize presn
15:30	A / Bamberg	Idrees / Wulandari	Invited talk *Mikhail Isaev*	Invited talk *Rongquan Feng*	Invited talk *Michael Giudici*
16:00	Bantva / Lansdown	Li / Anuwiksa			
16:30	Mitchell / Taherkhani	Tsiovkina / Hasan	Ganguly / Ulas	Assiyatun / Bagdasaryan	
17:00	Mattheus / Svob	Gajdzica / Kolpakov	Serdiuk / de Vega	Zamfirescu / Singh	
17:30					
18:00	Invited talk *Edwin van Dam*	Invited talk *Daniel Král'*	Invited talk *Bojan Mohar*	Invited talk *Vida Dujmović*	
18:30					
19:00					
19:30					
20:00					

Monday Timetable

Zoom links: Opening/Invited talks | Session 1 | Session 2

Time	Session 1	Session 2
8:50–9:00	Opening	
9:00–9:30	Mojtaba Moniri *Mining full-weight ternary trees in 2^{363}: background for Norm NFTs*	Hongyi Huang *Base-two primitive permutation groups and their Saxl graphs*
9:30–10:00	Carlos Vilchis-Alfaro *H-trails and dynamic H-trails in colored (di)graphs*	Michael James Gill *MOLS of order 10 from relations in nets*
10:00–10:30	Robert Hickingbotham *Shallow Minors, Graph Products and Beyond Planar Graphs*	Aidan Gentle *Perfect sequence covering arrays*
10:30–11:00	Ajani De Vas Gunasekara *Smaller embeddings of partial k-star decompositions*	Gunter Steinke *A note on the Hering types of finite inversive planes*

Time	Invited talk
11:30–12:30	Nick Wormald *Playing games with the k-core*

long break

Time	Session 1	Session 2
15:30–16:00	Tamil Elakkiya A *Gregarious Kite Decomposition of Tensor Product of Complete Multipartite Graphs*	John Bamberg *Minimal Ramsey graphs for cliques*
16:00–16:30	Devsi Bantva *Optimal radio labelings of trees*	Jesse Lansdown *The existence of synchronising groups of diagonal type*
16:30–17:00	Jeremy Mitchell *Perfect 1-Factorisations of Complete Uniform Hypergraphs*	Ali Taherkhani *Stability results for (s,t)-union intersecting families*
17:00–17:30	Sam Mattheus *A new construction of clique-free pseudorandom graphs*	Andrea Svob *Pairwise balanced designs and periodic Golay pairs*

Time	Invited talk
18:00–19:00	Edwin van Dam *Unit gain graphs with two eigenvalues and lines in complex space with few angles*

Tuesday Timetable

Zoom links: Invited talks | Session 1 | Session 2

Time	Session 1	Session 2
9:00–10:00	Julia Böttcher *Recent developments in graph and hypergraph packing* (Invited talk)	
10:00–10:30	Thomas Lesgourgues *Minimum degree of asymmetric Ramsey-minimal graphs*	Daniel Horsley *Generalising Novák's conjecture*
10:30–11:00	Joanne Hall *Optimal Data Distribution for Big-Data All-to-All Comparison using Finite Projective and Affine Planes*	Koji Imamura *On the representation of matroids over finite rings*
11:30–12:00	Angus Southwell *Properties of induced subgraphs of random graphs with given degree sequences*	Kengo Enami *Proper colorings of plane quadrangulations without rainbow faces*
12:00–12:30	Rui Zhang *Extremal independence in discrete random systems*	Xiao-Nan Lu *Almost external difference families via cyclotomy*

long break

Time	Session 1	Session 2
15:30–16:00	Nazeran Idrees *Spanning simplicial complex of some graph families*	Risma Wulandari *Disjoint union of paths is distance antimagic*
16:00–16:30	Yuxuan Li *Aldous' spectral gap conjecture for normal Cayley graphs*	Palton Anuwiksa *Multipartite Ramsey numbers of complete bipartite graphs arising from algebraic combinatorial structures*
16:30–17:00	Ludmila Tsiovkina *On distance-regular covers of complete graphs admitting a group of automorphisms with few orbits on arcs*	M. Ali Hasan *On the Local Multiset Dimension of Graphs*
17:00–17:30	Krystian Gajdzica *The Bessenrodt–Ono inequality in the theory of partitions*	Alexander Kolpakov *Semidefinite programming bounds for the average kissing number*
18:00–19:00	Daniel Kráľ *Quasirandom and common combinatorial structures* (Invited talk)	

Wednesday Timetable

Zoom links: AGM/Invited talks | Session 1 | Session 2

Time	Session 1	Session 2
9:00–9:30	Sandra Kingan *On cyclically 4-connected cubic graphs*	Fahim Rahim *Row-column factorial designs*
9:30–10:00	Anita Liebenau *On Sidorenko systems of linear equations*	Shasha Zheng *Cubic graphical regular representations of some classical simple groups*
10:00–10:30	Zhi Yee Chng *On the Ramsey numbers for the tree graphs versus certain generalised wheel graphs*	Tony Huynh *Approximation algorithms for vertex cover problems in hypergraphs*
10:30–11:00	Yumiko Ohno *Achromatic number and facial achromatic number of connected locally-connected graphs*	Tamas Makai *Degree sequences of random uniform hypergraphs*

Time	AGM/Invited talks
11:30–12:30	CMSA Annual General Meeting

long break

Time	AGM/Invited talks
15:30–16:30	Mikhail Isaev *The chromatic number of inhomogeneous random graphs*

Time	Session 1	Session 2
16:30–17:00	Aditya Ganguly *Existence of 2-factors in random uniform regular hypergraphs*	Maciej Ulas *Signs behaviour of sums of weighted numbers of partitions*
17:00–17:30	Andrii Serdiuk *Imbalance graphic block graphs*	F. Javier de Vega *A solution of the partition of a number into arithmetic progressions*

Time	AGM/Invited talks
18:00–19:00	Bojan Mohar *Graph searching*

Thursday Timetable

Zoom links: Invited talks Session 1 Session 2

Time	Session 1	Session 2
9:00–9:30	Andrea Freschi *Dirac-type results for vertex ordered graphs*	Marston Conder *The smallest symmetric cubic graphs with given action type*
9:30–10:00	Yudhistira Andersen Bunjamin *Group divisible designs with block size 4 and two group sizes*	Brendan Damien McKay *Surge: generator for chemical structures*
10:00–10:30	Adam Gowty *Bounding the Size of Sperner Partition Systems*	Ian Wanless *Maximally nonassociative quasigroups*
10:30–11:00	Jack Allsop *Row-Hamiltonian Latin squares*	Samuel Barton *Combinatorial methods for gene expression analysis*

Time	Invited talk
11:30–12:30	Jeroen Schillewaert *Constructing highly regular expanders from hyperbolic Coxeter groups*

long break

Time	Invited talk
15:30–16:30	Rongquan Feng *Directed Strongly Regular Graphs and their Constructions*

Time	Session 1	Session 2
16:30–17:00	Hilda Assiyatun *The locating-chromatic number of trees with maximum degree 3 or 4*	Armen Bagdasaryan *Solving third order linear homogeneous recurrence relations with applications to combinatorial sequences*
17:00–17:30	Carol Zamfirescu *Counting cycles in regular and planar graphs*	Alexandros Singh *On the number of beta-redices in random closed linear lambda-terms*

Time	Invited talk
18:00–19:00	Vida Dujmovic *Graph product structure with applications in coloring.*

Zoom links: Prize presn/Invited talks | Session 1 | Session 2

Time	Session 1	Session 2
9:00	Signe Lundqvist *Rigidity and flexibility of planar rod configurations*	Piotr Miska *On (non-)realizibility of Stirling numbers*
9:30	David Wood *Universality in minor-closed classes*	Robert Bailey *On strongly regular graphs with 136 vertices*
10:00	Iren Darijani *Arc-disjoint hamiltonian dipaths in toroidal digrids*	Gabriel Verret (k,t)*-regular graphs*
10:30	Nicholas Cavenagh *Mutually orthogonal cycle systems*	Youming Qiao *Some new connections between graphs and groups*
11:00		

Time	Session 1	Session 2
11:30	Shohei Satake *The restricted isometry property of the Paley ETF and Paley graph conjecture*	James East *How many pyramids are there?*
12:00	Leonard Paleta *On perfect Roman domination in the composition of graphs*	Stephen Glasby *On the maximum of the weighted binomial sum* $2^{-r}\sum_{i=0}^{r}\binom{m}{i}$
12:30	Graham Farr *Interpretations of some transforms on binary functions*	Daniel Robert Hawtin *Nonexistence of block-transitive subspace designs*
13:00		

long break

Time	Prize presn/Invited talks
15:20	Presentation of the student prize
15:30	Michael Giudici *s-arc-transitive graphs and digraphs*
16:30	

Abstracts

1. Gregarious Kite Decomposition of Tensor Product of Complete Multipartite Graphs

Speaker: Tamil Elakkiya A (Gobi Arts and Science College (India))

Time: 15:30 Mon 13 December **Zoom:**

Author(s): Tamil Elakkiya A

In this paper, we show that there exists a decomposition of $(K_m \otimes \overline{K}_n) \times (K_r \otimes \overline{K}_s)$ into gregarious kite if and only if $n^2s^2m(m-1)r(r-1) \equiv 0 \pmod 8$, where $\otimes, \times$ denotes the wreath product and tensor product of graphs respectively. We denote gregarious kite decomposition as GK-decomposition.

2. Row-Hamiltonian Latin squares

Speaker: Jack Allsop (Monash University)

Time: 10:30 Thu 16 December **Zoom:**

Author(s): Jack Allsop

A Latin square is a matrix of symbols such that every symbol occurs exactly once in each row and column. A Latin square can also be considered as a set of triples of the form (row, column, symbol). A conjugate of a Latin square is obtained by uniformly permuting the elements of each triple, hence each Latin square has 6 conjugates. Every pair of rows in a Latin square induces a permutation in 2-line form. We call a Latin square L row-Hamiltonian if the permutation induced by each pair of distinct rows of L is a full cycle permutation. Row-Hamiltonian Latin squares are equivalent to perfect 1-factorisations of complete bipartite graphs. For a Latin square L, we define $L\nu$ to be the number of conjugates of L which are row-Hamiltonian. We have constructed an infinite family of row-Hamiltonian Latin squares with $L\nu = 4$ for each Latin square L in the family. No such infinite family was previously known. This construction allows us to solve two published open problems, one posed by Wanless and the other by Falconer.

3. Multipartite Ramsey numbers of complete bipartite graphs arising from algebraic combinatorial structures

Speaker: Palton Anuwiksa (Bandung Institute of Technology)

Time: 16:00 Tue 14 December **Zoom:**

Author(s): Palton Anuwiksa, Rinovia Simanjuntak, and Edy Tri Baskoro

In 2019, Perondi and Carmelo determined the set multipartite Ramsey number of bipartite graphs by establishing a relationship between the set multipartite Ramsey number, Hadamard matrices, and strongly regular graphs, which is a breakthrough in Ramsey theory. However, since there is no Hadamard matrix of order not divisible by 4, many open problems arise from these results.

In this talk, we generalize Perondi and Carmelo's results by introducing the $[\alpha]$-Hadamard matrix that we conjecture exists for arbitrary order. We also establish a relationship of set and size multipartite Ramsey numbers, strongly regular graphs, and $[\alpha]$-Hadamard matrices. Finally, utilizing this relation, we determine set and size multipartite Ramsey numbers for particular complete bipartite graphs.

4. The locating-chromatic number of trees with maximum degree 3 or 4

Speaker: Hilda Assiyatun (Bandung Institute of Technology)

Time: 16:30 Thu 16 December **Zoom:**

Author(s): Hilda Assiyatun

A k-coloring of G is a function $c : V(G) \to \{1, 2, \ldots, k\}$ where $c(u) \neq c(v)$ for two adjacent vertices u and v in G and k is a positive integer. The partition $\pi = \{C_1, C_2, \ldots, C_k\}$ is induced by the k-coloring c of the vertices of G. The color code of vertex v is $c_\pi(v) = (d(v, C_1), d(v, C_2), \ldots, d(v, C_k))$ where $d(v, C_i) = \min\{d(v, x)|x \in C_i\}$ for $1 \leq i \leq k$. If all distinct vertices of G have distinct color codes, then c is called a locating k-coloring of G. The locating chromatic number of G, denoted by $\chi_L(G)$ is the least integer k such that G has a locating k-coloring.

In this talk we will discuss the locating-chromatic number of trees embedded in 2-dimensional grid and binary trees. This is an attempt to answer an open problem of determining the locating-chromatic number of trees with maximum degree 3 or 4.

5. Solving third order linear homogeneous recurrence relations with applications to combinatorial sequences

Speaker: Armen Bagdasaryan (American University of the Middle East)

Time: 16:30 Thu 16 December **Zoom:**

Author(s): Armen Bagdasaryan

Recurrence sequences have been a central part of number theory and combinatorics for many years. Many number sequences are defined as linear recurrences, e.g. Fibonacci, Lucas, and Tribonacci numbers and their generalizations, Fibonacci-Narayana numbers, Pell-Padovan numbers. The linear recurrences have been extensively studied and solutions have been obtained basically using generating functions, shift operators, or matrix methods. The aim of the talk is to present some new results on solving third order linear recurrence relations. Using a matrix approach, we develop a new matrix method for solving linear recurrence relations and present explicit formulae for the general solution of the third order linear homogeneous recurrence relations with variable coefficients. We also obtain a summatory formula for the general solution of the recurrence relation in a special case. Some particular cases of the recurrence and examples with applications to combinatorial sequences will be considered. The method can be further generalized for higher order linear homogeneous recurrences with variable coefficients.

6. On strongly regular graphs with 136 vertices

Speaker: Robert Bailey (Memorial University)

Time: 09:30 Fri 17 December **Zoom:**

Author(s): Robert Bailey

In this talk, we will consider strongly regular graphs with parameters $(136, 63, 30, 28)$. The best-known example of such a graph is $NO_8^-(2)$, a rank-3 graph arising from the group $PSO^-(8, 2)$. However, another graph with these parameters arises from a primitive action of the group $PSL(2, 17)$. We will see exactly how this graph arises and how it differs from $NO_8^-(2)$ in many ways.

This includes joint work with Alaina Pardy and Abigail Rowsell.

7. Minimal Ramsey graphs for cliques

Speaker: John Bamberg (The University of Western Australia)

Time: 15:30 Mon 13 December **Zoom:**

Author(s): John Bamberg

Burr, Erdős, and Lovász, in 1976, introduced the study of the smallest minimum degree $s(r, k)$ of a graph Γ such that any r-colouring of the edges of Γ contains a monochromatic clique of size k, whereas no proper subgraph of Γ has this property. Burr, Erdös, and Lovász were able to show the rather surprising exact result, that if $r = 2$, then $s(2, k) = (k-1)^2$. The behaviour of this function is still not so well understood for more than 2 colours. In 2016, Fox, Grinshpun, Liebenau, Person, and Szabó showed that for $r > 2$, $s(r, k)$ is at most $8(k-1)^6r^3$. The speaker, together with Anurag Bishnoi and Thomas Lesgourges, have recently used the theory of generalised quadrangles to improve this bound.

8. Optimal radio labelings of trees

Speaker: Devsi Bantva (Lukhdhirji Engineering College, Morvi)

Time: 16:00 Mon 13 December **Zoom:**

Author(s): Devsi Bantva

A radio labeling of a graph G is a mapping $f : V(G) \to \{0, 1, 2, ...\}$ such that $|f(u)-f(v)| \geq diam(G)+1-d(u, v)$ for every pair of distinct vertices u, v of G, where $diam(G)$ is the diameter of G and $d(u, v)$ is the distance between u and v in G. The radio number $rn(G)$ of G is the smallest number k such that G has radio labeling with $\max\{f(v) : v \in V(G)\} = k$. The concept of radio labeling is introduced by Chartrand *et al.* in [2,3] motivated through well known channel assignment problem. In [4], Liu gave a lower bound for the radio number of trees and presented a class of trees, namely spiders, achieving the lower bound. In [1], Bantva *et al.* gave a lower bound for the radio number of trees (which is same as one given by Liu in [4] but using different notation) and, gave a necessary and sufficient condition and two other sufficient conditions to achieve this lower bound. Denote the lower bound for the radio number of trees given in [1,Lemma 3.1] by $lb(T)$. A tree T is called a lower bound tree for the radio number if $rn(T) = lb(T)$. In this paper, we give some sufficient conditions for lower bound as well as non-lower bound trees for the radio number. We present some more lower bound trees and give techniques to find large lower bound trees for the radio number. We also presents classes of trees which are not lower bound trees.

[1] *D. Bantva, S. Vaidya and S. Zhou*: Radio number of trees, Discrete Applied Math., 217(2017), 110-122.

[2] *G. Chartrand, D. Erwin, F. Harary and P. Zhang*: Radio labelings of graphs, Bull. Inst. Combin. Appl., 33 (2001), 77-85.

[3] *G. Chartrand, D. Erwin and P. Zhang*: A graph labeling suggested by FM channel restrictions, Bull. Inst. Combin. Appl., 43 (2005) 43-57.

[4] *D. Liu*: Radio number for trees, Discrete Math., 308(2008), 1153-1164.

9. Combinatorial Methods for Gene Expression Analysis

Speaker: Samuel Barton (The University of Queensland)

Time: 10:30 Thu 16 December **Zoom:**

Author(s): Samuel Barton

Gene co-expression networks are weighted graphs where vertices represent genes and edges represent significant gene co-expression, weighted with some metric. However, in order to construct these graphs, we require a definition for a significant expression pattern between genes. This definition is dependent on the metric which is used to measure co-expression. As such, different metrics provide different graphs, which in turn highlights different interactions between genes. With most experimental data providing a large number of genes across a small number of time points, the resulting graph is often large and complex. In this talk, we will discuss various techniques which can be used to filter edges and identify important genes and gene interactions. We will also discuss how hypergraphs can provide a possibly more useful framework for modelling gene interactions.

10. Recent developments in graph and hypergraph packing

Speaker: Julia Böttcher (London School of Economics)

Time: 09:00 Tue 14 December **Zoom:**

Author(s): Julia Böttcher

Recent years have seen significant progress in the field of graph and hypergraph packing, with many powerful new methods developed. A packing of a family of guest (hyper)graphs into a host (hyper)graph is given by edge disjoint embeddings of the guest (hyper)graphs in the host (hyper)graph. Among the most prominent recent results in this direction are the proof of the existence of designs, the resolution of the Oberwolfach problem, and the verification of Ringel's tree packing conjecture (all for large (hyper)graphs). In this talk I will review these recent results, and also report on progress concerning a related problem, Gyárfás's tree packing conjecture, to some of which I have contributed (in joint work with Peter Allen, Dennis Clemens, Jan Hladký, Diana Piguet, Anusch Taraz).

11. Group divisible designs with block size 4 and two group sizes

Speaker: Yudhistira Andersen Bunjamin (UNSW Sydney)

Time: 09:30 Thu 16 December **Zoom:**

Author(s): R. Julian R. Abel, Thomas Britz, Yudhistira A. Bunjamin and Diana Combe

A k-GDD, or *group divisible design* with block size k, is a triple $(X, \mathcal{G}, \mathcal{B})$ where X is a set of *points*, $\mathcal{G}$ is a partition of X into subsets (called *groups*) and $\mathcal{B}$ is a collection of k-element subsets of X (called *blocks*) such that any two points from distinct groups appear together in exactly one block and no two distinct points from any group appear together in any block. The *group type* (or *type*) of a k-GDD is the multiset $\{|G| : G \in \mathcal{G}\}$ which denotes the group sizes.

There are a number of known necessary conditions for the existence of a GDD with a particular group type which come from simple counting arguments. However, these conditions are not sufficient. We say that a multiset of positive integers is a *feasible* group type for a k-GDD if it satisfies the currently known necessary conditions.

This talk will focus on 4-GDDs. We will introduce the two most common techniques for constructing GDDs and show how they can be used to construct a 4-GDD for all but a finite number of feasible types for some families of 4-GDDs with only two fixed group sizes.

12. Mutually orthogonal cycle systems

Speaker: Nicholas Cavenagh (University of Waikato)

Time: 10:30 Fri 17 December **Zoom:**

Author(s): Nicholas Cavenagh

Two cycle systems are said to be *orthogonal* if no two distinct cycles share more than one edge. Orthogonal cycle systems naturally arise from face 2-colourable polyehdra and in higher genus from Heffter arrays with certain orderings. Let $\mu(\ell, n)$ (respectively, $\mu'(\ell, n)$) be the maximum integer μ such that there exists a set of μ mutually orthogonal (cyclic) ℓ-cycle systems of the complete graph K_n. We show that if $\ell \geq 4$ is even and $n \equiv 1 \pmod{2\ell}$, then $\mu'(\ell, n)$, and hence $\mu(\ell, n)$, is bounded below by a constant multiple of n/ℓ^2. In contrast, we obtain the following upper bounds: $\mu(\ell, n) \leq n - 2$; $\mu(\ell, n) \leq (n-2)(n-3)/(2(\ell-3))$ when $\ell \geq 4$; $\mu(\ell, n) \leq 1$ when $\ell > n/\sqrt{2}$; and $\mu'(\ell, n) \leq n - 3$ when $n \geq 4$. We also obtain computational results for small values of n and ℓ. This is joint work with Andrea Burgess and David Pike.

13. On the Ramsey numbers for the tree graphs versus certain generalised wheel graphs

Speaker: Zhi Yee Chng (UNSW Sydney)

Time: 10:00 Wed 15 December **Zoom:**

Author(s): Zhi Yee Chng

Given two simple graphs G and H, the Ramsey number $R(G, H)$ is the smallest integer n such that for any graph of order n, either it contains G or its complement contains H. Let T_n be a tree graph of order n and $W_{s,m}$ be the generalised wheel graph $K_s + C_m$. In this research, we show that for $n \geq 5, s \geq 2$, $R(T_n, W_{s,6}) = (s+1)(n-1)+1$ and for $n \geq 5, s \geq 1$, $R(T_n, W_{s,7}) = (s+2)(n-1)+1$.

This is a joint work with Ta Sheng Tan and Kok Bin Wong from University of Malaya, Malaysia.

14. The smallest symmetric cubic graphs with given action type

Speaker: Marston Conder (University of Auckland)

Time: 09:00 Thu 16 December **Zoom:**

Author(s): Marston Conder

It is known that arc-transitive group actions on finite cubic (3-valent) graphs fall into seven classes, denoted by 1, 2^1, 2^2, 3, 4^1, 4^2 and 5, where s, s^1 or s^2 indicates that the action is s-arc-regular, and with s^2 indicating that there is no arc-reversing automorphism of order 2 (for $s = 2$ or 4). These classes can be further subdivided into 17 sub-classes, according to the types of arc-transitive subgroups of the full automorphism group of the graph, sometimes called the 'action type' of the graph. In this talk, I'll describe some work (under Covid lockdown last year) that completed the determination of the smallest graphs in each of these 17 classes, begun 12 years ago. It also resulted in finding the smallest 4-arc-transitive cubic graph that admits no automorphism of order 2 reversing some arc.

15. Arc-disjoint hamiltonian dipaths in toroidal digrids

Speaker: Iren Darijani (Memorial University)

Time: 10:00 Fri 17 December **Zoom:**

Author(s): Iren Darijani

A directed graph H consists of a set $V(H)$ of vertices together with a subset $A(H)$ of $V(H) \times V(H)$. The elements of $A(H)$ are called arcs and are ordered pairs of vertices. A *hamiltonian dipath* in a digraph is a sequence of vertices in which there exists an arc pointing from each vertex in the sequence to its successor in the sequence, with no repeated arcs that visits each vertex exactly once. The *Cartesian product* $H_1 \square H_2$ of two digraphs H_1 and H_2 is the digraph with vertex set $V(H_1) \times V(H_2)$ where the vertex (u_1, v_1) is joined to (u_2, v_2) by an arc if and only if either $u_1 = u_2$ and $v_1v_2 \in A(H_2)$ or $v_1 = v_2$ and $u_1u_2 \in A(H_1)$. The Cartesian product $C_m \square C_n$, where C_m and C_n are two dicycles, is called the toroidal digrid with m rows and n columns. In this talk, we see that there exists two arc-disjoint hamiltonian dipaths in every toroidal digrid.

16. Smaller embeddings of partial k-star decompositions

Speaker: Ajani De Vas Gunasekara (Monash University)

Time: 10:30 Mon 13 December **Zoom:**

Author(s): Ajani De Vas Gunasekara, Daniel Horsley

A k-star is a complete bipartite graph $K_{1,k}$. For a graph G, a *k-star decomposition of G* is a set of k-stars in G whose edge sets partition the edge set of G. If we weaken this condition to only demand that each edge of G is in at most one k-star, then the resulting object is a *partial k-star decomposition of G*. An embedding of a partial k-star decomposition $\mathcal{A}$ of a graph G is a partial k-star decomposition $\mathcal{B}$ of another graph H such that $\mathcal{A} \subseteq \mathcal{B}$ and G is a subgraph of H. This paper considers the problem of when a partial k-star decomposition of K_n can be embedded in a k-star decomposition of K_{n+s} for a given integer s. We improve a result of Noble and Richardson, itself an improvement of a result of Hoffman and Roberts, by showing that any partial k-star decomposition of K_n can be embedded in a k-star decomposition of K_{n+s} for some s such that $s < \frac{9}{4}k$ when k is odd and $s < (6 - 2\sqrt{2})k$ when k is even. For general k, these constants cannot be improved. We also obtain stronger results subject to placing a lower bound on n.

17. A solution of the partition of a number into arithmetic progressions

Speaker: F. Javier de Vega (King Juan Carlos University)

Time: 17:00 Wed 15 December **Zoom:**

Author(s): F. Javier de Vega

We present a solution of the enumeration of the set $\mathrm{AP}(n)$ of partitions of a positive integer n in which the nondecreasing sequence of parts form an arithmetic progression. In particular, we prove a formula for the number of nondecreasing arithmetic progressions of positive integers with sum n. We also present an explicit method to calculate all the partitions of $\mathrm{AP}(n)$.

Our talk proposes a novel way to study this problem based on [1,2]. The main idea is as follows: the usual divisors trivially solve the problem of the partition of a number into equal parts. Now, for each $k \in \mathbb{Z}$, we will consider a new product mapping ($\odot_k$) that will generate an arithmetic (*k-arithmetic*) similar to the usual one. In this new arithmetic, the divisors of an integer n will trivially solve the problem of the representation of n as the sum of arithmetic progressions whose difference is k.

[1] F. J. de Vega, *An extension of Furstenberg's theorem of the infinitude of primes*, arXiv preprint, (2021). arXiv:2003.13378
[2] F. J. de Vega, *A complete solution of the partition of a number into arithmetic progressions*, arXiv preprint, (2021). arXiv:2004.09505

18. Graph Product Structure with applications in coloring.

Speaker: Vida Dujmovic (University of Ottawa)
Time: 18:00 Thu 16 December **Zoom:**
Author(s): Vida Dujmovic

This talk will introduce the product structure theorem, which states that every planar graph is contained in the strong product of a bounded treewidth graph and a path. The theorem can be generalized from planar graphs to bounded genus graphs, apex-minor-free graphs, bounded-degree graphs from minor closed families, and k-planar graphs. Applications to graph coloring will then be presented, including nonrepetitive colouring, p-centered colouring, clustered colouring, and vertex ranking

19. How many pyramids are there?

Speaker: James East (Western Sydney University)
Time: 11:30 Fri 17 December **Zoom:**
Author(s): James East

Enumerating (congruence classes of) integer triangles with fixed perimeter is a classical problem, with a very neat solution. This has recently been extended to arbitrary polygons. In this talk I will report on joint work with Michael Hendriksen and Laurence Park on the corresponding problem for tetrahedra. It turns out that this is rather more complex, and the existence of a closed formula seems doubtful.

20. Proper colorings of plane quadrangulations without rainbow faces

Speaker: Kengo Enami (Seikei University)
Time: 11:30 Tue 14 December **Zoom:**
Author(s): Kengo Enami

We consider a proper coloring of a plane graph such that no face is rainbow, where a face is rainbow if any two vertices on its boundary have distinct colors. Such a coloring is said to be proper anti-rainbow. A plane quadrangulation G is a plane graph in which all faces are bounded by a cycle of length 4. In this paper, we show that the number of colors in a proper anti-rainbow coloring of a plane quadrangulation G does not exceed $3\alpha(G)/2$, where $\alpha(G)$ is the independence number of G. Moreover, if the minimum degree of G is 3 or if G is 3-connected, then this bound can be improved to $5\alpha(G)/4$ or $7\alpha(G)/6 + 1/3$, respectively. All of these bounds are tight. The talk is based on a joint work with Kenta Ozeki(Yokohama national University) and Tomoki Yamaguchi(Yokohama national University).

21. Interpretations of some transforms on binary functions

Speaker: Graham Farr (Monash University)
Time: 12:30 Fri 17 December **Zoom:**
Author(s): Graham Farr

A *binary function* is a function $f : 2^E \to \mathbb{C}$ for which $f(\emptyset) = 1$, where E is a finite ground set. Binary functions generalise binary matroids in the sense that any indicator function of a linear space over GF(2) is a $\{0, 1\}$-valued binary function (using the natural correspondence between subsets of E and their characteristic vectors in $\mathrm{GF}(2)^E$). The author showed in 1993 that binary functions have deletion and contraction operations and extend arbitrary matroids, with duality corresponding to the Hadamard transform, and admit a generalisation of the Whitney rank generating function (a close relative of the Tutte polynomial). In subsequent work (2004–2019), he provided a family of transforms $L^{[\mu]}$ and associated minor operations, indexed by complex numbers μ, and developed their theory, with the identity transform and Hadamard transform corresponding to $\mu = 1$ and $\mu = -1$ respectively.

In this talk, we look at properties of transforms $L^{[\mu]}$ when $|\mu| = 1$. We use these transforms to characterise those binary functions for which the Hadamard transform is just the elementwise complex conjugate. We then give an interpretation of $L^{[\mu]}f$, for $|\mu| = 1$: it yields an appropriate quantum superposition of all the partial Hadamard transforms of f. We discuss the interpretation for the special case of plane graphs.

22. Directed Strongly Regular Graphs and their Constructions

Speaker: Rongquan Feng (Peking University)

Time: 15:30 Thu 16 December **Zoom:**

Author(s): Rongquan Feng

A directed strongly regular graph with parameters (n, k, t, λ, μ) is a directed graph with n vertices satisfying two conditions: each vertex has k out-neighbors and k in-neighbors, including t neighbors counted as both in- and out-neighbors of the vertex, and the number of directed paths of length 2 from a vertex x to another vertex y is λ if there is a directed edge from x to y and μ otherwise. Directed strongly regular graphs are directed versions of strongly regular graphs, which was originally defined by A.M. Duval in 1988. In this talk, some constructions of directed strongly regular graphs will be given.

23. Dirac-type results for vertex ordered graphs

Speaker: Andrea Freschi (University of Birmingham)

Time: 09:00 Thu 16 December **Zoom:**

Author(s): Andrea Freschi

A *(vertex) ordered graph* or *labelled graph* H on h vertices is a graph whose vertices have been labelled with $\{1, \dots, h\}$. In recent years there has been a significant effort to develop both Turán and Ramsey theories in the setting of vertex ordered graphs (see for example [1,3,4,5]. Motivated by this line of research, Balogh, Li and Treglown [2] recently initiated the study of Dirac-type problems for ordered graphs. In particular, they focused on the problem of determining the minimum degree threshold for forcing a perfect H-tiling in an ordered graph for any fixed ordered graph H (recall that a perfect H-tiling in a graph G is a collection of vertex-disjoint copies of H covering all the vertices in G). In this talk we present a result which builds up on the ideas from [2] and fully resolve such problem. This provides an ordered graph analogue of the seminal tiling theorem of Kühn and Osthus [Combinatorica 2009]. We also determine the asymptotic minimum degree threshold for forcing an H-cover in an ordered graph (for any fixed ordered graph H).

This is joint work with Andrew Treglown.

[1] M. Balko, J. Cibulka, K. Král and J. Kynčl, Ramsey numbers of ordered graphs, *Electr. J. Combin.* **27** (2020), P1.16.

[2] J. Balogh, L. Li and A. Treglown, Tilings in vertex ordered graphs, (2020), `https://arxiv.org/abs/2007.10832`.

[3] D. Conlon, J. Fox, C. Lee and B. Sudakov, Ordered Ramsey numbers, *J. Combin. Theory Ser. B* **122** (2017), 353–383.

[4] J. Pach and G. Tardos, Forbidden paths and cycles in ordered graphs and matrices, *Israel J. Math.* **155** (2006), 359–380.

[5] G. Tardos, Extremal theory of vertex or edge ordered graphs, in Surveys in Combinatorics 2019 (A. Lo, R. Mycroft, G. Perarnau and A. Treglown eds.), London Math. Soc. Lecture Notes 456, 221–236, Cambridge University Press, 2019.

24. The Bessenrodt–Ono inequality in the theory of partitions

Speaker: Krystian Gajdzica (Jagiellonian University)

Time: 17:00 Tue 14 December **Zoom:**

Author(s): Krystian Gajdzica

In 2016, Bessenrodt and Ono showed that for all positive integers $a, b \geqslant 2$ such that $a + b > 9$, the classical partition function satisfies

$$p(a)p(b) > p(a + b).$$

Afterwards their result was widely generalized for other variations of partition functions — some of them will be discussed during the talk. Moreover, we will also present a new type of the Bessenrodt-Ono inequality for, so called, the restricted partition function $p_{\mathcal{A}}(n, k)$. Finally, we will also give a few notes about the log-concavity of the sequence $(p_{\mathcal{A}}(n, k))_{n \in \mathbb{N}_+}$.

25. Existence of 2-factors in random uniform regular hypergraphs

Speaker: Aditya Ganguly (UNSW Sydney)

Time: 16:30 Wed 15 December **Zoom:**

Author(s): Aditya Ganguly

In the theory of random graphs, it is a common objective to prove that almost all graphs of a certain type contain a specified subgraph. A powerful tool for this purpose is the small subgraph conditioning method which was introduced by Robinson and Wormald in 1992. This technique been used to prove the existence of subgraphs such as perfect matchings, Hamilton cycles and spanning trees in almost all regular graphs even when the second moment method fails to do so.

We prove a new threshold result for the asymptotically almost sure existence of a 2-factor in a random uniform regular hypergraph by using the small subgraph conditioning method. This extends results of Robalewska (1996), that almost all regular graphs contain a 2-factor, and Cooper et al. (1996), that almost all random uniform regular hypergraphs subject to a degree threshold contain a perfect matching. We also explain the consequences of our result for a version of qualitative equivalence between random hypergraph models known as 'contiguity'.

26. Perfect sequence covering arrays

Speaker: Aidan Gentle (Monash University)

Time: 10:00 Mon 13 December **Zoom:**

Author(s): Aidan Gentle

A perfect sequence covering array (PSCA) with parameters v, t and λ is a multiset of permutations of the v-element alphabet $\{0, \ldots, v-1\}$ such that every sequence of t distinct elements of the alphabet appears in the specified order in exactly λ permutations. PSCAs were introduced by Yuster in 2020 as a variant of sequence covering arrays. For $v \geq t \geq 2$, we define $g(v,t)$ to be the smallest positive integer λ such that a PSCA(v,t,λ) exists. In this talk, we present exhaustive search techniques for PSCA(v,t,λ) and use these methods to show that $g(6,3) = g(7,3) = g(7,4) = 2$ and $g(8,3) = 3$. We also discuss constructions of PSCAs using suitable permutation groups thus improving the upper bounds for $g(v,3)$ for $9 \leq v \leq 32$.

Joint work with Daniel Horsley and Ian Wanless.

27. MOLS of order 10 from relations in nets

Speaker: Michael James Gill (Monash University)

Time: 09:30 Mon 13 December **Zoom:**

Author(s): Michael James Gill

A pair of Latin squares is orthogonal if the superposition of the squares contains every ordered pair exactly once. A set of mutually orthogonal Latin squares (MOLS) is a set with every pair of squares in the set being orthogonal. Euler famously conjectured that any maximal set of MOLS for any order $n = 4t-2$ has size at most 1. Parker, Bose, and Shrikhande (1959) proved the existence of a pair of MOLS for every order n at least 7, resolving Euler's conjecture. However, the size of the largest set of MOLS of order $n = 4t-2$ is unknown for all n at least 10. Despite considerable effort, no example of a triple of MOLS of order 10 has been found.

Dukes and Howard (2014) characterised the set of relations that can be contained in a quadruple of MOLS of order 10. We used computational search techniques to find all pairs of MOLS satisfying two of the relations given by Dukes and Howard (2014). We showed that no pair of MOLS satisfying these relations are contained in a triple of MOLS. Thus any pair of MOLS contained in a triple is of dimension 37. We found two species of MOLS of order 10 with 5 disjoint common transversals, only one species of MOLS of order 10 is known with more than 5 disjoint common transversals (Egan and Wanless 2016).

28. s-arc-transitive graphs and digraphs

Speaker: Michael Giudici (The University of Western Australia)

Time: 15:30 Fri 17 December **Zoom:**

Author(s): Michael Giudici

The study of s-arc-transitive graphs goes back to the seminal work of Tutte in 1947 who showed that in the cubic case $s \leqslant 5$. This has motivated a large body of research on s-arc-transitive graphs and digraphs. I will survey some recent results in the area.

29. On the maximum of the weighted binomial sum $2^{-r}\sum_{i=0}^{r}\binom{m}{i}$

Speaker: Stephen Glasby (The University of Western Australia)

Time: 12:00 Fri 17 December **Zoom:**

Author(s): S.P. Glasby and G.R. Paseman

The weighted binomial sum $f_m(r) = 2^{-r}\sum_{i=0}^{r}\binom{m}{i}$ arises in coding theory, information theory and even permutation group theory. We prove that, for $m \notin \{0,3,6,9,12\}$, the maximum value of $f_m(r)$ with $0 \leqslant r \leqslant m$ occurs when $r = \lfloor m/3 \rfloor + 1$. We also show this maximum value is asymptotic to $\frac{3}{\sqrt{\pi m}}\left(\frac{3}{2}\right)^m$ as m grows.

30. Bounding the Size of Sperner Partition Systems

Speaker: Adam Gowty (Monash University)

Time: 10:00 Thu 16 December **Zoom:**

Author(s): Adam Gowty

An (n,k)-*Sperner partition system* is a set of partitions of some n-set such that each partition has k nonempty parts and no part in any partition is a subset of a part in a different partition. Of particular interest is the largest number of partitions possible for a given n and k, which is denoted SP(n, k). In this talk, we shall introduce different constructions for Sperner partitions systems that, under certain conditions on n and k, asymptotically meet the known upper bound on SP(n, k).

31. Optimal Data Distribution for Big-Data All-to-All Comparison using Finite Projective and Affine Planes
Speaker: Joanne Hall (Royal Melbourne Institute of Technology)
Time: 10:30 Tue 14 December **Zoom:**
Author(s): Joanne Hall

An All-to-All Comparison problem is where every element of a data set is compared with every other element. For large data sets, the comparison computations can be distributed across a cluster of computers. All-to-All Comparison does not fit the highly successful Map-Reduce pattern, so a new distributed compute framework is required. The principle challenge is to distribute the data in such a way that computations can be scheduled where the data already lies. This paper uses projective planes, affine planes and balanced incomplete block designs to design data distributions and schedule computations. The data distributions based on these geometric and combinatorial structures achieve minimal data replication whilst balancing the computational load across the cluster.

32. On the Local Multiset Dimension of Graphs
Speaker: M. Ali Hasan (Bandung Institute of Technology)
Time: 16:30 Tue 14 December **Zoom:**
Author(s): M. Ali Hasan and Rinovia Simanjuntak

Let G be a finite, connected, undirected and simple graph. A representation multiset of a vertex u in $V(G)$ with respect to a subset $W = \{w_1, \ldots, w_k\} \subseteq V$, is defined as the multiset of distances between u and the vertices in W. If for every two adjacent vertices u and v in G, $r_m(u|W) \neq r_m(v|W)$, the set W is called a local resolving set of G. If G has a local resolving set, then the local resolving set with the smallest cardinality is called the local multiset basis and its cardinality is called the local multiset dimension of G, $\mu_l(G)$.

In this talk we present some basic properties of the local multiset dimension of a graph, which include some lower bounds for the dimension and a necessary condition for a finite dimension. We also determine exact values of local multiset dimension for some classes of graphs.

33. Nonexistence of Block-Transitive Subspace Designs
Speaker: Daniel Robert Hawtin (University of Rijeka)
Time: 12:30 Fri 17 December **Zoom:**
Author(s): Daniel Robert Hawtin

Subspace designs are the q-analogues of balanced incomplete block designs. We prove that there are no non-trivial subspace designs that admit a group of automorphisms acting transitively on the set of blocks of the design.

34. Shallow Minors, Graph Products and Beyond Planar Graphs
Speaker: Robert Hickingbotham (Monash University)
Time: 10:00 Mon 13 December **Zoom:**
Author(s): Robert Hickingbotham, David R. Wood

The planar graph product structure theorem of Dujmović, Joret, Micek, Morin, Ueckerdt, and Wood [J. ACM 2020] states that every planar graph is a subgraph of the strong product of a graph with bounded treewidth and a path. This result has been the key tool to resolve important open problems regarding queue layouts, nonrepetitive colourings, centered colourings, and adjacency labelling schemes. In this talk, we extend this line of research by utilizing shallow minors to prove analogous product structure theorems for several beyond planar graph classes. The key observation that drives our work is that many beyond planar graphs can be described as a shallow minor of the strong product of a planar graph with a small complete graph. In particular, we show that k-planar, (k,p)-cluster planar, fan-planar and k-fan-bundle planar graphs can be described in this manner. Using a combination of old and new results, we deduce that these classes have bounded queue-number, bounded nonrepetitive chromatic number, polynomial p-centred chromatic numbers, linear strong colouring numbers, and cubic weak colouring numbers. In addition, we show that k-gap planar graphs have super-linear local treewidth and, as a consequence, cannot be described as a subgraph of the strong product of a graph with bounded treewidth and a path. This is joint work with David Wood.

35. Generalising Novák's conjecture
Speaker: Daniel Horsley (Monash University)
Time: 10:00 Tue 14 December **Zoom:**
Author(s): Daniel Horsley

Novák conjectured in 1974 that, for any Steiner triple system of order $n \equiv 1 \pmod 6$ admitting a cyclic automorphism, it is always possible to choose one block from each block orbit so that the chosen blocks are pairwise disjoint. I will discuss generalising this conjecture to the setting of (n, k, λ)-designs. In particular, I will outline a proof that this generalisation holds when n is prime and $\lambda = 1$ and also when $\lambda \leq (k-1)/2$ and n is sufficiently large compared to k. This is joint work with Tao Feng and Xiaomiao Wang.

36. Base-two primitive permutation groups and their Saxl graphs

Speaker: Hongyi Huang (University of Bristol)

Time: 09:00 Mon 13 December **Zoom:**

Author(s): Hongyi Huang

Let $G \leqslant \mathrm{Sym}(\Omega)$ be a permutation group and recall that a base for G is a subset of Ω with trivial pointwise stabiliser in G. In a recent paper, Tim Burness and Michael Giudici introduced the Saxl graph of G, denoted $\Sigma(G)$, with vertice set Ω and two vertices adjacent if anf only if they form a base.

In this talk, we will mainly focus on the case when G is primitive. In this setting, $\Sigma(G)$ is connected and vertex-transitive. It is then natural to consider some invariants of $\Sigma(G)$, including the valency, the diameter and the clique number of $\Sigma(G)$. This is based on a joint work with Tim Burness.

37. Approximation algorithms for vertex cover problems in hypergraphs

Speaker: Tony Huynh (Monash University)

Time: 10:00 Wed 15 December **Zoom:**

Author(s): Tony Huynh

Many optimization problems can be phrased as a vertex cover problem in a k-uniform hypergraph. For example, feedback vertex set in tournaments (FVST), split graph deletion (SVD), and cluster vertex deletion (CVD) are three such problems. Assuming the Unique Games Conjecture, none of these three problems can be solved efficiently within a factor better than 2. We present a 7/3-approximation algorithm for FVST, a $(2+\epsilon)$-approximation algorithm for SVD, and a 2-approximation algorithm for CVD.

This is joint work with Manuel Aprile, Matthew Drescher, and Samuel Fiorini.

38. Spanning Simplicial Complex of some graph families

Speaker: Nazeran Idrees (Government College University Faisalabad (Pakistan))

Time: 15:30 Tue 14 December **Zoom:**

Author(s): Nazeran Idrees

We study simplicial complexes which are spanned by certain graphs. These complexes are spanned by trees in the graphs which are actually facets of the complex We study their f-vectors, Hilbert function of Shellability of the complexes thus constructed.

39. On the representation of matroids over finite rings

Speaker: Koji Imamura (Kumamoto University)

Time: 10:30 Tue 14 December **Zoom:**

Author(s): Koji Imamura

Matroids were introduced by H. Whitney to axiomatizing combinatorial properties of finite sets of vectors in a vector space. On the other hand, it is known that there are a lot of matroids which do not arise from vector space. It is one of the most significant problems to determine whether a given matroid is representable over some field.

The aim of our study is to give some representations of non-representable matroids by using matrices over finite rings. Thus, we adopted modular independence, one of the generalizations of linearly independence over introduced by Y.H. Park. It was defined over the ring $\mathbb{Z}_{p^e}$ of integers modulo p^e, where p is a prime and $e \in \mathbb{Z}_{>0}$, as follows: the vectors $\boldsymbol{v}_1, \ldots, \boldsymbol{v}_k \in \mathbb{Z}_{p^e}$ are said to be *modular independent* if $\sum a_i \boldsymbol{v}_i = \mathbf{0}$ implies that all a_i are nonunits, i.e., $p \mid a_i$ for all i. In this talk, we will show how and under what conditions we can represent such matroids over finite rings. We also give some representations of well-known non-representable matroids.

40. The chromatic number of inhomogeneous random graphs

Speaker: Mikhail Isaev (Monash University)

Time: 15:30 Wed 15 December **Zoom:**

Author(s): Mikhail Isaev

The chromatic number of a graph is the minimum number of colours required to colour its vertices so that no pair of adjacent vertices have the same colour. The study of this graph invariant has been at the forefront of random graph theory, motivating some of the field's most significant developments. We discuss generalisations of Bollobas' classical result on the asymptotics of the chromatic number of the binomial random graph to various inhomogeneous random graph models. In particular, we consider the stochastic block model and exchangeable graph models associated with graphons. The talk is based on two recent preprints arXiv:2109.07773 and arXiv:2109.00737

(Joint work with Mihuyn Kang (TU Graz)

41. On cyclically 4-connected cubic graphs

Speaker: Sandra Kingan (Brooklyn College and the Graduate Center, CUNY)

Time: 09:00 Wed 15 December **Zoom:**

Author(s): R. J. Kingan and S. R. Kingan

We prove results that build on a result by Wormald that states that any cyclically 4-connected cubic graph other than the 4-ladder Q8 or the Mobius 4-ladder V8 can be obtained from a smaller cyclically 4-connected cubic graph by bridging a pair of non-adjacent edges. We introduce the concept of cycle spread, which generalizes the edge pair distance defined by Wormald, and show that the set of pairs of edges that needs to be considered in order to obtain all cyclically 4-connected cubic graphs is smaller than the set of all pairs of non-adjacent edges. We prove that all non-planar cyclically 4-connected cubic graphs with at least 10 vertices, except for the Petersen graph and the Mobius ladders, can be obtained from Q8 by bridging pairs of edges with cycle spread at least (1,2). Moreover, every graph obtained in this way is non-planar cyclically 4-connected and cubic. All planar cyclically 4-connected graphs with at least 10 vertices, except for the ladders, can be obtained from the ladders by bridging pairs of edges with cycle spread at least (1,2).

42. Semidefinite programming bounds for the average kissing number

Speaker: Alexander Kolpakov (Université de Neuchâtel)

Time: 17:00 Tue 14 December **Zoom:**

Author(s): Maria Dostert, Alexander Kolpakov, Fernando M. de Oliveira

The average kissing number of $\mathbb{R}^n$ is the supremum of the average degrees of contact graphs of packings of finitely many balls (of any radii) in $\mathbb{R}^n$. We provide an upper bound for the average kissing number based on semidefinite programming that improves previous bounds in dimensions $3, \ldots, 9$. A very simple upper bound for the average kissing number is twice the kissing number for congruent spheres: in dimensions $6, \ldots, 9$ our new bound improves over it up to 25%.

43. Quasirandom and common combinatorial structures

Speaker: Daniel Krá̌l (Masaryk University)

Time: 18:00 Tue 14 December **Zoom:**

Author(s): Daniel Král'

A combinatorial structure is said to be quasirandom if it resembles a random structure in a certain robust sense. The notion of quasirandom graphs, developed in the work of Rödl, Thomason, Chung, Graham and Wilson in 1980s, is particularly robust as several different properties of truly random graphs, e.g., subgraph density, edge distribution and spectral properties, are satisfied by a large graph if and only if one of them is. A closely related notion is the notion of common graphs, which are graphs whose number of monochromatic copies is minimized by the (quasi)random coloring of a host complete graph.

We will discuss quasirandom properties of other combinatorial structures, tournaments, permutations and Latin squares in particular, and present several recent results obtained using analytic tools of the theory of combinatorial limits. We will then present some recent results on common and locally common graphs, in particular, we show that there exists common connected graphs with arbitrary large chromatic number, whose existence was an open problem for more than 20 years.

The talk is based on results obtained with different groups of collaborators, including Timothy F. N. Chan, Jacob W. Cooper, Robert Hancock, Adam Kabela, Ander Lamaison, Taísa Martins, Roberto Parente, Samuel Mohr, Jonathan A. Noel, Sergey Norin, Yanitsa Pehova, Oleg Pikhurko, Maryam Sharifzadeh, Fiona Skerman, Jan Volec and Fan Wei.

44. The existence of synchronising groups of diagonal type

Speaker: Jesse Lansdown (The University of Western Australia)

Time: 16:00 Mon 13 December **Zoom:**

Author(s): Jesse Lansdown

Motivated originally by synchronisation in automata, there is ongoing work to classify primitive permutation groups within the sychronisation hierarchy. This hierarchy consists of natural classes of groups - synchronising, separating, and spreading - which lie between primitive and 2-transitive. Synchronising primitive groups must be of affine, almost simple, or diagonal type. Until recently, no synchronising groups of diagonal type were known. In this talk I will present recent work (with John Bamberg, Michael Giudici, and Gordon Royle) in which we show that PSL(2, q) $\times$ PSL(2, q) acting in its diagonal action on PSL(2,q) is separating, and hence synchronising, for q = 13 and q = 17, and non-spreading for all prime powers of q.

45. Minimum degree of asymmetric Ramsey-minimal graphs
Speaker: Thomas Lesgourgues (UNSW Sydney)
Time: 10:00 Tue 14 December **Zoom:**
Author(s): Thomas Lesgourgues

A graph G is q-Ramsey for a q-tuple of graphs $(H_1, \ldots, H_q)$, denoted by $G \rightarrow_q (H_1, \ldots, H_q)$, if every q-colouring $c : E(G) \rightarrow [q]$ contains a monochromatic copy of H_i in colour i, for some $i \in [q]$. The graph G is called q-Ramsey-minimal for $(H_1, \ldots, H_q)$ if it is q-Ramsey for $(H_1, \ldots, H_q)$ but no proper subgraph of G possesses this property. Let $s_q(H_1, \ldots, H_q)$ denote the smallest minimum degree of G over all graphs G that are q-Ramsey-minimal for $(H_1, \ldots, H_q)$.
The study of the parameter s_2 was initiated by Burr, Erdős and Lovász in 1976 when they showed that for cliques, $s_2(K_k, K_t) = (k-1)(t-1)$. In the past two decades the parameter s_q has been studied extensively, focusing on its symmetric version with $H_i = H$ for all i (H being a clique, a cycle, certain bipartite graph or from some sporadic classes of graphs). We present three new results in the asymmetric setting, two exact results with 2 colours for the parameters $s_2(K_k, C_\ell)$ and $s_2(C_k, C_\ell)$ (where C_ℓ is a cycle of length ℓ), and find various upper bounds on $s_q(K_k, \ldots, K_k, C_\ell, \ldots, C_\ell)$, depending on the range of parameters.
This is a joint work with Anurag Bishnoi, Simona Boyadzhiyska, Dennis Clemens, Pranshu Gupta, and Anita Liebenau.

46. Aldous' Spectral Gap Conjecture for normal Cayley graphs
Speaker: Yuxuan Li (The University of Melbourne)
Time: 16:00 Tue 14 December **Zoom:**
Author(s): Yuxuan Li, Binzhou Xia, and Sanming Zhou

Aldous' Spectral Gap Conjecture states that the second largest eigenvalue of each connected Cayley graph on the symmetric group S_n with respect to a set of transpositions is obtained by the standard representation of S_n. This celebrated conjecture, which was proved completely in 2010, has inspired much interest in searching for other families of Cayley graphs on S_n with the same property. In this talk, I will report two classes of connected normal Cayley graphs on S_n possessing this "Aldous property", one of which can be seen as a generalization of the "normal" case of Aldous' Spectral Gap Conjecture. This is a joint work with Binzhou Xia and Sanming Zhou.

47. On Sidorenko systems of linear equations
Speaker: Anita Liebenau (UNSW Sydney)
Time: 09:30 Wed 15 December **Zoom:**
Author(s): Anita Liebenau

A system of linear forms L over $\mathbb{F}_q$ is *Sidorenko* if the number of solutions to $L = 0$ in any subset A of $\mathbb{F}_q^n$ is asymptotically (as $n \rightarrow \infty$) at least the expected number of solutions in a random subset of $\mathbb{F}_q^n$ of density $|A|/q^n$. The systematic study of Sidorenko systems of linear equations was recently initiated by Saad and Wolf and follows an extensive research on Sidorenko's conjecture for graphs. Building on a result by Saad and Wolf, Fox, Pham and Zhao found a characterisation for one-equation systems that are Sidorenko.
In this talk, we report on recent progress towards characterising Sidorenko systems of two or more equations. In particular, we provide a simple necessary condition for a system to be Sidorenko by proving that the length of a shortest equation induced by the system must be even. We also find a large class of systems that are Sidorenko by combining Sidorenko equations in a certain way.
Joint work with Nina Kamčev and Natasha Morrison.

48. Almost external difference families via cyclotomy
Speaker: Xiao-Nan Lu (University of Yamanashi)
Time: 12:00 Tue 14 December **Zoom:**
Author(s): Xiao-Nan Lu

In this talk, we will introduce a new type of combinatorial designs, called almost external difference families (AEDFs). The notion of AEDFs is a generalization of external difference families, and AEDFs also have natural relationship with well-studied combinatorial designs such as almost difference sets, disjoint difference families, and difference systems of sets. AEDFs can be used as a combinatorial characterization for special types of optimal weak algebraic manipulation detection codes, which are employed as coding schemes for linear secret sharing. Furthermore, a construction of AEDFs via cyclotomy in finite fields will be proposed. This talk is based on joint work with Shota Kawaguchi and Miwako Mishima.

49. Rigidity and flexibility of planar rod configurations

Speaker: Signe Lundqvist (Umeå University)

Time: 09:00 Fri 17 December **Zoom:**

Author(s): Signe Lundqvist, Klara Stokes, Lars-Daniel Öhman

A planar rod configuration is a point-line realisation of a rank two incidence geometry in the Euclidean plane. Rod configurations generalise Euclidean frameworks of graphs. We provide generalisations to rod configurations of the concepts of continuous, global, and infinitesimal motion of graph frameworks, illustrating with planar examples. We also give a combinatorial characterisation of rigidity of planar rod configurations, hence providing an answer of how to solve the general form of the Molecular conjecture for incidence geometries in the plane.

50. Degree sequences of random uniform hypergraphs

Speaker: Tamas Makai (UNSW Sydney)

Time: 10:30 Wed 15 December **Zoom:**

Author(s): Tamas Makai

For $\mathbf{d} = \{d_1, \ldots, d_n\}$ consider $P_r(\mathbf{d})$, be the probability that a random graph selected uniformly from the set of r-uniform hypergraphs with n vertices and m edges,has degree sequence $\mathbf{d}$. Previously the value of this probability has been investigated by Kamčev, Liebenau and Wormald, where they examined degree sequences from very sparse to moderately dense hypergraphs when $r = o(n^{1/4})$ and the variation of the degrees is small, but exceeds the typical degree variation in random hypergraphs.

We extend their results, by establishing $P_r(\mathbf{d})$ for dense hypergraphs, which hold for any r and allow for a greater variation on the degrees.

This is joint work with Catherine Greenhill, Mikhail Isaev and Brendan McKay.

51. A new construction of clique-free pseudorandom graphs

Speaker: Sam Mattheus (Vrije Universiteit Brussel)

Time: 17:00 Mon 13 December **Zoom:**

Author(s): Sam Mattheus

We will discuss a new construction of clique-free pseudorandom graphs, which perform equally well as the recent result by Bishnoi, Ihringer and Pepe. The construction employs geometry over finite fields of even characteristic, while the latter result only works for odd characteristic. Although the computations are a bit cumbersome, we will see that the idea behind the construction is fairly simple. We will point out the commonalities and the differences between the two constructions and the limitations of this method.

Based on joint work with Francesco Pavese.

52. Surge: generator for chemical structures

Speaker: Brendan Damien McKay (Australian National University)

Time: 09:30 Thu 16 December **Zoom:**

Author(s): Brendan McKay, Christoph Steinbeck and Mehmet Aziz Yirik

We describe a new generator of chemical structures given a formula plus various constraints. Though still lacking all the facilities of existing generators, the new generator is two orders of magnitude faster.

53. On (non-)realizibility of Stirling numbers

Speaker: Piotr Miska (Jagiellonian University)

Time: 09:00 Fri 17 December **Zoom:**

Author(s): Piotr Miska

We say that a sequence $(a_n)_{n\in\mathbb{N}_+}$ of non-negative integers is realizable if there exists a set X and a mapping $T : X \to X$ such that a_n is the number of fixed points of T^n.

For each $k \in \mathbb{N}_+$ and $j \in \{1, 2\}$ we define a sequence

$$S_k^{(j)} = (S^{(j)}(n + k - 1, k))_{n\in\mathbb{N}_+},$$

where $S^{(j)}(n, k)$ is the Stirling number of the j-th kind (in case of $j = 1$ we consider unsigned Stirling numbers).

The aim of the talk is to prove that $S_k^{(2)}$ is realizable if and only if $k \in \{1, 2\}$, while for $k = 3$ the sequence $S_k^{(2)}$ is almost realizable with a failure $(k-1)!$, i. e. $(k-1)!S_k^{(2)}$ is realizable. Moreover, I will show that for each $k \in \mathbb{N}_+$ the sequence $S_k^{(1)}$ is not almost realizable, i. e. for any $r \in \mathbb{N}_+$ the sequence $rS_k^{(1)}$ is not realizable.

The talk is based on a joint work with Tom Ward (Newcastle, UK).

54. Perfect 1-Factorisations of Complete Uniform Hypergraphs
Speaker: Jeremy Mitchell (The University of Queensland)
Time: 16:30 Mon 13 December **Zoom:**
Author(s): Jeremy Mitchell

A *1-factorisation* of a graph is called *perfect* if the unions of every pair of 1-factors of the 1-factorisation are each isomorphic to the same connected graph. Using this definition we have defined a generalisation of perfect 1-factorisations(P1Fs) of graphs to the context of hypergraphs, and asked whether the complete uniform hypergraph K_n^k admits such 1-factorisations. In this talk I will show that, for $k \geq 3$, P1Fs of K_n^k can only exist when $k = 3$ and that when they exist they can be used to construct biplanes. I will also briefly mention other possible generalisations of P1Fs, and some results from known 1-factorisations.

55. Graph searching
Speaker: Bojan Mohar (Simon Fraser University)
Time: 18:00 Wed 15 December **Zoom:**
Author(s): Bojan Mohar

The speaker will discuss problems in the area of graph searching with special attention to the Game of Cops and Robber. This game that is played on a finite graph G asks for strategies of k cops, who move along the edges of G and want to catch the robber, who also moves on G with equal speed as the cops.

56. Mining full-weight ternary trees in 2^{363}: background for Norm NFTs
Speaker: Mojtaba Moniri (Normandale Community College)
Time: 09:00 Mon 13 December **Zoom:**
Author(s): Mojtaba Moniri

For a complete ternary tree T of depth n with 0-1 labeled edges, its weight $f(T)$ is the least number of path labels among binary subtrees. The maximum $f(n)$, over all labelings, of these weights starts with 1,2,3,4,8, and we have $9 \leq f(6) \leq 16$. These were shown by Downey-Greenberg-Jockusch-Milans in 2011, where they put bounds on $f(n)$ and solved a problem in computability theory. We show $f(6) \geq 12$, but focus on some challenging computations in still smaller depths. We investigate the expected value of $f(T)$ for T of depth $n \leq 5$. In depth 2, it is easy: $\frac{11}{8}$. Among the 2^{39} trees of depth 3, it is $\frac{31033}{16384}$. For depth 4, weight 1-4 trees constitute approximately $0.4^{-}\%$, 36%, $56^{+}\%$, and 7% of the 2^{120} trees (samples of various sizes have means ≈ 2.7).
Our main accomplishments are computations and mining illustrations in depth 5 (with 2^{363} trees): (1) We approximate the percentages for weights 1-8: 0, 1.04, 23.6, 55.0, 18.8, 1.54, 0, 0 (plus corresponding distributions for two classes of structured random trees); (2) Our supplements include thousands of trees of the more interesting rare weights 7-8, via mining based on a Ramseyan property in depth 3. The produced trees are linked to as collections of Non Fungible Tokens (opensea.io/rareconcurrencies). We also show level-wise optimality for a subtree could prevent optimality (with instances of a similar inconsistency in depth 6 for cluster-wise optimality).

57. Achromatic number and facial achromatic number of connected locally-connected graphs
Speaker: Yumiko Ohno (Yokohama National University)
Time: 10:30 Wed 15 December **Zoom:**
Author(s): Yumiko Ohno

A graph is locally-connected if the neighborhood of each vertex induces a connected graph. It is well known that a triangulation on a closed surface is locally-connected, and some results for triangulations were generalized to those for connected locally-connected graphs. In this paper, we extend two characterization theorems of triangulations for a complete coloring and a facial complete coloring, which are vertex colorings with constraints on the appearance of color tuples, to those of connected locally-connected graphs. This talk is based on the jointwork with Naoki Matsumoto (Keio University).

58. On perfect Roman domination in the composition of graphs
Speaker: Leonard Paleta (University of Southern Mindanao)
Time: 12:00 Fri 17 December **Zoom:**
Author(s): Leonard Paleta; Ferdinand P. Jamil

A *perfect Roman dominating function* on a graph $G = (V(G), E(G))$ is a function $f : V(G) \to \{0, 1, 2\}$ for which each $u \in V(G)$ with $f(u) = 0$ is adjacent to exactly one vertex $v \in V(G)$ with $f(v) = 2$. The *weight* of a perfect Roman dominating function f is the value $\omega_G(f) = \sum_{v \in V(G)} f(v)$. The *perfect Roman domination number* of G is the minimum weight of a perfect Roman dominating function on G. In this paper, we present some results on the perfect Roman domination in the composition of graphs.

59. Some new connections between graphs and groups

Speaker: Youming Qiao (University of Technology Sydney)

Time: 10:30 Fri 17 December **Zoom:**
Author(s): Youming Qiao

Let p be an odd prime. For a simple undirected graph G, through the classical procedures of Baer (Trans. Am. Math. Soc., 1938), Tutte (J. Lond. Math. Soc., 1947) and Lovász (B. Braz. Math. Soc., 1989), there is a p-group of class 2 and exponent p, P_G, that is naturally associated with G. In this talk, we examine some connections between G and P_G as follows: 1. Connectivity of G and central product decomposability of P_G [1]. 2. The maximum size of independent sets in G and the maximum order of abelian subgroups of P_G [2]. 3. The isomorphism type of G and the isomorphism type of P_G [3]. We discuss some generalisations of these connections, such as vertex and edge connectivities of G and certain group-theoretic properties of P_G regarding central product decompositions. Some new results and questions on P_G inspired by these connections will be reported.

[1] Y. Li, Y. Qiao: Group-theoretic generalisations of vertex and edge connectivities. Proc. Am. Math. Soc. 148: 4679-4693 (2020).
[2] X. Bei, S. Chen, J. Guan, Y. Qiao, X. Sun: From independent sets and vertex colorings to isotropic spaces and isotropic decompositions. SIAM J. Comput., 50(3), 924–971 (2021).
[3] X. He, Y. Qiao: On the Baer-Lovász-Tutte construction of groups from graphs: Isomorphism types and homomorphism notions. Eur. J. Comb. 98: 103404 (2021).

60. Row-column factorial designs

Speaker: Fahim Rahim (The University of Waikato)

Time: 09:00 Wed 15 December **Zoom:**
Author(s): Fahim Rahim

An $m \times n$ row-column factorial design is an arrangement of the elements of a factorial design into a rectangular array. Such an array is used in experimental design, where the rows and columns can act as blocking factors. We say that a design is of strength t if all the t-interactions of the factors in that design are estimable. In this talk, I will discuss some of the properties of these designs and other combinatorial structures (e.g., Frequency squares, orthogonal arrays) that are associated with these designs. I will also discuss some of the results related to the existence and non-existence of the designs. I will also describe a method that uses finite fields to construct these designs.

61. The restricted isometry property of the Paley ETF and Paley graph conjecture

Speaker: Shohei Satake (Kumamoto University)

Time: 11:30 Fri 17 December **Zoom:**
Author(s): Shohei Satake

Matrices with the *restricted isometry property* (*RIP*) play an important role in compressed sensing. In particular, constructing *deterministic* RIP matrices breaking the *square-root bottleneck* on the RIP is a challenging problem. Bandeira, Fickus, Mixon and Wong (2013) considered the RIP of a matrix, called *Paley ETF*, defined by quadratic residues of the p-element field where p is an odd prime, and they conjectured that Paley ETF could break the square-root bottleneck. Later Bandeira, Mixon and Moreira (2017) proved that this conjecture is true when $p \equiv 1 \pmod 4$ and a predicted character sum estimation holds. Also they proved that if Paley ETF breaks the square-root bottleneck, then a significantly improved upper bound on the clique number of *Paley graph* can be obtained.

In this talk, we consider the case of general odd primes p. We first prove that Paley ETF breaks the square-root bottleneck assuming that a widely-believed conjecture, namely, the *Paley graph conjecture*, holds. Moreover we show that if Paley ETF breaks the square-root bottleneck, then we have significantly improved upper bounds on the maximum size of transitive subtournaments in *Paley tournament* as well as on the clique number of Paley graph. Finally, assuming the RIP of Paley ETF, we show a result supporting the Paley graph conjecture as well.

62. Constructing highly regular expanders from hyperbolic Coxeter groups

Speaker: Jeroen Schillewaert (University of Auckland)

Time: 11:30 Thu 16 December **Zoom:**
Author(s): Jeroen Schillewaert

Given a string Coxeter system (W, S), we construct highly regular quotients of the 1-skeleton of its universal polytope $\mathcal{P}$, which form an infinite family of expander graphs when (W, S) is indefinite and $\mathcal{P}$ has finite vertex links. The regularity of the graphs in this family depends on the Coxeter diagram of (W, S). The expansion stems from superapproximation applied to (W, S). This construction is also extended to cover Wythoffian polytopes. As a direct application, we obtain several notable families of expander graphs with high levels of regularity, answering, in particular, the question posed by Chapman, Linial, and Peled positively. This is joint work with Marston Conder, Alex Lubotzky and François Thilmany.

63. Imbalance graphic block graphs

Speaker: Andrii Serdiuk (Kyiv-Mohyla Academy)

Time: 17:00 Wed 15 December **Zoom:**

Author(s): Andrii Serdiuk

The imbalance of an edge in a graph is the absolute difference of degrees of its vertices. A multiset of non-negative integers is called (multi)graphic provided it is the multiset of vertex degrees of some (multi)graph. In this talk, we present several results concerning graphs having graphic multisets of edge imbalances (the so-called imbalance graphic graphs). Mainly, we focus on block graphs. It is proved that the following types of block graphs are imbalance graphic: trees; block graphs having all cut vertices lying in a common block; block graphs in which the subgraph induced by the cut vertices is a path or a star. We also conjecture that every block graph is imbalance graphic and support the conjecture by proving that every block graph is in fact imbalance multigraphic. The conjecture is verified for all block graphs with ≤ 13 vertices.

64. On the number of beta-redices in random closed linear lambda-terms

Speaker: Alexandros Singh (Laboratoire d'informatique de Paris-Nord)

Time: 17:00 Thu 16 December **Zoom:**

Author(s): Alexandros Singh, Olivier Bodini, Noam Zeilberger

The linear λ-calculus and its connections to objects such as trivalent maps has been the focus of much research at the interface of combinatorics and logic. In this work we study the number of β-redices in random closed linear λ-terms, deriving asymptotic expressions for its mean and variance. In particular, we show that a term with $3k + 2$ subterms has asymptotically $\frac{k}{8}$ β-redices. This parameter is of great interest since, among other things, it provides a lower bound for the number of steps required to β-reduce a random closed linear term to its normal form.

65. Properties of induced subgraphs of random graphs with given degree sequences

Speaker: Angus Southwell (Monash University)

Time: 11:30 Tue 14 December **Zoom:**

Author(s): Angus Southwell

For a fixed n-element degree sequence $\mathbf{d}$, let $G(\mathbf{d})$ be a uniformly random graph with degree sequence $\mathbf{d}$. Let $S \subset [n]$ be a subset of the vertices, and let $G[S]$ be the subgraph of $G(\mathbf{d})$ induced on S. In this talk, we discuss the distribution of the degree sequence of $G(\mathbf{d})$, which we study using the method of switchings. We then combine this information with known results about random graphs with given degree sequences to predict properties of $G[S]$ based on the choice of the degree sequence $\mathbf{d}$ and the subset S.

66. A note on the Hering types of finite inversive planes

Speaker: Gunter Steinke (University of Canterbury)

Time: 10:30 Mon 13 December **Zoom:**

Author(s): Gunter Steinke

Inversive (or Möbius) planes are incidence geometries with points and blocks, normally called circles, satisfying two basic geometric axioms of joining and touching. Finite inversive planes of order n are precisely the $3-(n^2+1, n+1, 1)$ designs. All known finite inversive planes have order a prime power q and are obtained as the geometry of non-trivial plane sections of an ovoid in 3-dimensional projective space over the Galois field GF(q). If the ovoid is a an elliptic quadric the inversive plane is called miquelian because these planes are configurationally characterized by the Theorem of Miquel. As usual in incidence geometry, an automorphism of an inversive plane is a permutation of the point set such that circles are mapped onto circles.

Similar to the Lenz-Barlotti classification of projective planes with respect to linearly transitive groups of central automorphisms, C. Hering investigated linearly transitive groups of central automorphisms of inversive planes. He obtained a classification comprising 18 types. The Hering type of an inversive plane is the type according to according to this classification with respect to the full automorphism group of the plane. The question then is what Hering types of inversive planes an occur.

In this talk we survey the results on Hering types of finite inversive planes and discuss Hering type IV.2.

67. Pairwise balanced designs and periodic Golay pairs

Speaker: Andrea Svob (University of Rijeka)

Time: 17:00 Mon 13 December **Zoom:**

Author(s): Andrea Svob

In this talk we will focus on a connection between certain pairwise balanced designs with v points and periodic Golay pairs of length v. The talk is based on recent work [1] where we construct pairwise balanced designs with v points having an assumed cyclic automorphism group, and using isomorph rejection which is compatible with the equivalence of corresponding periodic Golay pairs, we complete the classification of periodic Golay pairs of length less than 40, up to equivalence. Further, we will show how we use similar tools to construct new periodic Golay pairs of lengths greater than 40 where classifications remain incomplete, and demonstrate that under some extra conditions on its automorphism group, a periodic Golay pair of length 90 do not exist.

This is a joint work with Dean Crnković, Doris Dumičić Danilović and Ronan Egan.

[1] D. Crnković, D. Dumičić Danilović, R. Egan, A. Švob, Periodic Golay pairs and pairwise balanced designs, J. Algebraic Combin., to appear.

68. Stability results for (s,t)-union intersecting families

Speaker: Ali Taherkhani (Institute for advanced studies in basic sciences)

Time: 16:30 Mon 13 December **Zoom:**

Author(s): Ali Taherkhani

Let n and k be two positive integers such that $n \geq k$. A family $\mathcal{A}$ of k-element subsets of $[n]$ is said to be intersecting if the intersection of every two members of $\mathcal{A}$ is non-empty. The well-known Erdős-Ko-Rado theorem states that every intersecting subfamily of k-element subsets of $[n]$ has the cardinality at most $\binom{n-1}{k-1}$ provided that $n \geq 2k$; moreover, if $n > 2k$, then only intersecting subfamilies of this cardinality are $\mathcal{S}_i$, where $\mathcal{S}_i = \{A | \, i \in A, |A| = k\}$. In 1967, as a generalization of the Erdős-Ko-Rado theorem, Hilton and Milner showed that for $n > 2k$ the maximum possible size of a nontrivial intersecting family $\mathcal{A}$ of k-element subsets of $[n]$ is $\binom{n-1}{k-1} - \binom{n-k-1}{k-1} + 1$. Furthermore, they determined the extremal cases.

A family of k-sets $\mathcal{A}$ on $[n]$ is said to be an (s,t)-union intersecting family if for each $\{A_1, \ldots, A_s\}$ and $\{B_1, \ldots, B_t\} \subseteq \mathcal{A}$, we have $(\cup_{i=1}^{s} A_i) \cap (\cup_{i=1}^{t} B_i) \neq \varnothing$. In this talk we shall show some extensions of the Erdős-Ko-Rado theorem and the Hilton-Milner theorem for (s,t)-union intersecting families. Moreover, we present a stability result for the the Erdős matching conjecture when n is sufficiently large.

69. On distance-regular covers of complete graphs admitting a group of automorphisms with few orbits on arcs

Speaker: Ludmila Tsiovkina (IMM UB RAS)

Time: 16:30 Tue 14 December **Zoom:**

Author(s): Ludmila Tsiovkina

In this talk, I will overview some old and new results on classification of distance-regular antipodal covers of complete graphs admitting a group of automorphisms with few orbits on arcs, mainly focusing on those covers that are edge-transitive or abelian.

70. Signs behaviour of sums of weighted numbers of partitions

Speaker: Maciej Ulas (None)

Time: 16:30 Wed 15 December **Zoom:**

Author(s): Maciej Ulas

Let A be a subset of positive integers. By A-partition of n we understand the representation of n as a sum of elements from the set A. For given $i, n \in \mathbb{N}$, by $c_A(i,n)$ we denote the number of A-partitions of n with exactly i parts. We present several result concerning signs behaviour of the sequence $S_{A,k}(n) = \sum_{i=0}^{n} (-1)^i i^k c_A(i,n)$, where $k \in \mathbb{N}$ is fixed. In particular, we prove that for a broad class $\mathcal{A}$ of subsets of $\mathbb{N}_+$ we have that for each $A \in \mathcal{A}$ we have $(-1)^n S_{A,k}(n) \geq 0$ for each $n, k \in \mathbb{N}$.

The talk is based on a joint work with Filip Gawron (Jagiellonian University).

71. Unit gain graphs with two eigenvalues and lines in complex space with few angles

Speaker: Edwin van Dam (Tilburg University)

Time: 18:00 Mon 13 December **Zoom:**

Author(s): Edwin van Dam

Since the introduction of the Hermitian adjacency matrix for digraphs, interest in so-called complex unit gain graphs has surged. In this talk, we consider such gain graphs with two distinct eigenvalues. Analogously to (undirected) graphs whose traditional adjacency matrix has few distinct eigenvalues, a great deal of structural symmetry is required. Besides combinatorial considerations, also the representation by lines in complex space is essential in the study of considered gain graphs. Examples are drawn from various relevant concepts from quantum information theory related to lines in complex space with few angles, such as SIC-POVMs and MUBs. Other examples relate to the hexacode, Coxeter-Todd lattice, and the Van Lint-Schrijver association scheme. Many other examples can be obtained as induced subgraphs by employing a technique parallel to the dismantling of certain association schemes. Specific examples thus arise from (partial) spreads in some small generalized quadrangles. Finally, we give a full classification of two-eigenvalue gain graphs with degree at most 4, or with a multiplicity at most 3.

72. (k, t)-regular graphs

Speaker: Gabriel Verret (University of Auckland)

Time: 10:00 Fri 17 December **Zoom:**

Author(s): Gabriel Verret

A graph is called (k, t)-*regular* if it is k-regular and the induced subgraph on the neighbourhood of every vertex is t-regular. We are interested in the following question:

For which pairs (k, t) does there exist a (k, t)-regular graph?

This is a very simple yet interesting question about which little was known. I will discuss previous knowledge as well as some new results obtained with Marston Conder and Jeroen Schillewaert.

73. H-trails and dynamic H-trails in colored (di)graphs

Speaker: Carlos Vilchis-Alfaro (Universidad Nacional Autónoma de México)

Time: 09:30 Mon 13 December **Zoom:**

Author(s): Carlos Vilchis-Alfaro

Alternating Euler trails has been extensively studied for its diverse applications, for example, in genetic and molecular biology, social science and channel assignment in wireless networks, as well as for theoretical reasons. We will consider the following edge-coloring. Let H be a (di)graph possibly with loops and G a (di)graph without loops. An H-coloring of G is a function $c : E(G) \to V(H)$. We will say that G is an H-colored (di)graph whenever we are taking a fixed H-coloring of G. A sequence $W = (v_0, e_0^1, \ldots, e_0^{k_0}, v_1, e_1^1, \ldots, e_1^{k_1}, v_2, \ldots, v_{n-1}, e_{n-1}^1, \ldots, e_{n-1}^{k_{n-1}}, v_n)$ in G, where for each $i \in \{0, \ldots, n-1\}$, $k_i \geq 1$ and $e_i^j = v_i v_{i+1}$ is an edge in G, for every $j \in \{1, \ldots, k_i\}$, is a dynamic H-trail if W does not repeat edges and $c(e_i^{k_i})c(e_{i+1}^1)$ is an edge in H, for each $i \in \{0, \ldots, n-2\}$. In particular a dynamic H-trail is an alternating Euler trail when H is a complete graph without loops and $k_i = 1$, for every $i \in \{1, \ldots, n-1\}$.

In this talk, we will introduce the concept of dynamic H-trails in (di)graphs and give a characterization of the 2-arc colored digraphs containing an alternating closed Euler trail.

74. Maximally nonassociative quasigroups

Speaker: Ian Wanless (Monash University)

Time: 10:00 Thu 16 December **Zoom:**

Author(s): Ian Wanless

A quasigroup is a set equipped with a binary operation that satisfies two cancellation laws that ensure its Cayley table is a Latin square. A quasigroup $(Q, *)$ is said to be *maximally nonassociative* if

$$(x * y) * z = x * (y * z) \iff x = y = z,$$

where $x, y, z \in Q$.

A quasigroup over the finite field $\mathbb{F}_q$ is *quadratic* if its operation is defined by

$$u * v = \begin{cases} u + a(v - u) & \text{if } v - u \text{ is a square;} \\ u + b(v - u) & \text{otherwise.} \end{cases}$$

for fixed $a, b \in \mathbb{F}$. Quadratic quasigroups have several applications; eg, in the study of mutually orthogonal Latin squares and perfect 1-factorisations of graphs.

We prove that there are at least $(c + o(1))q^2/\log q$ maximally nonassociative quadratic quasigroups over $\mathbb{F}_q$ for some constant $c > 0$. Leveraging that result, we are able to show that a maximally nonassociative quasigroup of order n exists for all $n \geq 9$, with the possible exception of

$$n \in \{11, 12, 15, 40, 42, 44, 56, 66, 77, 88, 90, 110\}$$

and orders of the form $n = 2p_1$ or $n = 2p_1p_2$ for odd primes p_1, p_2 with $p_1 \leq p_2 < 2p_1$.

Joint work with Aleš Drápal, Charles University, Prague.

75. Universality in minor-closed classes

Speaker: David Wood (Monash University)

Time: 09:30 Fri 17 December **Zoom:**

Author(s): David R. Wood

Stanislaw Ulam asked whether there exists a universal countable planar graph (that is, a countable planar graph that contains every countable planar graph as a subgraph). János Pach (1981) answered this question in the negative. We strengthen this result by showing that every countable graph that contains all countable planar graphs must contain (i) an infinite complete graph as a minor, and (ii) arbitrarily large complete graph subdivisions.

On the other hand, we construct a countable graph that contains all countable planar graphs and has several key properties such as linear colouring numbers, linear expansion, and every finite n-vertex subgraph has $O(\sqrt{n})$ treewidth (which implies the Lipton-Tarjan separator theorem). The graph is the strong product of the universal treewidth-6 graph and a 1-way infinite path. More generally, for every fixed positive integer t we construct a countable graph that contains every countable K_t-minor-free graph and has the above key properties.

Our final contribution is a construction, based on chordal partitions, of a countable graph that contains every countable K_t-minor-free graph as an induced subgraph, has linear colouring numbers and linear expansion, and contains no subdivision of the countably infinite complete graph (implying (ii) is best possible).

Joint work with Tony Huynh, Bojan Mohar, Robert Šámal and Carsten Thomassen [https://arxiv.org/abs/2109.00327].

76. Playing games with the k-core

Speaker: Nick Wormald (Monash University)

Time: 11:30 Mon 13 December **Zoom:**

Author(s): Nick Wormald

Given an integer $b > 0$. two players, called Maker and Breaker, play a game on a graph G. In each round, Breaker claims b unclaimed edges and then Maker claims one. Maker wins if she can form a giant component (one with at least tn vertices, for some given constant $t > 0$) from the edges she claimed. If the edges are all used up before she manages this, Breaker wins. Clearly there is either a winning strategy for Maker, or one for Breaker. The larger b is, the easier it is for Breaker to win.

Suppose that G is drawn randomly from the common random graph model $G(n, p)$. Maker cannot possibly win unless G has a giant component. The threshold value of p for which this giant component occurs (with high probability, i.e. close to 1) is $1/n$. So let $p = c/n$ for $c > 1$. We can determine the smallest b for which Breaker wins with high probability.

A key part of our proof involves properties of the k-core of the random graph. I will give some background on this, as well as on Maker-Breaker games, and describe how the two have come together in this problem. This is joint work with Rani Hod, Michael Krivelevich, Tobias Muller and Alon Naor.

77. Disjoint Union of Paths is Distance Antimagic

Speaker: Risma Wulandari (Bandung Institute of Technology)

Time: 15:30 Tue 14 December **Zoom:**

Author(s): Risma Wulandari and and Rinovia Simanjuntak

A simple graph G is called distance antimagic if there exists a bijection $f : V(G) \mapsto \{1, 2, ..., |V(G)|\}$ such that $w(x) \neq w(y)$, for all pairs of distinct vertices x, y, where $w(x) = \sum_{y \in N(x)} f(y)$ and $N(x)$ is the neighbourhood of x. It is conjectured that a graph is distance antimagic if and only if it does not contain two vertices with the same neighbourhood.

A completely separating system (CSS) on $[n] = \{1, 2, ..., n\}$ is a collection $\mathcal{C}$ of subsets of $[n]$ in which for each pair of distinct elements $a, b \in [n]$ there exist $A, B \in \mathcal{C}$ such that $a \in A - B$ and $b \in B - A$.In this talk, we modify a known algorithm used for the construction of completely separating systems to prove that disjoint union of paths is distance antimagic. keywords: CSS, distance antimagic, disjoint union of paths.

78. Counting cycles in regular and planar graphs

Speaker: Carol Zamfirescu (University of Ghent)

Time: 17:00 Thu 16 December **Zoom:**

Author(s): Carol T. Zamfirescu

In the first part of the talk, motivated by an old conjecture of Sheehan and two recent conjectures of Haythorpe, we discuss the minimum number of hamiltonian cycles occurring in hamiltonian regular graphs. In the second part we present results on the enumeration of cycles in triangulations; for instance, that every planar n-vertex triangulation with at most one separating triangle contains $\Omega(n)$ many k-cycles for every $k \in \{3, \dots, n\}$. The results presented in the second part are based on joint work with On-Hei Solomon Lo.

79. Extremal independence in discrete random systems

Speaker: Rui Zhang (Monash University)

Time: 12:00 Tue 14 December **Zoom:**

Author(s): Rui Zhang

Let $X(n) \in R^d$ be a sequence of random vectors, where $n \in \mathbb{N}$ and $d = d(n)$. Under certain weakly dependence conditions, we prove that the distribution of the maximal component of X and the distribution of the maximum of their independent copies are asymptotically equivalent. Our result on extremal independence relies on new lower and upper bounds for the probability that none of a given finite set of events occurs. As applications, we obtain the distribution of various extremal characteristics of random discrete structures such as maximum codegree in binomial random hypergraphs and the maximum number of cliques sharing a given vertex in binomial random graphs. We also generalise Berman-type conditions for a sequence of Gaussian random vectors to possess the extremal independence property.

80. Cubic graphical regular representations of some classical simple groups

Speaker: Shasha Zheng (The University of Melbourne)

Time: 09:30 Wed 15 December **Zoom:**

Author(s): Binzhou Xia, Shasha Zheng and Sanming Zhou

A graphical regular representation (GRR) of a group G is a Cayley graph of G whose full automorphism group is equal to the right regular permutation representation of G. In this talk, we study cubic graphical regular representations of several families of classical simple groups and show that a modified version of a conjecture by Spiga is true.

List of Registrants

Current as of Thu 9 Dec 2021

Dr Tamil Elakkiya A	Gobi Arts and Science College (India)
Dr Julian Abel (S)	UNSW Sydney
Dr Mikhail Abrosimov	Saratov State University
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