# BOOK OF ABSTRACTS

## SS26 - Group Theory and Applications

## 2nd Joint Meeting Brazil-Italy in Mathematics

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Messina, Italy

## Organizers:


Carmine Monetta, University of Salerno
Raimundo de Araújo Bastos Júnior, University of Brasilia

**SS26**

# On profinite groups with restricted centralizers of $n$th powers

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A group $G$ is said to have restricted centralizers if for every $x \in G$ the centralizer $C_G(x)$ either is finite or has finite index in $G$. Conditions on centralizers often impose strong structural constraints on profinite groups. A notable example is a theorem of Shalev asserting that profinite groups with restricted centralizers are virtually abelian.

In this talk, I will discuss the following recent result obtained jointly with Pavel Shumyatsky.

**Theorem 1.** *Let $n$ be a positive integer and $G$ a profinite group in which the centralizer of $x^n$ is either finite or open for every $x \in G$. Then $G$ has an open normal subgroup $T$ such that $G/Z(T)$ has finite exponent.*

I will also explain how this problem fits into a broader framework involving probabilistic group theory.

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# On the commuting conjugacy class graph

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The association of graphs to finite groups goes back to the 19th century with the introduction of the Cayley graph. Later, several graphs defined by certain group properties emerged. In other words, in these graphs the vertex set is usually a subset of the group, and distinct elements are adjacent if they generate a subgroup satisfying a prescribed property. A well-known example is the commuting graph, where the vertices are the non-central elements of the group, and two elements are connected by an edge if they commute. The general idea behind this area of research is to deduce algebraic information about a group by analyzing the combinatorial features of these associated graphs. In this talk, we focus on a variant of the commuting graph involving conjugacy classes. More precisely, if $G$ is a finite group, we denote by $\Gamma(G)$ the commuting conjugacy class graph of $G$, whose vertices are the conjugacy classes of non-central elements of $G$, and two distinct vertices are connected by an edge if there are commuting elements within those classes. The aim of this presentation is to discuss new results concerning the $k$-regularity and the connectivity of $\Gamma(G)$.

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# Self-similarity of permutational wreath product

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We study the self-similarity of permutational wreath products of the form $A \wr_X G$, where $A$ is a finitely generated abelian group and $G$ is a self-similar group acting on the set $X$. We give necessary and sufficient conditions for $A \wr_X G$ to admit a faithful self-similar action and describe constructions and examples illustrating these criteria. Joint work with Mailton Rego Almeida.

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# On monomiality and prime graphs of finite groups with the Magnus property

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A group $G$ is said to have the Magnus Property (MP) if whenever two elements of $G$ generate the same normal subgroup then these elements are conjugate or inverse-conjugate in $G$. In this talk we strengthen the observation that a finite MP group is solvable and show that such a group must be (subnormally) monomial, where a finite group is said to be (subnormally) monomial if every complex irreducible character of $G$ is induced from a linear character of a (subnormal) subgroup of $G$. We also classify the prime graphs arising from the set of finite MP groups, where, given a finite group $G$, the prime graph of $G$ has as set of vertices the set of primes dividing $|G|$ and two distinct vertices $p$, $q$ are joined by a simple edge if and only if $G$ has an element of order $pq$. This is joint work with Martino Garonzi of the Università degli Studi di Ferrara.

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# Finiteness properties of subgroups of fixed points

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We use Sigma-invariants to study homotopical and homological finiteness properties of fixed subgroups of automorphisms of a group $G$ in terms of its center $Z(G)$ and the induced automorphisms on its associated quotient $G/Z(G)$. Specializing to the case where the center is a direct factor of the group, we answer a question made by Lei, Ma and Zhang.

## References

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[1]Supported by FAPEMIG grant APQ- 02750-24
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# Commuting probability of Sylow subgroups in finite and profinite groups

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Given two subgroups $H$ and $K$ of a finite group $G$, the commuting probability $\Pr(H, K)$ measures the probability that a randomly chosen element of $H$ commutes with a randomly chosen element of $K$. In this talk, we focus on commuting probabilities involving Sylow subgroups and discuss how lower bounds on these probabilities impose restrictions on the structure of the ambient group. In particular, we consider the case of a $p$-subgroup $P$ satisfying $\Pr(P, P^x) \geq \varepsilon > 0$ for every conjugate $P^x$, and investigate whether the order of $P/O_p(G)$ can be bounded in terms of $\varepsilon$. We show that such a bound does not exist in general, but that it does hold when $P$ is a Sylow $p$-subgroup. We will also discuss related results in the setting of profinite groups.

## References

[1] E. Detomi, R. M. Guralnick, M. Morigi, P. Shumyatsky, *Commuting probability for conjugate subgroups of a finite group*, arXiv:2505.10521.

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# On twisted conjugacy in finite groups

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Let $G$ be a group and $\varphi$ be an automorphism of $G$. Elements $x, y \in G$ are said to be $\varphi$-conjugate if there exists $z \in G$ such as $y = z^{-1}xz^{\varphi}$. The relation defined in this way is an equivalence relation on $G$. In particular, if $\varphi = id_G$, then the relation considered is the usual conjugacy.

For each $g \in G$, one can consider the subgroup $R_\varphi(g) := \{x \in G | x^\varphi = x^g\}$. The index of this subgroup coincides with the cardinality of the $\varphi$-conjugacy class $[g]_\varphi$ of the element. In particular, the class of the identity element 1 has a cardinality equal to the index of the centralizer $C_G(\varphi) = R_\varphi(1)$ of the automorphism.

The cardinality of the set of $\varphi$-conjugacy classes is called the Reidemeister number of the considered automorphism, denoted by $R(\varphi)$, and the set of Reidemeister numbers of the automorphisms of G is called the spectrum of the group. If $\varphi = id_G$, then the class of 1 is its singleton, and the Reidemeister number is the number of conjugacy classes.

If G is a finite group, then the number of conjugacy classes and the set of the sizes of these classes have a great influence on the structure of the group. A broad and interesting line of research has studied, and continues to study, the possibility of classifying finite groups with a given number of conjugacy classes, as well as finite groups where the conjugacy classes have fixed sizes. One can therefore think of studying analogous problems by considering $\varphi$-conjugacy classes relative to automorphisms other than the identity.

## References

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[3] V. Bagnara, C. Nicotera, *On the Reidemeister spectrum of some finite groups*, to appear

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# Verbal subgroups of groups acting on regular rooted trees

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Groups of automorphisms of regular rooted trees form one of the richest sources of examples in modern group theory. Since Grigorchuk's construction in 1980 of an infinite, finitely generated periodic group, they have been used to settle long-standing problems, providing a negative answer to the General Burnside Problem and the first examples of groups of intermediate growth and of amenable but not elementary amenable groups.

The group of all automorphisms of the $d$-adic tree is a profinite group, and a natural way to describe its structure, as well as that of its most studied subgroups, is to describe their characteristic, fully invariant, and verbal subgroups.

Verbal subgroups are groups generated by all values of a given word, and every verbal subgroup is fully invariant, while the converse is not true in general. Smetaniuk and Sushchansky showed that every verbal subgroup of the finitary automorphism group of the binary tree is a term of the lower central series, and Muntyan described the verbal subgroups in the case of the $d$-adic tree with $d > 2$ and odd. For some distinguished subgroups, such as the Grigorchuk-Gupta-Sidki groups, attention has instead turned to the lower central series and derived series.

In this talk, we present the state of the art and new results regarding verbal subgroups in the full group of automorphisms of regular rooted trees and some of its subgroups.

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# Conjugacy in Group of Piecewise Projective Homeomorphisms

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In [4], N. Monod introduced a family $\{H(A) \mid A \subseteq \mathbb{R} \text{ is a subring}\}$ of groups consisting of piecewise projective, orientation-preserving homeomorphisms of the extended real line $\mathbb{R} \cup \{\infty\}$ that stabilize infinity. This construction provided new counterexamples to the von Neumann-Day conjecture.

Alternatively, a group $H(A)$ can be viewed as acting on $\mathbb{R}$ itself, where an element $f \in H(A)$ is characterized by finitely many breakpoints $t_1, t_2, \ldots, t_n \in \mathbb{R}$, which are fixed points of hyperbolic elements from $\mathrm{PSL}_2(A)$, such that on each interval $[t_i, t_{i+1}]$, $f$ acts as a Möbius transformation

$$f(t) = \frac{a_i t + b_i}{c_i t + d_i}, \quad a_i d_i - b_i c_i = 1,$$

for suitable coefficients $a_i, b_i, c_i, d_i \in A$. On the unbounded intervals $(-\infty, t_1]$ and $[t_n, +\infty)$, $f$ acts as the linear transformations

$$f(t) = a_0^2 t + a_0 b_0 \quad \text{and} \quad f(t) = a_n^2 t + a_n b_n,$$

respectively, where $a_0, a_n, b_0, b_n \in A$.

In this talk, we will discuss the results from [3] concerning the study of conjugacy and centralizers in Monod's group $H := H(\mathbb{R})$. These results adapt techniques developed in [1, 2].

## References

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[1] Aknowledgements to Fundação Araucária do Paraná for the finantial support.
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# The Learning With Errors Problem over Groups

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Since its introduction, the Learning With Errors (LWE) problem has become one of the standard hardness assumptions in post-quantum cryptography, due to its connection to certain lattice problems which are believed to remain hard even for quantum computers. It was later extended to various algebraic structures, leading to several variants of the original formulation.

In this talk, we focus on group-theoretic generalizations of LWE and discuss their applications in cryptography.

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# On the Equational Noetherianity of Wreath Products

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Let $G$ be a group, and let $F_k$ be the free group on $k$ free generators. An *equation* with constants in $G$ is an element $s$ of the free product $G * F_k$. We say that $G$ is *equationally Noetherian* if, for every non-negative integer $k$, any set of equations admits a finite subset with the same set of solutions. In some sense, this allows one to do algebraic geometry with groups.

The aim of this talk is to introduce the audience to a recent joint work with Iker de las Heras and J. Moritz Petschick in which we have partially answered a question of Plotkin about equational Noetherianity of wreath products, and completely answered the analogous question for unrestricted wreath products.

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