



GEOMETRIC AND ASYMPTOTIC
GROUP THEORY
WITH APPLICATIONS (GAGTA-5)

July 11th to 15th, 2011
Manresa (Barcelona, Spain)

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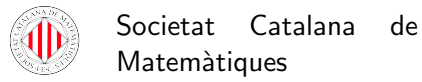
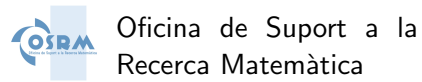
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Foreword

Welcome everybody to the GAGTA-5 conference, “Geometric and Asymptotic Group Theory with Applications”, held in Manresa (Catalonia) from July 11th to 15th, 2011.

This meeting is the fifth edition of a spontaneous series of meetings on Group Theory called GAGTA. The first one was also celebrated here in Manresa, in August 2006, as a satellite activity of the Madrid International Congress of Mathematicians ICM2006. Dortmund University (Dortmund, Germany) held the second edition on August 2007. Then, GAGTA-3 was held in the Stevens Institute of Technology (New Jersey, USA) on March 2009, and GAGTA-4 was celebrated just last August 2010 at CRM-Montréal (Montréal, Canada). With the event coming back to Manresa on its fifth edition, we hope to establish it as a consolidated series of conferences on Group Theory, running with a constant periodicity of about two years.

Our main goal in organizing GAGTA has been to offer another opportunity to the international community of researchers in Group Theory, for meeting together and discussing the new results in this modern area of mathematics. GAGTA is devoted to the study of a variety of topics in Geometric and Combinatorial Group Theory, including asymptotic and probabilistic methods, as well as algorithmic and computational topics related to groups. We also emphasize in the title the word “applications”, mainly referring to recent developments about “Group-based Cryptography”.

The first words of gratitude are for the conference participants, both senior researchers and students at all levels. Without them and their enthusiastic participation, a conference like this will have no success and even no purpose. To encourage the participation of students and young postdocs, we had a source of financial support dedicated to cover the local expenses of most of them. Although we had a smaller budget than we originally expected (due to the general economic situation), we are happy to have had this source of support; it had a clear effect on the registration since about 40% of the participants are young researchers or students.

We also thank the university campus holding the conference: the EPSEM, “Escola Politècnica Superior d’Enginyeria de Manresa”. Both the Direction and the Administration of the EPSEM took the celebration of GAGTA-5 with great enthusiasm, and helped with a lot of details regarding local arrangements.

Here, we also wish to express our thanks for the support received from several sponsors at different levels: the EPSEM, who gave us a grant to hire a student for helping with the organization (thank you Jordi for your great work); the “Departament de

Matemàtica Aplicada III" (MA3), the host department of the main organizer; the "Oficina de Suport a la Recerca Matemàtica" (OSRM) of the UPC offering valuable technical and human support (thank you Raquel for your great help in the organization); the "Universitat Politècnica de Catalunya" (UPC) as the general holding institution, collaborating at the formal, economic and practical levels. Also, our thanks to the "Societat Catalana de Matemàtiques" (SCM), the Catalan Mathematical Society, for its significant help in the framework of a programme to give support to all the events related to mathematics and held in (or organized from) Catalonia. And thanks also to the three local institutions from outside the university environment which, despite the difficulty of explaining to them the contents of the conference, are giving support to us: the Manresa City Hall, the Fundació Catalunya Caixa, and the Hotel Pere III. Finally, we are grateful for the economic support of the "Ministerio de Ciencia e Innovación" of the Spanish Government through grant number MTM2010-10302-E.

Manresa is a middle-sized city located at the geographical heart of Catalonia, and at the very base of Montserrat mountains, also the cultural and sentimental heart of Catalonia. The proximity to the big city of Barcelona (big in many senses), sometimes eclipses the visibility of the activities promoted and developed in the much smaller nearby cities. The celebration of GAGTA here in the Manresa university campus is a solid proof of the capacity of Manresa and its institutions to hold academic events at the highest international level. In this sense, we are happy that also some non academic institutions of the city have responded very well to the possibility of celebrating GAGTA here. In summary, we are very grateful to the city of Manresa for its warm hospitality towards GAGTA, one of the first international research conferences in any field ever celebrated here.

The organization of this second event shows the vitality of Catalonia also in this area of mathematics, in which the number and quality of catalan researchers has been significantly growing in recent years.

In this booklet you will find the detailed program of the conference, day by day, together with the list of speakers and the titles and abstracts of their talks. In the programme, you will also find the social activities, including a dinner and a promising cultural visit to Sant Benet, where we hope you can taste and touch a bit of the very rich history, tradition and culture of this country, Catalonia.

We hope you enjoy your stay in Manresa, and wish it to be very productive from the scientific point of view, and at the same time very pleasant.

Enric Ventura

On behalf of the GAGTA Organizing Committee.

Program

Monday, July 11th

(Main Room)

8:30 - 9:00	Registration
9:00 - 9:30	Opening session
9:30 - 10:30	Paul Schupp <i>"Recent results in generic computability"</i> (p. 26)
10:30 - 11:00	Coffee break
11:00 - 11:45	Volker Diekert <i>"Solving word problems in groups by data compression"</i> (p. 15)
11:55 - 12:40	Sean Cleary <i>"Commensurations and automorphisms of Thompson's group F"</i> (p. 14)
12:50 - 13:35	Juan González-Meneses <i>"Growth functions of braid monoids and generation of random braids"</i> (p. 18)

(Main Room, Room 2.4)

15:00 - 15:45	MR Francesco Matucci , <i>"Centralizers and dynamics in Thompson's group V"</i> (p. 23).
	2.4 Shane O Rourke , <i>"Affine actions on non-archimedean trees"</i> (p. 24).
16:00 - 16:45	MR Conchita Martínez-Pérez , <i>"Some finiteness conditions of generalisations of Thompson groups"</i> (p. 22).
	2.4 Ilya Kazachkov , <i>"Group actions on real cubings"</i> (p. 20).
17:00 - 17:45	MR Laura Ciobanu , <i>"On the asymptotics of visible elements and homogeneous equations in surface groups"</i> (p. 14).
	2.4 Elizaveta Frenkel , <i>"Amalgamated products of groups: generation of normal forms"</i> (p. 17).

18:45 - 21:00	Reception at Manresa City Hall
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Tuesday, July 12th

(Main Room)

9:00 - 10:00	Gilbert Levitt <i>"Automorphisms of relatively hyperbolic groups"</i> (p. 21)
10:00 - 10:30	Coffee break
10:30 - 11:15	Pedro Silva <i>"Finite automata for Schreier graphs of virtually free groups"</i> (p. 27)
11:30 - 12:15	Yago Antolin <i>"Dicks' simplification of Mineyev's proof of the strengthened Hanna Neumann conjecture"</i> (p. 12)
12:30 - 13:15	Arnaud Hilion <i>"The index of the dual lamination to an R-tree"</i> (p. 19)

(Main Room, Room 2.4)

15:00 - 15:45	MR Martin Lustig , <i>"Invariant laminations for irreducible automorphisms of free groups"</i> (p. 21).
16:00 - 16:45	MR Sarah Rees , <i>"Artin groups of large type"</i> (p. 26).
	2.4 Alexander Zakharov , <i>"Intersecting free subgroups in free amalgamated products of groups"</i> (p. 31).
17:00 - 17:45	MR Sang-hyun Kim , <i>"Embeddability between right-angled Artin groups"</i> (p. 20).
	2.4 Yago Antolin , <i>"On the Bredon homology for groups with cyclic torsion"</i> (p. 12).
18:00 - 18:45	MR Enric Ventura , <i>"On the difficulty of inverting automorphisms of free groups"</i> (p. 30).
	2.4 François Gautero , <i>"A non-trivial example of a free-by-free group with the Haagerup property"</i> (p. 17).

Wednesday, July 13th

(Main Room)

9:00 - 10:00	Zoran Šunić <i>"Group actions on rooted trees, symbolic dynamics, and Rabin automata"</i> (p. 28)
10:00 - 10:30	Coffee break
10:30 - 11:15	Olga Kharlampovich <i>"Polynomial time approximation schemes for construction geodesics in metabelian groups"</i> (p. 20)
11:30 - 12:15	Vladimir Remeslennikov <i>"Equational domains and co-domains in universal algebraic geometry"</i> (p. 26)
12:30 - 13:15	Alexei Miasnikov <i>"Cayley graph automatic groups"</i> (p. 23)

-	Free afternoon
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Thursday, July 14th

(Main Room)

9:00 - 10:00	Tatiana Smirnova-Nagnibeda <i>"Free groups, Schreier graphs and invariant measures"</i> (p. 28)
10:00 - 10:30	Coffee break
10:30 - 11:15	Andrew Duncan <i>"Rewriting systems and the word, geodesic and conjugacy problems"</i> (p. 16)
11:30 - 12:15	Susan Hermiller <i>"Tame filling invariants"</i> (p. 18)
12:30 - 13:15	Vladimir Shpilrain <i>"Learning with errors"</i> (p. 27)

(Main Room, Room 2.4)

15:00 - 15:20	MR Doron Puder , <i>"Measure preserving words are primitive"</i> (p. 25). 2.4 Thuy Pham , <i>"Abelian RA1-groups and afi-groups"</i> (p. 24).
15:30 - 15:50	MR Alexey Talambutsa , <i>"On the minimal exponential growth rate of some groups with periodic relations"</i> (p. 29). 2.4 Dmitry Kagan , <i>"Pseudocharacters on free groups"</i> (p. 19).
16:00 - 16:20	MR Amaia Zugadi-Reizabal , <i>"Grigorchuk-Gupta-Sidki groups: some new results"</i> (p. 32). 2.4 Rafal Lutowski , <i>"Holonomy groups of flat manifolds with R_∞ property"</i> (p. 22).
16:30 - 16:50	MR Maurice Chiodo , <i>"Some different types of universal finitely presented groups"</i> (p. 13). 2.4 Jordi Delgado , <i>"Algorithmic problems in free times free abelian groups"</i> (p. 15).

17:00 - 17:20	MR Michael Hull , <i>“Conjugacy growth in finitely generated groups”</i> (p. 19). 2.4 Ariadna Fossas , <i>“Thompson’s group T is the automorphism group of the asymptotic pants complex of a planar surface of infinite type”</i> (p. 17).
17:30 - 17:50	MR Andrei-Paul Grecianu , <i>“Groups acting on hyperbolic spaces”</i> (p. 18).

20:00 -	Visit to “St. Benet” Dinner
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Friday, July 15th

(Main Room)

9:00 - 10:00	Martin Dunwoody <i>"Almost invariant sets"</i> (p. 16)
10:00 - 10:30	Coffee break
10:30 - 11:15	Seymour Lipschutz <i>"Note on a question of Reihold Baer on pregroups II"</i> (p. 21)
11:30 - 12:15	Alina Vdovina <i>"New examples of expanders"</i> (p. 30)
12:30 - 13:15	Oleg Bogopolski <i>"Some new residual properties of groups"</i> (p. 13)

(Main Room, Room 2.4)

15:00 - 15:45	MR Gerald Williams , <i>"Finiteness and small cancellation conditions for a class of Fibonacci-type groups"</i> (p. 31). 2.4 Javier Aramayona , <i>"Homomorphisms between mapping class groups"</i> (p. 13).
16:00 - 16:45	MR Elena Aladova , <i>"Logical equations and types"</i> (p. 12). 2.4 Bruno Spanu , <i>"SQ-universality of $C(6)$-groups"</i> (p. 28).

Talks

Elena Aladova (Bar Ilan University)

Logical equations and types

(Joint work with Boris Plotkin and Eugene Plotkin). The aim of the talk is to define general notions of logical geometry and specify them for logical geometry over groups. This theory was developed by B. Plotkin within last years. Its emphasis is given to interaction between algebraic structure of an algebra and its geometrical and logical properties. We consider the ties between algebraic geometry and logical geometry over algebras/groups. In particular, we show that the concept of a type has deep connections with geometric properties of algebras. In this context we discuss the problem of homogeneity in free groups (cf. see recent result of C. Perin and R. Sklinos).

Yago Antolin (University of Southampton)

Dicks' simplification of Mineyev's proof of the strengthened Hanna Neumann conjecture

Very recently, Igor Mineyev gave a full proof of the Strengthened Hanna Neumann Conjecture, solving a more than fifty years old open problem which has generated a lot of interest and research. After his announcement, Warren Dicks considerably simplified the proof. In this talk, we shall give a complete proof for this result following Dicks' simplification.

Yago Antolin (University of Southampton)

On the Bredon homology for groups with cyclic torsion

(Joint work with Ramón J. Flores). We introduce a common framework for computing Bredon homology with coefficients in the complex representation ring for a wide class of groups which includes groups with aspherical presentation, one-relator quotients of products of locally indicable groups, extensions of \mathbb{Z}^n by cyclic groups, and fuchsian groups. We take profit of the torsion structure of these groups to use appropriate models of the universal space for proper actions which allow us, in turn,

to extend some technology defined by Mislin in the case of one-relator groups. We will apply these computations to describe the topological part of the Baum-Connes conjecture for some groups.

Javier Aramayona (National University of Ireland)

Homomorphisms between mapping class groups

(Joint work with Juan Souto). Let X and Y be surfaces of finite topological type, where $\text{genus}(X) > 5$ and $\text{genus}(Y) < 2 \text{genus}(X)$. In this talk, we will describe all homomorphisms from the mapping class group of X to the mapping class group of Y .

Oleg Bogopolski (Universität Düsseldorf)

Some new residual property of groups

(Joint work with K-U. Bux and F. Grunewald). The residual finiteness, the conjugacy separability, and the subgroup separability (LERF) are important properties of groups, which help to solve some algorithmic problems in groups and which are important in the theory of 3-manifolds. After a short introduction in these properties I will concentrate on a new residual property which is called subgroup conjugacy separability. A group G is called subgroup conjugacy separable (SCS) if for any two nonconjugate finitely generated subgroups, there exists a finite quotient of G , where the images of these subgroups are non-conjugate. We show that fundamental groups of orientable surfaces are SCS. The interesting point in the proof is the use of a hyperbolic metric for surfaces of genus at least 2.

Maurice Chiodo (University of Melbourne)

Some different types of Universal finitely presented groups

For ρ an algebraic property of groups, we call a finitely presented group G *Univer-*

sally- ρ if both of the following occur:

1. G has property ρ .
2. Every finitely presented group H with property ρ embeds in G .

Using the Higman embedding theorem, it has been shown that there exists a Universally-everything group; a finitely presented group in which every finitely presented group embeds. We will use some straightforward arguments to show that Universally-abelian groups do not exist (nor do Universally-nilpotent or Universally-soluble groups), yet universally-free groups do. Then, by closely analysing the Higman embedding theorem we will show that there exists a Universally-(torsion free) group.

Laura Ciobanu (Université de Fribourg)

On the asymptotics of visible elements and homogeneous equations in surface groups

(Joint work with Yago Antolin and Noelia Viles). Let F be a group whose abelianization is \mathbb{Z}^k , $k \geq 2$. An element of F is called visible if its image in the abelianization is visible, that is, the greatest common divisor of its coordinates is 1.

In this paper we compute three types of densities, annular, even and odd spherical, of visible elements in surface groups. We then use our results to show that the probability of a homogeneous equation in a surface group to have solutions is neither 0 nor 1, as the lengths of the right- and left-hand side of the equation go to infinity.

Sean Cleary (City College of New York)

Commensurations and automorphisms of Thompson's group F

Elements of Thompson's group F can be described by finite rooted tree pair diagrams. There are natural ways of constructing infinite, but eventually periodic, marked tree pair diagrams in an analogous manner. These infinite tree pair diagrams can be used to understand commensurations of F (joint work with Jose Burillo and Claas Roever) and automorphisms of F (joint work with Jose Burillo.) These diagrams give a good tool for understanding the metric structure of the automorphism group of F , where we describe some interesting subgroups of the automorphism group of F and show that the group of inner automorphisms of F is at least quadratically distorted in the

automorphism group of F .

Jordi Delgado (Universitat Politècnica de Catalunya)

Decision problems for free times free abelian groups

(Joint work with Enric Ventura). We study the group $F_n \times \mathbb{Z}^m$ and some decision problems for it. This family is presented as a generalization for which some notions and characteristic of free and free abelian groups consistently extend. For example, we see that it is closed by taking subgroups and supports *free by free-abelian* versions of concepts such as rank or basis. Similarly, we give expressions for the endomorphisms of $F_n \times \mathbb{Z}^m$ in terms of an endomorphism of F_n , another of \mathbb{Z}^m and a mixed term which controls how the abelian and free abelian parts interact. We also characterize the injectivity and exhaustivity of our endos in terms only of the first two; obtaining for the automorphisms and their composition a particularly simple form.

In the algorithmic part, we consider some decision problems over $F_n \times \mathbb{Z}^m$ which, by using the results of the first part, we reduce to the homonymous problems on the free group plus a more or less sophisticated abelian one. Under this pattern we solve over $F_n \times \mathbb{Z}^m$: the membership problem, the isomorphism problem, the finite index problem, the intersection problem, the fixed points problem, the twisted conjugacy problem, and the first Whitehead problem.

Volker Diekert (Universität Stuttgart)

Solving word problems in groups by data compression

(Joint work with Juern Laun and Alexander Ushakov). It is well-known that data compression might be essential to solve word problems in groups efficiently. For example, Schleimer showed that the automorphism group of a free group has a WP in PTIME using straight-line programs. Much higher compression rates can be obtained by power circuits. Power circuits were introduced by Myasnikov, Ushakov and Won and they showed that the WP of the Baumslag group $G_{(1,2)}$ with one defining relation $a^{a^b} = a^2$ is in PTIME. This result has been surprising, since the Dehn function of $G_{(1,2)}$ is non-elementary by a result of Gersten; and $G_{(1,2)}$ was believed to be among the hardest one-relator groups w.r.t. the complexity of the word problem.

Andrew Duncan (Newcastle University)

Rewriting systems and the word, geodesic and conjugacy problems

(Joint work with Volker Diekert and Alexei Miasnikov). I shall introduce and discuss some particular rewriting systems, namely geodesically perfect, that are useful for solving problems in monoids and groups. A particular feature of these systems is that they may be infinite, but nonetheless be useful for solving the word and geodesic problems.

I shall describe how geodesically perfect rewriting of cyclic words instead of linear words gives algorithms for finding shortest elements of conjugacy classes of elements of groups.

There is a close relationship between geodesically perfect systems and pregroups. I'll discuss this correspondence and its implications.

Martin Dunwoody (University of Southampton)

Almost invariant sets

Let G be a group and let H be a subgroup. A subset $S \subset G$ is said to be H -finite if S is contained in finitely many right cosets of H , i.e. for some finite subset F of G , we have $S \subset HF$. A subgroup K of G is H -finite, if and only if $H \cap K$ has finite index in K . Two subsets $R, S \subset G$ are said to be almost H -equal if the symmetric difference $R \cup S - R \cap S$ is H -finite. We write $R =_a S$. A set A is almost H -invariant if $A =_a Ag$ for every $g \in G$. If A is almost H -invariant, then so is $A^* = G - A$. We say that A is proper if neither A nor A^* is H -finite.

Conjecture. Let G be a group and let H be a subgroup. If there is a proper almost H -invariant subset A such that $A = AH$, then G has a non-trivial action on a tree with H -finite edge stabilizers.

For G finitely generated, this is a conjecture of Peter Kropholler. The conjecture is true if H has one element. This was proved by Stallings (1971) if G is finitely generated and by Dicks and Dunwoody (1989) for all groups. The talk will survey

known results and what remains to be proved.

Ariadna Fossas (Université Joseph Fourier)

Thompson's group T is the automorphism group of the asymptotic pants complex of a planar surface of infinite type

We will consider a planar surface Σ of finite type which has the Thompson group T as asymptotic mapping class group. We will construct the asymptotic pants complex C of Σ and prove that the group T acts transitively by automorphisms on it. Finally, we will establish that the automorphism group of the complex C is an extension of the Thompson group T by $\mathbb{Z}/2\mathbb{Z}$.

Elizaveta Frenkel (Moscow State University)

Amalgamated products of groups: generation of normal forms

(Joint work with Remeslennikov V.N. and Miasnikov A.G.). I shall talk about generation of random elements in a free product with amalgamation of free groups of finite ranks $G = A * B_C$. Some natural tasks of algorithmic group theory give us stratification of sets of different normal forms in G . On this way I shall describe some techniques of measuring in a free products of sets and apply these techniques to estimate sizes of strata of normal forms of elements in G .

François Gautero (Université de Nice)

A non-trivial example of a free-by-free group with the Haagerup property

We give a first example of a non-linear semidirect product between two non abelian free groups which satisfies the Haagerup property. This group, known in the literature as the group of Formanek-Procesi, was introduced for proving the non-linearity of the group of automorphisms of the free group with rang greater or equal to three.

Juan González-Meneses (Universidad de Sevilla)

Growth functions of braid monoids and generation of random braids

We explain how one can use the particular properties of the Garside structure of braid (and other Artin-Tits) monoids, to obtain a new simple formula for the growth functions of such monoids. We will also show how similar techniques provide a polynomial algorithm to generate random positive braids of given length.

Andrei-Paul Grecianu (University of Southampton)

Groups acting on hyperbolic spaces

Hyperbolic groups, which act properly and cocompactly on hyperbolic spaces, have been studied extensively and with much success since their introduction. Likewise, interesting results have been obtained about groups acting on trees and tree-like metric spaces, particularly Λ -trees when $\Lambda = \mathbb{Z}^n$ or \mathbb{R} .

A natural generalization would be to look at groups acting on hyperbolic metric spaces or metric spaces with hyperbolic metrics in \mathbb{Z}^n . This talk will present a few results that have been obtained in this direction and some other ideas which seem promising.

Susan Hermiller (University of Nebraska)

Tame filling invariants

(Joint work with Mark Brittenham). Tame filling invariants are refinements of the intrinsic diametric (i.e. isodiametric) and extrinsic diametric functions. I will discuss several examples and applications of these invariants.

Arnaud Hilion (Université Aix-Marseille III)

The index of the dual lamination to an \mathbb{R} -tree

(Joint work with Thierry Coulbois). In the 90's, Gaboriau and Levitt have defined and studied the index of an R -tree (with an action of a free group by isometries). In the case of a tree dual to a measured foliation on a surface, this gives the Euler-Poincaré index of the foliation. One can generalize the Euler-Poincaré index in a "dual" way to that of Gaboriau-Levitt: one obtains the Q -index of the tree. The Q -index and the Gaboriau-Levitt index detect different qualitative properties of the tree. We deduce a classification of iwip automorphisms of a free group refining the classification by Guirardel-Handel-Mosher.

Michael Hull (Vanderbilt University)

Conjugacy growth in finitely generated groups

(Joint work with Denis Osin). In this talk we will consider the conjugacy growth function associated to a finitely generated group G , which counts the number of conjugacy classes which non-trivially intersect the ball of radius n centered at the identity. We will show that given any non-decreasing, at most exponential function f , there exists a finitely generated group G with conjugacy growth equivalent to f . Also, there exists a group G with exponential conjugacy growth, such that G contains a subgroup of finite index with only two conjugacy classes. In particular, conjugacy growth is not a quasi-isometry invariant. The main tool in these constructions will be the theory of small cancellation over relatively hyperbolic groups, and we will discuss the main theorem from this theory and a few of the ideas behind the proof.

Dmitry Kagan (Moscow State University of Railway Engineering)

Pseudocharacters on free groups,

Pseudocharacters is considered in the papers of V.A. Faiziev, R.I. Grigorchuk, V.G. Bardakov, A.I. Shtern. A pseudocharacter is a function f from the group G to the space of real numbers R such that $|\varphi(ab) - \varphi(a) - f(b)| \leq \varepsilon$ for some positive

number ε and such that $\varphi(a^n) = n\varphi(a)$ for any $a \in G$. We investigate methods for constructing nontrivial pseudocharacters on free group F_n , invariant with respect to certain types of endomorphisms. Some conditions for endomorphisms of free group, under which there is a nontrivial pseudocharacter, which is invariant with respect to these endomorphisms are found. We consider free products $R = \tilde{R} * \prod_{i=k}^n \langle r_i \rangle$, where one factor - F_n , and the other - a group on which there is a pseudocharacter. For such products a similar result about the conditions of existence of nontrivial pseudocharacters invariant with respect to certain endomorphisms is obtained.

Ilya Kazachkov (Vanderbilt University)

Group actions on real cubings

(Joint work with Montserrat Casals-Ruiz). We introduce the notion of a real cubing. Roughly speaking, real cubings are to CAT(0) cube complexes what real trees are to simplicial trees. We develop an analogue of the Rips' machine and establish the structure of groups acting nicely on real cubings.

Olga Kharlampovich (McGill University)

Polynomial time approximation schemes for construction geodesics in metabelian groups

(Joint work with A. Mohajeri). It has been proved by A. Miasnikov, Romankov, Ushakov and Vershik that the geodesic length problem is NP-complete in free metabelian groups. We will construct polynomial time approximation schemes for construction geodesics in these groups.

Sang-hyun Kim (KAIST)

Embeddability between right-angled Artin groups

We study the existence of embeddings between two right-angled Artin groups. When

such right-angled Artin groups are two-dimensional, we have a complete combinatorial characterization. Another notable case to be resolved is when the defining graph of at least one right-angled Artin group is a forest. Finally, we give a concrete description of which right-angled Artin groups on cycles are embedded into each other. The key idea is to embed right-angled Artin groups into mapping class groups of closed surfaces and use the properties of pseudo-Anosov homeomorphisms on subsurfaces.

Gilbert Levitt (Université de Caen)

Automorphisms of relatively hyperbolic groups

I will report on work done with Vincent Guirardel and Ashot Minasyan (separately) about the outer automorphism group of a relatively hyperbolic group.

Seymour Lipschutz (Temple University)

Note on a question of Reinhold Baer on pregroups II

(Joint work with Anthony M. Gaglione and Dennis Spellman). Reinhold Baer asked the relationship between certain properties in a nonempty set P with a partial operation, called an add by Baer. The first paper in our sequence answered his question for Stallings' pregroup. This paper answers an analogous question for a wider class of adds.

Martin Lustig (Université Aix-Marseille III)

Invariant laminations for irreducible automorphisms of free groups

(Joint work with Ilya Kapovich). For every atoroidal iwip automorphism ϕ (i.e. the strict analogue of a pseudo-Anosov mapping class) of a free group F_n of finite rank $n \geq 2$ it is shown that the algebraic lamination dual to the forward limit tree $T_+(\phi)$ is obtained as "diagonal closure" of the support of the backward limit current $\mu_-(\phi)$. This diagonal closure is obtained through a finite procedure in analogy to

adding diagonal leaves from the complementary components to the stable lamination of a pseudo-Anosov homeomorphism. We also give several new characterizations as well as a structure theorem for the dual lamination of $T_+(\phi)$, in terms of Bestvina-Feighn-Handel's "stable lamination" associated to ϕ .

Rafal Lutowski (University of Gdansk)

Holonomy groups of flat manifolds with R_∞ property

(Joint work with Andrzej Szczepanski). Let M be a closed Riemannian manifold. We say that M has R_∞ property, if for every homeomorphism $f: M \rightarrow M$, the Reidemeister number $R(f)$ is equal to ∞ . M is flat if, at any point, its sectional curvature is equal to zero.

We investigate a relation between the holonomy representation ρ of a flat manifold M and the R_∞ property. In particular we consider the case, where the holonomy group of M is solvable. We show that, if ρ has – in a given sense unique – \mathbb{R} -irreducible subrepresentation of odd degree, then M has R_∞ property.

The result is related to Conjecture 4.8 from [1].

- [1] K. Dekimpe, B. De Rock, P. Penninckx, *The R_∞ property for infra-nilmanifolds*, Topol. Methods Nonlinear Anal. 34 (2009), no.2, 353–373.

Conchita Martínez-Pérez (Universidad de Zaragoza)

Some finiteness conditions of generalisations of Thompson groups

(Joint work with D. Kochloukova and B. Nucinkis). In this talk, we will review some recent results about the kind of cohomological finiteness properties that certain generalisations of Thompson groups satisfy.

We consider groups of automorphisms of a class of algebras which generalise those constructed by Higman to define the groups F_n . The groups obtained in this construction include the original Thompson groups F, T, V , its generalisations $G_{n,r}$, groups

already considered by Brown-Stein and Brin's groups sV . We prove that for all these groups the existence of finite type models for classifying spaces for proper actions is determined by ordinary cohomological finiteness properties, as being finitely presented and of type FP_∞ . In the particular case of Brin's groups $2V$ and $3V$ we prove that they are of type FP_∞ .

Francesco Matucci (University of Virginia)

Centralizers and dynamics in Thompson's group V

(Joint work with C.Bleak, A.Gordon, G.Graham, J.Jughes, H.Newfield-Plunkett and E.Sapir). We describe the structure of centralizers of elements in Thompson's group V . We use diagrams to uncover the dynamics of elements and then to divide the Cantor set into regions where it acts as the identity, as a permutation of intervals, or as a network between attractors and repellers. This decomposition reveals the structure of centralizers inside the group. We recover some known results along the way and byproducts such as that cyclic groups are undistorted in V .

Alexei Miasnikov (Stevens Institute)

Cayley graph automatic groups

(Joint work with Olga Kharlampovich and Bakh Khousainov). Automatic groups form a large class of groups which are at the same time beautiful and controversial. On the one hand they have nice easily computable normal forms of elements and tame word problem, but on the other hand, most of the other algorithmic problems in the class seem as hard as in the general case. They are defined via automatic structures with an eye on computational aspects, but the structure can be immediately forgotten and replaced by nice geometric conditions. They have very attractive properties: finite presentations, quadratic time decidable word problem, polynomial Dehn functions, etc, but they are also dull - no common structural results, or big unifying theorems. Currently they appear as a beautiful but unfinished piece of modern group theory: they went sufficiently far to lose the identity of hyperbolic groups, but not far enough to incorporate many interesting examples that morally should be there. I will discuss how one can naturally generalize the notion of an automatic group to remedy some of the

shortcomings of the original class. The new class of Cayley automatic groups contains the classical automatic groups, as well as many other interesting groups. For example, it contains some non-finitely presented wreath products of abelian groups, metabelian Baumslag-Solitar groups, Sol-type groups, free nilpotent groups, $UT(n, \mathbb{Z})$, etc. Of course, the generalization comes at a price. . . I will discuss some basics, trends, and perspectives.

Shane O Rourke (Cork Institute of Technology)

Affine actions on non-archimedean trees

Isometric actions on Λ -trees have been studied by many authors including Morgan and Shalen, who first defined them, and more recently, Kharlampovich, Myasnikov, Remeslennikov and Serbin. An important special case is of course the study of real trees, which has proven to be an indispensable tool in geometric group theory. Free actions are of special interest, and finitely generated groups admitting such actions on real trees are described by a celebrated theorem of Rips. I. Lioussé has extended the theory to *affine* actions on real trees: here 'affine' means that the group acts by dilations rather than isometries. She has produced some groups that admit free affine actions on real trees but which do not admit a free isometric action on any real tree. (However Lioussé's groups do admit free isometric actions on Λ -trees for non-archimedean Λ .)

In this talk we will extend these concepts by defining and examining affine actions on Λ -trees, with an emphasis on free actions. We will describe constructions and examples of groups that admit free affine actions which do not admit free isometric actions on any Λ -tree. While the focus will be on the non-archimedean case, some of our results are also new in the real case.

Thuy Pham (Moscow State Pedagogical University)

Abelian RAI-groups and afi-groups

An absolute ideal of an Abelian group G is a subgroup of G , which is an ideal in every ring over G . Absolute ideals are investigated in the work of Fried [1]. An abelian group is called afi-group if every its absolute ideal is a fully-invariant subgroup. An

Abelian group is called *RAI*-group if it admits a ring structure, in which every ideal is absolute. The problem of *RAI*-group description was formulated in [2, problem 93]

In this work, descriptions of *RAI* groups and *afi*-groups in some classes will be introduced.

Theorem 1. *Let T be a torsion group. Then T is a *RAI*-group if and only if its p -components T_p are *RAI*-groups for every prime number p .*

Theorem 2. *Let T be a reduced p -group, $B = \bigoplus_{i \in I} \langle e_i \rangle$ be its p -basic group, $B_n^* = \bigoplus_{o(e_i) \geq p^n} \langle e_i \rangle$. The group T is a *RAI*-group if and only if $|T/B| \leq |B_n^*|$ for any natural number n .*

Theorem 3. *Let $G = A \oplus T$, where A is a torsion free abelian group of rank 1, T is a fully transitive torsion group. The group G is a *RAI*-group if and only if T is a *RAI*-group.*

Theorem 4. *Let $G = A \oplus T$, where A is a torsion free abelian group of rank 1, the type of A is $(t_p)_{p \in P}$, T is a fully transitive torsion group. Then G is an *afi*-group if and only if for every prime number p such that $t_p = \infty$, the first Ulm subgroup of the p -component T_p of T is cyclic.*

[1] Fried E. On the subgroups of Abelian group that are ideals in every ring, Proc. Colloq. Abelian Groups, Budapest, 1964, 51-55.

[2] L. Fuchs, Infinite Abelian groups. Academic Press New York and London, 1973.

Doron Puder (Hebrew University)

Measure preserving words are primitive

We consider two properties of words in F_k , the free group on k generators. A word w is called primitive if it belongs to a basis (i.e. a free generating set) of F_k . It is called measure preserving if for every finite group G , the word map $w : G^k \rightarrow G$ induces uniform distribution on G (given uniform distribution on G^k). It is an easy observation that a primitive word is measure preserving. It is conjectured that the converse is also true. We prove it for F_2 , and in a very recent joint work with O. Parzanchevski,

prove the conjecture in full. As an immediate corollary we prove another conjecture involving \hat{F}_k , the profinite completion of F_k : If $w \in F_k$ belongs to a basis of \hat{F}_k , then it is primitive.

Sarah Rees (University of Newcastle)

Artin groups of large type

(Joint work with Derek Holt). I report on recent work with Derek Holt that describes the geodesics and shortlex geodesics in Artin groups of large type, given in their standard presentations. Both sets of geodesics are proved to be regular, and since the shortlex geodesics satisfy a fellow traveller condition, Artin groups of large type are proved automatic. A non-geodesic word is reduced to a geodesic representative using reductions involving only 2 generator subwords. Hence in particular, parabolic subgroups of Artin groups of large type are seen to be convex.

Vladimir Remeslennikov (Institute of Mathematics SB RAS)

Equational domains and co-domains in universal algebraic geometry

I will talk about equational domain and equational co-domains in algebraic geometry over arbitrary algebraic structures. Formally, equational domain is an algebra over which every finite union of algebraic sets is an algebraic set; equational co-domain is an algebra over which every proper finite union of algebraic sets is not an algebraic set. Also I will talk about description of equational domains and co-domains in groups and rings.

Paul Schupp (University of Illinois at Urbana-Champaign)

Recent results in generic computability

We survey some recent results about generic computability in geometric group theory and in the general theory of computability: some basic results, the Osin-Miasnikov

construction of a finitely generated group whose word problem is not generically computable, the Gilman-Miasnikov-Osin result on amenable groups and generic complexity, the construction of sets whose generic algorithms cannot have computable domain, and Igusa's result that there are no minimal pairs for relative generic computability.

Vladimir Shpilrain (City College of New York)

Learning with errors

Recovering a homomorphism between groups from several (preimage, image) pairs is a well studied problem, at least for some groups. It gets more interesting when images are distorted by "small errors". Recovering a homomorphism gets much harder in this setting, which makes this problem potentially suitable for applications in cryptography. However, there are some auxiliary problems about platform groups, including the geodesic length problem, that one has to address first.

Pedro Silva (Universidade do Porto)

Finite automata for Schreier graphs of virtually free groups

(Joint work with Xaro Soler-Escrivà and Enric Ventura). Finite automata became over the years the standard representation of finitely generated subgroups H of a free group F_A . The *Stallings construction* constitutes a simple and efficient algorithm for building an automaton $S(H)$ which can be used for solving the membership problem of H in F_A and many other applications. This automaton $S(H)$ is nothing more than the *core automaton* of the Schreier graph (automaton) of H in G , whose structure can be described as $S(H)$ with finitely many infinite trees adjoined.

Such an approach invites naturally generalizations for further classes of groups. For instance, an elegant geometric construction of Stallings type automata was achieved for amalgams of finite groups by Markus-Epstein. On the other hand, the most general results were obtained by Kapovich, Weidmann and Miasnikov for finite graphs of groups where each vertex group is either polycyclic-by-finite or word-hyperbolic and locally quasiconvex, and where all edge groups are virtually polycyclic. However, the complex algorithms were designed essentially to solve the generalized word problem, and it seems very hard to extend other features of the free group case, either geometric

or algorithmic.

We present a Stallings type approach with some generality which is robust enough to exhibit several prized algorithmic and geometric features, namely in connection with Schreier graphs. Moreover, we succeed on identifying those groups G for which it can be carried on: (finitely generated) virtually free groups.

Tatiana Smirnova-Nagnibeda (Université de Genève)

Free groups, Schreier graphs and invariant measures

We will review some new notions, problems and results about actions of free groups and associated Schreier graphs.

Bruno Spanu (Università di Cagliari)

SQ-universality of $C(6)$ -groups

(Joint work with M.A.R. Al Janabi, D.J.Collins and M. Edjvet). Let G be a group having a finitely related presentation which satisfies the standard non-metric cancellation condition $C(6)$. Using the “curvature redistribution” definitions on van Kampen diagrams due to Al-Janabi we prove, modulo some well known results in small cancellation theory, that G is SQ-universal except when it is cyclic or infinite dihedral.

Zoran Šunić (Texas A&M University)

Group actions on rooted trees, symbolic dynamics, and Rabin automata

In addition to the group structure, the group of rooted tree automorphisms carries metric structure and self-similarity structure (both “inherited” from the tree). Self-similar and topologically closed groups are the sets of tree automorphisms that are closed in all three structures. In the terminology of symbolic dynamics we may call such sets group shifts.

We characterize the group shifts that can be defined by a finite set of forbidden tree patterns (group shifts of finite type) in terms of the structure of its level stabilizers, describe their continuous images compatible with the shift (sofic group shifts) in terms of Rabin automata, and show that under some natural conditions (level transitivity and self-replication), the sofic group shifts are group shifts of finite type.

Alexey Talambutsa (Steklov Mathematical Institute)

On the minimal exponential growth rate of some groups with periodic relations

Let G be a group that is generated by a finite set S . If $F_{G,S}(n)$ is a growth function of G with respect to the set S , then the limit $\lambda(G, S) = \lim_{n \rightarrow \infty} F_{G,S}(n)^{1/n}$ is called the *exponential growth rate* of G with respect to S . We study the set $\Lambda(G) = \{\lambda(G, S)\}$ where all possible finite generating sets S for the given group G are considered. We prove that the greatest lower bound $\lambda(G) = \inf \Lambda(G)$ is attained for several classes of groups. First two classes have presentation with one periodic relation, precisely orientable Fuchsian groups

$$H_{g,n} = \langle s_1, t_1, \dots, s_g, t_g \mid ([s_1, t_1] \dots [s_g, t_g])^n = 1 \rangle, n \geq 2.$$

and non-orientable Fuchsian groups

$$P_{g,n} = \langle s_1, \dots, s_g \mid (s_1^2 \dots s_g^2)^n = 1 \rangle, n \geq 2.$$

Recently A.Mann has proved that for the group $G_3 = \langle a, b \mid a^2 = 1, b^3 = 1 \rangle$ the infimum $\lambda(G_3)$ is realized as $\lambda(G_3, \{a, b\})$ and is equal to $\sqrt{2}$. Also he has proved that similar result holds for $G_4 = \langle a, b \mid a^2 = 1, b^4 = 1 \rangle$, precisely $\lambda(G_4) = \lambda(G_4, \{a, b\}) = \frac{1+\sqrt{5}}{2}$. We extend these results to groups $G_n = \langle a, b \mid a^2 = b^n = 1 \rangle$, where n is a power of a prime. We prove that $\lambda(G_n) = \lambda(G_n, \{a, b\}) = 1/\alpha_n$ where α_n is a smallest positive root of the polynomial $1 - z - 2z^2 + 2z^{\frac{n+3}{2}}$ (if n is odd) or $1 - z - 2z^2 + z^{\frac{n}{2}+1} + z^{\frac{n}{2}+2}$ (if n is even).

We also study the connection between growth rates of group G and its central extension \tilde{G} . For finitely presented group G that has subexponential Dehn function we prove the equality $\lambda(\tilde{G}) = \lambda(G)$. It follows that $\lambda(G)$ can be realized in the group G if and only if $\lambda(\tilde{G})$ can be realized in the group \tilde{G} . Using this fact we extend our results on groups $H_{g,n}, P_{g,n}, G_n$ to their central extensions.

Alina Vdovina (Newcastle University)

New examples of expanders

(Joint work with Norbert Peyerimhoff (Durham University)). We give new examples of expanders of smallest possible degree of vertices, increasing girth and exponent two growth of the number of vertices

Enric Ventura (Universitat Politècnica de Catalunya)

On the difficulty of inverting automorphisms of free groups

(Joint work with P. Silva and M. Ladra). Let G be a group and X a finite set of generators. In this talk, we will introduce a function $f(n)$ whose asymptotic behavior measures how difficult it is to invert automorphisms of G . More precisely, $f(n)$ is the maximum norm of the inverses of all those automorphisms of G whose norm is less than or equal to n .

After analyzing some general properties of this function, we will restrict our attention to the free case. For all such groups we will show that $f(n)$ is polynomial. More specifically, it will be proven that, in rank r , $f(n)$ is bounded below by a polynomial of degree r ; and above by a quadratic polynomial in the special case of rank 2. We obtain these results essentially by abelianizing and playing with matrices and eigenvalues, and by arguing directly in the free group in the very special case of rank 2.

General upper bounds for $f(n)$ are more complicated to obtain: the main result in the talk is an upper bound in arbitrary rank, by a polynomial of big enough degree $M(r)$, depending only on the ambient rank r . The main ingredient in the proof of this last inequality is a recent result by AlgomKfir-Bestvina, about the asymmetry of the metric in the outer space.

Gerald Williams (University of Essex)

Finiteness and small cancellation conditions for a class of Fibonacci-type groups

This talk concerns a class of generalised Fibonacci groups introduced by Campbell and Robertson. I will discuss how relative asphericity can be used to prove that many groups within this class are infinite and show how, when combined with Adian graph techniques, this allows the finite semigroups (defined by these presentations) to be classified in terms of the finite groups. The so-called Cavicchioli-Hegenbarth-Repovš groups form a subclass of these groups. I will discuss small cancellation properties for these and note consequences such as SQ-universality, the existence of free subgroups, hyperbolicity, automaticity, and solvability of decision problems.

Alexander Zakharov (Moscow State University)

Intersecting free subgroups in free amalgamated products of groups

We partly generalize the estimate for the rank of intersection of subgroups in free products of groups, proved earlier by S.V.Ivanov, to the case of free amalgamated products of groups with normal finite amalgamated subgroup. We prove the following:

Suppose $G = G_1 *_T G_2$ is an amalgamated free product, T is normal (in G) finite, and subgroups H_1, H_2 of G intersect trivially with the conjugates to the factors and have finite ranks. Then the intersection $H_1 \cap H_2$ also has finite rank, and

$$\bar{r}(H_1 \cap H_2) \leq 2 \frac{q_f^*}{q_f^* - 2} |T| \cdot \bar{r}(H_1) \bar{r}(H_2) \leq 6 |T| \cdot \bar{r}(H_1) \bar{r}(H_2), \quad (1)$$

where $\bar{r}(H) = r(H) - 1$, q_f^* is the minimum of orders > 2 of subgroups of groups $G_1/T, G_2/T$, and $\frac{q_f^*}{q_f^* - 2} = 1$ if $q_f^* = \infty$, $|T|$ is the order of group T . In addition, the first estimate in (1) is sharp and cannot be further improved whenever G_1/T or G_2/T contains an involution and $G_1/T * G_2/T \not\cong \mathbb{Z}_2 * \mathbb{Z}_2$.

In the proof we use graph-theoretic approach for subgroups of free products of groups.

Amaia Zugadi-Reizabal (Euskal Herriko Unibertsitatea)

Grigorchuk-Gupta-Sidki groups: some new results

(Joint work with Gustavo A. Fernández Alcober and Olivier Siegenthaler). GGS-groups are a natural generalization of the Gupta-Sidki group and the second Grigorchuk group. In this talk, we approach these groups from the following two points of view. We show how the group order grows when taking images under the level stabilizers; as a consequence we compute Hausdorff dimension. And from a completely different line of attack, we obtain that some GGS-groups admit an abelian p -group structure, amongst them the Gupta-Sidki group.

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