

Conference on Group Theory and Related Topics

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School of Mathematical Sciences
National Institute of Science Education and Research Bhubaneswar
(An Autonomous Institute under Department of Atomic Energy, Government of India)

Organizers: Binod Kumar Sahoo, Kamal Lochan Patra, Sumana Hatui, Tushar Kanta Naik

Invited Talks

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Title and Abstract

1. Word maps on groups and algebras

Speaker: Anupam Kumar Singh, IISER Pune

Abstract: Given a word w in d variables it gives rise to a map on a group G , called word maps defined by evaluation. The main question is to understand what is the fibre and image of such maps. Such questions are motivated by the Waring problem in number theory and Ore's conjecture in group theory. In the last couple of decades, there has been tremendous progress in this area. In a similar spirit to a polynomial in d non-commuting variables, one defines a map on a central simple algebra A and again one wants to understand the nature of the image, like Kaplansky-L'ovo conjecture. In this expository talk, we will see some of the results proved in this direction and the kind of questions being studied.

2. A new combinatorial formula for the modified Macdonald polynomials

Speaker: Arvind Ayyer, IISc Bangalore

Abstract: Macdonald polynomials are a remarkable family of symmetric functions that are known to have connections to combinatorics, algebraic geometry and representation theory. The modified Macdonald polynomials are obtained from the Macdonald polynomials using an operation called plethysm. A combinatorial formula for the latter was given by Haglund, Haiman and Loehr in a celebrated work (JAMS, 2004). We will give a new combinatorial formula (arXiv:2011.06117).

Recently, a formula for the symmetric Macdonald polynomials was given by Corteel, Mandelshtam and Williams in terms of objects called multiline queues, which also compute

probabilities of a statistical mechanics model called the multispecies ASEP on a ring. It is natural to ask whether the modified Macdonald polynomials can be obtained using a combinatorial gadget for some other statistical mechanics model. We answer this question in the affirmative via a multispecies totally asymmetric zero-range process (TAZRP) in (arXiv:2209.09859).

These are joint works with J. Martin and O. Mandelshtam.

3. Elementwise containment among representations of a group

Speaker: Dipendra Prasad, IIT Bombay

Abstract: For two representations V and W of a group G , we define a weaker notion of containment of W inside V , denoted $W \prec V$, which we call W immersed in V , if for every element $g \in G$, the eigenvalues of the action of g on W (counted with multiplicity) is contained in the eigenvalues of g (counted with multiplicity) acting on V . We discuss this notion with some examples.

4. Revisiting Brauer Witt Theorem

Speaker: Gurmeet Kaur Bakshi, Panjab University

Abstract: A classical theorem due to Brauer and Witt implies that every simple component of the rational group algebra $\mathbb{Q}G$ of a finite group G is Brauer equivalent to a cyclotomic algebra containing \mathbb{Q} in its centre. The precise description of this cyclotomic algebra is not available from the proof of the Brauer-Witt theorem and it has been a problem of interest to determine the same in view of its central role in the study of central simple algebras. In this talk, a new approach using Shoda pair theory will be discussed, which is quite efficient from computational perspective.

5. On Kronecker Hecke Algebras

Speaker: K. N. Raghavan, IIMSc Chennai

Abstract: For which finite groups are all tensor products of irreducible representations multiplicity-free? The talk will present some recent joint work with Jyotirmoy Ganguly, Amritanshu Prasad, and Digjoy Paul surrounding the above question.

6. General primitivity in the mapping class group

Speaker: Kashyap Rajeevsarathy, IISER Bhopal

Abstract: For $g \geq 2$, let $\text{Mod}(S_g)$ be the mapping class group of the closed orientable surface S_g of genus g . A nontrivial $G \in \text{Mod}(S_g)$ is said to be a *root of an* $F \in \text{Mod}(S_g)$ *of degree* n if there exists an integer $n > 1$ such that $G^n = F$. If F does not have any roots, then it is said to be *primitive*. A natural question is whether one can determine if an arbitrary $F \in \text{Mod}(S_g)$ is primitive and compute the roots of F (up to conjugacy) when it is not primitive. We call this the *general primitivity problem* in $\text{Mod}(S_g)$. To begin with, we provide a solution to this problem for some special elements in $\text{Mod}(S_g)$ called *pseudo-periodic* mapping classes which play a critical role in this context. Using this solution, we will formulate an efficient algorithm for solving the general primitivity

problem in $\text{Mod}(S_g)$. Furthermore, we will provide realizable bounds on the degrees of pseudo-periodic mapping classes. We will conclude the talk by discussing the normal closures of pseudo-periodic mapping classes.

7. Solutions of YBE and related algebraic structures

Speaker: Manoj K. Yadav, HRI Prayagraj

Abstract: After a quick introduction of set theoretic solutions of the Yang-Baxter equation, we have a plan to explain its connection with braces and skew braces. Certain aspects of solutions ((in)decomposable, multi-permutation etc.) will be discussed.

8. Ovoids in $PG(3, q)$ and algebraic codes

Speaker: N. S. N. Sastry, ISI Bangalore (Retired)

Abstract: An ovoid in $PG(3, K)$, K a skew field, is an Incidence-Geometric analogue of a sphere in the Euclidean 3-space. Apart from the elliptic quadrics (that is, nondegenerate quadrics in $PG(3, K)$ containing no lines, which exist for all fields K), the only other finite ovoids known, and projectively nonequivalent to elliptic ovoids, are the Tits ovoids which exist only in $PG(3, 2^t)$, for all $t > 4$ and odd. Its stabilizer in $PGL(4, 2^t)$ was discovered by Michio Suzuki (1962) as the final step in the (mammoth!) classification of finite 2-transitive groups with no nontrivial element fixing more than two symbols (that is, the so called Zassenhaus groups); and the ovoid itself was discovered by Jacques Tits (1962) as the set of absolute points of a polarity of the generalized 4-gon $W(2^t)$, the spherical building for the simple group $PSp(4, 2^t)$. These ovoids are also finite Moufang sets (that is, rank 1-spherical buildings as interpreted by Tits).

In this talk, I outline a few important facts about these ovoids and their stabilizers; describe their connections with inversive planes, Tits (q, q^2) -generalized 4-gon and translation planes. I also try to indicate the role of algebraic codes in these matters.

9. Cohomology of uniform lattices in real semi simple Lie groups

Speaker: Parameswaran Sankaran, CMI, Chennai

Abstract: Let G be a real semi simple linear Lie group with finitely many components and let K be a maximal compact subgroup. Let L be a torsion-free lattice in G . The cohomology of the the double coset space $X_L = L \backslash G / K$, which is an Eilenberg-MacLane space $K(L, 1)$, is an important object of investigation. We shall outline a construction of Millson and Raghunathan (around 1987) which leads to submanifolds of complementary dimensions, called, geometric cycles. Under certain additional hypotheses, the geometric cycle represent non-zero real cohomology classes which cannot be represented by G -invariant forms. We shall highlight some recent developments in the study of geometric cycles in X_L .

10. Representations of general linear groups over local rings

Speaker: Pooja Singla, IIT Kanpur

Abstract: Let F be a non-Archimedean local field with the ring of integers \mathcal{O} and a finite residue field k of an odd characteristic. In contrast to the well-understood representation theory of the finite groups of Lie type $GL_n(k)$ or of the locally compact groups $GL_n(F)$, representations of groups $GL_n(\mathcal{O})$ are considerably less understood. This talk will cover the available tools and the difficulties we encountered in describing the complex representations of $GL_n(\mathcal{O})$. We will also mention some recent results and open problems in this direction.

11. **Bogomolov multiplier of finite groups and Lie algebras**

Speaker: Pradeep Kumar Rai, Mahindra University

Abstract: The Bogomolov multiplier of a finite group G is a cohomological invariant of G that has been studied in connection with the Noether's problem on rationality of function fields. In the first half of the talk we shall survey some results in connection with the object. In the next half of the talk we shall discuss about the extension of this notion to Lie algebras.

12. **Various graphs defined on finite groups**

Speaker: Rajat Kanti Nath, Tezpur University

Abstract: Over the last 50 years mathematicians have defined many graphs on finite groups. In this talk we shall discuss about the graphs arising from commutativity. In particular, we shall discuss various results on commuting graph, nilpotent graph, solvable graph of finite groups and their complements and various generalizations. We shall also consider commuting/ nilpotent/ solvable conjugacy class graphs of groups and finally we shall consider super graphs on finite groups, a notion introduced together with G. Arunkumar, P. J. Cameron and L. Selvaganesh in the year 2022. Among other results we shall discuss connections of these graphs with commuting probability of a finite group and its generalizations.

13. **G.I.T. quotient for the action of finite groups and torus**

Speaker: Santosha Kumar Pattanayak, IIT Kanpur

Abstract: Geometric invariant theory (or GIT) is a method for constructing quotients by group actions in algebraic geometry, which in many cases appear as moduli spaces parametrizing isomorphism classes of geometric objects such as vector bundles, polarized varieties, etc.. After giving a short introduction to GIT, I will discuss some geometric properties of the quotient for the action of a finite group or a torus.

14. **Twisted conjugacy for Chevalley groups over certain integral domains**

Speaker: Shripad M. Garge, IIT Bombay

Abstract: We will explain the notion of twisted conjugacy in the talk and discuss results on twisted conjugacy for Chevalley groups over certain integral domains.

15. **The lower and the upper central series of unit group of an integral group ring**

Speaker: Sugandha Maheshwary, IIT Roorkee

Abstract: In this talk, I will give an overview of the results associated to the upper as well as the lower central series of unit group of an integral group ring $\mathbb{Z}G$, where G is a finite group. I shall discuss about some recent developments in this direction and mention about some relevant questions.

16. **Quasi-permutation representation of finite groups**

Speaker: Sunil Kumar Prajapati, IIT Bhubaneswar

Abstract: For a finite group G , we denote by $\mu(G)$, and $c(G)$, the minimal degree of faithful permutation representation of G , and the minimal degree of faithful representation of G by quasi-permutation matrices over the complex field \mathbb{C} , respectively. We study $\mu(G)$ and $c(G)$ for various classes of p -groups. For VZ p -groups and Camina p -groups, we prove that the minimal degrees heavily depend on the minimal degrees of the center. We obtain bounds of minimal degrees for various classes of non-abelian p -groups.

17. **Baer like theorems for Profinite groups**

Speaker: Viji Z. Thomas, IISER Thiruvananthapuram

Abstract: A classical theorem of Baer states that if $G/Z_n(G)$ is finite, then $\gamma_{(n+1)}(G)$ is finite. We generalize this result to Profinite groups and consider different series other than $Z_n(G)$ and $\gamma_{(n+1)}(G)$.

18. **Orthomorphism Graphs of Groups**

Speaker: Vivek Kumar Jain, Central University of Bihar

Abstract: Let G be a group. A bijection $\theta : G \rightarrow G$ is called an orthomorphism of G if the map $\phi_\theta : x \mapsto x^{-1}\theta(x)$ is also a bijection on G . Orthomorphism which fixes the identity element of the group is called normalized orthomorphism. Two orthomorphism θ_1 and θ_2 are called orthogonal if $\theta_1\theta_2^{-1}$ is also an orthomorphism of G . A graph in which vertices are normalized orthomorphisms of G and adjacency being synonymous with orthogonality is called orthomorphism graph of G denoted as $Orth(G)$. In this talk we will discuss the results and problems related to the orthomorphism graph of finite groups.

Contributed Talks

List of speakers

1. Amit Kumar, IIIT Allahabad
2. Apeksha Sanghi, IISER Mohali
3. Archita Gupta, IIT Kanpur
4. Dibyendu Biswas, IIT Bombay
5. Digjoy Paul, IISc Bangalore
6. Gurleen Kaur, IISER Mohali
7. Harish Kishnani, IISER Mohali
8. Himanshi Khurana, IISER Bhopal
9. Himanshu Setia, IIT Ropar
10. Hiranya Kishore Dey, IISc Bangalore
11. Manideepa Saha, Presidency University
12. Neeraj Kumar Dhanwani, IISER Mohali
13. Nishant, HRI Prayagraj
14. Oorna Mitra, CMI, Chennai
15. Pallabi Manna, NIT Rourkela
16. Pankaj Kapdi, IISER Bhopal
17. Pravin Kumar, IISER Mohali
18. Rahul Kaushik, IISER Pune
19. Renu Joshi, IISER Bhopal
20. Rijubrata Kundu, IISER Mohali
21. Sandeep Dalal, NISER Bhubaneswar
22. Sanjay Mukherjee, NISER Bhubaneswar
23. Sucharita Biswas, Presidency University
24. Sumit Chandra Mishra, IISER Mohali
25. Tejbir, IISER Mohali

Title and Abstract

1. The Schur multiplier of finite multiplicative Lie algebra

Speaker: Amit Kumar, IIIT Allahabad

Abstract: In 2018, R.Lal and S.K.Upadhyay developed the theory of extensions of multiplicative Lie algebras and introduced the Schur multiplier of multiplicative Lie algebras as second cohomology. Since the Schur multipliers of the groups have proved to be a powerful tool in other areas, such as algebraic number theory, block theory of group algebras, and classification of finite simple groups, to mention only a few. In my talk I will present the Schur multipliers of some finite multiplicative Lie algebras with respect to arbitrary multiplicative Lie algebra structure.

2. Metacyclic actions on surfaces

Speaker: Apeksha Sanghi, IISER Mohali

Abstract: Let $\text{Mod}(S_g)$ denote the mapping class group of closed orientable surface S_g of genus $g \geq 2$. In this talk, we will discuss the necessary and sufficient conditions under which two torsion elements in $\text{Mod}(S_g)$ will have conjugates that generate a finite metacyclic subgroup of $\text{Mod}(S_g)$. As an application, we will analyze the liftability of certain periodic mapping class under some finite-sheeted regular cyclic covers of S_g . Furthermore,

we will see that $4g$ is an upper bound on the order of a non-split metacyclic action on S_g . Moreover, we give a complete characterization of the dihedral subgroups of $\text{Mod}(S_g)$ up to a certain equivalence. We conclude the talk by describing nontrivial geometric realizations of some metacyclic actions.

3. Tensor Products of the regular Representations of $\text{GL}_2(\mathfrak{o}_r)$

Speaker: Archita Gupta, IIT Kanpur

Abstract: Let \mathfrak{o} be the ring of integers in a non-Archimedean local field with finite residue field, \mathfrak{p} its maximal ideal, and $r \geq 2$ an integer. A particular class of representations, called the regular representations of the group $\text{GL}_N(\mathfrak{o}_r)$, $N \geq 2$ have been constructed by Alexander Stansinski and Shaun Stevens (2017) and Roi Krakovski, Uri Onn and Pooja Singla (2018). In this talk, we will discuss the decomposition of tensor products of regular representations into irreducible constituents of $\text{GL}_2(\mathfrak{o}_r)$. We will also see some results about multiplicities of regular representations in these tensor products.

4. Stability of Tensor Product of Representations of Classical Groups

Speaker: Dibyendu Biswas, IIT Bombay

Abstract: We will define the notion of stability of tensor product. We will mainly discuss the stability phenomenon for the general linear groups and if time permits, for other classical groups. From an irreducible representation of $\text{GL}(n, \mathbb{C})$ there is a natural way to construct irreducible representations of $\text{GL}(n+1, \mathbb{C})$ by adding a zero at the end of the highest weight $\underline{\lambda} = (\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_n)$ with $\lambda_i \geq 0$ of the irreducible representation of $\text{GL}(n, \mathbb{C})$. We consider the decomposition of tensor products of an irreducible representation of $\text{GL}(n, \mathbb{C})$ and of the corresponding irreducible representations of $\text{GL}(n+1, \mathbb{C})$ and proves a stability result about such tensor products. We will review Pieri's rule for general linear groups in details and similar results for other classical groups. If time permits, I will also discuss about the results of what happens before the stability of tensor products.

5. On Restriction Problem

Speaker: Digjoy Paul, IISc Bangalore

Abstract: Given an irreducible polynomial representation $W_\lambda(\mathbb{C}^n)$ of the general linear group $\text{GL}_n(\mathbb{C})$, we can restrict it to the symmetric group S_n that sits inside $\text{GL}_n(\mathbb{C})$ as a subgroup. The *restriction coefficient* $r_{\lambda\mu}$ is the multiplicity of the irreducible representation V_μ of S_n in the restriction of $W_\lambda(\mathbb{C}^n)$. To find combinatorial interpretations of the restriction coefficients is a long stand open problem in algebraic combinatorics. We briefly survey how we interpret the restriction coefficient as a *moment* of certain *character polynomials*. Character polynomials have been used to study characters of families of representations of symmetric groups by Macdonald, Garsia, and Goupil and in the context of FI-modules by Church, Ellenberg, and Farb. Finally, we present a combinatorial interpretation of $r_{\lambda\mu}$ when μ is a row/column partition, and λ is a hook/two-column partition. This talk is based on joint works with Narayanan, Prasad, and Srivastava.

6. On the embedding of finite solvable groups

Speaker: Gurleen Kaur, IISER Mohali

Abstract: A fundamental problem in group algebras is to explicitly determine the algebraic structure of rational group algebras, i.e., the Wedderburn decomposition and complete set of primitive central idempotents. A new direction to this investigation was provided by Olivieri, del Río and Simón, in 2004, when they introduced the notion of Shoda pairs and strongly monomial groups. In a joint work with Bakshi, we introduced the class of generalized strongly monomial groups which is a generalization of strongly monomial groups and provided an explicit description of the complete algebraic structure of rational group algebra for such groups. In this talk, we will see the vastness of the class of generalized strongly monomial groups. Recently, it has been proved that every finite solvable group can be (isomorphically) embedded in some generalized strongly monomial group with the same derived length (fitting length, supersolvable length).

7. Word maps in finite simple groups and in finite nilpotent groups

Speaker: Harish Kishnani, IISER Mohali

Abstract: Let F_d denote the free group on d letters and $0 \neq w \in F_d$ be a word. For a group G , let G^d denote the group of d -tuples in G . A *word map* $\tilde{w} : G^d \rightarrow G$ is the evaluation map of w on these d -tuples. The image of \tilde{w} is denoted by $w(G)$.

In this talk, I will first discuss some already known results on word maps and some open problems. My focus will be the work of Lubotzky, where he proves that for a finite simple group G , if A is an automorphism invariant subset containing the identity element then there exists $w \in F_2$ such that $A = w(G)$.

Then, I will present a work done in collaboration with Dr. Amit Kulshrestha and Dr. Dilpreet Kaur in where we have proved that for any nilpotent group G except the abelian groups of prime exponent, there exists a subset $A \subseteq G$ with the following properties

- (a). $1 \in A$.
- (b). A is $\text{Aut}(G)$ -invariant.
- (c). $A \neq w(G)$ for every word w .

Further, we classify all such subsets for the class of extraspecial p -groups. In the same article, we have introduced the concept of *d-exhaustive set* for word images and gave a 2-exhaustive set for nilpotent groups of class-2 which turns out to be a minimal exhaustive set for an infinite family of special- p groups.

8. A certain Twisted Jacquet module of $\text{GL}(4)$ over a finite field

Speaker: Himanshi Khurana, IISER Bhopal

Abstract: In the first part of the talk, we will briefly discuss the work of Prasad on the twisted Jacquet module to motivate our problem. In the second part of the talk, we will understand the structure of the twisted Jacquet module $\pi_{N,\psi}$ of an irreducible cuspidal representation π of $G = \text{GL}(4, F)$, where F is a finite field.

9. The normal complement problem in group algebras of symmetric groups

Speaker: Himanshu Setia, IIT Ropar

Abstract: Let S_n be the symmetric group and A_n be the alternating group on n symbols. In this talk, we have proved that if F is a finite field of characteristic $p > n$, then there does not exist a normal complement of S_n (n is even) and A_n ($n \geq 4$) in their corresponding unit groups $\mathcal{U}(FS_n)$ and $\mathcal{U}(FA_n)$. Moreover, if F is a finite field of characteristic 3, then A_4 does not have normal complement in the unit group $\mathcal{U}(FA_4)$. This is a joint work with Dr. Manju Khan.

10. On sum of powers of element orders in finite groups

Speaker: Hiranya Kishore Dey, IISc Bangalore

Abstract: For a finite group G , let $\psi(G)$ denote the sum of element orders of G . This function was introduced by H. Amiri, S. M. Jafarian Amiri, and I. M. Isaacs in 2009 and they proved that for any finite group G of order n , $\psi(G)$ is maximum if and only if $G \simeq \mathbb{Z}_n$ where \mathbb{Z}_n denotes the cyclic group of order n . Furthermore, M. Herzog, P. Longobardi, and M. Maj in 2018 proved that if G is non-cyclic, $\psi(G) \leq \frac{7}{11}\psi(\mathbb{Z}_n)$. S. M. Jafarian Amiri and M. Amiri in 2014 introduced the function $\psi_k(G)$ which is defined as the sum of the k -th powers of element orders of G and they showed that for every positive integer k , $\psi_k(G)$ is also maximum if and only if G is cyclic.

In this talk, we will at first see that if G is a non-cyclic group of order n , then $\psi_k(G) \leq \frac{1 + 3 \cdot 2^k}{1 + 2 \cdot 4^k + 2^k} \psi_k(\mathbb{Z}_n)$. Setting $k = 1$ in our result, we immediately get the result of Herzog et al. as a simple corollary. Besides, a recursive formula for $\psi_k(G)$ is also obtained for finite abelian p -groups G , using which one can explicitly find out the exact value of $\psi_k(G)$ for finite abelian groups G . Finally, we prove a new criterion for the solvability of the finite groups, depending on the function $\psi_k(G)$. We show that our result can be used to show the solvability of some groups for which the solvability does not follow from earlier similar kind of results and we emphasize the following: looking at $\psi_k(G)$ for $k > 1$ can be useful to get further pieces of information about the group G .

11. On Graphs Defined on Groups

Speaker: Manideepa Saha, Presidency University

Abstract: Associating graphs with groups dates back to Arthur Cayley. Cayley graphs play an important role in various fields of mathematics, ranging from geometric group theory to algebraic combinatorics, from representation theory to discrete mathematics, from operator algebras to coding theory. In this talk, we discuss about another such graph defined on groups, called *comaximal subgroup graph* $\Gamma(G)$ of a group G whose vertices are non-trivial proper subgroups of G and two vertices H and K are adjacent if $HK = G$. Though the definition allows the possibility of G to be infinite, in our discussion, we will focus mainly on finite groups. We discuss various graph parameters like diameter, connectedness, girth, bipartiteness etc. Finally, we will highlight some problems on realizability and graph isomorphisms, and some partial solutions to those questions in terms of properties of G .

12. **Dehn quandles of surfaces**

Speaker: Neeraj Kumar Dhanwani, IISER Mohali

Abstract: We begin the talk by defining the Dehn quandle of a surface. By analysing the characterization of these quandles, we generalise the construction to arbitrary groups. We discuss generating sets of these quandles, their automorphism groups and their canonical quotients. Returning to surfaces, we discuss relations between the Dehn quandle and the geometry of surfaces. We conclude the talk by discussing approaches to write presentations of these quandles.

13. **Extension and cohomology of Rota-Baxter groups**

Speaker: Nishant, HRI Prayagraj

Abstract: The notion of Rota-Baxter groups was recently introduced by Guo, Lang and Sheng [*Adv. Math.* 387 (2021), 107834, 34 pp.] in the geometric study of Rota-Baxter Lie algebras. They are closely related to skew braces as observed by Bardakov and Gubarev. In this talk, we will discuss about different type of cohomologies associated with Rota-Baxter groups and study extensions of Rota-Baxter groups by defining suitable second cohomology group.

14. **The conjugacy problem and other related algorithmic questions in solvable Baumslag Solitar groups**

Speaker: Oorna Mitra, CMI, Chennai

Abstract: In this talk, we will introduce some algorithmic problems in groups, namely the twisted conjugacy problem (TCP) and orbit decidability (OD), which are closely related to the classical conjugacy problem (CP) in groups. We will state some new results towards solving the CP in certain extensions of the solvable Baumslag Solitar groups, using a strategy developed by Bogopolski-Martino-Ventura (Orbit decidability and the conjugacy problem for some extensions of groups. *Trans. Amer. Math. Soc.* 362 (2010), no. 4, 2003–2036), which gives a way of solving CP in certain extensions of a group by solving the TCP in the group. This is based on joint work with Mallika Roy and Enric Ventura.

15. **On the groups whose power graph is P_4 -free**

Speaker: Pallabi Manna, NIT Rourkela

Abstract: Let G be a group. An undirected power graph, denoted by $P(G)$, of the group G is the graph whose vertices are the elements of the group G and there is an edge between two vertices u and v of G , $u \neq v$, such that either u is a power of v or v is a power of u .

A graph Γ , is called H -free if it does not contain H as an induced subgraph. In particular, a P_4 -free graph is called cograph. We completely identify the nilpotent groups whose power graphs are cograph. We investigate two finite groups G and H , for which power graph of $G \times H$ is a cograph. We show that groups whose power graph is a cograph can be characterized by a condition only involving elements whose orders are prime or the

product of two (possibly equal) primes. For finite simple groups we show that in most of the cases their power graphs are not cographs: the only ones for which the power graphs are cographs are certain groups $PSL(2, q)$ and $Sz(q)$ and the group $PSL(3, 4)$. However, a complete determination of these groups involves some hard number-theoretic problems.

16. **Infinite metacyclic subgroups of the mapping class group**

Speaker: Pankaj Kapdi, IISER Bhopal

Abstract: For $g \geq 2$, let $\text{Mod}(S_g)$ be the mapping class group of the closed orientable surface S_g of genus g . In this talk, we will discuss a complete characterization of the infinite metacyclic subgroups of $\text{Mod}(S_g)$ up to conjugacy. In particular, we discuss equivalent conditions under which a pseudo-Anosov mapping class generates a metacyclic subgroup of $\text{Mod}(S_g)$ with another mapping class. As application to our main results, we show the existence of certain infinite metacyclic subgroups of $\text{Mod}(S_g)$ explicitly.

17. **Congruence subgroups of small Coxeter groups**

Speaker: Pravin Kumar, IISER Mohali

Abstract: It is a well-known result of Tits that a Coxeter group $W = \langle S | R \rangle$ of rank n admits a faithful representation $W \rightarrow GL(n, \mathbb{R})$. We call a Coxeter system to be small if its Tits representation is integral. Examples of small Coxeter groups include, symmetric groups, universal Coxeter groups and right angled Coxeter groups. Furthermore, two canonical extensions of symmetric groups called twin groups and triplet groups are also small Coxeter groups. These groups can be thought of as planar forms of Artin braid groups, and have deep connection with low dimensional topology. In this talk, we will discuss principal congruence subgroups of small Coxeter groups, with a focus on twin groups and triplet groups. The content of this talk is part of a recent work with Dr. Mahender Singh and Dr. Tushar Kanta Naik.

18. **Commutators and commutator subgroups in finite p-groups**

Speaker: Rahul Kaushik, IISER Pune

Abstract: For a finite group G , denote by $\gamma_2(G)$ the commutator subgroup of G and set $K(G) := \{[x, y] | x, y \in G\}$, where $[x, y] = x^{-1}y^{-1}xy$ for $x, y \in G$. Notice that $\gamma_2(G)$ is generated by the set $K(G)$. A very old and well known theme in group theory is to determine whether $\gamma_2(G)$ is equal to $K(G)$ or not for a given group G . As is well known, $K(G) = \gamma_2(G)$ for all finite simple groups G (Ore conjecture, resolved in 2010). The study has also been taken up for many other classes of groups. Our interest here is in the groups of prime power order. It is planned, in this talk, to survey some relevant literature, also to present our work in the same direction. More precisely we'll talk about a characterisation of groups G having 4-generated $\gamma_2(G)$ of order p^4 and groups G of order p^7 , p prime, in which $K(G) \neq \gamma_2(G)$.

19. **The Schur Multiplier of finite p-groups of maximal class**

Speaker: Renu Joshi, IISER Bhopal

Abstract: Let G be a finite group. The Schur multiplier $M(G)$ of G is defined as $H^2(G, \mathbb{C}^*)$, where \mathbb{C}^* is the trivial G -module. For finite groups, several authors have determined the upper bounds of the order, rank, and exponent of $M(G)$. We demonstrated that the Schur multiplier $M(G)$ is an elementary abelian p -group whenever $4 \leq n \leq p+1$ and G is a p -group of maximal class of order p^n . The case $n = p+1$ answers the question raised by Primož Moravec in a research article. This is a joint work with Dr. Siddhartha Sarkar.

20. **Breadth and Breadth type of Nilpotent Lie algebras**

Speaker: Rijubrata Kundu, IISER Mohali

Abstract: Classification of finite dimensional nilpotent Lie algebras is an interesting and rather unexplored topic in Lie theory. It shares a lot of similarity with that of finite nilpotent groups and in particular p -groups. It is often helpful to understand this general problem by imposing certain stronger conditions on these Lie algebras. In this talk, we will discuss the notion of breadth and breadth-type of nilpotent Lie algebras which are interesting invariants in these directions.

21. **Lambda Number of the enhanced power graph of a finite group**

Speaker: Sandeep Dalal, NISER Bhubaneswar

Abstract: The enhanced power graph of a finite group G is the simple undirected graph whose vertex set is G and two distinct vertices x, y are adjacent if $x, y \in \langle z \rangle$ for some $z \in G$. An $L(2, 1)$ -labeling of a graph Γ is an integer labeling of $V(\Gamma)$ such that adjacent vertices have labels that differ by at least 2 and vertices distance 2 apart have labels that differ by at least 1. The λ -number of Γ , denoted by $\lambda(\Gamma)$, is the minimum range over all $L(2, 1)$ -labelings. In this talk, we will discuss the lambda number of the enhanced power graph $\mathcal{P}_E(G)$ of the group G . This work extends the corresponding results, obtained in [X. Ma, M. Feng, and K. Wang. Lambda number of the power graph of a finite group. *J. Algebraic Combin.*, 53(3):743–754, 2021], of the lambda number of power graphs to enhanced power graphs. Moreover, for a non-trivial simple group G of order n , we will show that $\lambda(\mathcal{P}_E(G)) = n$ if and only if G is not a cyclic group of order $n \geq 3$. Finally, we will discuss the lambda number of the enhanced power graphs of nilpotent groups.

22. **On the super graphs and reduced super graphs of some finite groups**

Speaker: Sanjay Mukherjee, NISER Bhubaneswar

Abstract: For a finite group G , let B be an equivalence (equality, conjugacy or order) relation on G and let A be a (power, enhanced power or commuting) graph with vertex set G . The B super A graph is a simple graph with vertex set G and two vertices are adjacent if either they are in the same B -equivalence class or there are elements in their B -equivalence classes that are adjacent in the original A graph. The graph obtained by deleting the dominant vertices (adjacent to all other vertices) from a B super A graph is called the reduced B super A graph. In this talk, for some pairs of B super A graphs, we will discuss about the finite groups for which a pair of graphs are equal. We also discuss the dominant vertices for the order super commuting graph $\Delta^o(G)$ of G . We will find the

values of n for which the reduced order super commuting graph $\Delta^o(S_n)^*$ of S_n and the reduced order super commuting graph $\Delta^o(A_n)^*$ of A_n are connected. We also prove that if $\Delta^o(S_n)^*$ (or $\Delta^o(A_n)^*$) is connected then the diameter is at most 3 and show that the diameter is 3 for many values of n .

23. Difference Graphs on Groups

Speaker: Sucharita Biswas, Presidency University

Abstract: The difference graph $D(G)$ of a finite group G is the difference of enhanced power graph of G and power graph of G , with all isolated vertices are removed. In this talk we will discuss the connectedness, diameter and perfectness of $D(G)$ with respect to various properties of the underlying group G .

24. Local-global principles for norms and product of norms over semi-global fields

Speaker: Sumit Chandra Mishra, IISER Mohali

Abstract: A well-known result of Hasse states that the local-global principle holds for norms over number fields for cyclic extensions. In other words, if L/F is a cyclic extension of number fields then an element $\lambda \in F$ is in the image of norm map $N_{L/F} : L \rightarrow F$ if and only if λ is in the image of the norm map locally everywhere i.e., for completions associated to all archimedean and non-archimedean places of F . In this talk, we would consider local-global principles for norms and product of norms over fields which are function fields of curves over complete discretely valued fields, for example, $\mathbb{C}((t))(x)$.

25. Reversibility of affine transformations

Speaker: Tejbir, IISER Mohali

Abstract: An element of group G is called reversible if it is conjugate to its inverse in G . An element of group G is called strongly reversible if it can be expressed as the product of two involutions in G . It has been a problem of broad interest to classify reversible and strongly reversible elements in a group. The first part of the talk will be based on basic notions, examples, and some known results related to the reversibility problem. The second part of the talk will constitute a recent work with Dr. Krishnendu Gongopadhyay and Dr. Chandan Maity, where we investigated the reversibility problem in the affine group $\text{GL}(n, \mathbb{D}) \ltimes \mathbb{D}^n$, where $\mathbb{D} = \mathbb{R}, \mathbb{C}$, or \mathbb{H} .