Symmetries and Covers of Discrete Objects

The Rydges Lakeside Resort
Queenstown, New Zealand
15–19 February 2016

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DEPARTMENT OF MATHEMATICS

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
8:55		Opening				
9:00		Ivic-Weiss	Negami	Nesetril	Siran	Kellerhals
9:50		Fernandes	Ohno	Garcia-Vazquez	Wang	Izquierdo
10:10		*Coffee*	*Coffee*	*Coffee*	*Coffee*	*Coffee*
10:40		Glasby	Montero	Popiel	Kwon	Cirre
11:00		Skoviera	Schulte	Lee	Zhang	Bacelo
11:20		Nedela	Monson	Steinke	Feng	Etayo-Martinez
11:40		Kovacs	Collins	Morris	Estelyi	O'Reilly
12:00		*Lunch*	*Lunch*	*Lunch*	*Lunch*	*Lunch*
1:30		Tucker	Hubard	Excursion	Jones	
2:20		Watkins	Lai		Wilson	
2:40		Bercic	Du		Giudici	
3:00		Fawcett	Morgan		Del Rio	
3:20		*Coffee*	*Coffee*		*Coffee*	
3:50		Crnkovic	Zemljic		Verret	
4:10		Rukavina	Klavik		Praeger	
4:30	*Registration*					
6:30	*Reception till 8:30*					
				7:00	*Dinner*	

Monday 15 February 2016

Clancys Room

8:55 – *Opening speech*

9:00 – **Asia Ivić Weiss** *(Plenary talk)*
Polyhedra, polytopes and beyond

9:50 – **Maria Elisa Fernandes**
Highest rank of a polytope for A_n

10:10 – *Coffee/Tea break*

10:40 – **Steven Glasby**
Completely reducible subgroups of $GL(d, p^f)$*: counting their composition factors of order* p

11:00 – **Martin Skoviera**
Hamilton cycles in embedded graphs

11:20 – **Roman Nedela**
Hamilton cycles in cubic maps

11:40 – **István Kovacs**
Skew-morphisms of cyclic p*-groups*

12:00 – *Lunch at Ben Lomond Restaurant*

1:30 – **Thomas Tucker** *(Plenary talk)*
Graphical Frobenius Representations

2:20 – **Mark E. Watkins**
Infinite Graphical Frobenius Representations

2:40 – **Katja Bercic**
A repository of cubic vertex transitive graphs and its companion Sage package

3:00 – **Joanna Fawcett**
Locally triangular graphs and normal quotients of n*-cubes*

3:20 – *Coffee/Tea break*

3:50 – **Dean Crnković**
Groups acting on combinatorial designs and related codes

4:10 – **Sanja Rukavina**
Orbit matrices of symmetric designs and related self-dual codes

Tuesday 16 February 2016

Clancys Room

9:00 – **Seiya Negami** *(Plenary talk)*
Faithful embedding of graphs on closed surfaces

9:50 – **Yumiko Ohno**
Triad colorings of triangulations on closed surfaces

10:10 – *Coffee/Tea break*

10:40 – **Antonio Montero**
Equivelar toroids with few flag-orbits

11:00 – **Egon Schulte**
Semiregular Polytopes and Amalgamated C-Groups

11:20 – **Barry Monson**
Manufacturing Permutation Representations of Monodromy Groups of Polytopes

11:40 – **José Collins**
Amalgamations of 2-orbit polytopes

12:00 – *Lunch at Ben Lomond Restaurant*

1:30 – **Isabel Hubard** *(Plenary talk)*
Chirality in abstract polytopes

2:20 – **Chunhui Lai**
Some problems on covering of graphs

2:40 – **Shaofei Du**
Lifting Theorem and Group Extensions

3:00 – **Luke Morgan**
Semiprimitive Groups: Are they wild or just misunderstood?

3:20 – *Coffee/Tea break*

3:50 – **Sara Zemljic**
Symmetries and orbits of Sierpinski graphs

4:10 – **Pavel Klavik**
Automorphism Groups of Geometrically Represented Graphs

Wednesday 17 February 2016

Clancys Room

9:00 – **Jaroslav Nešetřil** *(Plenary talk)*
Sparse representations of posets, groups, monoids and categories

9:50 – **Patricio Ricardo García-Vazquez**
Affine flag-transitive biplanes with prime number of points

10:10 – *Coffee/Tea break*

10:40 – **Tomasz Popiel**
Generalised quadrangles with primitive automorphism groups

11:00 – **Melissa Lee**
Hemisystems and relative hemisystems on generalised quadrangles and their generalisations

11:20 – **Günter Steinke**
Central automorphisms of finite Laguerre planes

11:40 – **Joy Morris**
Cyclic m-cycle systems of near-complete graphs

12:00 – *Lunch at Ben Lomond Restaurant*

1:30 – *Excursion*

Thursday 18 February 2016

Clancys Room

9:00 – **Jozef Širáň** *(Plenary talk)*
Regular maps with given automorphism groups, with emphasis on twisted linear groups

9:50 – **Yan Wang**
Regular balanced Cayley maps of minimal non-abelian metacyclic groups

10:10 – *Coffee/Tea break*

10:40 – **Young Soo Kwon**
Classification of orientably regular Cayley maps on dihedral groups

11:00 – **Jun-Yang Zhang**
Skew-morphism of groups and regular Cayley maps

11:20 – **Yan-Quan Feng**
Cayley digraphs of 2-genetic groups of prime-power order

11:40 – **István Estélyi**
An infinite family of trivalent vertex-transitive Haar garphs that are not Cayley graphs

12:00 – *Lunch at Ben Lomond Restaurant*

1:30 – **Gareth Jones** *(Plenary talk)*
Edge-transitive maps

2:20 – **Steve Wilson**
The Census of Tetravalent Edge-Transitive Graphs

2:40 – **Michael Giudici**
Cubic arc-transitive k-circulants

3:00 – **María del Río-Francos**
Flag Graph and Symmetry Type Graphs

3:20 – *Coffee/Tea break*

3:50 – **Gabriel Verret**
Vertex-primitive graphs of valency 5

4:10 – **Cheryl E Praeger**
Conway groupoids and other structures

7:00 – *Conference Dinner, Queenstown Room*

Friday 19 February 2016

Clancys Room

9:00 – **Ruth Kellerhals** *(Plenary talk)*
Hyperbolic volume, commensurability and Problem 23 of Thurston

9:50 – **Milagros Izquierdo**
On the family of Riemann surfaces with automorphism group of order $4g$

10:10 – *Coffee/Tea break*

10:40 – **Javier Cirre**
Extendability of finite group actions on compact surfaces.

11:00 – **Adrián Bacelo**
On the symmetric crosscap number of groups

11:20 – **J. J. Etayo**
The real genus of the symmetric groups

11:40 – **Eugenia O'Reilly-Regueiro**
Neighbourly abstract polytopes

12:00 – *Lunch at Ben Lomond Restaurant*

THE END – Safe travel !

Plenary talks

Chirality in abstract polytopes

Isabel Hubard

The term "chiral" comes from the greek "kheir", which means hand. Objects with chiral symmetry are those that differ from their mirror image. We shall introduce the concept of an abstract polytope and focus on those having maximum possible rotational symmetry, but are not "reflexible", which we call chiral. We shall see that chiral polytopes seem hard to come by, but present some examples of them, as well as some ideas for constructing chiral polytopes of every rank (or dimension). We'll also present some interesting algebraic, combinatorial and geometrical problems in the subject.

Polyhedra, polytopes and beyond

Asia Ivić Weiss

In this talk we summarize some recent results in the theory of polytopes and extend the concept of a polytope to that of a hypertope: a thin, residually connected incidence geometry. We present the characterization of their automorphism groups and review the known results on classification of globally and locally toroidal highly symmetric hypertopes.

Edge-transitive maps

Gareth Jones

In 1997 Graver and Watkins showed that edge-transitive maps can be divided into 14 types, depending on the quotient by their automorphism group. I shall describe this classification, and how it relates to a more recent one due to Karabáš and Nedela. Subsequently Širáň, Tucker and Watkins showed that for each of these 14 types there are maps with automorphism group isomorphic to the symmetric group S_n for each $n \geq 11$ with $n \equiv 3$ or 11 mod (12). I shall extend this result to all $n \geq 7$, and to all alternating groups A_n with $n \geq 9$, with analogous results for various other families of finite simple groups. Using classical results from combinatorial group theory, I shall show that for each of the 14 types there are uncountably many non-isomorphic automorphism groups (and hence also maps), and that every countable group can act as a group of automorphisms of a map of that type. I will also consider properties such as growth and decidability for the various types.

Hyperbolic volume, commensurability and Problem 23 of Thurston

Ruth Kellerhals

I shall discuss various aspects and some results around hyperbolic volume, Problem 23 of Thurston, Milnor's Conjecture and commensurability of hyperbolic Coxeter groups. Some parts are in collaboration with Rafael Guglielmetti and Matthieu Jacquemet.

Faithful embedding of graphs on closed surfaces

Seiya Negami

An embedding of a graph on a closed surface is said to be faithful if any automorphism of the graph extends to an auto-homeomorphism over the surface. We shall show the reason why the faithfulness of embedding is necessary in topological graph theory, discussing its connection to re-embedding theory, Planar Cover Conjecture and distinguishing colorings. As some recent results, we shall show that most of 3-connected planar graphs can be faithfully embeddable on suitable orientable closed surfaces other than the sphere and give a sufficient condition for a 3-connected planar graph to be faithfully embeddable on a non-orientable closed surface.

Sparse representations of posets, groups, monoids and categories

Jaroslav Nešetřil

Classical results imply that every group (monoid, category) can be represented as the group (monoid, category) of all isomorphisms (endomorphisms, homomorphisms) of a particular graph (or of a class of graphs). While all partial orders may be represented even by oriented paths (and e.g. by outerplanar graphs), for groups, monoids and categories this is not possible. In the context of the sparse hierarchy (bounded expansion, nowhere- and somewhere dense) we determine complexity of these problems in perhaps surprising exactness. This is a joint work with Jan Hubička (Prague) and Patrice Ossona de Mendez (Paris and Prague).

Regular maps with given automorphism groups, with emphasis on twisted linear groups

Jozef Širáň

A map is a cellular decomposition of a surface, or, equivalently, a cellular embedding of a graph in a surface. A flag of a map is a vertex-edge-'side' triple of mutually incident elements. An automorphism of a map is a permutation of its flags such that two flags sharing a vertex, edge or side are sent to a pair of flags sharing the same type of element. The collection of all such mappings under composition forms the automorphism group of a map, a semi-regular permutation group on the flag set. In the case when this group is regular we say that the map is regular as well. One often refers to automorphisms as symmetries and in this sense regular maps can be viewed as having the 'highest level of symmetry'. A slightly weaker concept is that of an orientably-regular map, where only orientable surfaces and orientation-preserving map automorphisms are considered.

The concept of a regular map embodies three kinds of objects: a graph, a surface carrying an embedding of the graph, and a group isomorphic to the automorphism group of the map. Classification of regular and orientably-regular maps, which is a central problem in this area of research, is therefore usually attempted for a particular class of underlying graphs, or carrier surfaces, or groups.

In our talk we will focus on the problem of classification of regular and orientably-regular maps with a given (isomorphism type of) automorphism group. We will give a survey of available results in this field. In particular, two-dimensional linear groups $PSL(2, q)$ and $PGL2, q)$ appear to be best understood from this point of view. The $PGL(2, q)$ groups are known to be one of the two infinite families of finite sharply 3-transitive permutation groups. The other such infinite family of the so-called twisted linear groups have been somewhat neglected in the literature and we will present new results on enumeration of regular and orientably-regular maps with this type of automorphism groups.

Graphical Frobenius Representations

Thomas Tucker

A Frobenius group is a transitive, but not regular, permutation group G such that the only element fixing two points is the identity. By a theorem of Frobenius, we can write $G = HK$ where H is a point stabilizer and K is a normal, regular subgroup; K is called the *kernel* and H the *complement.* A graphical Frobenius representation (GFR) for $G = HK$ is a Cayley graph for K with vertex stabilizer H. Determining which Frobenius groups have a GFR is a natural generalization of the classical graphical regular representation (GRR) problem;

its many cases were worked by many people between 1958 and the final solution in 1981. Mark Watkins proposed the GFR problem to a PhD student Kevin Doyle, but there have been no papers on it, other than the student's thesis in 1976. Except for abelian groups, generalized dicyclic groups, and 13 small exceptional groups, all groups have a GRR. From MAGMA computations, it appears that GFRs are also common. On the other hand, we can show for any odd prime, when $K = C_p^2$ and $|H| = p + 1$ there is no GFR, indicating that the problem is much more complicated than GRRs with possibly many infinite families of Frobenius groups not having a GFR. This is joint work with Marston Conder and Mark Watkins.

Contributed talks

On the symmetric crosscap number of groups

Adrián Bacelo

Non-orientable non-bordered Klein surfaces, also named non-orientable Riemann surfaces, are compact, non-bordered, non-orientable surfaces endowed with a dianalytic structure. Every finite group G acts as an automorphism group of some of these surfaces. The minimal topological genus of them is called the symmetric crossscap number of the group. In the last years, a great improvement in this parameter has been done, that is the least known of some similar ones. In this oral communication we will set out the obtained progress in the symmetric crosscap number spectrum, that is, in determining which natural numbers are symmetric crosscap number of some group, emphasizing the results of groups with symmetric crosscap number of the form $60k + 27$.

A repository of cubic vertex transitive graphs and its companion Sage package

Katja Bercic

GraphZOO is a project combining a central repository of symmetric graphs, its website front-end and extensions for software packages like Sage. The repository contains certain precomputed properties to speed up the processes of filtering, searching and computation. For now it can store graphs, with the groundwork already laid out for more combinatorial objects.

In the talk we will show how one can interact with GraphZOO on the example of the census of cubic vertex transitive graphs (by Potočnik, Spiga and Verret). We will perform some example searches on the website, download a subset of the database and showcase some queries that can be run locally.

Extendability of finite group actions on compact surfaces.

Javier Cirre

Given an action of a finite abstract group G on a compact surface S, it is a natural question to determine whether G is the full group $\mathrm{Aut}(S)$ of all automorphisms of S or, on the contrary, S admits additional automorphisms. In this talk I will describe some joint work with Emilio Bujalance and Mastor Conder on the above question. The work began with the case of Riemann surfaces (in 1995), first for cyclic G and later for arbitrary G, and more recently has concentrated on Klein surfaces, both unbordered (and non-orientable) and bordered (and orientable or non-orientable). The cyclic case has already been solved for both types of Klein surfaces and we are now focussed on the general case, where we have achieved some partial results. This is a joint work (in progress) with E. Bujalance and M. D. E. Conder.

Amalgamations of 2-orbit polytopes

José Collins

In this talk we'll review some known facts about 2-orbit polytopes and give some examples of polytopes with toroidal facets whose automorphism group has two orbits and with either regular or 2-orbit vertex figures.

Groups acting on combinatorial designs and related codes

Dean Crnković

We will describe a construction of 1-designs determined by a transitive action of a finite group. In some cases the constructed 1-designs are also 2-designs. Further, we discuss linear codes obtained from combinatorial structures and corresponding orbit matrices. In that way on can construct codes with large automorphism groups, which are suitable for permutation decoding.

Flag Graph and Symmetry Type Graphs

María del Río-Francos

Abstract: The combinatorial structure of a maniplex of rank $(n-1)$ (or an $(n-1)$-maniplex) is completely determined by an edge-coloured n-valent graph with chromatic index n, with $n > 2$, often called the flag graph of the maniplex. Maps will be regarded as 2-maniplexes. Similarly to maps, a k-orbit maniplex is one that has k orbits of flags under the action of its automorphism group. In the first part of this talk we introduce the notion of symmetry type graphs of maniplexes and how to make use of them to study k-orbit maniplexes. On the second part of this talk we will present some results obtained by using the symmetry type graphs in order to give the number of possible flag-orbits that a map has after applying certain operations such as medial, truncation, leapfrog or chamfering to a k-orbit map.

Lifting Theorem and Group Extensions

Shaofei Du

Let X be a regular covering of the graph Y with covering transformation group K and covering projection p. An automorphism $\alpha \in \mathrm{Aut}(Y)$ is said to be lifted to an automorphism $\overline{\alpha}$ if $\overline{\alpha}p = p\alpha$. We know that every covering X can be derived by a voltage assignment f, that is $X := Y_f \times K$. One of important problems is the following:
Given a subgroup H of $\mathrm{Aut}(Y)$, find all the voltage assignments f such that H lifts.
A famous Lifting Theorem is the following:
α lifts if and only if $f(W^\alpha) = 1$ for each closed walk W such that $f(W) = 1$.
On the other hand, if H lifts to a group G then $G/K \cong H$. Therefore, lifting problem is essentially a group extension problem. Further, group extension theory is related to many other group theory branches. In this talk, we shall introduce some technical methods, revel the relations between Lifting Theorem and group extension theory, compare the advantages of them in different situations. Moreover, it will become a powerful tool by combining them.

An infinite family of trivalent vertex-transitive Haar graphs that are not Cayley graphs

István Estélyi

In a recent paper Estélyi and Pisanski raised a question whether there exist vertex-transitive Haar graphs that are not Cayley graphs. In this talk we construct an infinite family of trivalent Haar graphs that are vertex-transitive but non-Cayley. The smallest example has 40 vertices and is the well known Kronecker cover over the dodecahedron graph first studied by Ivić Weiss already in 1984. This is a joint work with Marston Conder and Tomaž Pisanski.

The real genus of the symmetric groups

J. J. Etayo

Each finite group G acts as an automorphism group of several bordered Klein surfaces. For a given G, the minimal algebraic genus of those surfaces is called the real genus of the group, $\rho(G)$. The real genus has been obtained for some families of groups. In a recent paper, C.L.May states as one of the most interesting unsolved problems about the real genus, to determine $\rho(S_n)$ for all $n \leq 167$. This problem was solved by Carmen Cano in her Ph.D. thesis in 2011. Back in 1980 Marston Conder proved that for all $n > 167$ the group S_n has real genus $n!/12 + 1$. He used a diagrammatic argument which was also followed by Cano, with diagrams chosen ad-hoc, to prove that for all $n \geq 4, \rho(S_n) = n!/12 + 1$ with just three exceptions: $\rho(S_5) = 6, \rho(S_6) = 109, \rho(S_8) = 5041$. This is joint work with E. Martínez.

Locally triangular graphs and normal quotients of n-cubes

Joanna Fawcett

The triangular graph has vertex set the 2-subsets of a set of n points and edge set the pairs of 2-subsets intersecting at one point. Such graphs are known to be halved graphs of bipartite rectagraphs, which are connected triangle-free graphs in which every 2-path lies in a unique quadrangle. We will discuss a recent refinement of this result, which involves a parameter that generalises the concept of minimum distance for a binary linear code to arbitrary automorphism groups of the n-cube.

Cayley digraphs of 2-genetic groups of prime-power order

Yan-Quan Feng

A group is called 2-*genetic* if each normal subgroup of the group can be generated by two elements. Let G be a non-abelian 2-genetic group of order p^n for an odd prime p and a positive integer n. In this paper, we investigate connected Cayley digraphs $\mathrm{Cay}(G, S)$, and determine their full automorphism groups when $\mathrm{Aut}(G, S) = \{\alpha \in \mathrm{Aut}(G) \mid S^\alpha = S\}$ is a p'-group. With the result, we give the first known half-arc-transitive non-normal Cayley graphs of order an odd prime-power.

Highest rank of a polytope for A_n

Maria Elisa Fernandes

The existence of a regular polytope with a given automorphism group G can be translated into a group-theoretic condition on a generating set of involutions for G. For G the symmetric group S_n, the maximum rank of such a polytope is $n-1$, with equality only for the regular simplex. We prove that the highest rank of a string C-group constructed from an alternating group A_n is 0 if $n = 3, 4, 6, 7, 8$; 3 if $n = 5$; 4 if $n = 9$; 5 if $n = 10$; 6 if $n = 11$; and $\lfloor \frac{n-1}{2} \rfloor$ if $n \geq 12$. This is a joint work with Peter Cameron, Dimitri Leemans and Mark Mixer.

Affine flag-transitive biplanes with prime number of points

Patricio Ricardo García-Vazquez

Abstract: It is known that if a non-trivial biplane D admits a primitive flag-transitive automorphism group G, then either D has parameters (16,6,2), G is of almost simple type or $G \leq A\Gamma L_1(q)$, where q is an odd prime power. It is conjectured that the only example in the latter case with a prime number of points p is the known (37, 9, 2) biplane with $G = \mathbb{Z}_{37} \cdot \mathbb{Z}_9$. In this paper we prove that this is true when $p < 10^7$.
To see this we use the fact that a $(p, k, (k-1)/n)$-symmetric design admitting a flag-regular automorphism group exists if and only if every element $\alpha \in \mathbb{F}_p \setminus \{0\}$ can be represented as a difference of two elements of $D_n = \{x^n | x \in \mathbb{F}_p^x\}$ and the number of distinct representations is independent of the choice of α, or equivalently, that D_n is a $(p, k, (k-1)/n)$-difference set of $\mathbb{F}_p$.

Cubic arc-transitive k-circulants

Michael Giudici

Given a positive integer k, a k-circulant is a graph that admits an automorphism whose cycle decomposition consists of precisely k cycles, all of the same length. All cubic arc-transitive k-circulants with $k \leq 5$ have been classified by various authors. For $k = 1, 3$ and 5 there are finitely many, while for $k = 2$ and 4 there are infinitely many. In this talk I discuss recent work with István Kovács, Cai Heng Li and Gabriel Verret that investigates for arbitrary values of k, when are there infinitely many cubic arc-transitive k-circulants and when are there only finitely many.

Completely reducible subgroups of $GL(d, p^f)$: counting their composition factors of order p

Steven Glasby

Let G be a subgroup of $GL(d, q)$ with $q = p^f$, where p is a prime. The order $|G|_p$ of a Sylow p-subgroup of G is at most $p^{d(d-1)f/2}$. We prove that if G is solvable and completely reducible, then there is a much smaller bound. Our first bound $|G|_p \leq p^{(d-1)f}$ has recently been improved to $|G|_p \leq 2^{(d-1)f}$ if $p \neq 3$. The hypothesis of solvability can be eliminated, but then we are not counting the composition length of a Sylow p-subgroup but the number of composition factors of G of order p. This is joint work with Michael Giudici, Cai Heng Li and Gabriel Verret.

On the family of Riemann surfaces with automorphism group of order $4g$

Milagros Izquierdo

We see that with a finite (quite small) number of exceptions, given a genus g, there is just a uniparametric family of Riemann surfaces having full automorphism group of order $4g$. In this talk we study the this family and their real forms. The results are joint work with Antonio F. Costa, and Emilio Bujalance

Automorphism Groups of Geometrically Represented Graphs

Pavel Klavik

We describe a technique to determine the automorphism group of a geometrically represented graph, by understanding the structure of the induced action on all geometric representations. Using this, we characterize automorphism groups of planar, interval, permutation and circle graphs. We combine techniques from group theory (products, homomorphisms, actions) with data structures from computer science (3-connected decomposition, PQ-trees, split trees, modular trees) that encode all geometric representations.

For planar graphs, we give an inductive characterization. We prove that interval graphs have the same automorphism groups as trees, and for a given interval graph, we construct a tree with the same automorphism group which answers a question of Hanlon [Trans. Amer. Math. Soc 272(2), 1982]. For permutation and circle graphs, we give an inductive characterization by semidirect and wreath products. We also prove that every abstract group can be realized by the automorphism group of a comparability graph/poset of the dimension at most four. This talk is based on a joint work with Peter Zeman and Roman Nedela.

Skew-morphisms of cyclic p-groups

István Kovacs

A skew-morphism of a finite group A is a bijective mapping $\varphi : A \to A$ fixing the identity element of A and having the property that $\varphi(xy) = \varphi(x)\varphi^{\pi(x)}(y)$ for all $x, y \in A$, where the integer $\pi(x)$ depends only on x. In this talk I present a classification of all skew-morphisms of cyclic p-groups where p is an odd prime. This is a joint work with Roman Nedela.

Classification of orientably regular Cayley maps on dihedral groups

Young Soo Kwon

In this talk, we deal with classification of orientably regular Cayley maps on dihedral groups by considering their core-free quotients. We will also show recent results related to it. This is a joint work with István Kovacs.

Some problems on covering of graphs

Chunhui Lai

A set of subgraphs of a graph G is said to cover G if every edge of G is contained in at least one member of the set. Gallai conjectured that every simple connected graph on n vertices can be covered by $\leq [(n+1)/2]$ disjoint paths. Hajós conjectured that every simple even graph on n vertices can be covered by $\leq [n/2]$ disjoint cycles (see L. Lovász, On covering of graphs, in: P. Erdös, G.O.H. Katona (Eds.), Theory of Graphs, Academic Press, New York, 1968, pp. 231 - 236). Szekeres and Seymour conjectured that every graph without cut edges has a cycle double cover(see Bondy J. A., Murty U. S. R., Graph theory, Graduate Texts in Mathematics, 244, Springer, New York, 2008, Unsolved Problems 10). This talk summarizes some results on these problems and the conjectures that relate to these. We do not think Hajós conjecture is true.

Hemisystems and relative hemisystems on generalised quadrangles and their generalisations

Melissa Lee

In 1965, Segre defined the notion of a hemisystem of a Hermitian surface $\mathrm{H}(3, q^2)$, q odd as a subset of the lines that meet each point in half of its lines. In 2011, Penttila and Williford defined relative hemisystems as the analogous concept of hemisystems for q even. They were

motivated by the desire to generate rare primitive Q-polynomial 3-class association schemes, and discovered the first infinite family of them as a result of their infinite family of relative hemisystems. There are several generalisations of hemisystems and results concerning them, but none of the analogous generalisations have been explored for relative hemisystems.
In this talk, I will survey the history of hemisystems and relative hemisystems, why we care about them, and speak about the search for relative hemisystems on generalised quadrangles, and ways of extending this search.

Manufacturing Permutation Representations of Monodromy Groups of Polytopes

Barry Monson

Every polytope $\mathcal{P}$, whether convex or abstract, has a *monodromy group* $\mathrm{Mon}(\mathcal{P})$ (sometimes called the connection group). Typically $\mathrm{Mon}(\mathcal{P})$ has an obscure structure. Yet somehow it has encoded within all combinatorial properties of $\mathcal{P}$. For example, we can recover from $\mathrm{Mon}(\mathcal{P})$ the automorphism group $\mathrm{Aut}(\mathcal{P})$. Today we explain a simple way to exploit the interaction between $\mathrm{Mon}(\mathcal{P})$ and $\mathrm{Aut}(\mathcal{P})$ and so manufacture (with some luck) manageable permutation representations of $\mathrm{Mon}(\mathcal{P})$. Leah Berman, Deborah Oliveros, Gordon Williams and I have recently applied all this to the fully truncated nn-simplex $\mathcal{T}_n$. From that we can extract the minimal regular cover $\mathcal{R}_n$ for $\mathcal{T}_n$. This abstract regular polytope has an impressively huge number of flags.

Equivelar toroids with few flag-orbits

Antonio Montero

An $(n+1)$-toroid is a quotient of a tessellation of the n-dimensional euclidean space with a lattice group. Toroids are generalizations of maps in the torus on higher dimensions and also provide examples of abstract polytopes. Equivelar maps in the 2-torus (3-toroids) where classified by Brehem and Kœhnel in 2008. In 2012 Hubard, Orbanić, Pellicer and Weiss classified equivelar 4-toroids. However, a complete classification for any dimension seems to be a very hard problem. In the talk we will present a classification of equivelar $(n+1)$-toroids with less than n flag-orbits; in particular, we will discuss a classification of 2-orbit toroids of arbitrary dimension.

Semiprimitive Groups: Are they wild or just misunderstood?

Luke Morgan

The class of semiprimitive groups contains the classes of primitive, quasiprimitive and innately transitive groups. Every regular group creeps in too. Also every Frobenius group. There are just lots of semiprimitive groups! A classification of such groups (in the sense of an O?Nan-Scott theorem) seems difficult. In fact, the automorphism group of every 2-arc transitive graph is a semiprimitive group (on the vertex set), so a classification might be unfeasible. In joint work with Michael Giudici I have tried to bring some order to this chaos. I will talk about the beginnings of a theory, and discuss the following big question: Can semiprimitive groups be classified, or are they just wild?

Cyclic m-cycle systems of near-complete graphs

Joy Morris

There are certain straightforward necessary conditions for a graph to be decomposable into cycles of a fixed length m: the valency of every vertex must be even; the number of edges must be divisible by the cycle length. The graphs that are most natural to try to decompose into cycles, are complete graphs K_n. If n is even, then a 1-factor must be removed from the graph so that it meets the first necessary condition, and the resulting graph is denoted by $K_n - I$.

Alspach, Gavlas, and Šajna proved that the necessary conditions are sufficient to ensure an m-cycle decomposition of K_n, or of $K_n - I$. Since K_n has a great deal of symmetry, it is natural to ask whether or not some of that symmetry can carry over into an m-cycle decomposition. We let ρ denote the n-step rotation of the complete graph K_n, or of $K_n - I$ (where the 1-factor that has been removed is chosen so that the graph still has n-step rotational symmetry). An m-cycle system is called cyclic, if for any cycle C in the system, $\rho(C)$ is also in the system.

I will discuss results on cyclic m-cycle systems of K_n and more particularly $K_n - I$, including recent results dealing with the case where m is an even divisor of n.

Hamilton cycles in cubic maps

Roman Nedela

When one considers hamilton cycles in polytopal (or circular) maps on closed surfaces (both orientable, or non-orientable) a hamilton cycle can be either contractible, or bounding (separating) but non-contractible, or it is not bounding (non-separating).

This talk is a continuation of the talk of M. Škoviera. Here we restrict our attention to a particular, but important case when the underlying graph of the map is cubic. We show how the general methods can be applied to derive new results about existence of hamilton cycles in cubic maps. Our research is motivated by a recent progress done by Glover, Marušič, Kutnar and Malnič in a solution of particular case of the "Lovász problem" stating that the finite 2-generator Cayley graphs coming from presentations of the form $\langle x, y \mid y^2 = (xy)^3 = 1, \dots \rangle$ are hamiltonian, or contain a hamilton path. Further motivation comes from a recent result by Kardoš establishing that cubic spherical maps with faces of size at most 6 are hamiltonian (Barnette conjecture). We shall discuss the "parity problem" which appears both in works of Glover and Marušič, and of Kardoš. This is joint work with Michal Kotrbčík and Martin Škoviera.

Neighbourly abstract polytopes

Eugenia O'Reilly-Regueiro

Given $k \geq 1$ we say an abstract n-polytope $\mathcal{P}$ is *k-neighbourly* if every non-empty set of k or fewer vertices is the vertex set of a face of $\mathcal{P}$. In this talk we will give some general results on k-neigbourliness for abstract n-polytopes which are lattices, and then focus on $k = 3$ and ranks 4 or higher. This is joint work with Dimitri Leemans and Egon Schulte.

Triad colorings of triangulations on closed surfaces

Yumiko Ohno

A coloring of a triangulation on a closed surface is called a triad coloring with a set of triads if the three colors lying along the boundary cycle of each face form a triplet specified as a triad in the set. In particular, we consider triad colorings with a set of triads having an action of a cyclic group and analyze some properties of such triad colorings, using the covering spaces of simplicial 2-complexes.

Generalised quadrangles with primitive automorphism groups

Tomasz Popiel

A generalised quadrangle is a point–line incidence geometry such that (i) two distinct points lie on at most one common line, and (ii) given a line ℓ, every point not on ℓ is collinear with a unique point on ℓ. We are interested in generalised quadrangles with automorphism groups that act primitively on either points or lines. The so-called 'classical' generalised quadrangles admit such groups, and so do certain non-classical examples, so it is natural to seek a full classification. A result of Bamberg et al. (2012) states that a group acting primitively on both point and lines must be almost simple. I will survey some recent joint work with Bamberg, Glasby and Praeger which aims to weaken this assumption to primitivity on points alone.

Conway groupoids and other structures

Cheryl E Praeger

Recently some colleagues (Nick Gill, Neil Gillespie and Jason Semeraro) and I have had some fun exploring some structures which are similar in spirit to the wonderful six-transitive subset M_{13} introduced by John Conway in 1997. Along the way we encountered regular two-graphs, three-transposition groups, and various kinds of designs - inspired by John Conway's work. I'll attempt to explain what we found, and mention some of our unanswered questions.

Orbit matrices of symmetric designs and related self-dual codes

Sanja Rukavina

We explore codes spanned by the rows of an orbit matrix of a symmetric design induced by the action of an automorphism group that acts with all orbits of the same length. We show that under some conditions the rows of extended orbit matrix span a self-dual code. Further, we show that sometimes a chain of codes can be used to associate a self-dual code to an orbit matrix of a symmetric design. This is a joint work with Dean Crnković.

Semiregular Polytopes and Amalgamated C-Groups

Egon Schulte

In the classical setting, a convex polytope is semiregular if its facets are regular and its symmetry group is transitive on vertices. The talk is about semiregular abstract polytopes, which have abstract regular facets, still with a combinatorial automorphism group transitive on vertices. We analyze the structure of the automorphism group, focusing in particular on polytopes with two kinds of regular facets occurring in an "alternating" fashion. In particular we use group amalgamations to prove that given two compatible n-polytopes P and Q, there exists a universal abstract semiregular (n+1)-polytope which is obtained by "freely" assembling alternate copies of P and Q. We also employ modular reduction techniques to construct finite semiregular polytopes from reflection groups over finite fields. This is joint work with Barry Monson.

Hamilton cycles in embedded graphs

Martin Škoviera

Motivated by a recent work on Hamilton cycles in cubic Cayley graphs by Glover, Marušič and others we take a topological approach to the construction of Hamilton cycles in graphs embedded in surfaces. We develop general tools for the construction of Hamilton cycles in embedded graphs and establish necessary and sufficient conditions for a polytopal map (orientable or not) to have a bounding or contractible Hamilton cycle. Our results have numerous applications, especially to cubic graphs, which may be either vertex-transitive or not. In particular, all basic results of Glover, Marušič, Kutnar, and Malnič concerning Hamilton cycles in cubic Cayley graphs are generalised. Further details be presented in the subsequent talk of Roman Nedela. This is a joint work with Michal Kotrbčík and Roman Nedela.

Central automorphisms of finite Laguerre planes

Günter Steinke

A finite Laguerre plane of order n is a transversal (or group divisible) design $\mathrm{TD}_1(3, n+1, n)$ with $n+1$ generators and n points on each generator; three points, no two of which are on the same generator, determine a unique circle (a block of the transversal design). For each point of a Laguerre plane one obtains an affine plane, and thus a projective plane, as residual incidence structure. All known finite Laguerre planes are ovoidal, that is, they are obtained as the geometry of non-trivial plane sections of a cone over an oval in 3-dimensional projective space. It is a longstanding problem whether or not these are the only models of finite Laguerre planes.

It is well known that central collineations play a crucial role in the study of projective planes. We similarly consider central automorphisms of Laguerre planes. In particular, we are concerned with homotheties; except for the identity these are automorphisms that fix precisely two points (the centres) and induce homotheties in the derived projective plane at each of the fixed points. In 1979 R. Kleinewillinghöfer considered subgroups of homotheties which are linearly transitive, that is, are transitive on each circle through the two centres minus the centres. She obtained 13 different possible types, labelled 1 through to 13. All known finite Laguerre planes are of type 1, 8, 12 or 13; the latter type describes miquelian Laguerre planes, that is, those ovoidal planes obtained from a cone over a conic.

In this talk we review Kleinewillinghöfer's classification in case of finite Laguerre planes and show that certain types can only occur as types of subgroups of miquelian Laguerre planes.

Vertex-primitive graphs of valency 5

Gabriel Verret

A graph is *vertex-primitive* if its automorphism group does not preserve any nontrivial partition of its vertex-set. We recently classified finite vertex-primitive graphs of valency 5. (Graphs of valency at most 4 had previously been classified.)
I will describe this classification, some of the issues that arose in the proof, and our motivation. This is joint work with Joanna Fawcett, Michael Giudici, Cai Heng Li, Cheryl Praeger and Gordon Royle.

Regular balanced Cayley maps of minimal non-abelian metacyclic groups

Yan Wang

There are three classes of minimal non-abelian metacyclic groups including the quaternion group Q_8, and the other two classes are denoted by $M_{p,q}(m,r)$ and $M_p(n,m)$, respectively. We proved that there are regular balanced Cayley maps with $M_{p,q}(m,r)$ if and only if q is 2 and we listed out all the non-isomorphic regular balanced Cayley maps. While for $M_p(n,m)$, it has regular balanced Cayley maps if and only if $p = 2$ and $n = m$ or $n = m+1$ and in either case has only one regular balanced Cayley map of valency 4 in the sense of isomorphism. As a corollary, we proved that the metacyclic p-group for any odd prime number p doesn't have regular balanced Cayley maps. This is joint work with K. Yuan and Haipeng Qu.

Infinite Graphical Frobenius Representations

Mark E. Watkins

A *graphical Frobenius representation (GFR)* of a Frobenius (permutation) group G is a graph Γ whose automorphism group $\mathrm{Aut}(\Gamma)$ acts as a Frobenius permutation group on the vertex set of Γ, that is, $\mathrm{Aut}(\Gamma)$ acts vertex-transitively with the property that all nonidentity automorphisms fix either one or zero vertices and there are some of each kind.
The set K of all fixed-point-free automorphisms together with the identity is called the *kernel* of G. Whenever G is finite, K is a regular normal subgroup of G (F. G. Frobenius, 1901), in which case Γ is a Cayley graph of K. The same holds true for the infinite instances presented here.
Infinite, locally finite, vertex-transitive graphs can be classified with respect to (i) their number of *ends* and (ii) their *growth rate*. We present families of infinite GFRs for all possible combinations of these properties. There exist GFRs with polynomial growth of degree d for every positive integer d, and there are GFRs of exponential growth, both 1-ended and infinitely-ended, that are infinite chiral maps in the hyperbolic plane.

The Census of Tetravalent Edge-Transitive Graphs

Steve Wilson

I will talk about the Census, displaying some of its features, and describing some of the many families of graphs that are included.

Symmetries and orbits of Sierpinski graphs

Sara Zemljic

Sierpinski graphs are a two-parametric family of graphs which has been studied in various areas in mathematics and elsewhere. Due to their close relation to the problem of the Tower of Hanoi puzzle and easily understandable recursive structure, we are mainly interested in distances in Sierpinski graphs. In order to get more information on their properties, we started studying an algebraic view of these graphs. In the talk I will present new results on symmetries and orbits of Sierpinski graphs and how they can apply to their (metric) properties.

Skew-morphism of groups and regular Cayley maps

Jun-Yang Zhang

This talk focuses on the skew-morphism of groups and regular Cayley maps. Some new concepts such as skew-type, Cayley-core, Cayley-cover are introduced. The latest researches of us on the skew-morphism and regular Cayley maps are presented.

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