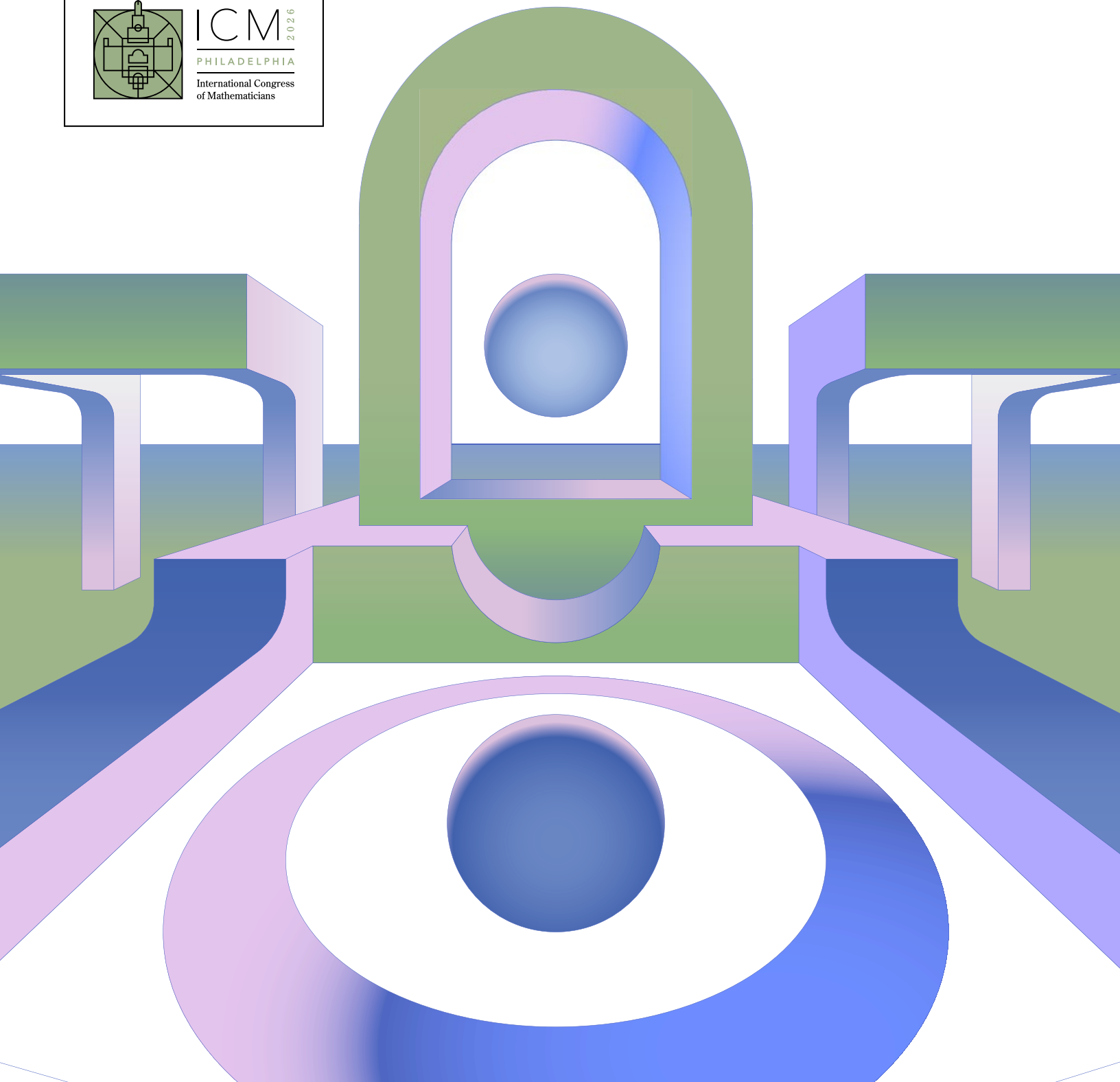
SHORT COMMUNICATIONS & POSTERS

BOOK OF ABSTRACTS

2026 INTERNATIONAL CONGRESS OF MATHEMATICIANS

Philadelphia, Pennsylvania
July 23-30, 2026

ICM 2026
PHILADELPHIA
International Congress of Mathematicians



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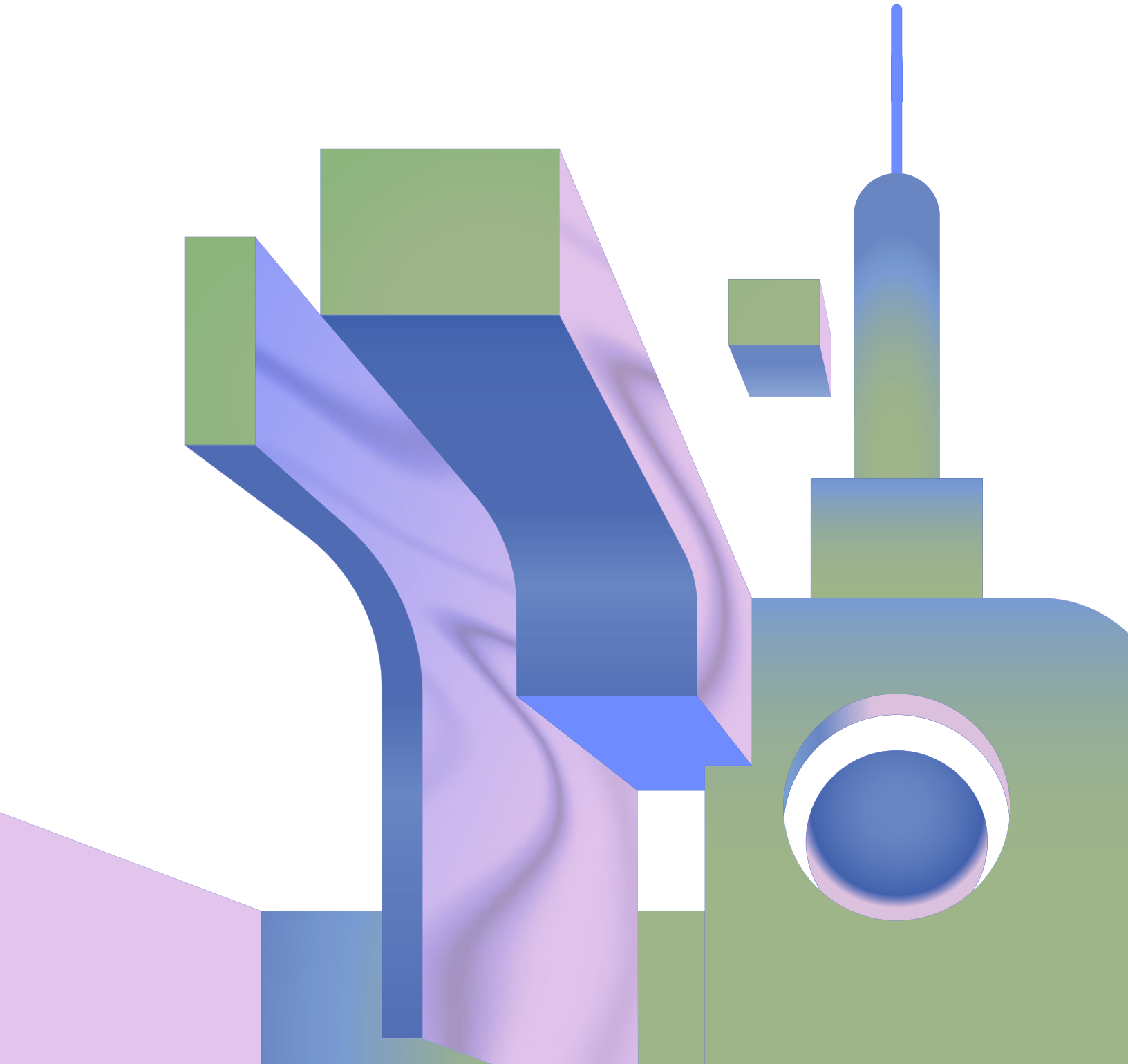
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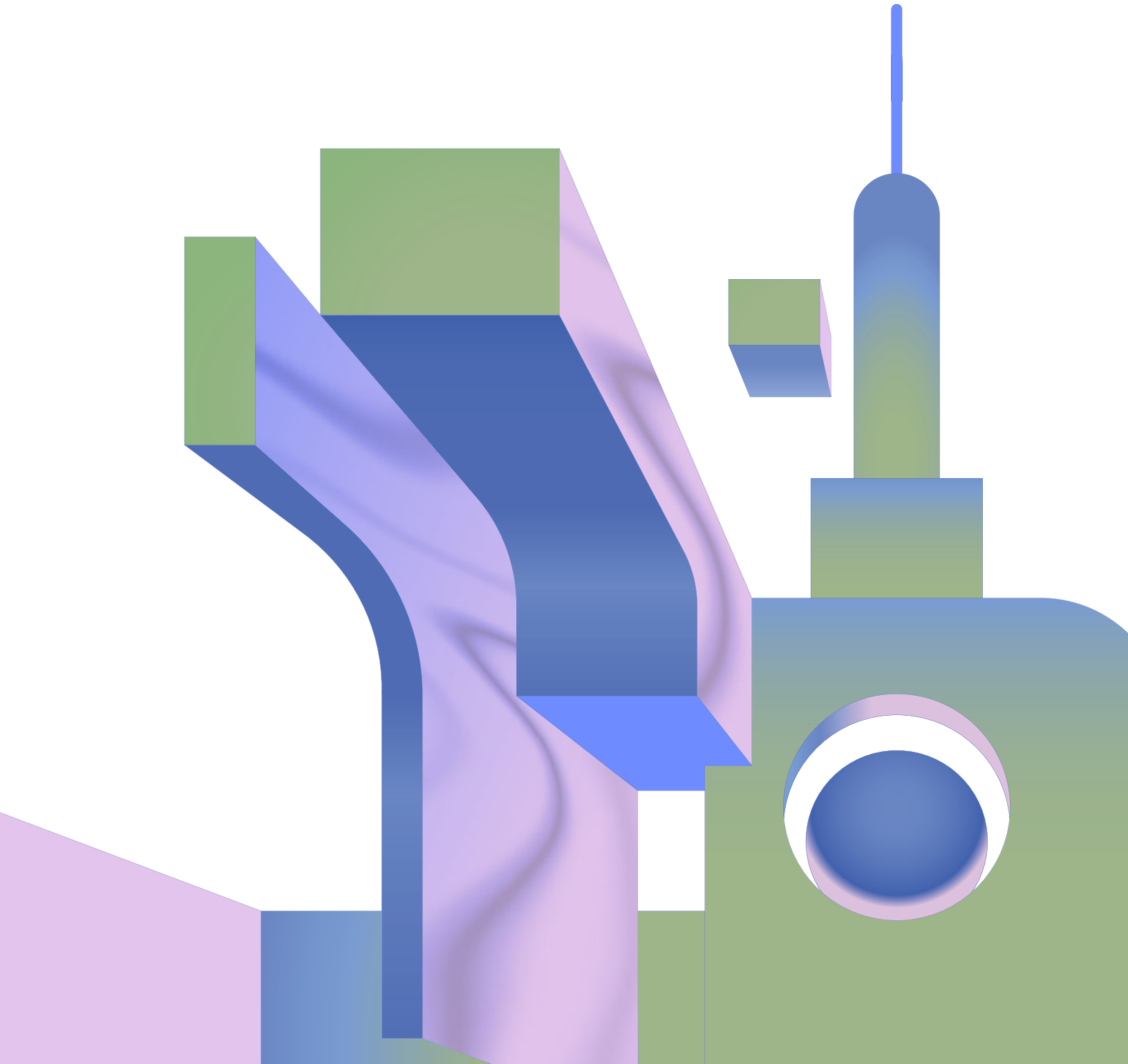
SHORT COMMUNICATIONS

2026 INTERNATIONAL CONGRESS OF MATHEMATICIANS



SHORT COMMUNICATIONS

SECTION 1 – LOGIC



CODAS-SORT Decision Modeling Using Neutrosophic Hyper Soft Rough Matrices for Cybersecurity Applications

Name: Boobalan Jayaraman

Institution: Annamalai University

Abstract: Cybersecurity risk assessment requires robust decision-making frameworks that can manage heterogeneous and uncertain information derived from multiple security evidence sources. In this paper, an integrated Neutrosophic Hyper Soft Rough Matrix (NHSRM) – based COmbinative Distance-based ASsessment – SORTing (CODAS-SORT) decision model is presented for effective evaluation and classification of cybersecurity threats. In the proposed approach, cybersecurity threats are evaluated using data collected from firewall alerts, intrusion detection systems, endpoint telemetry, and user behavior analytics. Lower and upper neutrosophic evaluations are combined to obtain a crisp decision matrix, which is subsequently examined using the CODAS technique. Euclidean and Taxicab distances from the negative ideal solution are employed to derive assessment scores, which are further categorized into predefined cybersecurity risk classes through the CODAS-SORT mechanism. The complete decision model is implemented using MATLAB, ensuring computational transparency, reproducibility, and practical feasibility. A representative cybersecurity case study is presented to demonstrate the applicability and effectiveness of the proposed framework, producing coherent and interpretable risk classification results.

Continuity of coordinate functionals for ideal Schauder bases

Name: Jarosław Swaczyna

Institution: Lodz University of Technology

Abstract: Schauder bases, introduced by Juliusz Schauder in the 1920s, became a central tool in the study of separable Banach spaces, providing series representations of their elements. For many years it was conjectured that every separable Banach space admits a Schauder basis. This belief was overturned by Enflo's breakthrough in 1973, when he constructed a separable Banach space without any Schauder basis. Enflo's example stimulated the search for weaker or more flexible notions of basis capable of accommodating the full class of separable Banach spaces. Various generalizations have since been proposed, including frames, Markushevich bases, and finite-dimensional decompositions. In this context, ideal Schauder bases provide a framework in which convergence is governed by ideals on naturals, offering a setting to investigate how classical basis phenomena may extend beyond the traditional notion. This line of research reflects the broader effort to reconcile representation theory with the intrinsic diversity of separable Banach spaces.

An open problem in the theory of ideal Schauder bases has been whether the associated coordinate projections must be continuous. Unlike the classical setting, where boundedness of projections follows from standard functional-analytic arguments, these methods break down in the ideal framework and leave the question unresolved. In this talk, I will explain the source of these difficulties, show why classical techniques cannot be directly adapted, and present a solution that establishes continuity under appropriate assumptions. This work answers a question

of Vladimir Kadets and was obtained jointly with Tomasz Kania and Noe de Rancourt.

Drawing infinite graphs

Name: Agnieszka Widz

Institution: Lodz University of Technology

Abstract: The classical Rado graph (or random graph) occupies a central place in model theory, Fraïssé theory, and combinatorics: it is the unique countable graph that appears with probability one when each pair of natural numbers is independently connected with probability 1/2. Its uniqueness was proved by Erdős and Rényi, prompting Erdős and Spencer to remark that "the theory of infinite random graphs is demolished by Erdős and Rényi's theorem." Yet this construction relies on repeatedly tossing the same (possibly asymmetric) coin. Our goal is to revive the study of infinite random graphs generated instead by a sequence of different asymmetric coins.

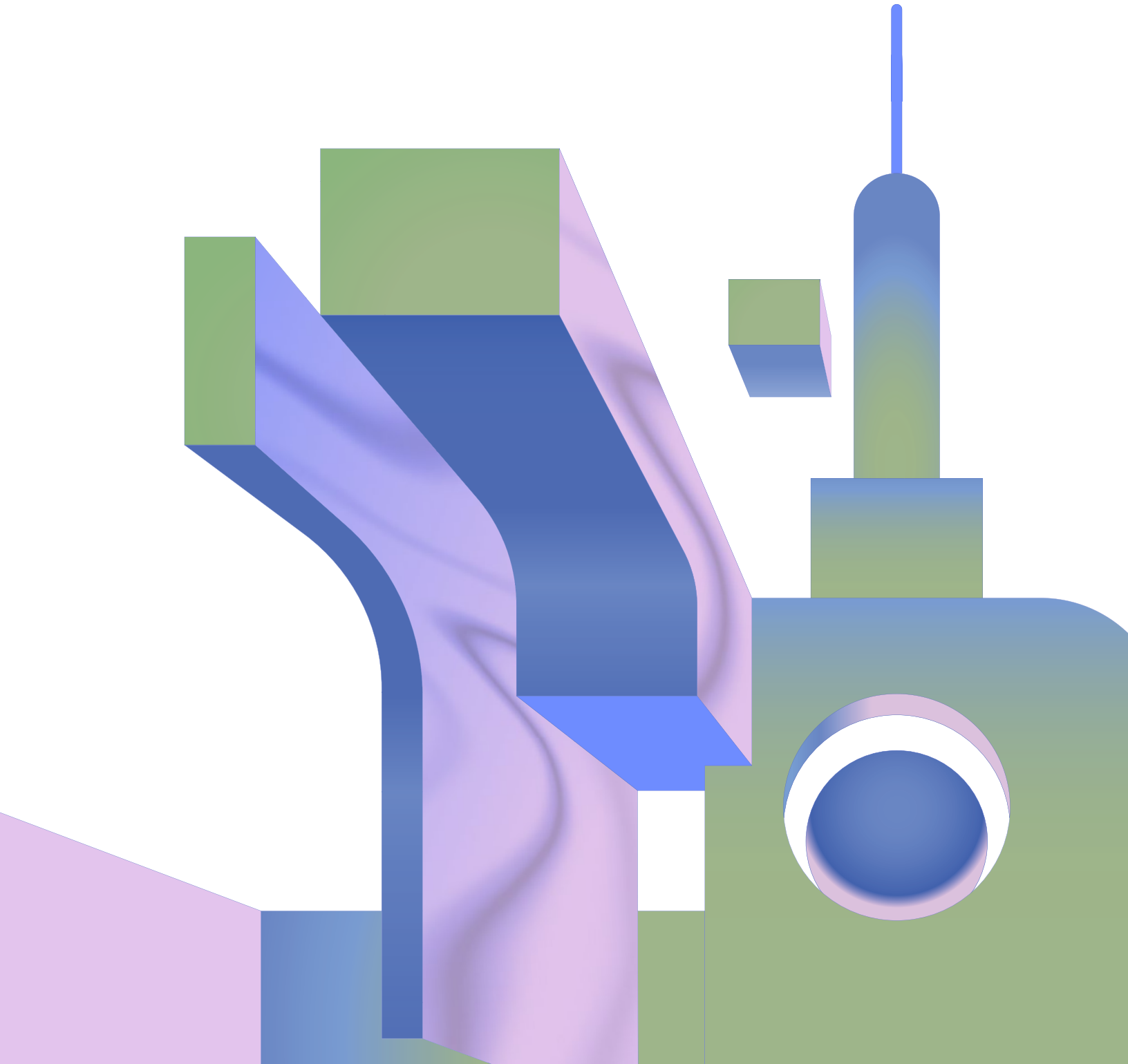
This broader framework allows us to explore how far one may deviate from the classical Rado graph while still obtaining a well-defined "almost sure" infinite structure.

The aim of the lecture is to present the central ideas without unnecessary technicalities, highlighting how randomness, structural invariance interact to produce a surprisingly rich landscape of infinite random graphs, especially with regard to questions about which graphs can be drawn.

The results are joint with Jarosław Swaczyna, Ziemowit Kostana, and Leonardo N. Coregliano.

SHORT COMMUNICATIONS

SECTION 2– ALGEBRA



Injectivity of Topological Modules

Name: Yunita Septriana Anwar

Institution: Universitas Muhammadiyah Mataram

Abstract: Let R be a topological ring and M a topological R-module. A module U is called a topological M-injective module if for every continuous monomorphism $f\colon K \to M$, where K is an open submodule of M, and for every continuous homomorphism $g\colon K \to U$, there exists a continuous homomorphism $h\colon M \to U$ such that $hf = g$. A topological M-injective module is a topological injective module relative to all topological R-modules in the category $Top_{\sigma[M]}$. The direct product of topological M-injective modules in the categories $Top_{R\text{-}MOD}$ and $Top_{\sigma[M]}$ is also a topological M-injective module. An infinite direct sum of topological M-injective modules is again topological M-injective provided that the direct sum is an open submodule of the direct product of the topological M-injective modules.

The topological M-injective hull of a topological module N is a minimal topological M-injective module containing N. Injectivity of infinite direct sums of injective modules does not necessarily hold in general, and the existence of injective hulls is not guaranteed in arbitrary categories. If $(N, \tau) \in Top_{\sigma[M]}$, then N admits a topological injective hull in $Top_{\sigma[M]}$, namely the topological trace $Tr^*(M, E_\tau(N))$, where $E_\tau(N)$ is the topological injective hull of N in $Top_{R\text{-}MOD}$. Furthermore, if $(N, \tau) \in Top_{\sigma[M]}$, the injective hulls of N in the categories $R\text{-}MOD$, $\sigma[M]$, $Top_{R\text{-}MOD}$, and $Top_{\sigma[M]}$ are respectively denoted by $E(N)$, $\widehat{N}$, $E_\tau(N)$, and $\widetilde{N}$. The relationships among these injective hulls are given by

$$N \subseteq Tr^*(M, E_\tau(N)) \subseteq E_\tau(N) \subseteq E(N)$$

and

$$N \subseteq Tr^*(M, E_\tau(N)) \subseteq Tr(M, E(N)) \subseteq E(N).$$

Compactness in topological spaces is closely related to finiteness properties in topology. For a topological module in $Top_{\sigma[M]}$, a compact topological M-injective module containing it does not always exist. In particular, for non-precompact topological modules and locally compact topological modules, there is no compact topological M-injective module containing them, whereas a compact topological module can be embedded into a compact topological M-injective module.

Description of right (left) Rickart algebras

Name: Farkhodzhon Arzikulov

Institution: V.I. Romanovskiy Institute of Mathematics, Uzbekistan Academy of Sciences

Abstract: When Rickart introduced the concept of B_p^*-algebra, he used left and right annihilators. Later, Kaplansky in his work called B_p^*-algebras Rickart C^*-algebras. For Rickart C^*-algebras, it was unimportant which annihilator to use, left or right. To find the difference between using left and right annihilators, it was necessary to expand the class of the algebraic structures under consideration. This was done in 1960 by A. Hattori. A. Hattori introduced the concept of a right p.p. ring, as a ring in which each principal left ideal is projective. It was later proved that right p.p. rings are precisely left Rickart rings.

The chosen notions were built around a right (left) annihilator. For each nonempty subset $\mathcal{S}$ of an associative ring $\mathcal{R}$, the right (left) annihilator of $\mathcal{S}$ is defined by $\mathcal{S}^r := \{a \in \mathcal{R} : sa = \mathbf{0},\ \forall s \in \mathcal{S}\}$ (resp. $\mathcal{S}^l := \{a \in \mathcal{R} : as = \mathbf{0},\ \forall s \in \mathcal{S}\}$). Thus, an associative ring $\mathcal{R}$ is called a right (left) Rickart ring if, for each element $a \in \mathcal{R}$, there exists an idempotent $e \in \mathcal{R}$ such that $\{x\}^r = e\mathcal{R}$ (resp. $\{x\}^l = \mathcal{R}e$).

Our study of the algebra-theoretic analogue of Rickart C*-algebras is based on the following definition: an associative algebra that is a right (left) Rickart ring is called a right (resp. left) Rickart algebra.

In our paper, we provide a criterion for some associative algebras to be a right (left) Rickart algebra. Namely, we prove that an associative algebra $\mathcal{A}$ with an idempotent p and a nonzero nilpotent radical $\mathcal{N}$ such that $\mathcal{A} = \mathbb{F}p\dot{+}\mathcal{N}$ is a right Rickart algebra if and only if, for any nonzero $a, b \in \mathcal{N}$, $ab = 0$, $pa = a$ and $ap = 0$. And we prove that, an associative algebra $\mathcal{A}$ with mutually orthogonal idempotents p, q and a nilpotent radical $\mathcal{N} \neq \{0\}$ such that $\mathcal{A} = \mathbb{F}p\dot{+}\mathbb{F}q\dot{+}\mathcal{N}$ is a right Rickart algebra if and only if $p + q$ is a left unit of $\mathcal{A}$, $p\mathcal{N}p = \{0\}$, $q\mathcal{N}q = \{0\}$, $q\mathcal{N}p = \{0\}$, and, for any $a \in q\mathcal{N}$ such that $a(p + q) = 0$, and for any $b \in p\mathcal{N}q$, from $a \neq 0$, $b \neq 0$ it follows that $ab \neq 0$. Theorems symmetric to these theorems hold for left Rickart algebras.

A Computational Approach to Wedderburn Decomposition and Matrix Units in Rational Group Algebras

Name: Gurmeet Kaur Bakshi

Institution: Panjab University, Chandigarh, India

Abstract: Let G be a finite group and $\mathbb{Q}G$ its rational group algebra. Although the Wedderburn-Artin theorem ensures that $\mathbb{Q}G$ decomposes as a finite direct product of matrix algebras over division algebras, obtaining this decomposition explicitly together with concrete matrix units for the simple components remains a challenging problem. Classical character theoretic methods determine primitive central idempotents, but they do not provide explicit realizations of the corresponding simple components. In this talk, we present a computational approach to the Wedderburn decomposition and a construction of matrix units in rational group algebras, based on Shoda pairs and their refinements. For a large class of monomial groups, this method yields an explicit description of a simple component as a matrix algebra over a crossed product algebra, thereby providing a constructive form of the Brauer-Witt theorem. We also illustrate how this approach can be applied to compute Schur indices over $\mathbb{Q}$ for certain classes of finite groups. The results presented are based on recent joint work with Jyoti Garg and Gabriela Olteanu during 2023-2025.

Coalgebra measurings and maps between (co)homology theories

Name: Abhishek Banerjee

Institution: Indian Institute of Science, Bangalore

Abstract: The notion of a measuring coalgebra, introduced by Sweedler, induces generalized maps between algebras. This leads to an enrichment of algebras over coalgebras. In other words, the category of algebras is linearized in a manner that reminds of adding correspondences as generalized morphisms between schemes in algebraic geometry. Since an algebra may be seen as a "noncommutative scheme," we are motivated to look at morphisms between (co)homology theories induced by coalgebra measurings.

In particular, we construct morphisms induced by coalgebra measurings in the following contexts:

(1) Hochschild & cyclic homology of algebras

(2) Chevalley-Eilenberg homology of Lie algebras

(3) Operadic homology of algebras over operads

(4) Cyclic cohomology of Hopf algebroids

(5) Hochschild cohomology with coefficients in stable anti-Yetter Drinfeld (SAYD) modules

(This is joint work with S. Kour)

On Zero-Divisor Graph for the factor rings and its Metric Dimension

Name: Vijay Kumar Bhat

Institution: Shri Mata Vaishno Devi University

Abstract: This study pertains to the metric dimension of the zero-divisor graph (ZDG) $\Gamma(R)$ for the factor ring $R = \mathbb{Z}_{p^2}[y]/\langle y^2 \rangle$, where $p \geq 3$ is a prime number. The ZDG is constructed using the zero-divisors of this ring. We first characterize the set of zero divisors $Z(R)$ and analyze the structure of the graph, confirming its diameter is 2.

Metric dimension of the ZDG $\Gamma(\mathbb{Z}_{p^2}[y]/\langle y^2 \rangle)$ has been computed by analyzing how its $p^3 - 1$ vertices partition into twin equivalence classes (T), which represent vertices undifferentiable by distance. The findings reveal a critical dependence on the prime q: for the minimal case, $\mathbf{p = 3}$, the complex algebraic structure leads to

$$\dim(\Gamma(\mathbb{Z}_9[y]/\langle y^2 \rangle)) = \mathbf{21}.$$

However, for all primes $\mathbf{p \geq 5}$, the structure simplifies and the metric dimension follows to the general formula

$$\dim(\Gamma(\mathbb{Z}_{p^2}[y]/\langle y^2 \rangle)) = \mathbf{p^3 - 2p - 1}.$$

This clear difference between the linear increase of T ($\mathbf{2p}$ classes) and the cubic expansion of vertices validates the graph's huge symmetry and explains why its metric dimension is still very high, almost equal to the entire number of vertices.

The finding that $p = 3$ is an exceptional case

$$\dim(G) = 21 \quad \text{vs.} \quad p^3 - 2p - 1 = 3^3 - 2(3) - 1 = 27 - 7 = 20$$

highlights that the algebraic properties of $\mathbb{Z}_9[y]/\langle y^2\rangle$ are fundamentally different from those of $\mathbb{Z}_{p^2}[y]/\langle y^2\rangle$ for $p \geq 5$, despite their visual similarity.

A MATLAB Code for the zero-divisor graph has also been discussed.

Some theoretical foundation for protein identification through cyclic codes

Name: Diana Bueno

Institution: Pontificia Universidad Javeriana, seccional Cali

Abstract: In recent work, the possible relationship between protein synthesis processes and digital transmission systems has been successfully investigated. Advances in this area could lead to conclusions about evolution and the connection between species. Based on the Code Theory, biological sequences have been identified as BCH code words to verify the validity of this model. In the article Construction of Cyclic Codes over Z20 for Identifying Proteins [1], three algorithms were designed to identify odd-length biological sequences of amino acids as keywords of cyclic codes. In this talk, we will present some aspects of the mathematical background of the algorithms through which we have been able to detect possible improvements for some steps of the above-mentioned algorithms.

On Nil ideals of Leavitt path algebras over commutative rings

Name: Ardeline Mary Buhphang

Institution: North-Eastern Hill University

Abstract: In this talk we show that for any graph E and for a commutative unital ring R, the nil ideals of the Leavitt path algebra $L_R(E)$ depend solely on the nil ideals of the ring R. We also obtain results on the Jacobson radical of $L_R(E)$ for a graph E with no regular vertex. Additionally, we obtain that for a nil ideal I of a Leavitt path algebra $L_R(E)$, the ideal $M_2(I)$ is also nil thus establishing that Leavitt path algebras over arbitrary graphs satisfy the Köethe's conjecture.

A Combinatorial Technique for Rational Representations and Rational Group Algebras of Metacyclic p-groups

Name: Ram Karan Choudhary

Institution: Indian Institute of Science Education and Research, Pune

Abstract: In this talk, I will present a combinatorial formula for computing the Wedderburn decomposition of the rational group algebra $\mathbb{Q}G$, where G is a metacyclic p-group for any prime

p. I will also introduce a formula to count the irreducible rational representations of G with distinct degrees. Furthermore, I will outline a method for explicitly constructing all inequivalent irreducible rational matrix representations of G.

Zero-dilation indices and numerical ranges

Name: Paul Reine Kennett Dela Rosa

Institution: University of the Philippines Diliman

Abstract: The zero-dilation index $d(A)$ of a matrix A is the largest integer k for which $\begin{bmatrix} 0_k & * \\ * & * \end{bmatrix}$ is unitarily similar to A. In this study, the zero-dilation indices of certain block matrices are considered, namely, the block matrix analogues of companion matrices and upper triangular KMS matrices, respectively shown as

$$\mathcal{C} = \begin{bmatrix} 0 & \bigoplus_{j=1}^{m-1} A_j \\ B_0 & [B_j]_{j=1}^{m-1} \end{bmatrix} \text{ and } \mathcal{K} = \begin{bmatrix} 0 & A & A^2 & \cdots & A^{m-1} \\ 0 & 0 & A & \ddots & \vdots \\ 0 & 0 & 0 & \ddots & A^2 \\ \vdots & \vdots & \vdots & \ddots & A \\ 0 & 0 & 0 & \cdots & 0 \end{bmatrix}$$

where $\mathcal{C}$ and $\mathcal{K}$ are mn-by-mn and A_j, B_j, A are n-by-n. Provided $\bigoplus_{j=1}^{m-1} A_j$ is nonsingular, it is proved that $d(\mathcal{C})$ satisfies the following: if $m \geq 3$ is odd (respectively, $m \geq 2$ is even), then $\frac{(m-1)n}{2} \leq d(\mathcal{C}) \leq \frac{(m+1)n}{2}$ (respectively, $d(\mathcal{C}) = \frac{mn}{2}$). In the odd m case, examples are given showing that it is possible to get as zero-dilation index each integer value between $\frac{(m-1)n}{2}$ and $\frac{(m+1)n}{2}$. On the other hand, $d(\mathcal{K})$ is proved to be equal to the number of nonnegative eigenvalues of $(\mathcal{K} + \mathcal{K}^*)/2$. Alternative characterizations of $d(\mathcal{K})$ are given. The circularity of the numerical range of $\mathcal{K}$ is also considered.

Finitistic dimension and singularity categories

Name: Souvik Dey

Institution: University of Arkansas

Abstract: Let A be a Noetherian ring (not necessarily commutative). When is there a uniform upper bound on the projective dimensions of all (left) A-modules of finite projective dimension? When A is commutative, it follows from the works of Bass and Raynaud-Gruson, that this is the case if and only if A has finite Krull dimension. The question of whether such a uniform upper bound exists for Artin algebras, even when restricted to finitely generated modules only, was first publicized by Bass in the 1960s. This question, since known as the finitistic dimension conjecture, remains open even after half a century. In this talk, based on ongoing joint work with Jan Stovicek, we will present some criteria for the existence of such uniform upper bounds in terms of certain

form of generation in module category and singularity category. One ingredient of our approach is based on certain generalizations of the ” delooping level” of Gelinas.

Product of commutators with b-generalized skew derivations on Lie ideals

Name: Basudeb Dhara

Institution: Belda College

Abstract: Let R be any prime ring of char $(R) \neq 2, 3$, Q_r be the right Martindale ring of quotients of R, C be the extended centroid of R and L a non-central Lie ideal of R. Let $b \in Q_r$. An additive map $F : R \to Q_r$ is said to be a b-generalized skew derivation of R, if there exists a skew derivation d of R associated with an automorphism α such that

$$F(xy) = F(x)y + b\alpha(x)d(y)$$

for all $x, y \in R$. If F and G are two non-zero b-generalized skew derivations of R such that

$$[F(X), X][G(X), X] = 0$$

holds for all $X \in L$, then all possible forms of the maps F and G are described. It is proved that one of the following conclusions holds:

(i) $F(x) = \lambda x$ for all $x \in R$ and for some $\lambda \in C$; (ii) $G(x) = \mu x$ for all $x \in R$ and for some $\mu \in C$; (iii) $R \subseteq M_2(K)$, the algebra of 2×2-matrices over a field K.

Linearity index in the interval of matching numbers

Name: Nursel Erey

Institution: Gebze Technical University

Abstract: The linearity index of an edge ideal $I(G)$, is the smallest integer k such that the kth squarefree power of $I(G)$ has linear resolution. It is known that the linearity index is bounded between the induced matching number and the matching number of the graph. In this talk, we will discuss the possible values of the linearity index in the interval of matching numbers. This is based on joint work with Takayuki Hibi.

Functional Identities Involving Inverses over Division Rings

Name: Münevver Pınar Eroğlu

Institution: Dokuz Eylül University

Abstract: In the context of ring theory, a functional identity (FI) is defined as an equation that holds for all elements in a ring and involves unknown maps acting upon those elements. As a specialized and rigorous branch of algebra, the Theory of Functional Identities systematically investigates the precise forms of such maps and explores how their existence dictates the underlying structural properties of the algebra, such as its commutativity or dimensionality.

This work investigates the evolution of FIs, starting from the classical roots of Cauchy's additive functions in 1821 to Israel Halperin's provocative 1963 challenge in the "New Scottish Book," which catalyzed the study of modern rational functional identities. Our focus lies at the intersection of these historical problems and cutting-edge algebraic techniques, specifically within the framework of non-commutative division rings.

We present a complete and unified characterization of the general identity $f(x) = x^n g(x^{-1})$ for all invertible elements x, where f and g are additive maps on a division ring D. While existing literature has predominantly addressed specific cases for $n = 1, 2, 3$, and 4, this presentation unveils recent findings that provide a definitive and comprehensive solution for all integers $n \geq 0$.

A key highlight of our results is the striking structural transition occurring at $n = 2$: we demonstrate that while the identity forces a specific structural form when $n = 2$, it collapses into the standard zero solution for all other cases. This is joint work with T.-K. Lee and J.-H. Lin.

Jordan and Lie σ-Derivations on Path Algebras

Name: Brahim Fahid

Institution: High School of Technology – Ibn Tofail University

Abstract: Lie σ-derivations on path algebras. Motivated by Benkovič's works on triangular algebras and by Li and Wei's studies on derivations of path algebras, we extend these results by removing the faithfulness condition. We establish that every Jordan σ-derivation on a path algebra associated with a finite acyclic quiver is a σ-derivation, and every Lie σ-derivation is of standard form. These findings confirm that, under suitable algebraic constraints, Jordan and Lie σ-derivations behave analogously to classical σ-derivations, thus generalizing existing results in algebraic structures connected to quivers and representation theory.

Homological Ideals over Auslander algebras of radical square zero algebras of Dynkin quiver

Name: Pedro Fernando Fernández Espinosa

Institution: Universidad Pedagógica y Tecnológica de Colombia

Abstract: The notion of homological ideals was introduced by M. Auslander et al. in 1992; they referred to them as strong idempotent ideals. These ideals exhibit several interesting properties and have been further studied by Gatica, Lanzilotta, and Platzeck to explore their connections with the Finitistic Dimension Conjecture.

In this talk, we will describe some of the main properties of these ideals, and we will generalize ideas given in 2023 by A. Moreno Cañadas and P. F. Fernández Espinosa to provide a combinatorial description of the number of homological ideals in Auslander algebras of radical-square-zero Dynkin algebras.

Fixed Superalgebras, Supertraces, and Structural Properties via Graded Embeddings

Name: Claudemir Fideles Bezerra Junior

Institution: UNICAMP

Abstract: Let K be a field of characteristic zero, and let E denote the infinite-dimensional Grassmann algebra over K. In this talk, we present recent results on algebras that can be embedded into the tensor product of a graded-central-simple algebra A with a supercommutative superring. Under suitable hypotheses, if a supertrace algebra B belongs to the same PI-variety as $A \otimes E$, then B admits an embedding into $A \otimes \Xi$, where Ξ is the so-called A-universal supermap of B—a supercommutative algebra compatible the supertrace structure of B. This embedding holds whenever B satisfies all supertrace identities of $A \otimes E$.

As a consequence, we show that if B is finitely generated as an algebra, then its Baer and Jacobson radicals coincide, and its Gelfand – Kirillov dimension is always an integer.

These structural findings also contribute to the understanding of the interplay between geometry and the theory of polynomial identities. In particular, we draw inspiration from classical results of Susan Montgomery, who demonstrated that under certain conditions, a ring can inherit polynomial identities from its fixed subrings under group actions—especially when the subring is a centralizer.

This presentation is based on joint work with Charles Almeida and Lucio Centrone, supported by FAPESP grant No. 2023/04011-9. These results are new, and are currently submitted.

Complexity, curvature and homological dimension of modules under linkage

Name: Dipankar Ghosh

Institution: Indian Institute of Technology Kharagpur

Abstract: In this article, we analyze how (projective and injective) complexity, curvature, and complete intersection dimension behave under linkage of modules and ideals. Let R be a Gorenstein local ring. Consider a Gorenstein perfect ideal $\mathfrak{a}$ (e.g., $\mathfrak{a}$ is generated by an R-regular sequence). Let M and N be two Cohen-Macaulay R-modules linked by $\mathfrak{a}$. We prove that $\mathrm{cx}_R(M) = \mathrm{injcx}_R(N)$ and $\mathrm{curv}_R(M) = \mathrm{injcurv}_R(N)$. In particular, when R is complete intersection, $\mathrm{cx}_R(M) = \mathrm{cx}_R(N)$ and $\mathrm{curv}_R(M) = \mathrm{curv}_R(N)$. Furthermore, we show that projective dimension $\mathrm{pd}_R(M) = \mathrm{pd}_R(N)$, and complete intersection dimension $\mathrm{cid}_R(M) = \mathrm{cid}_R(N)$. If any of these dimensions is finite, it is equal to height of $\mathfrak{a}$. Similar results are obtained for linkage of ideals.

All these results highly extend a classical result of Peskine and Szpiro in many directions. We construct several examples that complement our results. These also show how properties like 'integrally closed', '$\mathfrak{m}$-full' and 'Burch' behave under linkage of ideals.

This is a joint work with Subhadip Bhowmick.

Projectives over Leavitt Path Algebras

Name: Rishabh Goswami

Institution: North-Eastern Hill University

Abstract: The monoid of isomorphism classes of finitely generated projective modules is a fundamental invariant of a Leavitt path algebra, it allows us to explore the relation between its algebraic structure and the combinatorics of the underlying graph. This monoid underlies the Grothendieck group K_0 via group completion and plays a central role in classification problems, Morita equivalence, and algebraic K-theory.

In this talk, we study this monoid across several generalizations of Leavitt path algebras. We begin with weighted Leavitt path algebras, examining how edge weights modify the defining relations of the aforementioned monoid, with particular attention to the confluence and cancellation properties of the monoid. Next, we consider the monoid of finitely generated graded projective modules, where the grading provides a refinement of its ungraded version. Here, we focus on the standard grading when investigating the corresponding monoid. (joint work in progress with A. Sebandal).

Finally, we discuss Leavitt path algebras of quantum quivers, introduced in our joint work with J. Graham and J. Palin. We describe the monoid of iso-classes of finitely generated projective modules in this setting and comment on its K_0-group. These algebras are particularly interesting as they provide a machinery to explore Leavitt path algebras in the context of quantum graphs introduced by Brannan et al.

A new symbolic algorithm for the equidimensional decomposition of varieties defined by sparse polynomials

Name: Gabriela Jeronimo

Institution: Universidad de Buenos Aires

Abstract: Sparse polynomials (namely, polynomials with nonzero coefficients only at prescribed sets of monomials) have become a central topic in the computer algebra framework over the last decades, due to their ubiquity in applications and the computational challenge of solving general systems of polynomial equations.

We will present a new symbolic probabilistic algorithm that, given a system of sparse polynomials, $f_1, \ldots, f_m$ in $\mathbb{Q}[x_1, \ldots, x_n]$, characterizes completely all the equidimensional components of its zero set $V = \{x \in \mathbb{C}^n \mid f_1(x) = 0, \ldots, f_m(x) = 0\}$. Based on deformation techniques, the algorithm computes a finite set of representative points for each of the equidimensional

components of V within a complexity which is polynomial in combinatorial invariants associated to the supports of $f_1, \ldots, f_m$.

This is joint work with María Isabel Herrero (Universidad Torcuato Di Tella, Argentina) and Juan Sabia (Universidad de Buenos Aires and CONICET, Argentina).

Characterization of Rubik's Cube Groups using Fractal Structure

Name: Babushri Srinivas Kedukodi

Institution: Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, Karnataka, India

Abstract: We present a new approach to characterize the well-known Rubik's cube group by using the fractal nature of the cube. We use this characterization to count the possible configurations of both the $2 \times 2 \times 2$ and $3 \times 3 \times 3$ cubes.

On Generalized p.q.-Baer $*$-rings

Name: Anil Khairnar

Institution: Abasaheb Garware College

Abstract: We introduced the class of weakly generalized p.q.-Baer $*$-rings. It is proved that under some assumptions every weakly generalized p.q.-Baer $*$-ring can be embedded in generalized p.q.-Baer $*$-ring. We proved that a generalized p.q.-Baer $*$-rings has partial comparability. If a generalized p.q.-Baer $*$-ring satisfies the parallelogram law then it is proved that every pair of projections has an orthogonal decomposition. A separation theorem for generalized p.q.-Baer $*$-rings is obtained. As an application of spectral theory, it is proved that generalized p.q.-Baer $*$-rings have a sheaf representation with injective sections.

Endo-reduced modules exhibiting von Neumann regularity

Name: Philly Ivan Kimuli

Institution: Kyambogo University

Abstract: Strongly regular rings are von Neumann regular with no nonzero nilpotent elements. Various notions of von Neumann regularity for modules, including endo-regularity and F-regularity, have been studied. Recently, endo-reduced modules have been introduced as modules whose endomorphism rings have no nonzero nilpotent elements. In this talk, we study endo-reduced modules exhibiting von Neumann regularity. We show that an endo-reduced, endo-regular module is Abelian endo-regular and, equivalently, an endo-reduced module that is both P-flat and P-injective. Finally, we show that endo-reduced strong F-regularity unifies several module-theoretic characterizations of strongly regular rings.

Frobenius, separability and Maschke properties for contramodules over entwining structures with several objects

Name: Surjeet Kour

Institution: IIT Delhi

Abstract: A contramodule N over a coalgebra C consists of a structure map $Hom(C, N) \longrightarrow N$ satisfying certain conditions determined by coassociativity and counitality. Although the notion of contramodules is classical, introduced by Eilenberg and Moore along with comodules, their development has lagged behind the study of comodules. In recent years there has been much interest in developing the theory of contramodule categories in tandem with those of comodule and module categories.

More specifically, we work with contramodule categories over an entwining structure. An entwining structure (C, A, ψ) consists of a coalgebra C and an algebra A woven together with a map $\psi : C \otimes A \longrightarrow A \otimes C$ that satisfies conditions similar to a bialgebra. For instance, an entwining structure captures the essence of a coalgebra Galois extension, or may be seen as a noncommutative replacement for a principal fiber bundle produced by the quotient of the free action of an affine algebraic group on a scheme. The properties of such a noncommutative space are then understood in terms of the category of modules over it. In general, modules over an entwining structure bring together several objects of study in the literature, such as relative Hopf modules, Doi-Hopf modules and Yetter-Drinfeld modules.

We consider contramodules over an entwining structure $(\mathscr{C}, A, \psi)$, where $\mathscr{C}$ is a "coalgebra with several objects," i.e., a category like object with cocomposition structures. This is the coalgebra counterpart of the philosophy of Mitchell, where a small preadditive category is seen as a "ring with several objects." The entwined contramodules now capture essential properties of the noncommutative quotient space associated to $(\mathscr{C}, A, \psi)$. In fact, this noncommutative quotient space need not exist as an explicit geometric object, but is understood only by means of the modules, comodules and contramodules over it. As such, we use adjoint functors between these contramodule categories to study ring like properties of extensions between these noncommutative quotient spaces. In particular, we give explicit categorical criteria for these extensions to satisfy (1) Frobenius properties, (2) Maschke properties and (3) separability properties.

Primary decomposition in S-Noetherian modules

Name: Shiv Datt Kumar

Institution: Motilal Nehru National Institute of Technology Allahabad, Prayagraj, India

Abstract: Let R be a commutative ring with identity, $S \subseteq R$ be a multiplicative set, and M be an R-module. We say that a submodule N of M with $(N :_R M) \cap S = \emptyset$ has an S-primary decomposition if it can be written as a finite intersection of S-primary submodules of M. Let Q be a submodule of an R-module M with $(Q :_R M) \cap S = \emptyset$, where $(Q :_R M) = \{r \in R \mid rM \subseteq Q\}$. Then Q is said to be an S-primary submodule if there exists $s \in S$ such that for all $a \in R$ and $m \in M$ if $am \in Q$,

then either $sa \in \sqrt{(Q :_R M)}$ or $sm \in Q$. Following is an example of an S-Noetherian module in which primary decomposition does not exist.

Example 1. *Let $R = \mathbb{F}[x_1, x_2, \ldots, x_n, \ldots]$ be a polynomial ring in infinitely many indeterminates over a field $\mathbb{F}$ and $M = (x_1, x_2, \ldots, x_n, \ldots)$. Then M is not Noetherian R-module and hence a non-Laskerian module. Consider a multiplicative set $S = R \setminus \{0\}$. Let N be a non-zero submodule of M and $0 \neq f \in N$. Then $f \in S$. Take $s = f \in S$. This implies that $sN \subseteq sM \subseteq sR \subseteq N$. Put $K = sR$. Then K is finitely generated submodule of N such that $sN \subseteq K \subseteq N$. Hence N is S-finite, and M is an S-Noetherian module but not a Laskerian module.*

Theorem 1. *(**S-Primary Decomposition**) Let M be an S-Noetherian R-module. Then every proper submodule N with $(N :_R M) \cap S = \emptyset$ can be written as a finite intersection of S-primary submodules.*

Theorem 2. *Let R be an S-Noetherian ring and M a finitely generated R-module. Let $(0) = N_1 \cap N_2 \cap \cdots \cap N_r$ be reduced S-primary decomposition of 0 in M, N_i being S-P_i-primary $(1 \leq i \leq r)$, where P_i is S-prime. If S contains no zero-divisors of M/N_i for all $i = 1, 2, \ldots, r$, then $Ass(M) = \{P_1, P_2, \ldots, P_r\}$.*

Theorem 3. *Let N be a submodule of R-module M such that $N = \bigcap_{i=1}^{n} N_i$ is a minimal S-primary decomposition, where N_i is S-P_i-primary submodule of M. Then for each $x \in R$, P_i is precisely the S-prime ideal satisfying $sP_i \subseteq s'\sqrt{((N :_M x) :_R M)} \subseteq P_i$ for some $s, s' \in S$. Also these P_i are independent of decomposition of N.*

On structural aspects of essential ideals in matrix nearrings and group nearrings

Name: Syam Prasad Kuncham

Institution: Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal

Abstract: Essential submodules play a vital role in the study of finite Goldie dimension in modules over associative rings. In this work, we extend these ideas to modules over nearrings. Nearrings are natural generalizations of associative rings in which addition need not be commutative and only one distributive law holds. We introduce the concept of essential ideals in matrix nearrings and establish several properties that highlight the interplay between nearrings and their corresponding matrix nearrings. Furthermore, we the study of essential ideals to group nearrings and explore their structural aspects. Finally, we prove the properties of graphs associated with these ideals and illustrate the results through suitable examples.

On finite groups defined by conjugacy relations and character fields

Name: Sugandha Maheshwary

Institution: Indian Institute of Technology Roorkee

Abstract: For a finite group G, the conjugacy classes in G and the irreducible characters of G are both topics of fundamental interest and are closely related to each other as well as to

the structure of G. Some classes of groups, for instances rational groups and real groups are based on the character values of irreducible characters of G, and are equivalently defined by the conjugacy criterion satisfied by elements in G. Lately, some interesting generalisations of rational groups have been recognised, of which some are related to the central units of integral group ring of G. In this short communication, I will give a brief overview of these classes, which will also demonstrate the relationship between the conjugacy relations in G and its character fields. I will demonstrate some recent progress on problems related to some of these classes.

Semigroup Actions on 2x2 Tropical Matrices

Name: Any Muanalifah

Institution: UIN Walisongo Semarang

Abstract: Tropical algebra is a semiring where the addition and multiplication operations are replaced by maximum and addition, respectively. Within this algebraic structure, tropical matrices form semigroups under tropical matrix multiplication. Among the most fundamental algebraic ideas connected to semigroups is that of a semigroup action. The concept of semigroup actions has been discussed on posets and preimage quasi-orders and on sets and the burnside ring. But, it has not been discussed in the context of a tropical setting. This paper discusses semigroup actions defined by 2×2 tropical matrices, and their freeness, transitivity, and regularity.

Topological Analysis of Changing Weighted Graphs Using Persistent Homology and THI

Name: Intan Muchtadi

Institution: Institut Teknologi Bandung

Abstract: This paper studies how the shape of a weighted graph changes over time using tools from topological data analysis. At each moment, we construct a filtration from the edge weights and compute persistent homology to capture important structures, such as connected components and cycles. We use the Topological Homology Index (THI) to summarize the total strength of these structures into a single number. By looking at THI at different times, we can see when topological features appear, grow, or disappear. We also introduce simple measures that show how sensitive these features are to changes in the graph. This framework helps identify stable patterns and remove noise in many types of dynamic graphs or discrete data.

Maxmin-ω Systems: Generalization of Max-Plus and Min-Plus Systems

Name: Muhammad Syifa'ul Mufid

Institution: Department of Mathematics, Institut Teknologi Sepuluh Nopember

Abstract: Maxmin-ω systems are introduced as a parametric generalization that bridges max-plus and min-plus algebraic systems through a threshold $0 < \omega \leq 1$. When $\omega = 1$, the system behaves as a classical max-plus system; when $\omega \approx 0$, it corresponds to a min-plus system; and for intermediate values of ω, the system exhibits a fuzzified interaction between maximization and minimization. Interestingly, several fundamental properties that hold in pure max-plus or min-plus systems no longer hold in the maxmin-ω setting. This breakdown reveals a richer, more flexible system that enables the modeling of nonlinear transitions between optimization extremes. We further discuss how these altered properties influence solution methods for problems such as linear equations and eigenproblems, providing insights into the behavior and potential applications of this new class of systems.

Primes and absolutely or non-absolutely irreducible elements in atomic domains

Name: Sarah Nakato

Institution: Kabale University

Abstract: An irreducible element of a commutative ring is called absolutely irreducible if none of its powers has more than one (essentially different) factorizations into irreducibles. Otherwise, the irreducible element is called non-absolutely irreducible. While absolute irreducibility has been studied in various contexts, including the study of number fields and class groups, its investigation in the theory of non-unique factorization of domains is still limited.

Not all absolutely irreducible elements are prime, and certain domains exhibit striking extremes: either all irreducibles are absolutely irreducible, or none are.

In this talk, we discuss integral domains that realize each of the eight logically possible scenarios concerning the existence or non-existence of primes, absolutely irreducibles that are not prime, and irreducible elements that are not absolutely irreducible. These constructions highlight the diversity of factorization behavior in commutative algebra and give new insights into the structure of integral domains.

Generator sets for the Magma Monoid

Name: Isaac Owusu-Mensah

Institution: University of Skills Training and Entrepreneurial Development

Abstract: In this talk, we will explore the algebraic structures of the magma monoid $(\mathcal{M}(S), \triangleleft)$, where $\mathcal{M}(S)$ comprises all binary operations on S. We investigate the order and generator set of elements characterizing idempotents, almost constant operations, and units - facilitating our analysis. A procedure for finding inverses of units is presented, along with key results on almost constant operations. Focusing on $|S| = 2$ and $|S| = 3$, we classify the elements into various categories, determine their orders and identify generating sets for the magma monoid. These

findings inform a concise methodology for identifying the generator sets of an arbitrary element $* \in \mathcal{M}(S)$.

Hypernorms and Bounded Operators in Hypervector Spaces

Name: Harikrishnan Panackal

Institution: Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal

Abstract: A hyperoperation generalizes the notion of a binary operation by allowing the composition of two elements to yield a set rather than a single element. Extending this idea, Al-Tahan and Davvaz introduced hypervector spaces over hyperfields as a generalization of vector spaces over fields. In this work, we study linear and weak linear transformations on hypervector spaces and obtain results on their isomorphisms. We introduce the concept of a hypernorm on a hypervector space and provide illustrative examples. Results on open maps and quotient spaces are established. We examine the structure and completeness of the set of all bounded operators on hypervector spaces and investigate sequences of bounded linear operators in complete hyper Banach spaces.

Study on Chain Conditions in Modules and Rings

Name: Manoj Kumar Patel

Institution: National Institute of Technology Nagaland

Abstract: In this talk we would like to explore the study of ascending/ descending chain condition of variants of module and ring structures. Here we will try to explore several properties of Artinian/ Noetherian modules and rings and their generalizations in the various context of chain condition, also trying to establish the relationship of these modules with injective/ projective modules. Further, we will focus on well-known Hopkins-Levitzki theorem and Hilbert's Basis theorem.

We investigate whether Hopkins-Levitzki Theorem extend to semi-projective/ semi-injective modules. Unfortunately the answer we have is negative; counter examples are provided. However it is shown that, the answer is positive for certain large classes of semi-projective/ semi-injective modules.

Orthogonal Jordan Derivations on Γ-semihyperrings

Name: Kishor Pawar

Institution: Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Abstract: We introduce the concept of orthogonal derivations on Γ-semihyperrings and explore some fundamental properties of orthogonal Jordan derivations. It is shown that a non-zero derivation is not necessarily orthogonal to itself and we establish the specific conditions under

which such a derivation becomes orthogonal to itself. Furthermore, we prove that the sum of two orthogonal derivations remains orthogonal to each of its summands. A necessary and sufficient condition for two derivations to be orthogonal is also derived.

Köethe Conjecture Revisited: an Introduction to Quasi Reduced Rings

Name: Puguh Wahyu Prasetyo

Institution: Universitas Ahmad Dahlan

Abstract: The Koethe conjecture was proposed by Gottfried Koethe in 1930. It states: In any ring, the sum of a nilpotent subring and a nil subring is nil. It holds true for several significant classes of rings, including all right Noetherian rings and quasi $2-$primal rings. In this paper, we work on $2-$primal rings, weakly $2-$primal rings, and quasi $2-$primal rings as key elements in our investigation. We introduce a quasi reduced ring as a generalization of a reduced ring and prove that quasi reduced rings also satisfy the Koethe conjecture. The class of all quasi reduced rings is denoted by $\mathcal{Q}_{\mathcal{R}}$. We technically show that the class $\mathcal{Q}_{\mathcal{R}}$ of all quasi reduced rings forms a weakly special class of rings and it is precisely the semisimple class $\mathcal{SK}$ of the Koethe nilradical $\mathcal{K}$ which implies that the upper radical $\mathcal{U}(\mathcal{Q}_{\mathcal{R}})$ is precisely the Koethe nilradical $\mathcal{K}$. We also provide a taxonomy related to $2-$primal rings, weakly $2-$primal rings, quasi $2-$primal rings, and quasi reduced rings. Finally, we give necessary and sufficient conditions for the Koethe conjecture to have a positive answer in quasi reduced ring perspective.

Lifting of Fischer Matrices method

Name: Abraham Prins

Institution: University of Fort Hare

Abstract: Bernd Fischer developed the Fischer matrices method based on Clifford theory, which is a technique used to construct the ordinary character tables of finite group extensions. It is well known that the ordinary irreducible characters of a factor group can be lifted to the full group. Let $\overline{G} = P.G$ be a finite extension of a p-group P by a group G and consider the factor group $\overline{F} = \frac{\overline{G}}{K}$, where $K \trianglelefteq \overline{G}$ is a characteristic subgroup of P. In this talk, we introduce the lifting of Fischer matrices method, which is a technique for constructing a Fischer matrix of $\overline{G}$, denoted $M(g)$, from the corresponding Fischer matrix $\widehat{M(g)}$ of $\overline{F}$. We will illustrate this technique to demonstrate how the Fischer matrices of the maximal subgroup $MS = 2^{9+16\cdot}Sp_8(2)$ of the simple Baby Monster group $\mathbb{B}$ can be derived from the Fischer matrices of an underlying factor group with structure $2^{1+16\cdot}Sp_8(2)$ and how these matrices can then be used to construct the character table of MS.

Numerical Semigroups of Sally Type

Name: Nil Şahin

Institution: Bilkent University

Abstract: A numerical semigroup S is called Sally type if its multiplicity is one more than its width. In this talk, we will analyze the properties of numerical semigroups of Sally type with embedding dimension $e-1$ and $e-2$ where e denotes the multiplicity. We compute the minimal number of generators of the defining ideal together with the minimal generators and minimal graded free resolutions in some special cases.

Partial order in module over a matrix nearring and a group nearring

Name: Tapatee Sahoo

Institution: Manipal Institute of Technology Bengaluru

Abstract: The notion of partial order plays a significant role in studying concepts such as positive elements, convex ideals, and ordered morphisms in algebraic systems. In this presentation, we introduce a partial order on modules over a nearring and explore its connections with matrix nearring. Due to the absence of one of the distributive properties in nearrings (compared to rings), the structural aspects of partial orders in nearrings and matrix nearrings become especially significant. We establish a characterization of the positive cone in a group nearring, analogous to the positive cone in a matrix nearring. Furthermore, we examine properties of convex ideals and the conditions associated with Archimedean orders in both matrix nearrings and group nearrings. These results give new developments into the structure of ordered nearrings.

Modifying the Field Axioms to Create Infinite and Infinitesimal Real Numbers

Name: Brendan Santangelo

Institution: Stockton University

Abstract: By modifying three of the field axioms and including two other axioms, it is possible to create extensions to fields using the equivalence classes of equivalence relations. If that field is the field of real numbers, then an ordering can be placed on these extensions. As a result, we get what can be called infinite and infinitesimal real numbers. An introduction and analysis of these extensions is conducted concluding with the creation of infinite and infinitesimal real numbers. And in hope of justifying their names, a quick discussion comparing these numbers to other known infinite and infinitesimal numbers is conducted.

Structure-Preserving Transformations: Recent Updates on the Homological Analysis of Bieberbach Groups

Name: Nor Haniza Sarmin

Institution: Universiti Teknologi Malaysia

Abstract: Homological invariants are powerful algebraic tools that are used to capture and classify the structural properties of groups, particularly through their extensions and cohomology. These invariants provide deep insights into the algebraic configuration of symmetry and structure, making them highly relevant in various areas of mathematics and physics. In crystallography, the symmetrical arrangement of atoms in crystalline solids naturally leads to the study of groups that preserve these symmetries. Among such groups, Bieberbach groups—which are torsion-free, discrete, and cocompact subgroups of the isometry group of Euclidean space—play a central role in modelling the symmetry of crystal lattices. Their intricate algebraic structure allows for the application of homological methods to analyze and classify their properties. This talk will present recent developments in the homological analysis of Bieberbach groups, with a particular focus on the influence of their point groups, whether abelian or nonabelian. Special attention will be given to new results, techniques, and classification outcomes that contribute to the growing body of knowledge in this area.

Probabilistically nilpotent finite groups

Name: Pavel Shumyatsky

Institution: University of Brasilia

Abstract: There are many ways to characterize finite nilpotent groups. For example, a finite group G is nilpotent iff all long commutators in G are trivial, or iff any two Sylow subgroups of coprime orders commute, and so on.

In this talk we will discuss finite groups in which one of such features holds with high probability and we will see how this affects the structure of the group.

Upper bound for the F-threshold of determinantal rings

Name: Jyoti Singh

Institution: Visvesvaraya National Institute of Technology

Abstract: In this talk, we discuss a new upper bound for the F-threshold $c^{\Updownarrow}(\Updownarrow)$ of determinantal rings generated by maximal minors by using a combinatorial approach. We prove that $c^{\Updownarrow}(\Updownarrow)$ coincides with the negative a-invariant in the case of $3 \times n$ and $4 \times n$ matrices and we conjecture such equality holds for all matrices. This is a joint work with Barbara Betti, Alessio Moscariello and Francesco Romeo.

Algebraic versions of $\mathbb{T}^2$ and of $\mathbb{P}^1 \times \mathbb{P}^1$ and Hochschild cohomology

Name: Andrea Solotar

Institution: Facultad de Ciencias Exactas y Naturales - Universidad de Buenos Aires

Abstract: We examine the Hochschild cohomology for triangular algebras that capture some aspects of geometry and topology of the torus and of the quadric surface, and for deformations of these algebras. In particular, this shows that the cup product on the Hochschild cohomology of a triangular algebra does not generally follow the intuition coming from monomial algebras. Our examples also demonstrate that the Hochschild cohomology of a deformation of an algebra may not experience the dimension drop but still have a different cup product structure, and that the Hochschild cohomologies of deformations of two derived equivalent algebras may exhibit noticeably different behaviours.

Reversibility in special linear groups

Name: Tejbir Tejbir

Institution: Indian Statistical Institute, Delhi Centre, India

Abstract: An element of a group is called reversible if it is conjugate to its inverse, and strongly reversible if it can be expressed as a product of two involutions. These notions arise naturally in several areas of mathematics, and their study forms a historically rich and active area of research. While every reversible element in a general linear group over a field is strongly reversible, this correspondence fails for special linear groups. In this talk, I will introduce the concept of reversibility in groups and present a classification of reversible and strongly reversible elements in the complex and quaternionic special linear groups. This is joint work with Krishnendu Gongopadhyay and Chandan Maity.

Classification and Gauss Composition using Clifford Invariants

Name: Venkata Balaji Thiruvalloor Eesanaipaadi

Institution: Indian Institute of Technology Madras

Abstract: (Co-Author: Soham Mondal). To a binary quadratic form with values in a line bundle (over an arbitrary base scheme), we may naturally associate the Clifford pair consisting of its generalised even Clifford algebra and its Clifford bimodule, which are respectively the degree zero and degree one graded pieces of its generalised Clifford algebra. A similarity of such binary quadratic forms (with values in isomorphic line bundles) naturally induces an isomorphism of Clifford pairs, which is an isomorphism of the associated quadratic (even Clifford) algebras and a compatible isomorphism of the associated Clifford bimodules. We show that this association induces a natural functorial correspondence between similarity classes of binary quadratic forms and isomorphism classes of Wood pairs consisting of a quadratic algebra and a traceable module over that algebra. This generalises previous work of Martin Kneser in the affine case and reconciles with the work of Melanie Matchett Wood which involved linear binary forms on the dual modules.

We apply our result to describe the Picard group of quadratic algebras, generalising earlier work of Martin Kneser and reconciling with recent work of Melanie Matchett Wood and William Dallaporta on Gauss Composition.

Some problems in algebra, number theory and combinatorics

Name: Dashdorj Tserendorj

Institution: National University of Mongolia

Abstract:

Problem 1. Prove the theorem from references [1] and [2] without the restriction $\frac{1}{2} \in \Phi$.

Problem 2. Find all forms of algebraic numbers that cannot be expressed using finite radicals [4].

Problem 3. Let $R = q\sqrt{D}$, where $0 < q \in \mathbb{Q}$ and $D \in \mathbb{N}$ is free of quadrant. Find the exact number of points with pairwise integral distances on a circle with radius R like in [5].

Problem 4.[3] If

$$[24] := \{1, 2, \ldots, 24\} = A_1 \cup A_2 \cup A_3,\ i \neq j,\ A_i \cap A_j = \varnothing,$$

then $\exists\ A_i,\ \exists x \neq y,\ z \in A_i,\ x + y = z$.

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On the Odd Unitary Analogue of Gram-Schmidt Process

Name: Aparna Pradeep Vadakke Kovilakam

Institution: Indian Institute of Technology Madras, India

Abstract: The Gram-Schmidt process introduced by J.P. Gram and E. Schmidt enables one to orthonormalize a set of vectors in an inner product space. Using this, one can transform a square matrix to an orthogonal matrix by an upper triangular matrix. This motivated L.N. Vaserstein to introduce a similar method for symplectic matrices in 1976. For a given alternating matrix ☒ of size 2n, Vaserstein proved the existence of two elementary matrices of size 2n − 1, which can

be modified to get symplectic matrices with respect to ⊠. In our recent paper, we defined a set of matrices analogous to Vaserstein-type matrices, for Petrov's odd unitary group, which is a generalization of all classical groups. We proved that these are elementary linear matrices, and these matrices belong to Petrov's odd unitary group under some conditions. We also proved that these matrices generate Petrov's odd elementary hyperbolic unitary group when the ring is commutative. Thus our construction gives a new set of generators for the odd elementary hyperbolic unitary group and thereby visualizing this group in a simpler form. We have also proved that the elementary matrices in the odd unitary analogue of the Vaserstein's construction form a set of generators for the elementary linear group. I would like to discuss this result in detail.

Cleanness of Modules from Grothendieck Category Point of View

Name: Indah Emilia Wijayanti

Institution: Department of Mathematics Universitas Gadjah Mada

Abstract: Clean module is defined as a generalization of clean ring. Since a module does not necessary have a multiplication, the definition of clean module is obtained from its homomorphisms ring. It has already well known the necessary and sufficient condition of clean module, which was introduced by some previous authors, for example in Lemma 2.1 and Proposition 2.2 of Camillo et al. [2]. The theorem is very useful for guiding observation of cleanness in other structures, for example for clean comodules or clean coalgebras. However, we propose a different approach, namely using some properties in Grothendieck category, such that we obtain a more general proof of the necessary and sufficient condition of clean module. Moreover, we can extend our observation in any Grothendieck category to get a categorical "clean" element.

Simple derivations and isotropy groups

Name: Dan Yan

Institution: Hunan Normal University

Abstract: In the talk, we will discuss the simple derivations and the structure of isotropy groups according to a simple derivation.

Pro-representability of Chow groups and Hodge numbers

Name: Sen Yang

Institution: Chuzhou University

Abstract: In this talk, I will discuss the pro-representability of the Chow group $CH^p(X)$, where X is a smooth projective variety over a number field k. When certain Hodge numbers of X vanish, namely, $H^p(X, \Omega^i_{X/k}) = H^{p+1}(X, \Omega^i_{X/k}) = \cdots = H^{2p-1-i}(X, \Omega^i_{X/k}) = 0$ for i such that $0 \leq i \leq p-2$,

we prove that the formal completion $\widehat{CH}^p(A)$ of $CH^p(X)$ at a local augmented Artinian k-algebra A with the maximal ideal m_A satisfies

$$\widehat{CH}^p(A) \cong H^p(X, \Omega^{p-1}_{X/k}) \otimes_k m_A.$$

This provides a unified cohomological criterion for the pro-representability of the functor $\widehat{CH}^p$, generalizing earlier work by Bloch, Stienstra, and Mackall for $p = 2$ and $p = 3$. Our result reveals an intrinsic connection between the deformation theory of algebraic cycles and the Hodge structure of X.

Key-Exchange Protocols Based on Split-Octonions and Zero Divisors

Name: El Haoui Youssef

Institution: Ecole Normale Supérieure, Moulay Ismail university of Meknes

Abstract: Split-octonions form an eight-dimensional, non-associative, non-commutative algebra equipped with a quadratic pseudo-norm and containing zero divisors. Leveraging this structure, we propose a key-exchange protocol where parties generate random non-invertible identifiers, and the public communication identifier is constructed via quaternionic decomposition. Subkeys are exchanged and combined into a shared session key, with correctness guaranteed by the right Moufang identity. Efficient algorithms are developed for split-octonion multiplication and coefficient encoding/decoding, and numerical examples are provided to demonstrate the protocol's effectiveness. This work highlights a novel use of pseudo-norms and non-associative algebras in cryptography, suggesting broader applications of higher-dimensional composition algebras in secure communications.

The Structure of (R, S)-Semimodules over Hemirings

Name: Dian Ariesta Yuwaningsih

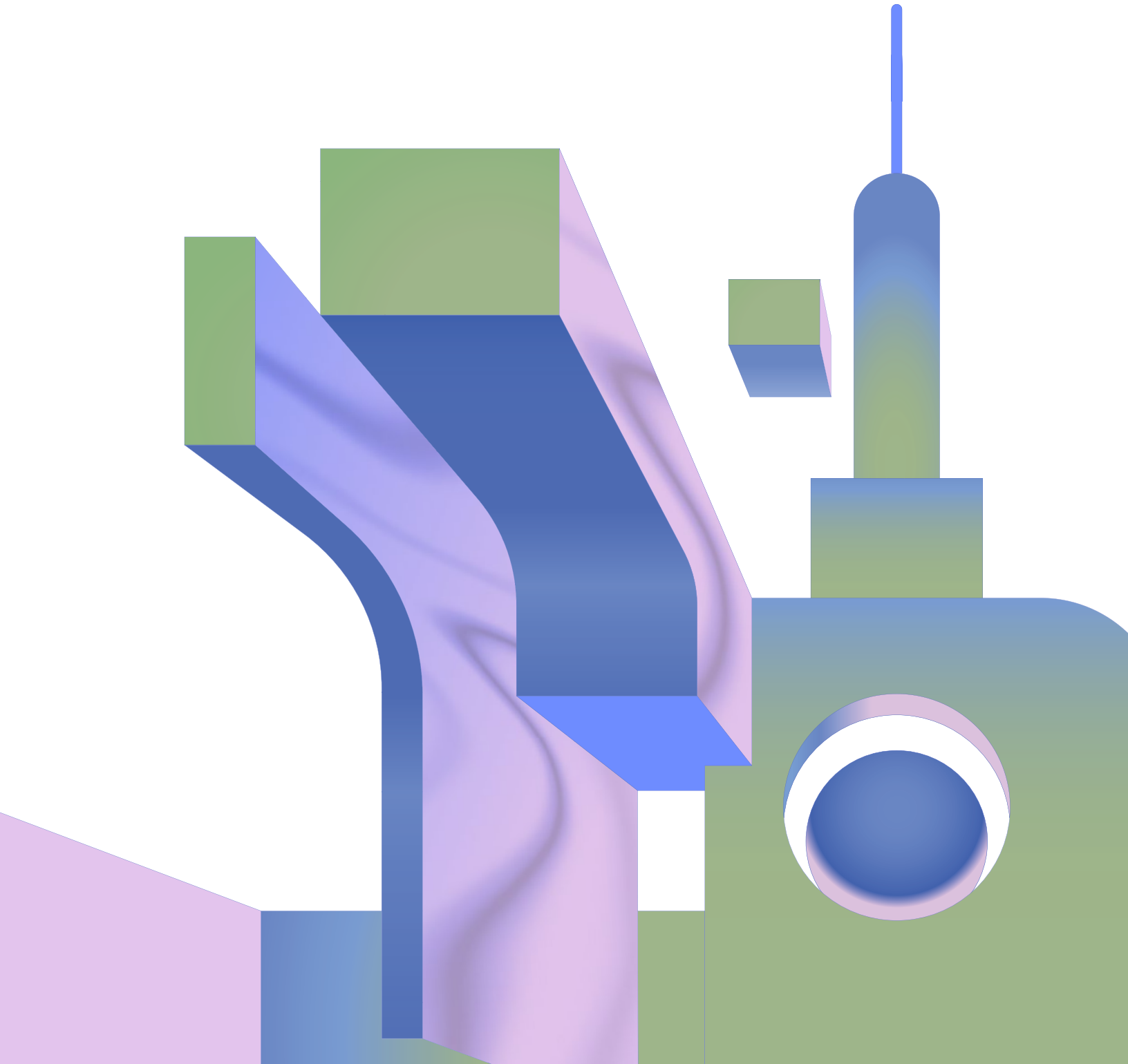
Institution: Universitas Ahmad Dahlan

Abstract: In ring theory, the bimodule structure has been extended to a (K, L)-module, where every (K, L)-bimodule is a (K, L)-module, but the converse holds only when the rings K and L possess central idempotents. The generalization of this concept to a hemiring R, a hemiring S, and a commutative additive monoid $(M, +)$ yields an (R, S)-bisemimodule. However, the structure of an (R, S)-semimodule, as a natural generalization of a bisemimodule, has not been extensively explored, even though it is essential for the development of radical theory and the study of non-unital structures in algebra. This study constructs an (R, S)-semimodule over a hemiring as a generalization of an (R, S)-bisemimodule. The choice of hemirings ensures that the resulting (R, S)-semimodule does not trivially reduce to a bisemimodule (as may occur in the case of semirings). Furthermore, the constructions of (R, S)-subsemimodules, cyclic (R, S)-semimodules, factor (R, S)-semimodules, and multiplication (R, S)-semimodules are presented, along with their main properties. These results enrich module theory over hemirings and open

further research opportunities on primeness and its generalizations, prime radicals, and the duality of primeness within the structure of (R, S)-semimodules.

SHORT COMMUNICATIONS

SECTION 3– NUMBER THEORY



A q-Series Identity of Uchimura and its Numerous Generalizations

Name: Archit Agarwal

Institution: IIT Indore

Abstract: In 1981, Uchimura rediscovered an interesting q-series identity of Ramanujan, whose one side is the generating function for the divisor function $d(n)$. Mainly, he proved the following identity. For $|q| < 1$,

$$\sum_{n=1}^{\infty} nq^n(q^{n+1})_\infty = \sum_{n=1}^{\infty} \frac{(-1)^{n-1}q^{\frac{n(n+1)}{2}}}{(1-q^n)(q)_n} = \sum_{n=1}^{\infty} \frac{q^n}{1-q^n}.$$

Over the years, this identity has been generalized by many mathematicians in different directions. Uchimura himself in 1987, Dilcher (1995), Andrews-Crippa-Simon (1997), and recently Gupta-Kumar (2021) found a generalization. Any generalization of the right most expression of the above identity, we call as divisor-type sum, whereas a generalization of the middle expression we say Ramanujan-type sum, and generalization of the left most expression as Uchimura-type sum. In this talk, we shall discuss these generalizations and present a unified theory. This is joint work with S.C. Bhoria, P. Eyyunni and B. Maji.

Diophantine Approach to Understanding Surface Area and Volume Ratios in Prisms

Name: Jerico Bacani

Institution: University of the Philippines Baguio

Abstract: This study explores the interplay between number theory and geometry using the Diophantine equation $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = \frac{1}{n}$, where x, y and z are positive integers. We derive and analyze solutions for $n = 4, 5, 6$ and use Python to determine solutions for higher values of n. The study then connects these number-theoretic results to geometry by using the solutions as dimensions of prisms – rectangular, right triangular, and regular p-gonal prisms. We analyze how the surface area to volume (SA/V) ratios vary with n and prism type. For rectangular prisms, it is trivial that the SA/V ratio simplifies to $\frac{2}{n}$, while for other prism types, the expressions involve more complicated dependencies on n, the base shape, and apothem length. Explicit formulas for SA/V for such geometries shall be presented.

Self-dual representations of metaplectic SL(2)

Name: Kumar Balasubramanian

Institution: Indian Institute of Science Education and Research Bhopal

Abstract: Let F be a non-Archimedean local field of characteristic zero and $G = \mathrm{SL}(2, F)$. Let $\widetilde{G} = \widetilde{\mathrm{SL}}(2, F)$ be the metaplectic double cover of G. Let π be an irreducible smooth genuine

self-dual generic representation of $\widetilde{G}$. We will discuss an analogue of a result of Dipendra Prasad for the sign of π. This is a joint work with Ila Ahmad, Sanjeev Kumar Pandey and Varsha Vasudevan.

What is Monogenity?

Name: Tapas Chatterjee

Institution: IIT Ropar

Abstract: A number field K is called monogenic if it has a power basis, i.e. there exists an algebraic integer α such that $\{1, \alpha, \cdots, \alpha^{n-1}\}$ is a basis of K over $\mathbb{Q}$. Let $f(x) = x^n + ax^3 + bx + c$ be the minimal polynomial of an algebraic integer θ over the field of rationals with certain conditions on $a,\ b,\ c$, and n. Let $K = \mathbb{Q}(\theta)$ be a number field and $\mathcal{O}_K$ be the ring of integers of K. In this talk, we characterize all the prime divisors of the discriminant of $f(x)$ which do not divide the index of $\mathbb{Z}[\theta]$ in $\mathcal{O}_K$. As an interesting corollary, we establish necessary and sufficient conditions for $\mathbb{Z}[\theta]$ to be integrally closed which implies the number field $K = \mathbb{Q}(\theta)$ is Monogenic. In addition, we investigate the types of solutions to certain differential equations associated with the polynomial $f(x)$ with the help of monogenity of the splitting field of $f(x)$.

A quantitative solution to Hilbert's Tenth Problem: Universal pairs and formal verification

Name: Marco David

Institution: University of California, Berkeley

Abstract: This talk explores two themes: bounding the complexity of Diophantine equations over the integers, which provides a quantitative negative solution to Hilbert's Tenth Problem, and developing mathematical proofs with the assistance of interactive theorem provers.

Hilbert's Tenth Problem asks about the decidability of Diophantine equations and has been answered negatively by Davis, Putnam, Robinson and Matiyasevich. It is natural to ask for which subclasses of Diophantine equations Hilbert's Tenth Problem remains undecidable. Such subclasses can be defined in terms of universal pairs: simultaneous bounds on the number of variables ν and degree δ such that all Diophantine equations can be rewritten in at most this complexity. Our work develops explicit universal pairs (ν, δ) for integer unknowns, achieving new bounds that cannot be obtained by naive translations from known results over the natural numbers.

In parallel, we have conducted a formal verification of our results using the proof assistant Isabelle. While formal proof verification has traditionally been applied a posteriori to known results, this project integrates formalization into the discovery and development process. We also describe key insights gained from this unusual approach and its implications for mathematical practice. Our work contributes both to the study of Diophantine equations and to the broader question of how mathematics is conducted in the 21st century.

On Cilleruelo-Nathanson's method in Sidon sets

Name: Jinhui Fang

Institution: Nanjing Normal University

Abstract: A set A of integers is defined as a Sidon set if all the sums $a + a'$, $a \leq a'$, $a, a' \in A$ are distinct. In 2022, Nathanson further considered Sidon sets for linear forms. In this talk, we will present our recent results on generalized Sidon sets.

Existence of simple non-cyclic abelian varieties over arbitrary finite fields and of a given dimension g>1

Name: Alejandro Giangreco

Institution: Facultad de Ingeniería, Universidad Nacional de Asunción

Abstract: Vladuts characterized in 1999 the set of finite fields k such that all elliptic curves defined over k have a cyclic group of rational points. Under the conjecture of infinitely many Mersenne primes, this set is infinite. In these notes we prove that there is no a finite field k such that all the simple abelian varieties defined over k of dimension $g > 1$ have a cyclic group of rational points.

On Two Variable Artin's Conjecture

Name: Suhita Hazra

Institution: Chennai Mathematical Institute

Abstract: In 1927, during a conversation with H. Hasse, E. Artin posed the following conjecture: If a is neither -1 nor a perfect square then a is primitive root for infinitely many primes. Moreover he conjectured the asymptotic density of such primes. Though many significant partial results are known in this direction, yet we do not know a single integer a, for which the conjecture holds. A variant of this conjecture, known as the two variable Artin's conjecture, introduced by Moree and Stevenhagen in 2000 asks about the size of the set

$$\{p \leq x \ : \ p \text{ prime}, \quad a \bmod p \in \langle b \bmod p \rangle\}$$

for any two multiplicatively independent elements a and b in $\mathbb{Q}^*$. In this talk, we would like to present a recent work with M. Ram Murty and Jyothsnaa Sivaraman where we improve the unconditional lower bound of the above set given by Murty-Seguin-Stewart.

On irrationality criteria for certain constants

Name: Suraj Singh Khurana

Institution: SRM University-AP

Abstract: We discuss a criterion for the irrationality of certain constants that arise from the Ramanujan summation of a family of infinite divergent sums. This work is motivated by a result of J. Sondow on the irrationality criterion for the Euler – Mascheroni constant.

Distributions of prime truncations

Name: Matilde Lalin

Institution: Université de Montréal

Abstract: The prime number 35768631264621656762913 7 is notable because of the unusual property that it remains prime successively on removing the left digit until there are no remaining digits. In this talk we will explore the more general phenomena of the distribution of the number of prime truncations of integers and irreducible truncations of polynomials with coefficients over a finite field. This is joint work with Vivian Kuperberg.

Opposite Biases among Primes Associated with Elliptic Curves

Name: Sung Min Lee

Institution: Wake Forest University

Abstract: Let $E/\mathbb{Q}$ be an elliptic curve and p be a prime of good reduction for E. Several results have investigated the distribution of primes in arithmetic progressions for which the reduction, $E_p(\mathbb{F}_p)$ is cyclic or has prime order, showing that such biases depend on the arithmetic structure of E.

In this talk, we take a statistical perspective by considering a family of elliptic curves rather than a single one. We demonstrate that, on average, the primes with these properties tend to cluster in certain residue classes modulo n more than others. Interestingly, although the condition that $E_p(\mathbb{F}_p)$ has prime order implies that it is cyclic, we find that these two sets of primes exhibit opposite congruence class biases across the family.

This is joint work with Dr. Jacob Mayle and Dr. Tian Wang.

Explicit images for the Shimura Correspondence

Name: Swati Lnu

Institution: University of South Carolina

Abstract: For $(r, 6) = 1$ with $1 \leq r \leq 23$, and a non-negative integer s, we define

$$\mathcal{A}_{r,s,N,\chi} = \{\eta(z)^r f(z) : f(z) \in M_s(N, \chi)\}.$$

In 2014, Yang showed that for $F \in \mathcal{A}_{r,s,1,1_N}$, the r-th Shimura image associated to the theta-multiplier $\mathrm{Sh}_r(F \mid V_{24}) = G \otimes \chi_{12}$ where $G \in S^{new}_{r+2s-1}\left(6, -\left(\frac{8}{r}\right), -\left(\frac{12}{r}\right)\right)$. He proved a similar result for $(r, 6) = 3$. His proofs rely on trace computations in integral and half-integral weights.

In this talk, we provide a constructive proof of Yang's result. We obtain explicit formulas for $\mathcal{S}_r(F)$, the r-th Shimura lift associated to the eta-multiplier defined by Ahlgren, Andersen, and Dicks, when $1 \leq r \leq 23$ is odd and $N = 1$. We also obtain formulas for lifts of Hecke eigenforms multiplied by theta-function eta-quotients and lifts of Rankin-Cohen brackets of Hecke eigenforms with theta-function eta-quotients.

Rubin-Stark Units and Equivariant Annihilators of Class Groups

Name: Youness Mazigh

Institution: Moulay ismail university, faculty of sciences, Meknes

Abstract: We establish a Gras-type equality for finite abelian extensions of number fields, relating Fitting ideals of certain components of ray class groups to annihilators of quotients involving Rubin-Stark elements. This framework connects special values of Artin L-functions at $s = 0$ with the arithmetic of class groups and units for general rank r. We show that the equality is equivalent to the corresponding component of the equivariant Tamagawa Number Conjecture, and we discuss its consequences in the cases $r = 0$ and $r = 1$, which recover and refine results related to the Brumer-Stark conjecture and certain index formulae involving elliptic units.

Rademacher-type exact formula and higher order Turán inequalities for cubic overpartitions

Name: Fnu Meghali

Institution: IIT Indore

Abstract: In 1918, Hardy and Ramanujan made a breakthrough by developing the circle method to deduce an asymptotic formula for the partition function p(n), which was later refined by Rademacher in 1937 to produce an absolutely convergent series representation for p(n). Since then, Rademacher-type exact formulas for various partition functions have been investigated by many mathematicians. The concept of overpartitions was introduced by Lovejoy and Corteel in 2004. Kim, in 2010, studied an overpartition analogue of cubic partitions, termed as cubic overpartitions. The main objective of this paper is to establish a Rademacher-type exact formula for cubic overpartitions and, as an application, to derive an explicit error term that leads to their log-concavity. Furthermore, applying a result of Griffin, Ono, Rolen, and Zagier, we establish higher-order Turán inequalities for cubic overpartitions. In addition, we obtain log-subadditivity and generalized log-concavity properties for cubic overpartitions inspired by the work of Bessenrodt-Ono and DeSalvo-Pak on the ordinary partition function.

For This Ramsey – Collatz Equivalence Relation on Bitspace(363), Computational Search Establishes Over 16,000 Classes (by Definition, Not Exceeding 20,017)

Name: Mojtaba Moniri

Institution: Minneapolis College

Abstract: Our computational study concerns positive integers $n < 2^{363}$ (Bitspace(363)) under the Collatz map and a Ramsey weight function, focusing on the size of a resulting equivalence relation.

The Collatz map is defined as $n \mapsto n/2$ if even, and $n \mapsto (3n+1)/2$ if odd. Define the stopping time $c(n)$ as the number of steps to reach 1, or infinity if no such step exists. Stopping times are here partitioned into four categories: $c < 700$, individual values 700–3199, $c \geq 3200$, and infinity.

The Ramsey weight $w(n)$ is derived from binary digits of n labeling edges of a ternary tree of depth 5 (padding with leading zeros as needed); the smallest root-to-leaf path count across all binary subtrees gives $w(n) \in \{1, \ldots, 8\}$.

Considering equivalence classes by paired (c, w)-values (with merging for extreme c-ranges and merging w-values if c is infinity), the absolute upper bound is 20,017 classes.

Our computational search establishes a lower bound of 16,022 classes (16,874 without merging), including 1,595 weight-8 classes and nine of the potentially 16 merged classes for $c < 700$ or $c \geq 3200$. We also achieve long consecutive stopping-time ranges for weights 1–8 (e.g., weight 1 spans $[1, 2585]$). These results reveal significant structural diversity within Bitspace(363) under Collatz dynamics combined with Ramsey-theoretic constraints.

Cyclic number fields with prescribed elementary Iwasawa module

Name: Ali Mouhib

Institution: Sidi Mohamed Ben Abdellah university of Fes, Polydisciplinary Faculty of Taza, Morocco

Abstract: For a number field F and a prime number p, let F_∞ be the cyclotomic $\mathbb{Z}_p$-extension of F and $X_\infty(F)$ be the unramified Iwasawa module of F_∞, that is the Galois group over F_∞ of the maximal abelian unramified pro-p-extension. We prove that each finite elementary abelian p-group is realizable as $X_\infty(F)$, where F runs over an infinite set of cyclic number fields of degree p.

On a non-Archimedean analogue of a question of Atkin and Serre

Name: Sunil Naik

Institution: Queen's University, Kingston, Canada

Abstract: In this talk, we will discuss a non-Archimedean analogue of a question of Atkin and Serre. More precisely, we will discuss lower bounds for the largest prime factor of non-zero Fourier coefficients of non-CM normalized cuspidal Hecke eigenforms of even weight $k \geq 2$, level N with integer Fourier coefficients. In particular, we will show that for such a form f and for any real number $\epsilon > 0$, the largest prime factor of the p-th Fourier coefficient $a_f(p)$ of f, denoted by $P(a_f(p))$, satisfies

$$P(a_f(p)) \ > \ (\log p)^{1/8}(\log\log p)^{3/8-\epsilon}$$

for almost all primes p. This improves a result of Ram Murty, Kumar Murty, Saradha. Further, assuming the generalized Riemann hypothesis (GRH), we will show that there exists a positive constant c such that the set of primes p for which

$$P(a_f(p)) \ > \ cp^{1/14}(\log p)^{2/7}$$

has lower density at least $1 - \frac{2}{13(k-1)}$. Further, we extend these results to Fourier coefficients at natural numbers n using Brun's sieve. More precisely, we will show that the set

$$\left\{n \in \mathbb{N} \ : \ a_f(n) = 0 \text{ or } P(a_f(n)) > (\log n)^{1/8}(\log\log n)^{3/8-\epsilon}\right\}$$

has natural density equal to 1. We also discuss a number field analogue of a recent result of Bennett, Gherga, Patel and Siksek about the largest prime factor of $a_f(p^m)$ for $m \geq 2$. This is a joint work with Yuri F. Bilu and Sanoli Gun.

Inhomogeneous Diophantine approximations: some recent advances

Name: Vasiliy Neckrasov

Institution: Brandeis University

Abstract: This talk is about the inhomogeneous Diophantine approximations, that is, approximations of pairs of a matrix and a vector (or, equivalently, approximations of systems of affine forms) from the metric point of view. There are three natural ways to treat this setup: we can just look at all pairs; we can fix the matrix (this is called "twisted approximations"), or we can fix some vector. In recent years, a lot has been done in the setup of pairs and fixed vector. However, many essential questions remained unanswered in the twisted case.

We will give answers to some of these questions, build the metric theory of twisted approximations and observe some parallels between the twisted case and classical homogeneous Diophantine approximations. We will also see how twisted results serve as a bridge between the classical Khintchine-Groshev's theorem and zero-one law for Lebesgue measure of uniform approximations of pairs by Kleinbock and Wadleigh. Lastly, we will complement the aforementioned zero-one law by describing the sets of pairs uniformly approximable with arbitrary rates, and completely describe the Dirichlet spectra for this problem.

This talk is based on preprints arXiv:2503.21180 (with Nikolay Moshchevitin), arXiv:2508.01912 and some work in progress.

Factorization problems of p-adic L-functions arising in iwasawa theory

Name: Aprameyo Pal

Institution: Harish-Chandra Research Institution

Abstract: The goal is to explain factorization phenomena for certain p-adic L-functions, guided by the Artin formalism. I will begin by recalling some background and previously known results in the setting of GL_2 and $GL_2 \times GL_2$. I will then describe some of our recent work on factorization problems for triple products of Hida families and for twisted triple products of Hilbert modular forms over real quadratic fields. The proofs are largely based on comparisons between different Euler systems arising in these settings. Finally, I will give sketches of the proofs in selected cases, illustrating both analytic and algebraic factorization results, with an emphasis on the main ideas rather than technical details. These are joint works with K. Büyükboduk, D. Casazza, CdV Piquero and B. Das.

Unramified Pro-p Extensions and the Uniform Fontaine – Mazur Conjecture

Name: Supriya Pisolkar

Institution: Indian Institute of Science Education and Research(IISER)-Pune, India

Abstract: The uniform version of Fontaine – Mazur Conjecture predicts that uniform analytic pro-p groups cannot occur as Galois groups of infinite everywhere unramified pro-p extensions of number fields. A key invariant governing the structure of such groups is the relation rank r(G), which is difficult to compute in practice. Motivated by work of N. Boston, we identify families of bi-quadratic extensions that come close to violating the conjecture. In this talk, I present our results on whether the Galois groups associated to these bi-qudratic extensions yield genuine counterexamples, using recent results of Hajir, Maire, and Ramakrishna on the deficiency of the p-class tower to compute r(G). This is a joint work with Christian Maire.

Irrationality of zeros of Polygamma functions

Name: Preeti Preeti

Institution: Chennai Mathematical Institute

Abstract: Our work owes its origin to a recent note of Ram Murty in which he proved that all the zeros of the digamma function are irrational with at most one possible exception. We extend this investigation to higher-order polygamma functions.

Study of Semi-Geometric Sequences

Name: Jean Jolly Rakoto

Institution: University of Antananarivo, Madagaskar

Abstract: In this work, we study semi-geometric sequences and special semi-geometric sequences, focusing on their general term, recurrence relations, sums of consecutive terms, and convergence behavior. These sequences originate from the study of Ehrhart polynomials and counterexamples to a conjecture proposed by Beck et al. Our analysis provides explicit formulations and convergence criteria for these sequences, highlighting their role in discrete geometry and their potential applications in various fields such as evolutionary theory, epidemiology, finance, and mathematical modeling.

The possible adelic indices for elliptic curves admitting a rational cyclic isogeny

Name: Fnu Rakvi

Institution: The University of Maine

Abstract: In the 1970s, Serre proved that the adelic index of a non-CM elliptic curve over a number field is finite. More recently, Zywina conjectured the complete set of adelic indices for such curves over $\mathbb{Q}$. In this talk, we discuss a recent joint work with Kate Finnerty, Tyler Genao and Jacob Mayle in which we prove that Zywina's conjecture is true for the family of non-CM elliptic curves over $\mathbb{Q}$ that admit a nontrivial rational cyclic isogeny. This strengthens a result of Lemos that resolved Serre's uniformity question for the same family of curves.

Uniform bounds on S-integral preperiodic points for Chebyshev polynomials

Name: Sudhansu Sekhar Rout

Institution: National Institute of Technology Calicut, India

Abstract: Let K be a number field with algebraic closure $\bar{K}$, let S be a finite set of places of K containing all the archimedean places of K and let $\alpha, \beta \in \bar{K}$. We say that β is S-integral relative to α if no conjugate of β meets any conjugate of α at primes lying outside of S. For a rational map $\varphi : \mathbb{P}^1 \to \mathbb{P}^1$ defined over a field K, a point $x \in \mathbb{P}^1(\bar{K})$ is preperiodic if there exist distinct positive integers m, n such that $\varphi^m(x) = \varphi^n(x)$. In this talk, we will discuss uniformity results on the number of S-integral preperiodic points for a Chebyshev polynomial. In particular, suppose that $\varphi : \mathbb{P}^1 \to \mathbb{P}^1$ is a Chebyshev polynomial and $\beta \in K^\times$ is not a preperiodic point of φ, i.e., β is not of the form $\zeta + \zeta^{-1}$ for any root of unity ζ. Then we will see that there exists a constant $C := C([K : \mathbb{Q}], S)$ such that for any such β, if α is preperiodic and S-integral relative to β then the size of $\mathrm{Gal}(\bar{K}/K)$-orbit of α is bounded by the constant C.

Determinants of Mahler measures and special values of L-functions

Name: Detchat Samart

Institution: Burapha University

Abstract: In this talk, we will present some recent results about Mahler measures of two families of bivariate polynomials, namely $P_t = x + x^{-1} + y + y^{-1} + \sqrt{t}$ and $Q_t = x^3 + y^3 + 1 - \sqrt[3]{t}xy$. In the cases when the zero loci of these polynomials define CM elliptic curves over number fields, we derive general formulas for their Mahler measures in terms of L-values of cusp forms. For each family, we also classify all possible values of t in number fields of degree not exceeding 4 for which the corresponding elliptic curves have complex multiplication. Finally, for all such values of t in totally real number fields of degree $n = 2$ and $n = 4$, corresponding to elliptic curves $\mathcal{F}_t$ (resp. $\mathcal{C}_t$), we prove that determinants of $n \times n$ matrices whose entries are Mahler measures corresponding to their Galois conjugates are non-zero rational multiples of $L^{(n)}(\mathcal{F}_t, 0)$ (resp. $L^{(n)}(\mathcal{C}_t, 0)$).

Zariski Density of Grand Orbit Transversals in Arithmetic Dynamics

Name: Joseph Silverman

Institution: Brown University

Abstract: Let $f : X \to X$ be an endomorphism of a smooth projective variety X defined over a number field K, and assume that $X(K)$ is Zariski dense in X. Each point $P \in X(K)$ determines a grand orbit

$$\mathcal{O}_f^{\text{grand}}(P) := \big\{Q \in X(K) : f^n(Q) = f^m(P) \text{ for some } m, n \ge 0\big\}.$$

Distinct grand orbits are disjoint, so they define a dynamical orbital partition of $X(K)$. An *f-transversal of $X(K)$* is a subset $T \subseteq X(K)$ that contains exactly one point from each grand orbit. We ask to what extent f-transversals are large. More precisely, we say that a triple (X, K, f) is *weakly transversal* (respectively *strongly transversal*) if, after replacing K with a finite extension, there exists at least one Zariski dense f-transversal (respectively, if every f-transversal is Zariski dense). Weak and strong transversality quantify the idea that the collection of orbits should be widely spaced, and thus the two transversality properties are in some sense orthogonal to the more widely studied problem of density of individual orbits. We will describe recent work proving weak transversality for $\mathbb{P}^n$ and for K3 surfaces and strong transversality for linear maps of $\mathbb{P}^n$ and for abelian varieties, highlighting the variety of methods employed in the proofs. As time permits, we will discuss stronger properties that use only transversals formed by taking one point from each Zariski dense grand orbit. [Joint work with Hector Pasten]

Perfect Powers in Sequences of Polygonal Numbers

Name: Gokhan Soydan

Institution: Bursa Uludağ University

Abstract: If s is the number of sides in a regular polygon, the formula for the n-th s-gonal number is

$$P_s(n) = \frac{(s-2)n^2 - (s-4)n}{2}.$$

If s is the number of sides in a regular polygon, the formula for the n-th s-gonal number is

$$P_s(n) = \frac{(s-2)n^2 - (s-4)n}{2}.$$

Consider the Diophantine equation

$$P_s(n) = t^m$$

for integers n, s, t and $m > 2$. All solutions to this equation are known for $m > 2$ and $s \in \{3, 5, 6, 8, 10, 20\}$. Here we extend these results to the cases $s = 2k+4$ (where $k = 4, 6$ or $5 \leq k \leq 97$ is a prime number) and $s = k + 4$ (where $k = 9, 15$ or $3 \leq k \leq 97$ is a prime number). The proofs of our results use the modular and hypergeometric methods, linear forms in logarithms and extensive calculations. We were unable to completely solve the above Diophantine equations, but we expect (based on GRH and weak effective abc conjecture) that there will be no additional solutions beyond those explicitly shown in our main results.

This is a joint work with Andrzej Dabrowski, Salah Eddine Rihane and Paul Voutier.

Non-principal Euclidean Ideals in Real Biquadratic Fields

Name: Mohammed Taous

Institution: Mohammed First University, Faculty of Sciences, Oujda

Abstract: In his foundational work, Lenstra introduced the notion of a Euclidean ideal class and showed, under the Generalized Riemann Hypothesis, that for a non-imaginary quadratic number field the existence of a Euclidean ideal class is equivalent to the class group being cyclic. Later, Graves developed a powerful method to prove the existence of Euclidean ideals in more general settings by combining a Motzkin-type lemma with large sieve estimates. Building on these ideas and on subsequent work of Hsu, Chattopadhyay–Muthukrishnan, and Krishnamoorthy–Pasupulati, we study non-principal Euclidean ideal classes in real biquadratic extensions of $\mathbb{Q}$.

We consider families of real biquadratic fields $K = \mathbb{Q}(\sqrt{q}, \sqrt{d})$, with $q \equiv 3 \pmod 4$, where the class group $\mathrm{Cl}(K)$ is a 2-group and its Sylow 2-subgroup is cyclic. For such fields, we compute the 2-rank of $\mathrm{Cl}(K)$, describe the (narrow) genus field, and obtain explicit conditions on the ramification and splitting of primes which ensure that the Hilbert genus field is a quadratic extension of K. Combining these structural results with a density statement à la Graves for suitable sets of prime ideals, we prove that whenever the class number h_K is a power of two, there exists a non-principal Euclidean ideal class in K. We also give many explicit examples obtained with PARI/GP that illustrate the range of applicability of the method.

Finally, we discuss how the same strategy can be adapted to other families of real biquadratic fields and how it suggests possible extensions to more general abelian number fields over $\mathbb{Q}$, where the interaction between genus theory, capitulation phenomena, and Euclidean ideal classes remains largely open.

Roth's Theorem in Super Smooth Numbers

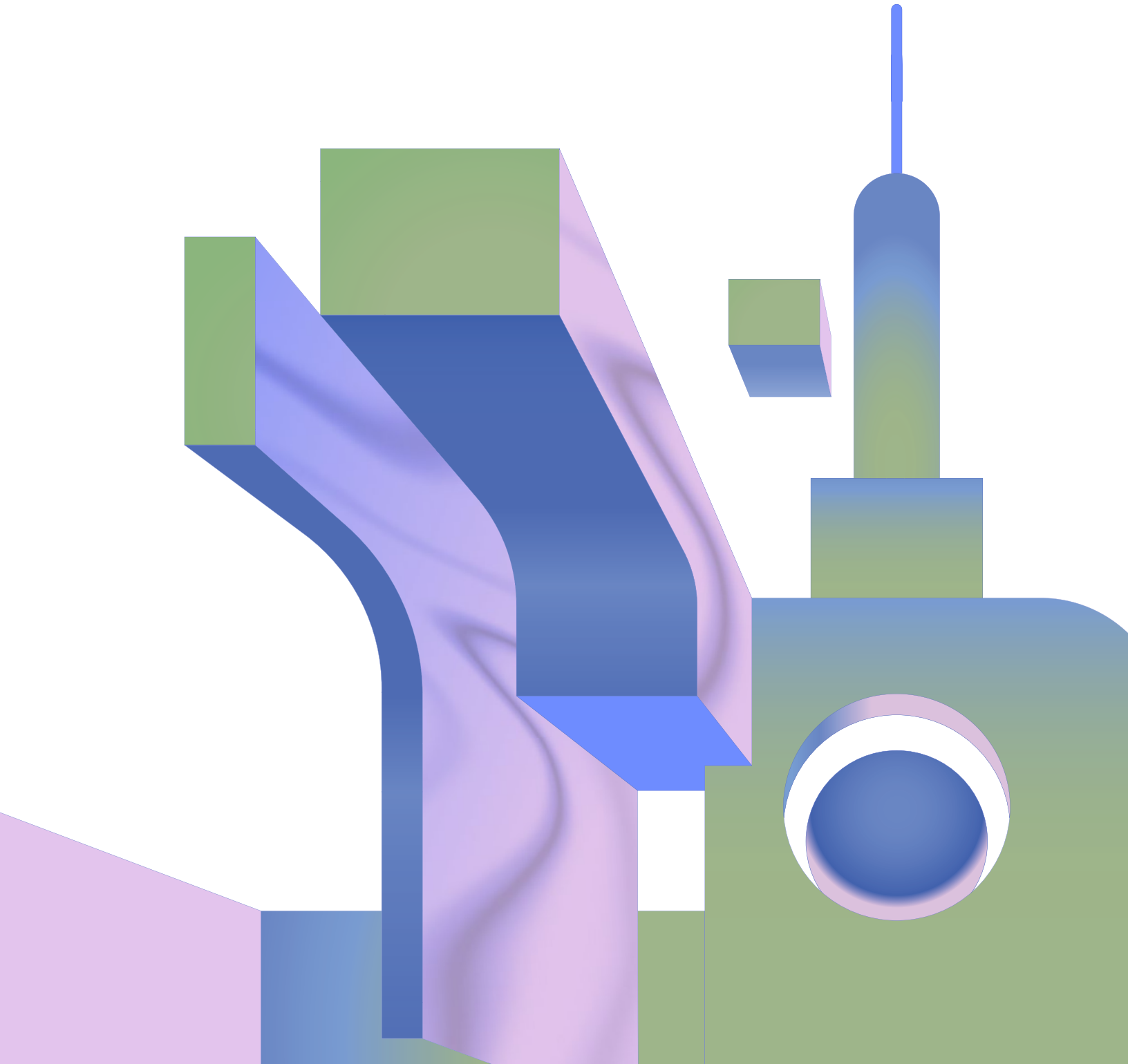
Name: Laurence Petrus Wijaya

Institution: University of Kentucky

Abstract: We say that the set of y-smooth numbers $\mathcal{S}(N, y)$ up to N is super smooth if $y = \log^K N$ for a large fixed constant K. We show that the Roth's theorem on arithmetic progressions is true in super smooth numbers case. This extends the result of Harper where he showed the statement is true under a weaker hypothesis.

SHORT COMMUNICATIONS

SECTION 4– ALGEBRAIC AND COMPLEX GEOMETRY



Uniform rationality and related properties

Name: Juliusz Banecki

Institution: Jagiellonian University

Abstract: In 1989, motivated by applications to Oka theory, M. Gromov asked whether every smooth rational complex algebraic variety X is uniformly rational, meaning that each point of X admits a Zariski open neighbourhood isomorphic to a Zariski open subset of the affine space. Despite a promising attempt at solving it in the affirmative using the Weak Factorization Theorem, it still remains open. In my talk, I will describe two alternative versions of this problem, where instead of rationality one considers different birationally invariant properties (stable rationality and retract rationality), and discuss my recent solutions to these versions.

Symmetries of Hypersurfaces

Name: Louis Esser

Institution: Princeton University

Abstract: Beginning from the study of Platonic solids in ancient times, a key program in mathematics is to classify objects of various types with the most symmetries. In algebraic geometry, some of the most basic objects to investigate are hypersurfaces, those spaces defined by a single polynomial equation. To capture all their inherent symmetries, we study these hypersurfaces inside complex projective space.

In this work, joint with Jennifer Li, we determine exactly which smooth hypersurfaces of complex projective space have the largest symmetry group in every dimension and every degree. We find that the Fermat equation defines the hypersurface with the most symmetries in all but exactly eight cases and describe these exceptions. The exceptional examples have an exceedingly rich geometry and history extending back to the discovery of the first example by Klein in the 1870s. This presentation will illuminate the 150-year mathematical journey that finally led to the full classification.

Equivariant structure of the cohomologies of curves

Name: Jędrzej Garnek

Institution: Adam Mickiewicz University, Poznan

Abstract: The study of the cohomology of algebraic varieties equipped with an action of a finite group is a classical and well-developed area. In this talk, I present new results on the Hodge, de Rham, and crystalline cohomology of smooth projective curves endowed with an action of a finite p-group in characteristic p.

I show that the Hodge and de Rham cohomologies of an arbitrary p-group cover admit a decomposition into a global part and local parts. The global part depends only on the 'topology' of the cover (i.e. the stabilizer groups and the quotient curve). The local parts arise from Harbater

– Katz – Gabber covers that approximate the cover over a given point. This extends my earlier results for generic covers and generalizes a theorem of Nakajima in the étale case.

I then address the analogous question for crystalline cohomology. Although such a decomposition is not known in general, I present a new result for $\mathbb{Z}/p^n\mathbb{Z}$-covers which provides evidence that a similar local – global phenomenon should hold in this setting as well.

Derivative of the circulation invariant and preservation of the diffeomorphism of vortex filaments

Name: Elena Milyute

Institution: Department of Mathematical Computer Science, Vilnius University

Abstract: In vortex dynamics of matter, the concept of a kern serves as a fundamental structure for understanding the transport of vortex motion of matter in incompressible spiral flows that create the kern of an elliptical vortex. A vortex kern is defined as the core of a cone where, at the boundaries of the kern, the vortex formation lines act together to form an alternating right and left coherent structure that is preserved under the conditions of "ideal" twisted spiral filaments that behave as autowaves. The study of such complex vortex topological structures ($3R$) is central to understanding both the local and global topology of matter distribution in a closed vortex. In this paper, the differential properties of vortex helicity, a well-known topological invariant governing the quantities μ and the Lie derivative in the three-dimensional case were investigated. Helicity, defined by the volume integral of the scalar product of the velocity and vortex formation fields, remains constant in time in Euler dynamics. The behavior of the helicity functional for infinitesimal deformations of the flow map, considering variations that preserve the diffeomorphic structure of vortex filaments with their own spin and twist was analyzed. I have determined that the derivative μ ("myu"), characterizing the microvortex circulation vector, relative to smooth deformations of the vortex kern boundary can be expressed through boundary flows of helicity density and tangential flow components. The variational formulation emphasizes the invariance of the microvortex vorticity vector relative to volume-preserving diffeomorphisms of vortex filaments passing through the kern, with conservation of the vector and velocity of circulation of matter transfer. In addition, it was found that during a smooth transition to the center of an elliptical vortex, the conservation of helicity implies a limitation on the tangential stretching of the vortex formation lines, which gives an idea of the stability and constancy of such structures. This result links the conformal geometry and vortex dynamics of matter, suggesting that the dynamics of the vortex filaments that make up the kern carcass are regulated by the global vortex potential of the elliptical vortex kern, which determines its energy and stability. Accurate understanding of this vortex mechanism opens the way for the application of models of interaction of closed vortices of different spins in both theoretical hydrodynamics and CFM.

The reduced special fiber of any potentially semistable model of a curve is semistable

Name: James Myer

Institution: The City University of New York Graduate Center

Abstract: We show that if X is a smooth projective curve defined over a complete discretely valued field K with algebraically closed residue field k, then any potentially semistable model of X already has semistable reduced special fiber.

Canonical Coordinates for Moduli Spaces of Connections on Curves and Geometric Painlevé property of Isomonodromic Differential Equations

Name: Masa-Hiko Saito

Institution: Kobe Gakuin University

Abstract: In this talk, we study a geometric counterpart of the cyclic vector which allow us to put a meromorphic connections on a curve into a “companion” normal form. This allow us to naturally identify an open set of the moduli space of connections (with fixed generic spectral data, i.e. unramified, non resonant) with some Hilbert scheme of points on the twisted cotangent bundle of the curve. We prove that this map is symplectic, therefore providing Darboux (or canonical) coordinates on the moduli space, i.e. separation of variables. We will also discuss about Riemann-Hilbert correspondences from moduli spaces of connections to moduli spaces of generalized monodromy data (monodromy data and Stokes data). We also review on a result of Inaba-Iwasaki-Saito about a proof of Painlevé property of all isomonodromic differential equations including Painlevé equations and Garnier equations. The Hamiltonian structure of these equaions can be understood by the canonical coordinates.

Classifying torsors of tori with Brauer groups

Name: Pankaj Singh

Institution: University of South Carolina

Abstract: Using Mackey functors, we provide a general theory for classifying torsors of algebraic tori in terms of Brauer groups of finite field extensions of the base field. This generalizes Blunk’s description of the tori associated to del Pezzo surfaces of degree 6 to all retract rational tori, which is essentially the largest class where this is possible.

Equivariant birational geometry

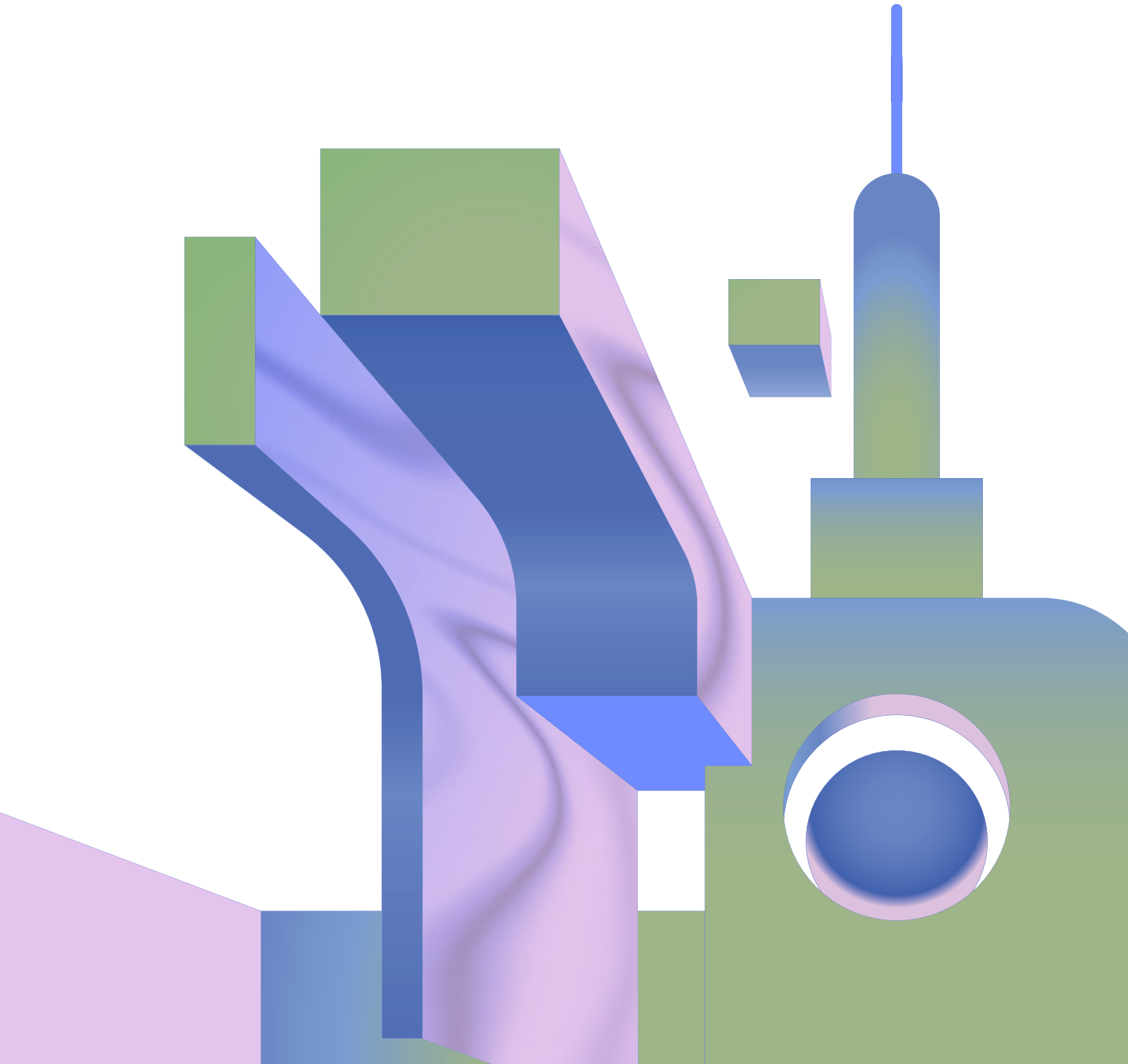
Name: Zhijia Zhang

Institution: New York University

Abstract: Let X be an algebraic variety and G a finite subgroup of the automorphism group of X. We will discuss a few results on how rationality properties of X behave under the G-action.

SHORT COMMUNICATIONS

SECTION 5– GEOMETRY



Holonomy of the Obata connection on 2-step hypercomplex nilmanifolds

Name: Adrian Andrada

Institution: Universidad Nacional de Cordoba - CONICET

Abstract: We study the holonomy of the Obata connection on 2-step hypercomplex nilmanifolds. By explicitly computing the curvature tensor, we determine the conditions under which the Obata connection is flat, showing that this depends on the nilpotency step of each complex structure. In particular, we show that the holonomy algebra of the Obata connection is always an abelian subalgebra of $\mathfrak{sl}(n,\mathbb{H})$: to establish this, we prove the $\mathbb{H}$-solvable conjecture for 2-step hypercomplex nilmanifolds. Furthermore, we provide new examples of k-step nilpotent hypercomplex nilmanifolds, with arbitrary k, which are not Obata flat.

On the existence of a Riemannian structure for a given connection

Name: Manelo Anona

Institution: Université d'Antananarivo

Abstract: Let M be a connected and paracompact differentiable manifold of dimension $n \geq 2$, and let J be the vector 1-form defining the natural tangent structure of the tangent bundle TM. An energy function $E : TM \to \mathbb{R}_+$, which vanishes on the null section and is homogeneous of degree two such that the 2-form $\Omega = dd_J E$ has maximal rank (where $d_J = [i_J, d]$ and d is the exterior derivative), defines a metric on the vertical bundle by $g(JX, JY) = \Omega(JX, Y)$ for all $X, Y \in \chi(TM)$ (where $\chi(TM)$ denotes the set of vector fields on TM). The relation $i_S dd_J E = -dE$ defines a canonical spray S, where i_S denotes the inner product with respect to S. The vector 1-form $\Gamma = [J, S]$ is an almost-product structure ($\Gamma^2 = I$, where I is the identity map), considered by Grifone as a torsion-free linear connection of H. Rund using the Frölicher-Nijenhuis formalism. We demonstrate that the connection Γ comes from a Riemannian metric if and only if there exists an energy function E_0 satisfying $d_R E_0 = 0$, where $R = \frac{1}{2}[h, h]$ is the Nijenhuis tensor of the horizontal projector $h = \frac{\Gamma + I}{2}$, and such that the scalar 1-form $d_v E_0$ (where $v = \frac{I - \Gamma}{2}$) is completely integrable. Under these conditions, there exists a function $\varphi(x)$, constant on the fibers, such that $e^{\varphi(x)} E_0$ is the energy function associated with the connection Γ. The equation $d_R E_0 = 0$ reduces to a system of linear equations and is, therefore, explicitly solvable. Once the function E_0 is obtained, one must verify that $d_v E_0$ is completely integrable. The function $\varphi(x)$ is then determined by the condition $d_h(e^{\varphi(x)} E_0) = 0$. Several explicit examples illustrate the effectiveness of this method.

Complex structures on nilpotent almost abelian Lie groups

Name: Romina Arroyo

Institution: CONICET & Universidad Nacional de Córdoba

Abstract: The study of left-invariant geometric structures on nilpotent Lie groups is an active field

of research and several results are known in low dimensions. A particularly intriguing problem within this field is the classification of nilpotent Lie groups that admit left-invariant complex structures. Although there are many contributions to the subject, it is considered a wild problem and in general it is far from being solved.

In this talk, we will focus on left-invariant complex structures on nilpotent almost abelian Lie groups. We will present the classification of nilpotent almost abelian Lie groups that admit left-invariant complex structures.

These results were obtained through collaborative work with María Laura Barberis (Universidad Nacional de Córdoba & CONICET, Argentina), Verónica Díaz (Universidad Nacional de Mar del Plata, Argentina), Yamile Godoy (Universidad Nacional de Córdoba & CONICET, Argentina) and María Isabel Hernández (CONACYT - CIMAT Mérida, Mexico).

ω-Bach solitons and quasi-Bach solitons on some Riemannian manifolds

Name: Arindam Bhattacharyya

Institution: Jadavpur University

Abstract: In this article, we introduce ω-Bach tensor corresponding to one form ω and correspondingly introduce ω-Bach solitons and almost ω-Bach solitons. We characterize almost ω-Bach solitons, when the potential vector field of the soliton generates an infinitesimal harmonic transformation, or is an affine conformal vector field, or is a projective vector field, or is a Killing vector field, when the ω-Bach tensor is divergence free, or is a harmonic 1 form or is a Killing 1-form. One of the main results of this note is that we explicitly find some of the gradient almost ω-Bach solitons on the product manifolds $S^2 \times H^2$, $R^2 \times H^2$ and $R^2 \times S^2$. We have also introduced quasi-Bach tensor and correspondingly introduced almost quasi Bach solitons. We explore some properties of gradient quasi Bach solitons with harmonic Weyl curvature tensor. We also find the evolution of volume, Einstein metric, Ricci curvature and scalar curvature, under the quasi Bach flow. Our results obtained here extends the results of Bach solitons and Bach flow. Finally, we obtain the characterization of gradient quasi-Bach soliton of type I, a particular quasi Bach soliton, on the product manifolds $S^2 \times H^2$ and $R^2 \times H^2$.

Sections of rational elliptic Lefschetz fibrations

Name: Mohan Bhupal

Institution: Middle East Technical University

Abstract: We give a list of monodromy factorizations in the pure mapping class group $\mathrm{PMod}(\mathrm{T}^2_{d+1})$ of a torus with $d+1$ marked points that represent all lines (aka rational (-1)-curves) on a del Pezzo surface $Y = \mathbb{C}P^2\#(9-d)\overline{\mathbb{C}P}^2$ of degree d, for $d \leq 3$. These factorizations are lifts of a certain fixed monodromy factorization in $\mathrm{PMod}(\mathrm{T}^2_d)$ that represents Y.

In the case $d = 1$, which we discuss in more detail, we give an explicit correspondence between the set of such factorizations and the 240 roots of $E_8 = K^\perp$ (orthogonal complement in $H_2(Y)$ of

the canonical class).

This is a joint work with Sergey Finashin.

Eta-Ricci-Bourguignon solitons on Three-Dimensional H-Paracontact Manifolds

Name: İrem Küpeli Erken

Institution: Bursa Technical University

Abstract: This work explores the geometric properties of Eta-Ricci-Bourguignon solitons and their gradient counterparts within the framework of 3-dimensional H-paracontact manifolds. Our main focus lies in characterizing these solitons through the structural behavior of the associated operator h. To complement our theoretical results, we also construct examples that demonstrate the validity and applicability of our results.

Gauge theory and the Bogomolov-Miyaoka-Yau inequality for symplectic 4-manifolds

Name: Paul Feehan

Institution: Rutgers University

Abstract: We describe recent progress in our work to prove the conjecture that symplectic 4-manifolds with obey the Bogomolov-Miyaoka-Yau inequality. Our method uses Morse theory on the moduli space of non-Abelian monopoles. The method aims to use the fact that there is at least one non-vanishing Seiberg-Witten invariant to produce a solution to the anti-self-dual Yang-Mills equation on a vector bundle with suitable topology over the symplectic 4-manifold. The talk is based on joint work with Tom Leness and the monographs https://arxiv.org/abs/2010.15789 (to appear in AMS Memoirs) and https://arxiv.org/abs/2206.14710.

Rigidity results for Serrin's overdetermined problems in Riemannian manifolds

Name: Allan George de Carvalho Freitas

Institution: Federal University of Paraíba

Abstract: In this lecture, we are interested in studying Serrin's overdetermined problems in Riemannian manifolds. For manifolds endowed with a conformal vector field, we prove a Pohozaev-type identity to establish a Serrin-type rigidity result using the P-function approach introduced by Weinberger. To achieve this, we proceed with a conformal change, starting from a geometric

identity due to Schoen. Moreover, we obtain a symmetry result for the associated Dirichlet problem by utilizing a generalized normalized wall shear stress bound.

A formula for the α-Futaki character

Name: Kartick Ghosh

Institution: Institute of Geometry and Physics, USTC, China

Abstract: Álvarez-Cónsul–Garcia-Fernandez–García-Prada introduced the Kähler-Yang-Mills equations. They also introduced the α-Futaki character, an analog of the Futaki invariant, as an obstruction to the existence of the Kähler-Yang-Mills equations. The equations depend on a coupling constant α. Solutions of these equations with coupling constant $\alpha > 0$ are of utmost importance. We provide a formula for the α-Futaki character on certain ample line bundles over toric manifolds. We then show that there are no solutions with $\alpha > 0$ on certain ample line bundles over certain toric manifolds and compute the value of α if a solution exists. We also relate our result to the existence result of Keller-Friedman in dimension-two.

Milnor Spheres via Spherical T-Duality and Generalized Log Transform

Name: Lino Grama

Institution: University of Campinas

Abstract: In talk we will explore the interplay between Spherical T-duality, exotic spheres, and the generalized log transform, highlighting new connections in geometric topology and complex geometry. Spherical T-duality extends the classical T-duality by replacing the role of the circle group $\mathrm{U}(1)$ with the 3-sphere S^3 or the group $\mathrm{SU}(2)$, relating $\mathrm{SU}(2)$ bundles equipped with degree-7 cohomology cocycles. A remarkable class of examples involves the 7-dimensional homotopy spheres Σ^7, whose product with S^1 exhibits phenomena such as distinct holomorphic structures transported via spherical T-duality, which contrasts with classical Hopf manifolds like $\mathrm{S}^3 \times \mathrm{S}^1$.

Building on this framework, we introduce the generalized log transform, a tool extending classical techniques from 4-dimensional elliptic fibrations to higher-dimensional settings. Applying this to 8-dimensional homotopy Hopf manifolds, we reveal parallels between these constructions and their lower-dimensional counterparts, providing new insights into the role of singularities and complex structures. This is joint work with Leonardo Cavenaghi and Ludmil Katzarkov.

The isoperimetric problem for hyperideal polyhedra

Name: Ren Guo

Institution: Oregon State University

Abstract: In this talk, I will discuss the isoperimetric problem for hyperbolic hyperideal polyhedra. A convex hyperideal polyhedron, with all vertices beyond the sphere at infinity and equal edge lengths, uniquely maximizes volume among those with the same combinatorial type and surface area. Constructed examples include hyperideal counterparts of all convex uniform polyhedra, certain Johnson solids, and other hyperideal polyhedra with no analogues in Euclidean space.

From symplectic and contact geometry to urban and architecture modelling

Name: Hassan Ait Haddou

Institution: Paris-Cité University ENSAPVS

Abstract: This work extends results introduced at the ICM 2018 in Rio-de-Janeiro, focusing on the application of differential geometry to Building Information Modeling (BIM) and computational approaches to architecture. Within the scope of that research, the primary objective was to introduce and give some properties around architectural geometry which is an important generalization of the basic geometry. In particular, we developed new models to analyze and assess environmental impacts over the entire life cycle of a product, modeled within an n-dimensional closed manifold M.

This work builds upon the results presented in the book published by my PhD advisor, Banyaga, together with Hurtubise and Spaeth (2024), where the Twisted Morse Homology Theorem is established and the connection with Lichnerowicz cohomology is made explicit. The Lichnerowicz cohomology $H^*_\omega(M)$ (i.e. cohomology of the complex of differential forms on a smooth manifold with the de Rham differential operator deformed by a closed 1-form ω) was initiated by A. Lichnerowicz. Since its introduction, this cohomology has attracted a lot of interest and its importance comes from the fact that it is well adapted to locally conformal symplectic geometry.

The aim of this new contribution is to extend this framework by investigating the structure of Lichnerowicz cohomology to identify new cohomological invariants and develop new models to analyze and assess environmental impacts over the entire life cycle of a product in the n-dimensional closed manifold M.. As we have shown in our previous research, mathematical models and outcomes developed in the context of research projects in architectural geometry often lack interoperability, primarily because the simulation environments used are closed systems rather than open-source platforms. The question that then arises is how to produce a tool that allows the flow of information between the various simulators based on symplectic and contact geometry that are complementary but not integrated.

Strongly adapted contact geometry of Anosov 3-flows

Name: Surena Hozoori

Institution: Brandeis University

Abstract: We will discuss some recent developments in the contact geometric theory of Anosov

3-flows, whose roots go back to the works of Mitsumatsu and Eliashberg-Thurston in the mid 1990s. In particular, we provide a contact geometric characterization of Anosov 3-flows based on interactions with Reeb dynamics, as well as investigate some properties of the resulting geometries. We will briefly highlight how these results allow one to re-approach some classical open questions in Anosov dynamics.

Gromov-Lawson and Gromov conjectures for Kähler metrics

Name: Ekansh Jauhari

Institution: University of Florida

Abstract: The conjectures of Gromov-Lawson and Gromov predict obstructions to the existence of Riemannian metrics of positive scalar curvature on closed manifolds in terms of their asphericity and large-scale geometry, respectively. In this talk, I will address these conjectures for Kähler metrics on smooth projective manifolds. In detail, I will propose a strengthening of the Gromov-Lawson conjecture in the Kähler projective setting and show that a smooth aspherical projective variety cannot support a Kähler metric of positive scalar curvature. I will also propose a version of the Gromov conjecture in this setting and show that a smooth projective variety with maximum macroscopic dimension cannot support a Kähler metric of positive scalar curvature. The latter result is refined in the case of totally non-spin manifolds and complex projective surfaces. The proofs of these results draw new connections between the theories of the minimal model, positivity in complex algebraic geometry, and macroscopic dimensions. This talk is based on joint work with Luca F. Di Cerbo and Alexander Dranishnikov.

Adjoint Integration of Lie Algebroids

Name: Pooja Joshi

Institution: Washington University in Saint Louis

Abstract: The adjoint integration of a Lie algebroid—when it exists—is its minimal (i.e., smallest) Lie groupoid integration. In this talk, we investigate the conditions for the existence of adjoint integrations and develop systematic methods for their construction. We show that such an integration exists if and only if the source-simply connected integration admits a maximal discrete normal subgroupoid; the adjoint integration is then obtained as the corresponding quotient.

A key result is that the category of discrete normal subgroupoids—and, in the Poisson setting, Lagrangian discrete normal subgroupoids—is invariant under (symplectic) Morita equivalence. This invariance offers a conceptual explanation for the naturality of minimality in the integration of Lie algebroids.

Following the approach of Garmendia and Villatoro, we construct the holonomy groupoid of a Lie algebroid. These results lay the groundwork for our next goal: defining the C^*-algebra of this (possibly non-smooth) holonomy groupoid and developing an associated pseudodifferential calculus, with applications to index theory and noncommutative geometry.This is a joint work with Joel Villatoro.

Ricci Flow on ALF manifolds

Name: Dain Kim

Institution: Massachusetts Institute of Technology

Abstract: Following the seminal work of Hamilton and Perelman, Ricci flow has proved to be a powerful tool for understanding the topology and geometry of three-dimensional manifolds. A natural and fundamental question is whether Ricci flow can play a similar role in dimension four. In this work, we investigate the long-time behavior of Ricci flow on four-dimensional manifolds, with particular emphasis on Ricci-flat asymptotically locally flat (ALF) spaces. Ricci-flat ALF manifolds constitute the simplest class of collapsing Ricci-flat 4-manifolds and are widely expected, according to a folklore conjecture, to arise as singularity models in the long-time behavior of Ricci flow on 4-manifolds.

We develop a framework for studying Ricci flow on ALF manifolds. First, we show that the ALF structure is preserved along the Ricci flow. We then introduce a renormalized version of Perelman's λ-functional adapted to the ALF setting, defined using a notion of relative mass with respect to a fixed Ricci-flat reference metric at infinity. Within this framework, we prove that the Ricci flow can be interpreted as the gradient flow of this adapted λ-functional in a weighted L^2 sense. This variational structure allows us to define and analyze notions of linear and dynamical stability for Ricci-flat ALF metrics.

As an application, we show that conformally Kähler but non-hyperkähler Ricci-flat ALF metrics are dynamically unstable under the Ricci flow. This instability is significant from the perspective of long-time analysis, as it suggests that such metrics may be dynamically disfavored as singularity models. A key analytic ingredient is a Fredholm theory for the Laplacian operator on weighted Hölder spaces over ALF manifolds.

Finally, our results point toward several open questions. In particular, it remains an open problem whether the relative mass introduced here satisfies positivity properties analogous to classical positive mass theorems. Moreover, recent constructions of new Ricci-flat ALF metrics raise the question of whether these examples are dynamically stable or unstable under Ricci flow.

This is a joint work with Tristan Ozuch.

Time-minimizing navigation on Riemannian manifolds in generalized wind

Name: Piotr Kopacz

Institution: Gdynia Maritime University

Abstract: In this talk, we present the purely geometric solution to the generalized minimum-time navigation problem by means of Riemann-Finsler geometry, which encompasses as particular cases the classical Matsumoto's slope-of-a-mountain problem under gravity and Zermelo's navigation problem on Riemannian manifolds in the presence of space-dependent wind, among

other new scenarios. Having constructed a two-parameter model of a slippery mountain slope characterized by traction coefficients, by the anisotropic deformation of the background Riemannian metric and rigid translation with the use of the rescaled generalized wind, we obtain the new Finsler metrics of general (α, β)-type. The strong convexity conditions under which the related time-minimizing trajectories can be described as Finslerian geodesics are thoroughly established. Besides the theoretical results referred to geometric properties of the solution, we are concerned with its effective applications to modern theoretical physics and mathematical modelling in low dimensions, where time-minimizing geodesics play the key role. In particular, the new setting has significant physical relevance, as it more accurately models real-world scenarios involving movement under an arbitrary type of wind and slope. Moreover, the evolution of time fronts and the behavior of Finslerian geodesics in relation to various impacts of the generalized wind and direction of motion in the slippery slope model are discussed and illustrated by some examples.

Geometry of Spacelike Hypersurfaces with Statistical Structure in Generalized Robertson-Walker Spacetimes

Name: Rakesh Kumar

Institution: Punjabi University, Patiala

Abstract: In this work, we investigate the geometry of generalized Robertson – Walker (GRW) spacetimes by treating their fibers as statistical manifolds, thereby equipping the spacetimes with a statistical structure. A non-trivial example is presented to illustrate this construction. We derive the expression for the statistical Ricci tensor of a GRW spacetime endowed with such a structure and examine its statistical spacelike hypersurfaces. In this context, we establish necessary and sufficient conditions for the existence of a statistical Ricci soliton on these hypersurfaces. Further, we analyze the case where the fiber itself admits a statistical Ricci soliton and obtain the conditions under which the corresponding GRW spacetime admits an almost Ricci soliton structure. Finally, we consider the situation in which both the fiber and the ambient GRW spacetime are Ricci solitons, and we determine the condition under which the corresponding statistical spacelike hypersurfaces also admit a Ricci soliton structure.

On ζ-Normalized Null Hypersurfaces of Indefinite Sasakian Manifolds

Name: Theophile Kemajou Mbiakop

Institution: University of Maroua

Abstract: We examine null hypersurfaces that are normalized by the structure vector field ζ (briefly, ζ-normalized null hypersurfaces) in almost contact metric manifolds. We characterize the geometry of such null hypersurfaces, and an example is provided. We show that leaves of an integrable screen distribution within these hypersurfaces admit an almost contact metric structure $(\psi, h, \nu, U,)$. In cases where the ambient space is an indefinite Sasakian, we show that it is not always possible to choose a structure vector field with specific geometric properties, along with prescribed geometric properties for the null hypersurface. The necessary and sufficient condition

for normality of $(\psi, h, \nu, U,)$-structure is established. Integrability conditions for the distributions on a ζ-normalized null hypersurface of an indefinite Sasakian manifolds are investigated.

Enumerating Meanders via Dynnikov Coordinates

Name: Elif Medetogullari

Institution: TED University

Abstract: In 1912, Henri Poincaré posed the problem of determining the number of distinct simple closed curves intersecting a fixed line at a given number of times. These configurations, later called meanders by Vladimir Arnold in 1987, have been studied by many researchers and remain a compelling subject.

In this work, we present an algorithmic approach for the enumeration of meanders via Dynnikov coordinates, which assign integer-valued vectors to isotopy classes of essential simple closed curves on the punctured disk. By encoding the geometric structure of a meander within this coordinate system, our method enables effective computation and facilitates the detection of such curves.

Canonical Parameters on Timelike Surfaces in Pseudo-Euclidean 4-spaces

Name: Velichka Milousheva

Institution: Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

Abstract: We introduce special isotropic parameters (which we call canonical parameters) for some classes of timelike surfaces in the Minkowski 4-space and the pseudo-Euclidean 4-space with neutral metric, namely: zero mean curvature surfaces, surfaces with parallel normalized mean curvature vector field, and marginally trapped (quasi-minimal) surfaces. These parameters allow us to describe these classes of surfaces in terms of minimal number of invariant functions satisfying a natural system of partial differential equations. This solves the Lund-Regge problem for timelike surfaces.

The author is partially supported by the National Science Fund, Ministry of Education and Science of Bulgaria under contract KP-06-N82/6.

Killing tensors on symmetric spaces

Name: Yuri Nikolayevsky

Institution: La Trobe University

Abstract: I will present new results on geometry and algebra of higher rank Killing tensor fields on Riemannian symmetric space, with a particular focus on the following question: Is any Killing

tensor field on a symmetric space a polynomial in Killing vector fields? The talk will include some joint results with Vladimir Matveev (Germany) and Owen Dearricott and An Ky Nguyen (Australia).

Statistical soliton on statistical Poisson warped product space

Name: Buddhadev Pal

Institution: Banaras Hindu University

Abstract: In this article, we first define the concept of a statistical Poisson manifold. We then explore the structure of Einstein statistical Poisson warped product spaces. Following this, we introduce the notion of a statistical soliton on a statistical Poisson warped product space and provide a detailed discussion of its properties.

Next, we establish a version of Chen's inequality for immersed statistical Poisson warped product submanifolds within a statistical Poisson manifold of constant sectional curvature. We also derive the dual Einstein gravitational equations and the dual contravariant Einstein equations for contravariant Lorentzian statistical Poisson warped product spaces.

Furthermore, we define the concept of a contravariant Poisson space-time warped product space with a potentially infinite cometric, and then examine the corresponding contravariant statistical Poisson space-time warped product space in detail.

Torsion, Curvature and Serret-Frenet's Geometry in Quantum Mechanics

Name: Aalok Pandya

Institution: Indira Gandhi National Tribal University, Amarkantak 484887 India

Abstract: Torsion and curvature associated with quantum states of physical systems are formulated. The proposed exercise presents significant geometric features in the context of Background Independent Quantum Mechanics (BIQM). For the first time torsion in quantum evolution is evaluated by using first principles is found to be precisely equal to the sixth order moments. Now, if the odd order moments and odd order expectation values for symmetric functions are equated to zero, the principal term in the expression of square of torsion is found to have reduced to a concise expression $\tau^2 = \frac{\langle H^6 \rangle}{\langle H^2 \rangle^3}$. Also, square of the curvature is found to be precisely equal to fourth order moments what is known as kurtosis in statistics, whereas, square of torsion is found to be equivalent to the sixth order moments of Hamiltonian of a system. For the perfectly symmetric functions, for which the third order moments known as skewness and odd order expectation values when assumed to be zero, the principal term in the expression of curvature is found be $\kappa^2 \equiv \frac{\langle H^4 \rangle}{\langle H^2 \rangle^2}$. This verifies the earlier results of Brody and Houghston by estimator approach. Thus, the direct evaluation of curvature and torsion in the framework of Geometry of $Serret - Frenet$ formulae in the context of Geometric Quantum Mechanics bears extremely meaningful results.

What is conformal heat flow?

Name: Woongbae Park

Institution: University of Rochester

Abstract: In this presentation I will introduce the concept of conformal heat flow, which is originally designed to smoothing harmonic map flow. A conformal heat flow consists of evolution equations of map and metric of domain, where the metric evolves in conformal direction and depends on the energy density. We showed that the conformal heat flows of harmonic maps does not develop finite time singularity unlike original flow does.

Primitive invariants from laminations

Name: Veronica Pasquarella

Institution: SIMIS (Shanghai Institute for Mathematics and Interdisciplinary Sciences)

Abstract: Combining geometric group theory techniques with geometric topology tools, we show how primitive cohomologies provide useful insights towards unifying the mathematical formulation of Gromov-Witten invariants. In particular, we emphasise the role played by geodesic laminations in analysing such invariants for the case of complete intersections in projective space.

A relative version of Weinstein's morphism

Name: Andrés Pedroza

Institution: Universidad de Colima

Abstract: In 1989, A. Weinstein introduced a morphism

$$\mathcal{A}\colon \pi_1(\mathrm{Ham}(M,\omega)) \to \mathbb{R}/\mathcal{P}_2(M,\omega),$$

defined via the action functional associated to loops of Hamiltonian diffeomorphisms. Here, $\mathrm{Ham}(M,\omega)$ denotes the group of Hamiltonian diffeomorphisms of the symplectic manifold (M,ω). A holomorphic variant of this morphism was later proposed by P. Seidel , using pseudoholomorphic curve techniques.

This construction was extended by the author to higher homotopy groups:

$$\mathcal{A}\colon \pi_{2k-1}(\mathrm{Ham}(M,\omega)) \to \mathbb{R}/\mathcal{P}_{2k}(M,\omega),$$

for all $1 \leq k \leq n$, where $\mathcal{P}_{2k}(M,\omega)$ denotes the group of symplectic periods in degree $2k$.

The goal of this work is to define a relative version of Weinstein's morphism. Let $L \subset (M,\omega)$ be a Lagrangian submanifold, and denote by $\mathrm{Ham}(M,L)$ the subgroup of Hamiltonian diffeomorphisms that preserve L.

In this talk, we introduce the relative Weinstein morphism

$$\mathcal{A}^L\colon \pi_{2k-1}(\mathrm{Ham}_0(M,L)) \to \mathbb{R}/\mathcal{P}_{2k}(M,\omega),$$

for each $k \in \{1, \ldots, n\}$. We will present several explicit computations in the case where (M, ω) is a symplectic toric manifold and $L \subset M$ is a Lagrangian torus fiber.

A result on the Jacobian conjecture

Name: Princy Randriambololondrantomalala

Institution: University of Antananarivo

Abstract: The Jacobian conjecture has been launched by O. Keller in 1939 and is still open until now, saying that a polynomial function G from $\mathbb{R}^n$ to itself for $n \geq 2$ having jacobian $det\,(J_G)$ equal to 1, is bijective. It is the 16th on the Smale's list of problems for the 21st century. We solve partially it when $n = 2$ on the coordinate system (x, y) with $G = (G_1, G_2)$ when

$$G_1 := a_0 + a_1 x + l_1 y + \sum_{i=1}^{m} b_i x y^i + \sum_{i=1}^{m} e_i x^2 y^i + \sum_{i=2}^{m} c_i y^i + \sum_{i=2}^{m} f_i x^i$$

$$G_2 := a_{-1} + r_1 x + s_1 y + \sum_{i=1}^{m} k_i x y^i + \sum_{i=1}^{m} w_i x^2 y^i + \sum_{i=2}^{m} t_i y^i + \sum_{i=2}^{m} u_i x^i,$$

where all coefficients of the polynomials are real. We define the degree of G as $deg(G) = m$ for $m \geq 2$ and solve $det\,(J_G) = 1$ by Maple: First, for $f_i = u_i = e_i = w_i = 0$ for all $2 \leq i \leq m$ when $e_1 = w_1 = 0$ by solving $det\,(J_G) = 1$ for $deg(G) = 2m$ when $f_i = u_i = e_i = w_i = 0$ for all $2 \leq i \leq 2m$, $e_1 = w_1 = 0$ and $b_i = c_i = k_i = t_i = 0$ for all $m + 1 \leq i \leq 2m$. Then, we find that G is injective, then G is a bijection. Second, when $e_i = w_i = 0$ for all $1 \leq i \leq m$, we have $f_i = u_i = 0$ for all $3 \leq i \leq m$. Then, we have three cases to be solved in Maple up to the symmetry on (x, y): the first is the one above which has already been solved, the second is:

$$G_1 := a_0 + a_1 x + l_1 y + \sum_{i=2}^{s} c_i y^i$$

$$G_2 := a_{-1} + r_1 x + s_1 y + \sum_{i=1}^{s} k_i x y^i + \sum_{i=2}^{2s} t_i y^i + \sum_{i=2}^{2} u_i x^i,$$

and the last is:

$$G_1 := a_0 + a_1 x + l_1 y + \sum_{i=1}^{s} b_i x y^i + \sum_{i=2}^{2s} c_i y^i + \sum_{i=2}^{2} f_i x^i$$

$$G_2 := a_{-1} + r_1 x + s_1 y + \sum_{i=1}^{s} k_i x y^i + \sum_{i=2}^{2s} t_i y^i + \sum_{i=2}^{2} u_i x^i$$

for $s \geq 1$ and $2s \leq m$. Let us use the following theorem, G beying polynomial, G is proper if and only if G hasn't zero in the infinity. We solve $G_1(x, y) = 0$ and $G_2(x, y) = 0$ as polynomials of second degree in x, looking for zeros of G in the infinity by Maple. Thus, We find that G is proper. G beying a local homeomorphism and proper, by the Hadamard theorem on local homeomorphism, G is bijective. Third, we solve $det\,(J_G) = 1$ in general form and we have $e_i = w_i = 0$ for all $2 \leq i \leq m$, we run again the Maple program with this data when $e_1 \neq 0$ or

$w_1 \neq 0$, we find that $deg(G) \leq 4$. By Moh's result saying that if the usual degree of G is less than 101, the Jacobian conjecture is true for $n = 2$, we get G as a bijection. We conclude by these results that G verifies the Jacobian conjecture for $m \geq 2$.

Geometry of conformal Riemannian maps from manifolds admitting a Ricci soliton

Name: Rachna Rani

Institution: Punjabi University, Patiala

Abstract: In this work, we investigate the geometry of conformal Riemannian maps between Riemannian manifolds, with particular attention to the interaction between such maps and Ricci soliton structures. We derive a Bochner-type identity and establish the conditions under which such maps are harmonic or totally geodesic. In addition, we investigate horizontally homothetic and totally umbilical conformal Riemannian maps between Riemannian manifolds. The study is then extended to the case where the total manifold admits a Ricci soliton structure, and a non-trivial example is provided to illustrate the construction. Within this framework, we obtain conditions under which the fiber and the target manifold of a conformal Riemannian map admit either a Ricci soliton or an Einstein structure. Moreover, we study harmonicity and biharmonicity in this context and provide necessary conditions for conformal Riemannian maps, defined on total manifolds admitting Ricci solitons, to be harmonic or biharmonic. The results contribute to a deeper understanding of the interplay between Ricci soliton geometry and the theory of conformal Riemannian maps, extending earlier developments on harmonic maps and Riemannian submersions.

Rigidity of compact quasi-Einstein manifolds with boundary

Name: Ernani Ribeiro Junior

Institution: Universidade Federal do Ceará

Abstract: In this talk, we will discuss the classification of compact quasi-Einstein manifolds with boundary and constant scalar curvature. It is known by the classical book "Einstein Manifolds" (1984) that a quasi-Einstein manifold corresponds to a base of a warped product Einstein metric. Another interesting motivation to investigate quasi-Einstein manifolds derives from the study of diffusion operators by Bakry and Emery (1985), which is linked to the theories of smooth metric measure spaces, static spaces and Ricci solitons.

We will show that a 3-dimensional simply connected compact quasi-Einstein manifold with boundary and constant scalar curvature must be isometric to either the standard hemisphere $\mathbb{S}^3_+$, or the cylinder $I \times \mathbb{S}^2$ with product metric. For dimension $n = 4$, we prove that a 4-dimensional simply connected compact quasi-Einstein manifold with boundary and constant scalar curvature is isometric to either the standard hemisphere $\mathbb{S}^4_+$, or the cylinder $I \times \mathbb{S}^3$ with product metric, or the product space $\mathbb{S}^2_+ \times \mathbb{S}^2$ with the product metric. Other related results for arbitrary dimensions are also discussed. This is a joint work with Johnatan Costa and Detang Zhou.

Extrinsic Geometry of Foliations

Name: Vladimir Rovenski

Institution: University of Haifa

Abstract: In memory of friend and colleague Professor Paweł Walczak (1948-2025)

Extrinsic geometry of foliations, presented in a monograph by V. Rovenski and P. Walczak, deals with properties of leaves (submanifolds of a Riemannian manifold), which depend on the second fundamental form. The part of the Riemann tensor of a foliation, called the mixed or mutual curvature, depends on the first derivative of metric and belongs to extrinsic geometry. In this talk, I will discuss the concepts and topics of extrinsic geometry of foliations recently introduced by V. Rovenski.

1. Weak metric structures, i.e., the complex structure in almost Hermitian, almost contact and f-contact manifolds and their subclasses is replaced by a nonsingular skew-symmetric tensor, generalize the classical structures and allow finding new applications. We discuss our latest results on geodesic and Killing fields, Ricci-type solitons and Einstein-type metrics, the (κ,μ)-nullity condition, etc. in this new area of Riemannian geometry.

2. Mutual curvature invariants of a Riemannian manifold, being an alternative to Chen's δ-invariants, use the mutual sectional curvature of subspaces of the tangent bundle, are well adapted to foliated manifolds and submanifolds and can be applied in the natural sciences. We discuss our recent results on variations of Willmore-type functionals and the corresponding geometrical inequalities, including our curvature invariants and the squared mean curvature, as well as ideal immersions of foliated manifolds.

On the generalizations of some fiber bundles and their model foliations

Name: Adamou Saidou

Institution: Université Dan Dicko Dankoulodo de Maradi

Abstract: In this talk I will speak about generalization of some fiber bundle and their model foliations. Let ψ be an Anosov diffeomorphism of the torus $\mathbb{T}^2$ induced by a matrix $A \in SL(2,\mathbb{Z})$ with $|trA| > 2$. Consider the 3-manifold $\mathbb{T}^3_A$ obtained by suspension of ψ. We obtain two codimension-one foliations without compact leaves on this manifold. These two foliations are called *model foliations*. We generalize this construction as follows? Le A be a matrix A in $SL(2,\mathbb{Z})$ which is diagonalizable and the eigenvalues are irrational numbers. We obtain the manifold $\mathbb{T}^{n+1}_A$ by suspension of the diffeomorphism of the $n-$torus $\mathbb{T}^n$ induced by the matrix A. This manifold fibers over the circle with fiber the $n-$torus $\mathbb{T}^n$. We construct two families of model foliations which are codimension-$(n-1)$ foliations and codimension-one foliations. We call these foliations respectively the codimension-$(n-1)$ model foliations and the codimension-one model foliations on $\mathbb{T}^{n+1}_A$. More generaly for $1 < k < n-1$ we can construct a family of codimension-$(n-k)$ model foliations on $\mathbb{T}^{n+1}_A$.

We first prove that the codimension-one model foliations are transversely affine and can be defined by a locally free action of a Lie group. These two situations are the same as the model

foliations on Anosov bundles. We also prove that codimension-$(n-1)$ orientable model foliations can be defined by a locally free action of a Lie group of dimension 2.

The second step of generalization is the following. Let $\psi : \mathbb{T}^2 \to \mathbb{T}^2$ be a diffeomorphism induced by a matrix $A \in SL(2,\mathbb{Z})$ with $|tr(A)| > 2$ and $\mathbb{T}^3_A$ the $3-$manifold obtained by suspension of ψ. We define a diffeomorphism of $\mathbb{T}^2 \times [0,1]$ as follows:

$$\Psi(x,t) = (\psi(x), t)$$

This diffeomorphism descends to the quotient to give a diffeomorphism of $\mathbb{T}^3_A$ which we denote also by Ψ. We define the $4-$manifold M^4_A by suspension of Ψ.

$$M^4_A = \mathbb{T}^3_A \times [0,1]/(X,0) \sim (\Psi(X),1).$$

M^4_A is a fiber bundle over the circle with fiber $\mathbb{T}^3_A$. We construct by suspension of the model foliations on $\mathbb{T}^3_A$ by a diffeomorphism of $\mathbb{T}^3_A$, two codimension-one foliations on M^4_A called model foliations.

Conformally Flat Manifolds with Constant Ricci Scalar

Name: Khalid Saifullah

Institution: National University of Sciences & Technology (NUST), Islamabad.

Abstract: We present characterisations of Lorentzian manifolds with constant Ricci scalar curvature. We study 2-, 3- and 4-dimensional conformally flat Lorentzian manifolds and construct their Ricci scalar curvature in terms of the conformal factor. We do this by solving the relevant (non-linear) partial differential equations. We substantiate our results by providing insightful illustrative examples of our investigation, like the Minkowski space.

On the σ_2-curvature and volume of compact manifolds

Name: Maria de Andrade Costa e Silva

Institution: Universidade Federal de Sergipe

Abstract: Inspired by the foundational work of Fischer and Marsden (1975) on scalar curvature deformations, we study the variational theory of the σ_2-curvature and its interplay with volume in compact Riemannian manifolds.

For closed manifolds, we characterize critical points of the total σ_2-curvature functional as σ_2-Einstein metrics. Building on results of Gursky – Viaclovsky and Hu – Li, we obtain a sharp necessary and sufficient condition for such a critical metric to be Einstein. Furthermore, we establish a volume comparison theorem for Einstein manifolds with respect to σ_2-curvature, showing that, under certain curvature conditions, the volume is controlled by σ_2.

For compact manifolds with non-empty boundary, we examine the volume functional restricted to metrics with constant σ_2-curvature and prescribed boundary metric. We characterize critical

points via a boundary-value problem and prove that, in space forms, these critical points correspond precisely to geodesic balls. Finally, through a second-order analysis, we demonstrate that geodesic balls are local minima of the volume functional along a natural direction of variations.

This work systematizes and extends the deformation theory of higher-order curvatures and provides new geometric rigidity and comparison results related to σ_2.

This is part of a joint work with A. Silva Santos (UFS - Brazil) and T. Cruz (UFAL - Brazil).

Reference: Andrade, M.; Cruz, T.; Silva Santos, A. On the σ_2-curvature and volume of compact manifolds. Annali di Matematica Pura ed Applicata, v. 202, p. 367 – 395, 2023.

Geometric Potential of Surfaces in Euclidean Spaces

Name: Betul Bulca Sokur

Institution: Bursa Uludag University

Abstract: In the present study, we considered skew curvatures of the surfaces to generate their geometric potentials. The method depends essentially on the mean and Gaussian curvatures and their principal curvatures. In quantum mechanics in the study of the dynamics of massive particle with mass m constrained to move on a surface. In such a case, the difference function of the squared mean curvature with the Gaussian curvature induces a geometric (scalar) potential. This potential appears in the Shröndiger type equations. Considering the skew curvatures of the rotational surfaces, some results on the meridian curves are obtained. The term "geometric potential" in the context of rotational surfaces often relates to the functional or energy that describes certain properties of these surfaces. The geometric potential of rotational surfaces encompasses various functionals and energies related to their geometry. Furthermore, the geometric potentials of level surfaces and generalized helicoidal surfaces are calculated. Finally we discuss the some applications of these types of surfaces in quantum mechanics.

Convergence of Riemannian Manifolds and Metric Spaces

Name: Christina Sormani

Institution: CUNYGC and Lehman College

Abstract: We present advances in the study of Gromov-Hausdorff (GH) and Sormani-Wenger Intrinsic Flat (SWIF) Convergence of Riemannian manifolds, metric spaces, and integral current spaces. We begin with a review of GH and F convergence including Gromov's GH Compactness Theorem and Wenger's SWIF Compactness Theorem. We also review volume preserving notions of convergence including work of Fukaya, Cheeger, Colding, Naber, Sturm, Portegies, Matveev, Jauregui, Lee and Perales.

We compare and contrast these notions using examples from joint papers with Allen and by Allen-Bryden. We present methods of proving convergence from joint work with Lakzian, joint work with Huang and Lee, the joint VADB paper with Allen and Perales, and the recent monotone convergence paper with Perales. We present applications of these methods to study sequences

of manifolds with nonnegative scalar curvature. This includes tunnel constructions with Basilio and Dodziuk, with Basilio and Kazaras, and by Sweeney and Krandel. We conclude with the extreme limits of manifolds with nonnegative scalar curvature in work with Tian and Wang and with Tian and Yeung.

Warped products of dualistic structures in information geometry

Name: Léonard Todjihounde

Institution: Institut de Mathématiques et de Sciences Physiques - Université d'Abomey-Calavi

Abstract: Dualistic structures on statistical manifolds are a fundamental concept connecting information geometry, affine geometry and Hessian geometry. Since several statistical manifolds can be seen as warped product spaces, we construct dualistic structures on product statistical manifolds based on warped product methods and we give some topological and geometrical conditions under which they induced an Hessian geometry on the statistical manifolds.

Einstein metrics on spheres

Name: Matthias Wink

Institution: UC Santa Barbara

Abstract: In this talk we give a brief introduction to the topic of Einstein metrics on spheres. In particular, we explain the existence of three non-round Einstein metrics with positive scalar curvature on the ten-dimensional sphere S^{10}. Previously, the only even-dimensional spheres known to admit non-round Einstein metrics were S^6 and S^8.

This talk is based on joint work with Jan Nienhaus.

Ruled surfaces as self-similar solutions to the harmonic mean curvature flow in Minkowski 3-space

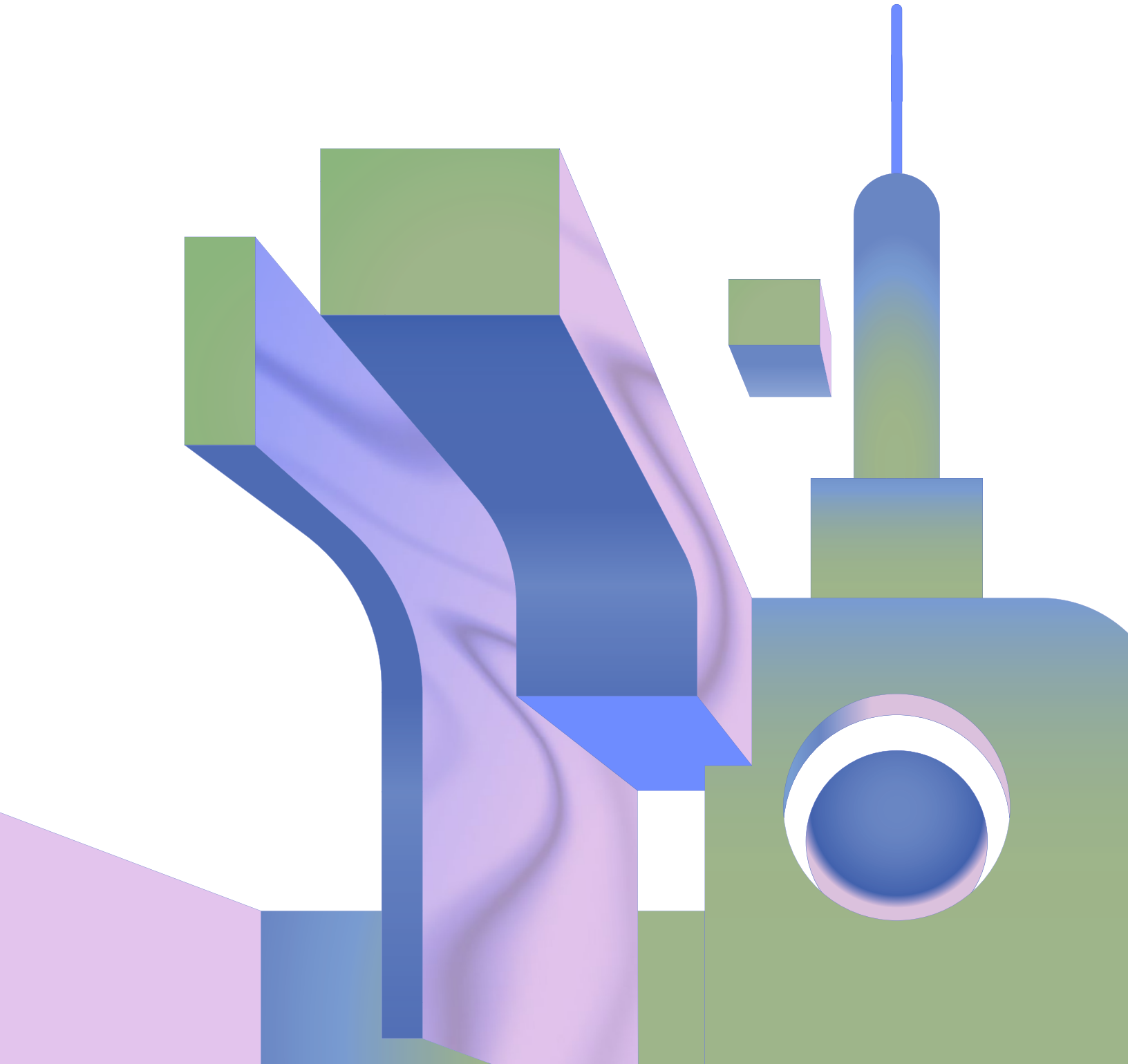
Name: Akhilesh Yadav

Institution: Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi-221005, India

Abstract: Ruled surfaces having a significant importance in geometry as well as other fields like CAD and architecture, are one of the main-stream topics in research at present. In this paper, we classify the ruled surfaces in Minkowski 3-space that are self-similar solutions to the harmonic mean curvature flow (HMCF) under the translation and homothetic motion. We give the classification of such ruled surfaces in accordance with the causality of their rulings in Minkowski 3-space and proved that there is no non-degenerate ruled surface with pseudo-null ruling which is a homothetic self-similar solution to the HMCF.

SHORT COMMUNICATIONS

SECTION 6– TOPOLOGY



Recent Fixed Point Results on Digital Metric Spaces

Name: Özlem Acar

Institution: Selçuk University

Abstract: The 21st century is widely regarded as the age of information and technology, in which fixed point theory plays a crucial role in image processing and computer graphics. One of the main objectives in this area is to obtain meaningful fixed point results on digital images. In recent years, digital topology has become an active research field, providing a solid mathematical framework for the analysis of digital images. In this talk, we introduce a class of F-contractions in digital metric spaces and establish fixed point theorems via F-contractive mappings. Moreover, we present an application of the Banach fixed point theorem to digital images.

Crystallizations of small covers over the n-simplex and the n-prism

Name: Anshu Agarwal

Institution: Indian Institute of Technology Delhi

Abstract: A crystallization of a PL manifold is an edge-colored graph that corresponds to a contracted triangulation of the manifold, facilitating the study of its topological and combinatorial properties. A small cover over a simple convex n-polytope P^n is a closed n-manifold with a locally standard $\mathbb{Z}_2^n$-action such that its orbit space is homeomorphic to P^n. In this talk, we will discuss the crystallizations of small covers over the n-simplex Δ^n and the prism $\Delta^{n-1} \times I$. It is known that the small cover over the n-simplex Δ^n is $\mathbb{RP}^n$. For every $n \geq 2$, we prove that $\mathbb{RP}^n$ has a unique 2^n-vertex crystallization. We also demonstrate that there are exactly $1 + 2^{n-1}$ D-J equivalence classes of small covers over the prism $\Delta^{n-1} \times I$, where $n \geq 3$. For each $\mathbb{Z}_2$-characteristic function of $\Delta^{n-1} \times I$, we present the construction of a $2^{n-1}(n+1)$-vertex crystallization of the small cover $M^n(\lambda)$ with regular genus $1 + 2^{n-4}(n^2 - 2n - 3)$, where $n \geq 4$. The concept of regular genus for closed PL manifolds extends the notions of surface genus and Heegaard genus for 3-manifolds to higher dimensions. Classifying PL n-manifolds based on regular genus is a fundamental problem in combinatorial topology. The classification of closed orientable prime PL 4-manifolds up to regular genus 5 is known. As a consequence of our construction, we get four orientable and four non-orientable $\mathbb{RP}^3$-bundles over $\mathbb{S}^1$ up to D-J equivalence with regular genus 6.

Characterizations of Normal 3-Pseudomanifolds with Small Second Face-Number Invariant

Name: Biplab Basak

Institution: Indian Institute of Technology Delhi

Abstract: In this talk, we characterize normal 3-pseudomanifolds K with $g_2(K) \leq 4$. It is known that if a normal 3-pseudomanifold K with $g_2(K) \leq 4$ has no singular vertices, then it is a triangulated 3-sphere. We first prove that a normal 3-pseudomanifold K with $g_2(K) \leq 4$ has at most two singular vertices. Subsequently, we show that if K is not a triangulated 3-sphere, it can be

obtained from certain boundary complexes of 4-simplices by a sequence of operations, including connected sums, edge expansions, and edge folding. Furthermore, we establish that such a 3-pseudomanifold K is a triangulation of the suspension of $\mathbb{RP}^2$. Additionally, by building upon the results of Walkup, we provide a reframed characterization of normal 3-pseudomanifolds with no singular vertices for $g_2(K) \leq 9$.

Fixed point results in Neutrosophic Fuzzy Banach spaces

Name: Ramakant Bhardwaj

Institution: Amity University Kolkata , India

Abstract: The present work introduces the fundamental concept of "Neutrosophic Fuzzy Banach Space". This provides a rigorous framework that extends the classical Banach Space as well as the Fuzzy Banach space by incorporating the notations of truth, indeterminacy, and falsity into the norm structure with respect to classical Neutrosophic Fuzzy sets. Where Fuzzy sets deal with uncertainty using the degree of membership and Neutrosophic set deals with the same using truth, indeterminacy and falsity membership grade. We establish the criteria to establish a Neutrosophic Fuzzy Banach Space and established the behaviour of convergent and Cauchy sequence with this framework. Some fixed point results are established in the said space. Some related examples for fixed point also be formed in the support of established results. Few examples are presented to demonstrate how Neutrosophic Fuzzy Banach Space unify and generalize existing structure while providing a richer environment for analysis. A thorough analysis proposing the fundamental properties as well as the potential utility and theoretical importance of the said space has also been provided. The concepts associated with the space hence established are then utilized along with the concept of contraction mappings to check for fixed point results in it. The results hence obtained, are then considered for application in solving initial value and boundary value problems.

Fast Euclidean Embeddings for Projective Spaces and Lens Spaces

Name: Michael Casey

Institution: Recently completed postdoc at the United States Air Force Research Laboratory

Abstract: Whitney's embedding theorem guarantees any compact smooth manifold of dimension n may be smoothly embedded into $\mathbb{R}^{2n}$. Hopf and James have provided embeddings for the real, complex, and quaternionic projective spaces which realize the dimension bound, but may require on the order of n^2 operations to compute a point. We show variants of these embeddings cost on the order of $n\log(n)$ operations per point, using the Fast Fourier transform. Using these embeddings, we can also construct embeddings for the lens spaces into dimension Cn that cost on the order of $Cn\log(n)$ with C a constant that depends on the action of $\mathbb{Z}/(m\mathbb{Z})$ used. When the lens space admits a large symmetry group, C is close to 3, but when the symmetry group is small, C may approach n. Giving each of the spaces a real-analytic semi-algebraic structure as abstract manifolds, our embeddings are real-analytic semi-algebraic, as they are induced by

polynomial maps on the corresponding spheres.

Eilenberg-MacLane Spectra and Connective Complex K-theory as MU-Thom Spectra

Name: Preston Cranford

Institution: Northwestern University

Abstract: We study how the Eilenberg-MacLane spectra $H\mathbb{F}_2$ and $H\mathbb{Z}$ and the connective complex K-theory spectrum ku arise as $\mathbb{E}_3$-MU-Thom spectra. Consequently we calculate as $\mathbb{E}_2$-rings that $\mathrm{THH}(H\mathbb{F}_2/\mathrm{MU}) \cong H\mathbb{F}_2[\mathrm{BU}]$, $\mathrm{THH}(H\mathbb{Z}/\mathrm{MU}) \cong H\mathbb{Z}[\mathrm{BSU}]$, and $\mathrm{THH}(\mathrm{ku}/\mathrm{MU}) \cong \mathrm{ku}[\mathrm{BU}\langle 6\rangle]$.

Knotted handlebodies and Dehn surgery on knots

Name: Mario Eudave-Muñoz

Institution: Universidad Nacional Autonoma de Mexico

Abstract: Many years ago the author decribed a family of hyperbolic knots having a half-integral toroidal surgery, that is, a surgery producing a manifod that contains an incompressible torus, hence a non-hyperbolic manifold. The important point in this construction is that the surgery coefficient is non-integral. Later, Gordon and Luecke proved that such a family consists of all hyperbolic knots that admit a non-integral toroidal surgery.

However, this constuction was made by means of tangles and double branched covers, and then no explicit figure of the knots was given. Recently, the author has given an explicit constuction of some of the knots, and now will present an explicit construction of some infinite families of such knots.

The construction is more or less as follows. Let H be a genus 2-handlebody embedded in the 3-sphere, which is knotted, that is, the bounday of its exterior is incompressible. Suppose that M is a Möbius band properly embedded in the exterior of H, such that the boundary of M intersects any meridian disk of H. Then it can be shown that the core of the Möbius band M is a knot K with a half-integral toroidal surgey. The surgery coefficient is determined by the intersection of M with a regular neighborhood of K.

The difficult point is to find explicit figures of the handlebody H and the Möbius band M. We will show a procedure to find such explicit embeddings of handlebodies and Möbius bands.

On the minimal total curvature of cubical spun 2-knots

Name: Gabriela Hinojosa

Institution: Autonomous State University of Morelos

Abstract: We say that a cubical 2-knot K^2 is an embedding of the 2-sphere in the 2-skeleton of the canonical cubulation of $\mathbb{R}^4$. In this paper, we generalize the notion of minimal lattice curvature of one-dimensional knot type to cubical knots of dimension two, as the infimum over all the total curvatures of cubical 2-knots isotopic to the given knot type. In this talk, we address the following question: What is the minimal total curvature of a knot type if it is a cubical spun 2-knot? For this family of cubical 2-knots, we estimate an upper bound.

C-Chain Connectedness

Name: Zoran Misajleski

Institution: Ss. Cyril and Methodius University in Skopje

Abstract: Let $\mathcal{U}$ be an open covering of the topological space X in X, $C \subseteq X$ and $x, y \in X$. A chain in $\mathcal{U}$ that connects x and y is a finite sequence of elements of $\mathcal{U}$ such that x belongs to the first element of the sequence, y to the last, and intersection of any two consecutive elements of the chain is nonempty. The set C is totally weakly chain separated in X if for every two distinct points $x, y \in C$ there exists an open covering $\mathcal{U} = \mathcal{U}_{xy}$ of X such that there is no chain in $\mathcal{U}$ that connects x and y. The set C is totally chain separated in X if there exists an open covering $\mathcal{U}$ of X such that for every two distinct points $x, y \in C$ there is no chain in $\mathcal{U}$ that connects x and y. The set C is C-chain connected in X, if for every clopen (closed and open) covering $\mathcal{U}$ of X and every $x, y \in C$, there exists a chain in $\mathcal{U}$ that connects x and y. Let A and B be nonempty subsets of X. The sets A and B are C-weakly chain separated in X, if for every point $x \in A$ and every $y \in B$, there exists a clopen covering $\mathcal{U} = \mathcal{U}_{xy}$ of X such that there is no chain in $\mathcal{U}$ that connects x and y. The sets A and B are C-chain separated in X, if there exists a clopen covering $\mathcal{U}$ of X such that for every point $x \in X$ and every $y \in Y$, there is no chain in $\mathcal{U}$ that connects x and y. In this presentation we will study the properties of those sets. We will formulate statements in which the notions of C-chain connectedness, homotopy, and shape appear. Furthermore we will define analog notions for one previously given open or clopen covering. At the end we will define analog notions in a more general space then a topological.

Symplectic rational homology ball fillings of Seifert fibered spaces

Name: Burak Ozbagci

Institution: Koc University

Abstract: We characterize when some small Seifert fibered spaces can be the convex boundaries of symplectic rational homology balls and give strong restrictions for others to bound such manifolds. (This is a joint work with J. B. Etnyre and B. Tosun.)

The fixed point property for (c)-mappings and unbounded sets

Name: Najah Redjel

Institution: University of Souk Ahras

Abstract: In this talk, we will prove that a closed convex subset C of a real Hilbert space X has the fixed point property for (c)-mappings if and only if C is bounded. Some convergence results about the itérations are obtained.

Extending free group action on surfaces

Name: Carlos Segovia González

Institution: Instituto de Matematicas UNAM Oaxaca

Abstract: We develop a complete invariant for the solution to the following question: Which free actions on oriented surfaces equivariantly bound? the Schur multiplier is divided by toral classes to obtain the Bogomolov multiplier, then a free action of a finite group G over an oriented closed surface M equivariantly bounds, if and only if, the class $[G, M]$ is trivial in the Bogomolov multiplier. We show that free actions always extend in the case of abelian, dihedral, symmetric, and alternating groups. We show extendable actions for Coxeter groups and the analog of non-orientable surfaces and three-manifolds.

Fundamental n-quandles of links are residually finite

Name: Mahender Singh

Institution: Indian Institute of Science Education and Research (IISER) Mohali

Abstract: We present some recent results on the residual finiteness and subquandle separability of quandles, properties that respectively imply the solvability of the word problem and the generalized word problem for these non-associative structures. Fundamental n-quandles of oriented links are canonical quotients of their fundamental quandles, and are closely related to n-fold cyclic branched covers of the 3-sphere branched over links. We prove that the fundamental n-quandle of any oriented link in the 3- sphere is residually finite for each $n \geq 2$. This supplements the recent result on residual finiteness of fundamental quandles of oriented links, as well as the classification of links whose fundamental n-quandles are finite for some n.

Some algorithmically easy and hard problems in knot theory

Name: Anastasiia Tsvietkova

Institution: Rutgers University, Newark

Abstract: Many classical knot theory problems can be formulated as decision problems. Quite a few of them are now known to lie in complexity classes NP or co-NP. At the same time, only several knot theory problems are known to be NP-hard, and even fewer non-trivial knot theory problems are known to have a polynomial algorithm. We will discuss two new such results: diagrammatic unknotting number being NP-hard (joint with Jaeyun Bae), and alternating link equivalence having polynomial complexity, when alternating diagrams are given (joint with Touseef Haider). Note that unknotting number (by crossing changes) has been particularly resistant to establishing any complexity bounds, with neither upper nor lower ones previously known. The proofs use tools from low-dimensional topology, at times mixing them with algorithmic complexity theory and topological graph theory.

Small Dehn surgery and SU(2)

Name: Fan Ye

Institution: Peking University

Abstract: Kronheimer and Mrowka (2004) demonstrated that for any nontrivial knot $K \subset S^3$ and a rational slope $r \in [0, 2]$, the Dehn surgery manifold $S^3_r(K)$ is always $SU(2)$ *non-abelian*—meaning its fundamental group admits a homomorphism to $SU(2)$ with non-abelian image. For slopes beyond this interval, subsequent work by Baldwin – Sivek (2023), Baldwin – Li – Sivek – Ye (2024), Farber – Reinoso – Wang (2024), and Li – Ye (2025) has extended the $SU(2)$ non-abelian property to all rational slopes $r = p/q \in (2, 6)$ where $p = x^e$ or $p = 2x^e$ for some prime x and natural number e. The only exceptions arise for the right-handed trefoil knot at slopes of the form $6 - 1/n$ with n a positive integer. These advances rely crucially on recent developments in the framed instanton Floer homology of Dehn surgery manifolds, studied over coefficient fields $\mathbb{C}$ and $\mathbb{Z}/2$.

Non-split, alternating links bound unique Seifert surfaces in the 4-ball

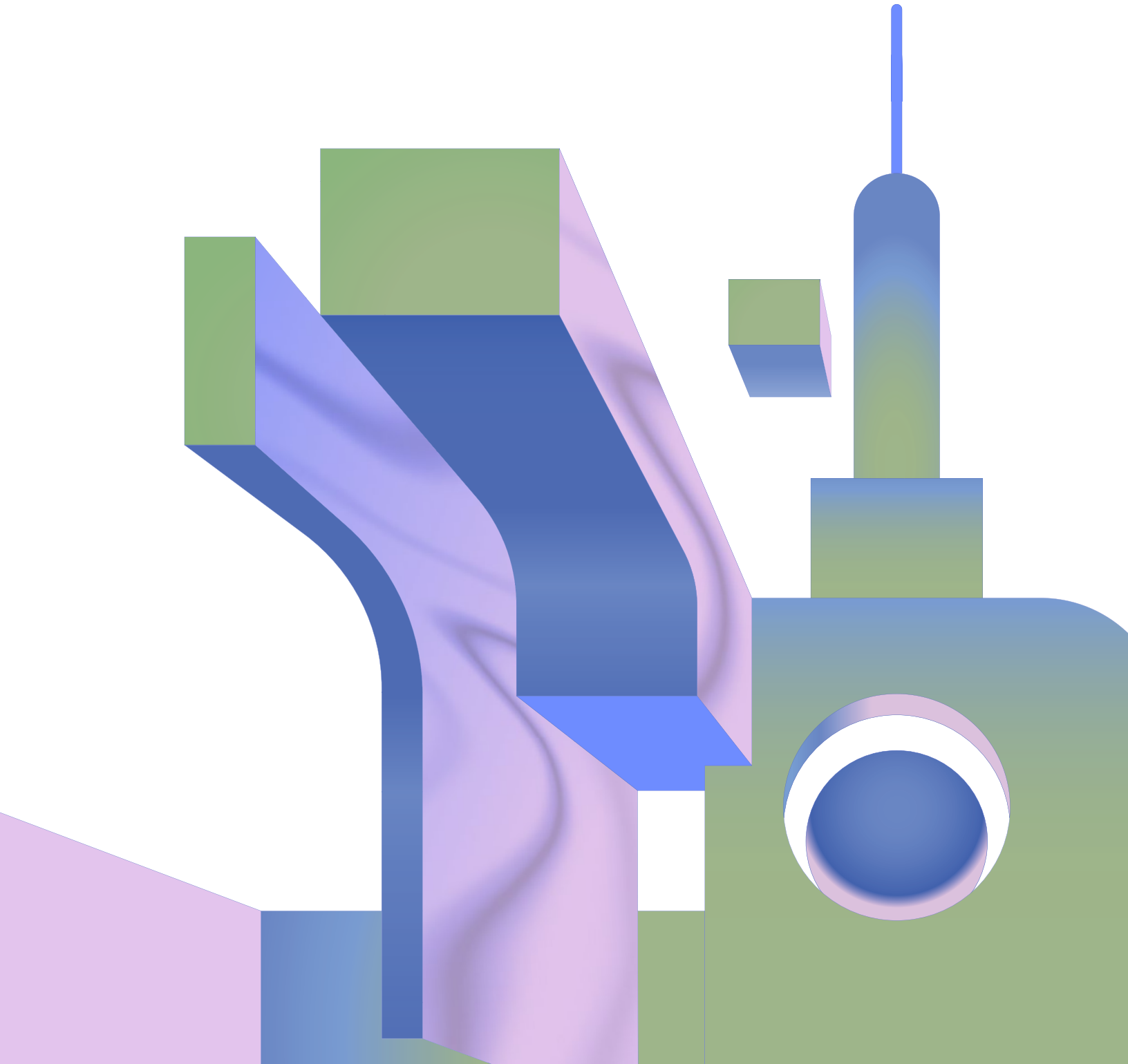
Name: Jaehoon Yoo

Institution: Indiana University Bloomington

Abstract: We show that any two same-genus, oriented, boundary parallel surfaces bounded by a non-split, alternating link into the 4-ball are smoothly isotopic fixing boundary. In other words, any same-genus Seifert surfaces for a non-split, alternating link become smoothly isotopic fixing boundary once their interiors are pushed into the 4-ball. We conclude that a smooth surface in S^4 obtained by gluing two Seifert surfaces for a non-split alternating link is always smoothly unknotted.

SHORT COMMUNICATIONS

SECTION 7– LIE THEORY AND GENERALIZATIONS



Classification of 4-dimensional Hom-Lie algebras

Name: María Alejandra Alvarez

Institution: Universidad de Antofagasta

Abstract: In this work we consider complex multiplicative Hom-Lie algebras of dimension 4 associated with non-nilpotent linear maps. We prove that for this class of algebras we can always obtain a 3-dimensional multiplicative Hom-Lie subalgebra. This allows us to obtain the full classification of these 4-dimensional Hom-Lie algebras.

This is a joint work with Sonia Vera from Universidad Nacional de Córdoba.

Characterization of generalized Lie-type derivations on algebras

Name: Mohammad Ashraf

Institution: Aligarh Muslim University

Abstract: Let $\mathcal{A}$ be an algebra over a commutative unital ring $\mathcal{R}$. For any $x_1, x_2, \ldots, x_n \in \mathcal{A}$, define $p_1(x_1) = x_1$, $p_2(x_1, x_2) = [x_1, x_2]$ and $p_n(x_1, x_2, \ldots, x_n) = [p_{n-1}(x_1, x_2, \ldots, x_{n-1}), x_n]$ for all integers $n \geq 2$, where $[x_1, x_2] = x_1x_2 - x_2x_1$ denotes the Lie product of x_1 and x_2 in $\mathcal{A}$. An $\mathcal{R}$-linear mapping $\delta : \mathcal{A} \to \mathcal{A}$ is said to be a *Lie n-derivation* ($n \geq 2$) if $\delta(p_n(x_1, x_2, \ldots, x_n)) = p_n(\delta(x_1), x_2, \ldots, x_n) + p_n(x_1, \delta(x_2), \ldots, x_n) + \cdots + p_n(x_1, x_2, \ldots, \delta(x_n))$ holds for all $x_1, x_2, \ldots, x_n \in \mathcal{A}$. Lie n-derivations have been further generalized as follows: Let $\xi : \mathcal{A} \to \mathcal{A}$ be an $\mathcal{R}$-linear mapping and δ be a Lie n-derivation on $\mathcal{A}$. Then ξ is called a generalized Lie n-derivation associated with the Lie n-derivation δ if $\xi(p_n(x_1, x_2, \ldots, x_n)) = p_n(\xi(x_1), x_2, \ldots, x_n) + p_n(x_1, \delta(x_2), \ldots, x_n) + \cdots + p_n(x_1, x_2, \ldots, \delta(x_n))$ holds for all $x_1, x_2, \ldots, x_n \in \mathcal{A}$. For $n = 2$, ξ is said to be a generalized Lie derivation while for $n = 3$, ξ is called generalized Lie triple derivation. Generalized Lie derivation, generalized Lie triple derivation, generalized Lie n-derivation are collectively known as generalized Lie-type derivation.

The study of the Lie structure of an associative algebra is one of the important topics in mathematics. In the present talk, we shall discuss characterization of generalized Lie-type derivations and related mappings on algebras and finally some potential future research problems in this direction will also be provided.

Geometry of anti-Poisson involutions in the deformations and resolutions of Kleinian singularities

Name: Mengwei Hu

Institution: Yale University

Abstract: Kleinian singularities are quotients of $\mathbb{C}^2$ by finite subgroups of $\mathrm{SL}_2(\mathbb{C})$. They are in bijection with the ADE Dynkin diagrams via the McKay correspondence. The filtered Poisson deformations of Kleinian singularities are parametrized by $\mathfrak{h}/W$, where $\mathfrak{h}$ is the Cartan space and W is the Weyl group. In this talk, I will introduce certain singular Lagrangian subvarieties

in the deformations and resolutions of Kleinian singularities that are related to the geometric classification of certain Harish-Chandra modules over quantizations of nilpotent orbits. The irreducible components of these singular Lagrangian subvarieties are projective lines and affine curves. I will describe how they intersect with each other through the realization of deformations of Kleinian singularities as Nakajima quiver varieties.

On the Cohomology of homogeneous spaces of Lie groups

Name: Chandan Maity

Institution: Indian Institute of Science Education and Research(IISER) Berhampur

Abstract: The study of the de Rham cohomology of a homogeneous space G/H, where G is a connected Lie group and H is a closed subgroup, in relation to the algebraic invariants of G, H, and the inclusion of H into G, is a classical theme in differential geometry and topology. In this talk, I will present explicit descriptions of certain low-dimensional Betti numbers of homogeneous spaces of Lie groups. As an application, we obtain an interesting invariant of compact homogeneous spaces expressed in terms of the numbers of simple factors of the ambient group and of the associated closed subgroup. From a computational point of view, these descriptions are new and very useful, and they play an important role in determining the cohomology of nilpotent orbits; the talk is based on joint work with Indranil Biswas and Pralay Chatterjee.

Weyl modules for Lie superalgeras

Name: Saudamini Nayak

Institution: National Institute of Technology Calicut

Abstract: The Weyl modules play an important role in the representation theory of infinite-dimensional Lie algebras. However, in super setting the study of Weyl modules has been less developed than the corresponding theory in Lie algebras. Calixto, Lemay and Savage study Weyl modules (global and local) for Lie superalgebras of the form $\mathfrak{g} \otimes_{\mathbb{C}} A$, where A is an associative commutative unital $\mathbb{C}$-algebra and $\mathfrak{g}$ is a basic complex Lie superalgebra or $\mathfrak{sl}(n,n), n \geq 2$. Bagci, Calixto and Macedo studied Weyl modules and Weyl functors for the superalgebras $\mathfrak{g} \otimes A$, where $\mathfrak{g}$ is either $\mathfrak{sl}(n,n), n \geq 2$, or any finite dimensional simple Lie superalgebra not of type $\mathfrak{q}(n)$. We define global and local Weyl modules for $\mathfrak{q} \otimes A$, where $\mathfrak{q}$ is the queer Lie superalgebra and A is an associative commutative unital $\mathbb{C}$-algebra. In this talk, we will discuss global Weyl modules are universal highest weight objects in certain category up to parity reversing functor Π. Then with the assumption that A is finitely generated, we show that the local Weyl modules are finite dimensional and further they are universal highest map-weight objects in certain category up to Π.

Weyl Modules for Twisted Toroidal Lie Algebras

Name: Ritesh Kumar Pandey

Institution: Indian Institute of Technology Kanpur

Abstract: In this talk, we extend the notion of Weyl modules for twisted toroidal Lie algebra $\mathcal{T}(\mu)$. We prove that the level one global Weyl modules of $\mathcal{T}(\mu)$ are isomorphic to the tensor product of the level one representation of twisted affine Lie algebras and certain lattice vertex algebras. As a byproduct, we calculate the graded character of the level one local Weyl modules of $\mathcal{T}(\mu)$.

On compatible Leibniz algebras

Name: Ripan Saha

Institution: Raiganj University

Abstract: In this talk, we study the notion of compatible Leibniz algebras. We explore the classification of complex Leibniz algebras in dimensions two and three in order to obtain explicit examples of compatible pairs. We further characterize compatible Leibniz algebras in terms of Maurer-Cartan elements of a suitable differential graded Lie algebra. Moreover, we introduce a cohomology theory for compatible Leibniz algebras, which, in particular, governs one-parameter formal deformations of this algebraic structure. Motivated by classical applications of cohomology, we also investigate abelian extensions of compatible Leibniz algebras.

Non-commuting graphs of projective spaces over central quotients of Lie algebras

Name: Songpon Sriwongsa

Institution: King Mongkut's University of Technology Thonburi

Abstract: Let L be a finite-dimensional non-abelian Lie algebra with the center $Z(L)$. In this talk, we define a non-commuting graph associated with L as the graph whose vertex set is the projective space of the quotient algebra $L/Z(L)$, and two vertices Span $\{x + Z(L)\}$ and Span $\{y + Z(L)\}$ are adjacent if x and y do not commute under the Lie bracket of L. We present several theoretical properties of this graph. For certain classes of Lie algebras, we show that if the non-commuting graphs from two Lie algebras are isomorphic, then these Lie algebras themselves must be isomorphic. Furthermore, we discuss a relation between graph isomorphisms between non-commuting graphs of Lie algebras over finite fields and the size of the algebras.

Linkage principle for small quantum groups

Name: Cristian Vay

Institution: Universidad Nacional de Córdoba

Abstract: We consider small quantum groups with root systems of Cartan, super and modular type, among others. These are constructed as Drinfeld doubles of finite-dimensional Nichols algebras of diagonal type. We discuss their connections with other algebras in the literature and highlight distinctive features of their representation theory. Based on the homonymous work by the author [Adv. Math. 475 (2025) 110347], we prove a linkage principle for them by adapting techniques from the work of Andersen, Jantzen and Soergel in the context of Lusztig's small quantum groups. As a consequence, we characterize the blocks of the category of modules. We also introduce a notion of (a)typicality analogous to that appearing in the representation theory of Lie superalgebras. The typical simple modules turn out to be the simple and projective Verma modules. Moreover, we deduce a character formula for 1-atypical simple modules.

The projective functors on the category O

Name: Xinrui You

Institution: Université Picardie Jules Verne, LAMFA / IMJ-PRG

Abstract: Bernstein and Gelfand classified the projective functors (i.e. direct summands of the tensor by a finite dimensional representation) on the category of Z-finite modules on 1980. We will discuss the restriction of the projective functors on the category O, and the connection to Soergel bimodules.

Permutation Orbifolds of Vertex Operator Algebras

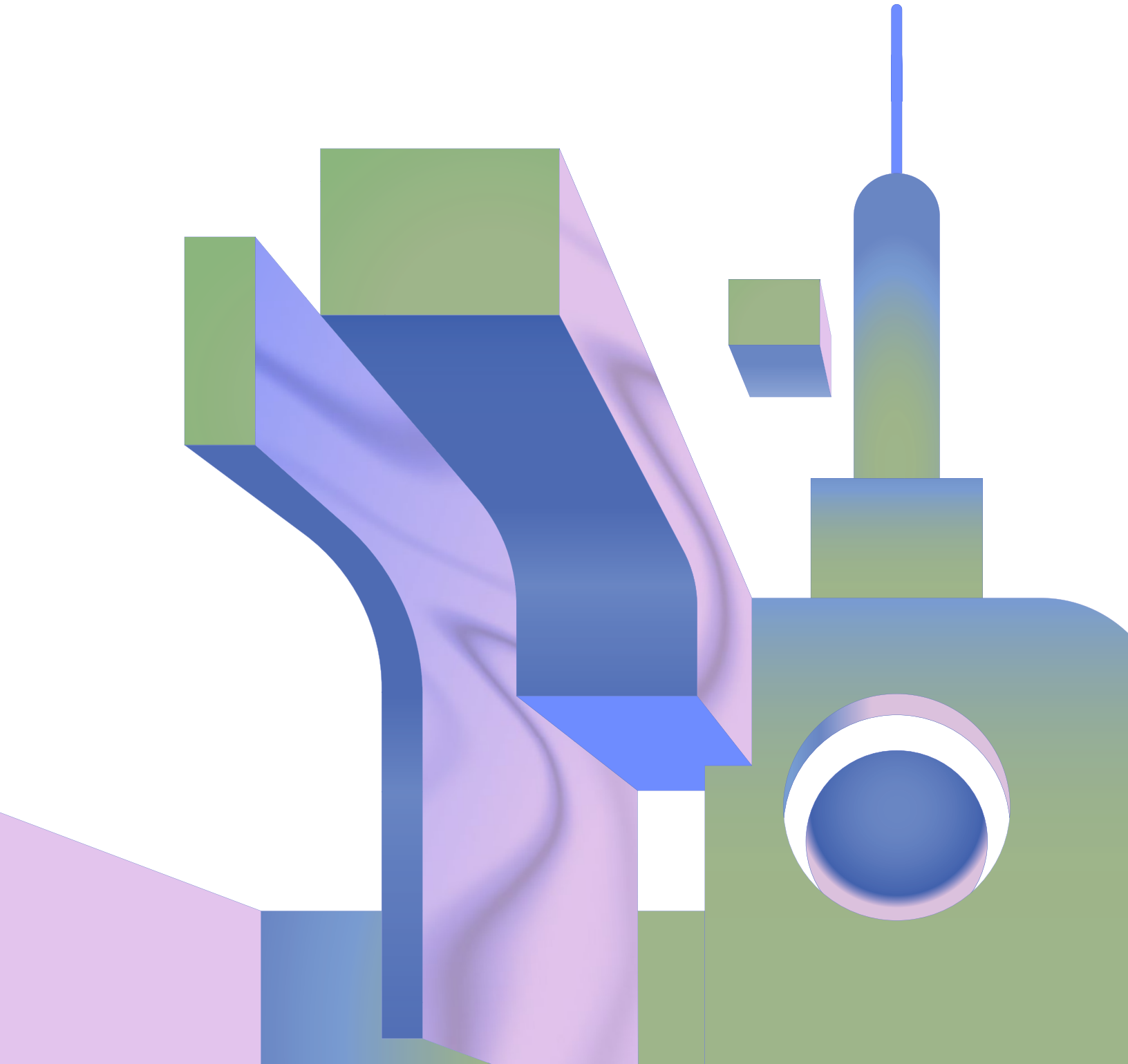
Name: Nina Yu

Institution: Xiamen University

Abstract: A central problem in the theory of vertex operator algebras (VOAs) is the orbifold problem, which concerns the relationship between a VOA V and its fixed-point subalgebra V^G under the action of a finite automorphism group G. Understanding how the representation theory of V relates to that of V^G is fundamental to both the structure theory of VOAs and their connections with conformal field theory.

In this talk, we focus on permutation orbifolds, arising from the natural action of the symmetric group S_n on the tensor product $V^{\otimes n}$. Such orbifolds play an important role in the construction and classification of vertex operator algebras and conformal field theories. We discuss recent progress on the structure and representation theory of permutation orbifolds.

SECTION 8– ANALYSIS



Recent results on sampling type series and applications to image processing

Name: Tuncer Acar

Institution: Selçuk University

Abstract: In this talk, we present several recent developments concerning sampling type series and their approximation properties in various function spaces. Sampling type series constitute an important class of approximation operators, playing a fundamental role in approximation theory, harmonic analysis, and signal reconstruction. In recent years, significant progress has been made in understanding their convergence behavior and rate of approximation under different structural assumptions.

A particular emphasis will be placed on the study of sampling type series in weighted function spaces. We discuss how the presence of suitable weight functions influences the approximation order, smoothness preservation, and error estimates of these operators. Connections with modulus of continuity, quantitative estimates, and embedding properties of weighted spaces will be highlighted, illustrating the advantages of working within this more general framework.

In the second part of the talk, we focus on applications of sampling type series to image processing. We demonstrate how the theoretical results can be effectively employed in practical problems such as image reconstruction, denoising, and resolution enhancement. Several examples will be discussed to show how sampling based approximation schemes provide efficient and robust tools for processing digital images. The aim of this presentation is to bridge the gap between abstract approximation theory and concrete applications in image and signal processing.

On a boundary value problem with integral and multi-point boundary conditions associated with a fractional q-difference equation

Name: Umit Aksoy

Institution: Atilim University

Abstract: In this study, a class of nonlinear q-difference equations of fractional order under multi-point and integral boundary conditions is studied. Green's type functions are constructed with some of their properties and the representation of the solution of the linear equation with multi-point and integral conditions is obtained. The nonlinear boundary value problem is transformed into an integral equation and the fixed points of the related integral operator are investigated by using a contractive condition involving a comparison function. The Ulam-Hyers stability of the problem is also investigated. An example is provided to illustrate the main results.

A fixed point iterative approach for solving an elastic beam equation

Name: Faeem Ali

Institution: Aligarh Muslim University, Aligarh, India

Abstract: This paper applies a fixed-point iteration method to approximate the solution of a nonlinear elastic beam equation in a Banach space. The existence and uniqueness of the solution of the elastic beam equation are proved. Moreover, some convergence results are demonstrated for almost ⊠-contraction by the F*- fixed point iteration method. Some illustrative numerical examples are formulated to validate our results. The results presented in this paper are new and extend, improve, and unify several relevant results in the literature.

A functional identity for the Hilbert metric

Name: Sahsene Altinkaya

Institution: Marmara University

Abstract: The Hilbert metric is defined as the logarithm of the cross-ratio determined by two points $a, b \in \mathbb{B}^2$

$$h_\mathbb{B}\text{^}2(a,b) = \log \frac{|u-b||a-v|}{|u-a||b-v|},$$

where u, v are the intersection points of the line $L[a,b]$ through a and b, and the unit circle $\partial\mathbb{B}^2$ ordered in such a way that $|u-a| < |u-b|$. The visual angle metric defined for $a, b \in \mathbb{B}^2$ by

$$v_\mathbb{B}\text{^}2(a,b) = \sup\{\alpha : \alpha = \measuredangle(a,z,b), z \in \partial\mathbb{B}\text{^}2\}.$$

In this work, we establish a functional identity between the Hilbert metric and the visual angle metric in $\mathbb{B}^2$. This identity leads to sharp distortion estimates for quasiregular mappings and analytic functions, now expressed naturally in terms of the Hilbert metric. We further prove that Hilbert circles coincide with Euclidean ellipses. Computer algebra methods, such as the application of Gröbner bases, are employed in the proof.

Acknowledgments. Şahsene Altınkaya is supported by the Scientific and Technological Research Council of Türkiye (TUBITAK) according to the research project 1059B192402218.

Composition of Activation functions and the Reduction to finite domain

Name: George Anastassiou

Institution: University of Memphis **Abstract:** This work takes up the task of the determination of the rate of pointwise and uniform convergences to the unit operator of the ” normalized cusp neural network operators” . The cusp is a compact support activation function, which is the composition of two general activation functions having as domain the whole real line. These convergences are given via the modulus of continuity of the engaged function or its derivative in the form of Jackson type inequalities. The composition of activation functions aims to more flexible and powerful neural networks, introducing for the first time the reduction of infinite domains to the one domain of compact support.

Asymptotic value of the multidimensional Bohr radius

Name: Vibhuti Arora

Institution: National Institute Of Technology (NIT) Calicut

Abstract: In this talk, I will discuss the exact asymptotic value of the Bohr radii and the arithmetic Bohr radii for the holomorphic functions defined on the unit ball of the ℓ_p^n space and having values in the simply connected domain of $\mathbb{C}$. Moreover, I will present the sharp Bohr radius for four distinct categories of holomorphic functions. These functions map the bounded balanced domain G of a complex Banach space X into the following domains: the right half-plane, the slit domain, the punctured unit disk, and the exterior of the closed unit disk.

Diagonal process and applications

Name: Youssef Azouzi

Institution: University of Carthage

Abstract: We present a general diagonalization process for nets, which extends the classical Cantor diagonal argument for sequences. While the countable version is constructive, the general form is not. Several applications are provided in functional analysis, topology, and the theory of vector and Banach lattices. We also show that our result allows for a simplification of the proofs of several known theorems.

Ball separation characterization of ball dentability and related properties

Name: Sudeshna Basu

Institution: Loyola University

Abstract: In Euclidean spaces, every closed, bounded, convex set can be characterized by two equivalent notions of separation properties. This is not true in general for arbitrary Banach spaces. In this work, we present a ball separation characterization for spaces where the unit ball is dentable. We also explore related properties.

Fourier inequalities in variable Lebesgue spaces

Name: Matías Caruso

Institution: Instituto Balseiro

Abstract: Variable Lebesgue spaces were introduced by Orlicz in the 1930s and systematically studied by Nakano in the 1950s. During the last few years, they have gained great interest due to their applications to the modelling of electrorheological fluids and image processing.

Many results that hold for classical Lebesgue spaces can be extended to the variable setting. However, a remarkable exception is the famous Hausdorff-Young inequality, that establishes that if $f \in L^p(\mathbb{R}^n)$, $1 \leq p \leq 2$, then

$$\|\hat{f}\|_p \leq C\|f\|_{p'},$$

where $\hat{f}$ is the Fourier transform of f and p' is the conjugate exponent of p. This has motivated the consideration of extra ingredients in the search of the correct generalization of the inequality to the variable context, leading, for example, to weighted inequalities, inequalities with rearrangements or extra hypotheses.

In this short communication, we provide different sufficient conditions and necessary conditions for the validity of Fourier inequalities in variable Lebesgue spaces.

The inhomogeneous Cauchy-Riemann equation with or without Dini continuity

Name: Adam Coffman

Institution: Purdue University Fort Wayne

Abstract: Regarding the interior regularity of the inhomogeneous Cauchy-Riemann equation $\partial u/\partial \bar{z} = f$, it has been known since the work of Chern, and Hartman and Wintner, that the property of Dini continuity of f is sufficient for the continuity of all first derivatives of u. We show by example that f can be continuous and very close to Dini continuous, while u is classically differentiable everywhere and vanishing to infinite order at a point, but $\partial u/\partial z$ is discontinuous. The main application is to the regularity of J-holomorphic curves for rough almost complex structures J. Joint work with Yifei Pan, Purdue University Fort Wayne.

Global hypoellipticity for systems on asymptotically Euclidean manifolds

Name: Sandro Coriasco

Institution: Dipartimento di Matematica "G. Peano", Università di Torino

Abstract: We study the global hypoellipticity of the operator

$$\mathbb{L} = \mathrm{d}_t + \sum_{k=1}^{m} \omega_k \wedge \partial_{x_k},$$

defined on differential forms over product manifolds $M \times \mathbb{T}^m$. Explicitely, M is a non-compact manifold, diffeomorphic to the interior of an asymptotically Euclidean manifold, that is, a compact manifold with boundary, equipped with a scattering metric, while $\mathbb{T}^m$ is the m-dimensional torus.

In the expression of $\mathbb{L}$, d_t denotes the exterior derivative acting on the variable t on $M, \omega_1, \ldots, \omega_m$ are smooth, real-valued, closed 1-forms on M, and $x = (x_1, ..., x_m)$ are the angular coordinates on $\mathbb{T}^m$. Operators of the form $\mathbb{L}$ arise naturally in the context of involutive structures, where the associated distribution is closed under the Lie bracket. Locally, they can be interpreted as systems of commuting first-order partial differential equations, with a geometric structure encoded by the 1-forms ω_k , $k = 1, ..., m$. Extending known results in the compact setting, we characterize the global hypoellipticity of $\mathbb{L}$ in terms of arithmetic properties of the forms ω_k, $k = 1, \ldots, m$. The analysis relies on microlocal techniques and a version of the Hodge Theorem available on asymptotically Euclidean manifolds. This is joint work with A. Kirilov, W. A. A. de Moraes, and P. M. Tokoro (Universidade Federal do Paraná, Curitiba, Paraná, Brazil), published in The Journal of Geometric Analysis.

Submanifolds with boundary and Stokes' Theorem in Heisenberg groups

Name: Marco Di Marco

Institution: ETH Zürich

Abstract: We introduce the notion of submanifolds with boundary with intrinsic C^1 regularity in the setting of sub-Riemannian Heisenberg groups. We present a Stokes' Theorem for such submanifolds involving the integration of Heisenberg differential forms introduced by Rumin. Talk based on a joint work with A. Julia, S. Nicolussi Golo and D. Vittone.

Strong convergence of new iterative methods for quasi-monotone variational inequalities

Name: Behzad Djafari-Rouhani

Institution: University of Texas at El Paso

Abstract: We consider variational inequalities with quasi-monotone and Lipschitz continuous operators in a Hilbert space. We introduce two new algorithms and show the strong convergence of the generated sequence to a solution of the variational inequality problem, both with the knowledge, as well as without any knowledge of the Lipschitz constant of the operator. We give also some examples of applications and numerical experiments of our main results and compare the speed of convergence of the two methods.

Emerging Works on Hahn Difference Equations and Oscillation

Name: Sibel Dogru Akgol

Institution: Çukurova University

Abstract: Oscillation theory for difference equations involving the full Hahn operator remains largely unaddressed in the literature, despite extensive work on the qualitative analysis of solutions. While significant progress has been made in spectral and asymptotic properties, dedicated oscillation criteria are notably absent. Historical research has focused on transform methods and solution techniques, such as the Fourier – Hahn transform for quantum models, rather than oscillatory behavior. Even recent advances—including the adaptation of the Asymptotic Iteration Method and applications of Nevanlinna theory—provide powerful tools yet do not directly confront oscillation phenomena. In this talk, we initiate the systematic study of oscillation for such equations by establishing foundational, classical oscillation theorems for the second-order case.

Hilbert Scale-based extension of Homeier-Type Iterative strategies for Nonlinear Ill-Posed Problems

Name: Shobha M Erappa

Institution: Manipal Institute of Technology, Manipal Academy of Higher Education Manipal

Abstract: In this study, a sixth-order Homeier-like method for approximating solutions to nonlinear ill-posed equations within the framework of Hilbert scales, specifically involving monotone operators is proposed. The convergence analysis is conducted under weaker assumptions on the first Fréchet derivative of the operator. For selecting the regularization parameter, adaptive strategy introduced by Pereverzev and Schock (2005) is adapted and the derived error estimate is shown to be of optimal order.

On some recently defined metric extensions, their properties and applications

Name: Inci Erhan

Institution: Aydin Adnan Menderes University

Abstract: The concept of distance, or more generally, metric, is a basic one in almost all sciences. The most commonly used metric is the usual distance in 3-dimensional Euclidean space. However, the research and developements in many different areas of science, engineering and technology require use of new types of distances(metrics) for various reasons: reducing the computational time and cost for the solutions of particular problems, providing the existence and uniqueness of their solutions in cases when the usual metrics do not apply, and others.

Recently, the definition of the metric has been altered in different ways to give a new and more general form of a metric. Among the older ones can be mentioned the quasi-metric, b-metric, partial metric, G-metric, rectangular metric. Some of the more recent ones are the so-called suprametric, perturbed metric, interpolative metric, ϕ-metric.

The purpose of this talk is to present some of the most recent metric generalizations and give relations between them. In addition, we aim to introduce the use of these metrics in certain real

life problems which illustrate the significance of the new metric types in connection with the solutions of these real life problems.

Commutator of Calderón-Zygmund operator in Fofana-Hardy spaces

Name: Justin Feuto

Institution: Université Félix Houphouët-Boigny

Abstract: We prove that the commutator of a Calderón-Zygmund operator with an element in an appropriate subspace of BMO space is bounded in a Hardy-type space defined by taking, in the definition of classical Hardy spaces, the quasi-norm of Wiener amalgam spaces instead of the quasi-norm of Lebesgue spaces.

Norm behavior of Jordan and bidiagonal matrices

Name: Krishna Kumar G

Institution: University of Kerala

Abstract: According to the spectral theorem, the norm behavior of normal matrices can be completely determined from their spectrum; however, for non-normal matrices, the spectrum alone is not sufficient to describe their behavior. Determining the norm behavior of non-normal matrices from spectral-related sets is a fundamental problem in matrix theory. In this work, we prove that the pseudospectra and condition spectra completely characterize the norm behavior of Jordan matrices for any matrix p-norm. Furthermore, we provide sufficient conditions for determining the 1-norm and ∞-norm behavior of bidiagonal matrices based on their pseudospectra and condition spectra.

Zero dynamics for a class of robustly stable polynomials

Name: Luis Garza Gaona

Institution: Universidad de Colima

Abstract: In this contribution, we introduce two different methods to construct robustly stable Schur polynomials that depend on an uncertain parameter, by using basic properties of orthogonal polynomials on the unit circle. We also develop a procedure to describe the behavior of the zeros of a class of uncertain polynomials with respect to the uncertain parameters. Some illustrative examples are presented.

Generalized Sequence Spaces in the Bicomplex Framework

Name: Jhavi Ghimire

Institution: Central Department of Mathematics, Tribhuvan University, Kathmandu, Nepal

Abstract: Abstract This presentation focuses on generalizing classical sequence spaces to the bicomplex setting, where sequences consist of bicomplex numbers. We study their structural properties, including convergence and summability. We also explore how classical results extend or differ in this richer framework. Using the idempotent representation, we examine zero divisors and show how complex-valued results appear as special cases. This talk not only broadens the scope of existing sequence space theory but also suggests potential applications in bicomplex analysis and related mathematical areas.

Algebraic and C*-Algebraic Invariants for Subshifts

Name: Daniel Goncalves

Institution: Universidade Federal de Santa Catarina

Abstract: We associate to one-sided subshifts—over finite or infinite alphabets—naturally defined C*-algebras and purely algebraic Leavitt-type algebras that extend the classical graph and Leavitt path algebra frameworks. These constructions retain strong dynamical information: for the subshifts of Ott – Tomforde – Willis, topological conjugacy can be fully characterized through (C*)-algebraic properties, and for countable alphabets equipped with the product metric they also detect isometric conjugacy. Furthermore, algebraic invariants such as K-theory and the socle arise naturally in this setting and provide additional tools for distinguishing subshifts.

Fractional calculus of zeta functions: further results

Name: Emanuel Guariglia

Institution: São Paulo State University

Abstract: In this short communication, we deal with new analytic results concerning fractional calculus of zeta functions. First, we study the zero-free regions of the α-order fractional derivative of the Riemann zeta function. In particular, we show some zero-free regions of $\zeta^{(\alpha)}(s)$. Furthermore, we prove existence of a zero-free region in the left half-plane depending on the complement of a circle of finite radius r_α centered at the origin. In the second part, we prove and discuss the property of universality of $\zeta^{(\alpha)}(s)$. As a consequence, a wide class of analytic functions can be approximated by shifts of $\zeta^{(\alpha)}(s+i\tau)$, $\tau \in \mathbb{R}$.

Finner-like inequalities in the Heisenberg group

Name: Kaiyi Huang

Institution: University of Wisconsin-Madison

Abstract: We completely characterize the range of L^p-boundedness of certain multilinear Radon-like transforms involving vertical projections in the Heisenberg group.

Weak Centrality for Certain Tensor Products of C^*-algebras

Name: Ranjana Jain

Institution: University of Delhi

Abstract: A unital C^*-algebra A is weakly central if two maximal ideals M and M' of A coincide whenever $M \cap Z(A) = M' \cap Z(A)$, where $Z(A)$ is the centre of A (see, R. J. Archbold and I. Gogic, The centre-quotient property and weak centrality for C*-algebras, Int. Math. Res. Not., 2 (2022), 1173-1216). The C^*-algebras satisfying the Dixmier property (in particular, von Neumann algebras) are some prominent examples of weakly central algebras. In this talk, we shall introduce weak centrality for Banach algebras and discuss some of its properties. We use this to discuss the weak centrality of the tensor product $A \otimes_\alpha B$ (a Banach algebra) in terms of the weak centrality of A and B, where A and B are C^*-algebras, and $\otimes_\alpha$ is either the Haagerup or the Banach space projective tensor product. We also identify the largest weakly central ideal of $A \otimes_\alpha B$ in terms of that of A and B. We further study the relationship between weak centrality and centre-quotient property for $A \otimes_\alpha B$. This talk is based on our research article (A. Paliwal and R. Jain, Weak Centrality for certain tensor products of C^*-algebras, https://arxiv.org/abs/2508.08838v1) and some unpublished work.

Hypergeometric Matrix functions and their properties

Name: Ranjan Jana

Institution: Sardar Vallabhbhai National Institute of Technology

Abstract: In this talk, a generalization of the extended gamma matrix function(EGMF) and extended beta matrix function(EBMF) are to be introduced using the four-parameter Mittag-Leffler matrix function. Several fundamental properties will be explored. Further, extended hypergeometric matrix function(EHGMF) and extended confluent hypergeometric matrix function(ECHGMF) will be investigated by utilizing the newly generalized extended beta function. Various properties of these functions are examined, such as their integral representations, differentiation formulas, transformation formulas, beta transforms, recurrence relations and generating functions.

ON SOME COMMON FIXED POINT RESULTS UNDER NEW COMPATIBILITY

Name: Kanhaiya Jha

Institution: Kathmandu University

Abstract: Metric space clearly forms a natural environment for exploring fixed points of single and multivalued mappings. The fixed point theory as a part of non-linear analysis is a study of function equation in metric or non-metric settings. It provides necessary tools for the existence of theorems in non-linear problems. The classical Banach contraction principle in metric space is one of the fundamental results with wide applications. Among several generalized forms of metric space, the study of common fixed point of mappings in a fuzzy metric space satisfying certain contractive conditions has been at the center of vigorous research activities. Also, the role of compatible mappings for the existence of common fixed point is very crucial. The notion of compatible mappings of type (K) in metric space was introduced by K. Jha, V. Popa and K.B. Manandhar in 2014. The objective of this talk is to discuss some common fixed results for self-mappings in some generalized forms of metric space under this new compatible mappings which generalizes and improves similar results of fixed points.

Hopf conjecture for Gaussian curvature of minimal graphs

Name: David Kalaj

Institution: University of Montenegro

Abstract: In this paper, we solve the longstanding Gaussian curvature conjecture of a minimal graph S over the unit disk. The conjecture asserts that for any minimal graph above the unit disk, the Gaussian curvature at the point directly above the origin satisfies the sharp inequality $|\mathcal{K}| < \frac{\pi^2}{2}$. We first reduce the conjecture to the problem of estimating the Gaussian curvature of certain Scherk-type minimal surfaces defined over bicentric quadrilaterals inscribed in the unit disk, containing the origin. We then provide a sharp estimate for the Gaussian curvature of these minimal surfaces at the point above the origin. Our proof employs complex-analytic methods, as the minimal surfaces in question allow a conformal harmonic parameterization.

Quantitative and qualitative results on Distance Sets in Large Fractal-Type Sets

Name: Senthil Raani Kalirathnam Srinivasagam

Institution: IISER Berhampur

Abstract: In this talk, we synthesize two recent advances in distance-set theory. We briefly see an improved threshold for the Falconer pinned-distance conjecture in higher dimensions by Du, Ou, Ren & Zhang, and then the quantitative structure of distance sets in sparse but large - dimension sets obtained in the work joint with Malabika Pramanik. Together, these results offer both qualitative and quantitative analysis of distance sets.

To study the quantitative structure of the distance sets we explore how “large” Borel sets in d-dimensional Euclidean space $\mathbb{R}^d$, even those of Hausdorff dimension near d but not full measure, produce rich distance sets containing explicit unions of intervals, with lengths governed by density - rich subcubes, yielding a quantitative Mattila – Sjölin theorem. Further, we discuss the

characterizations of the sets that admit all sufficiently large distances and discuss the structure of the distance sets of quasi-regular sets.

We end with applications of techniques to quantify other patterns, such as k-chains, finite trees in thin sets and potential problems of distance sets in Heisenberg group.

Characterization of Generalized Hausdorff operator on Bergman spaces

Name: Kalaivani Kamalakannan

Institution: Vellore Institute of Technology

Abstract: In this talk, at first, we will discuss the basic theorems of Hausdorff operator starting from the work of Xiao, for the class of integrable functions on $\mathbb{R}^+$, which was later considered by Stylogiannis for the spaces of analytic functions on the complex plane. After that, we will discuss the recent developments of generalized Hausdorff operator generated by the kernal ϕ on the weighted integrable spaces on $\mathbb{R}^+$ and Bergman spaces on the upper half of the complex plane. Lastly, we explore the boundedness and compactness of the Hausdorff operator on Bergman space on the upper half of the plane.

Remarks on recent fixed point results and thoughts on the future of it

Name: Erdal Karapinar

Institution: Atilim University

Abstract: This talk aims to reveal the dilemmas of the fixed point theorems that were first constructed by Banach in 1922. It is possible to transform many of the real-world problems into fixed-point theorems. This shows how the fixed point theory is useful and how huge the application potential is. On the other hand, a lot of results are repeated in this theory, which is of great interest. A substantial part of the new results suggested overlaps with the old results.To support this observation, a few examples from the current literature will be shared.

Multidimensional Fuzzy-Random Neural Network Operators (NNOs) Based on Trainable-Symmetrical Activation Dynamics

Name: Seda Karateke

Institution: Istanbul Atlas University

Abstract: In this study, we introduce a family of multidimensional neural network operators (NNOs) based on fuzzy-random quasi-interpolation with symmetric and trainable activation dynamics. We calculate the degree of convergence of the multivariate pointwise and uniform convergences obtained using these operators to the fuzzy-random unit operator in p-mean sense. In particular, we shall discuss the advantages of the activation mechanism we use here, which

is a trainable half-hyperbolic tangent function, over other activation functions in the literature. Moreover, we incorporate multivariate probabilistic-Jackson-type inequalities using the multivariate Fuzzy-random modulus of continuity when calculating convergence rates. The resulting convergence rates and error estimates demonstrate that this operator family is based on a robust theoretical framework. We present a validation of our theoretical findings through numerical examples and error reduction graphs obtained using the Python 3.9 programming language. As a result, we shall blend the theory used here with today's Artificial Intelligence (AI) perspective and give examples of interesting real-life applications.

Reverse dynamic Hardy – Copson type inequalities on time scales for $0 < p < 1$

Name: Zeynep Kayar

Institution: Van Yuzuncu Yil University

Abstract: This paper focuses on establishing nabla and delta dynamic inequalities on time scales for the parameter range $0 < p < 1$. In contrast to the classical dynamic Hardy – Copson inequalities derived for $p > 1$, the inequalities presented herein do not preserve the direction observed in the classical cases. Instead, owing to the exponent lying within the interval $(0, 1)$, the direction of the resulting inequalities is reversed. Furthermore, the derived inequalities are not only novel but also provide a unified framework for continuous and discrete cases, addressing the parameter range $0 < p < 1$ which has previously been unexplored.

Support of semiclassical measures in higher dimensions

Name: Elena Kim

Institution: Massachusetts Institute of Technology

Abstract: A central question in quantum chaos is how classical chaotic dynamics influence quantum behavior. On compact Support of Semiclassical measures in higher dimensions manifolds, pure quantum states correspond to Laplacian eigenfunctions. The quantum unique ergodicity (QUE) conjecture of Rudnick and Sarnak predicts that on hyperbolic manifolds, all high-energy eigenfunctions become uniformly distributed. The asymptotic behavior of eigenfunctions can be formulated in terms of semiclassical measures, which describe the microlocal distribution of eigenfunction mass. One approach towards the QUE conjecture applies microlocal analysis and uncertainty principles to characterize the support of semiclassical measures. I will discuss recent work that uses the breakthrough higher-dimensional fractal uncertainty principle of Cohen. Using this uncertainty principle, we prove the first result on the support of semiclassical measures on real hyperbolic n-manifolds. This is joint work with Nicholas Miller.

Stokes Phenomenon in Cauchy-Riemann Geometry

Name: Ilya Kossovskiy

Institution: Southern University of Science and Technology

Abstract: This work is related to remarkable connections between CR (Cauchy-Riemann) geometry and the theory of Dynamical Systems, recently developed in my joint work with R.Shafikov, B.Lamel, L.Stolovitch, and P.Ebenfelt (the CR - DS method).

CR geometry is the geometry of embedded real submanifolds in a complex manifold (CR submanifolds) endowed with the induced complex structure on their complex tangent bundle. It originated in the 1907 work of Poincare on the Riemann Mapping Theorem in SCV, and was further developed in the fundamental work of E.Cartan, Tanaka, Chern and Moser.

Stokes phenomenon for classes of dynamical systems means those systems exhibiting different geometric behavior in various sectorial domains associated with a stationary point. Transformations of such systems to a simpler model with the given asymptotics may vary depending on the sector, which results in the appearance of a nontrivial transition cocycle (Stokes cocycle). The latter is a geometric invariant of the dynamical system "invisible" from the point of view of formal power series classification. Stokes Phenomenon shows up for such important classes of dynamical systems as saddle-node singularities of vector fields and parabolic singularities of diffeomorphisms.

A typical phenomenon of Cauchy-Riemann geometry is the analytic hypoellipticity: formal or smooth transformations of analytic CR manifolds are analytic too, for large classes of CR manifolds. However, in a number of recent publications (e.g. [JEMS2016], [JDG2016], [AJM2018], [AIM22]) we demonstrated the failure of the analytic hypoellipticity for classes of CR manifolds. This raised a key question on their actual analytic classification.

In this joint work with L.Stolovitch, we discover that the CR classification problem here falls into the scope of Stokes Phenomena. For a general class of CR manifolds (infinite type hypersurfaces in complex 2-space), we show the existence of an in general nontrivial transition (Stokes) cocycle uniquely associated with an infinite type point. Two CR manifolds appear to be equivalent iff they are formally equivalent and their Stokes cocycles coincide. Our approach relies on the above mentioned CR - DS method, and the Multisummabilty Theory for solutions of differential equations (developed in earlier work of Balser, Braaksma, Ecale, Malgrange, Ramis, Sibuya).

Our outcome gives probably the first description of Stokes Phenomenon for geometric structures on manifolds.

Multi-dimensional Bohr radii of Banach space valued holomorphic functions

Name: Shankey Kumar

Institution: Indian Institute of Technology Madras

Abstract: We studied the multi-dimensional Bohr radii of holomorphic functions defined on the Banach sequence spaces with values in the Banach spaces. For the case of finite-dimensional Banach spaces, we exhibited the exact asymptotic growth of the Bohr radius. To achieve our goal in the finite case, we used $\ell_{p'}$-summability of certain coefficients of a given polynomial in terms of its uniform norm on ℓ_p^n. The infinite case is handled using the techniques developed in recent

years from the work of Defant, Maestre and Schwarting. We crucially used several properties of the symmetric M-linear mapping associated with a homogeneous polynomial of degree M in our analysis. Furthermore, we studied the bounds of the arithmetic Bohr radius of Banach space-valued holomorphic functions defined on the Banach sequence spaces, which generalises the work of Defant, Maestre, and Prengel in this direction.

Boundedness of pseudo-differential operators via coupled fractional Fourier transform

Name: Kanailal Mahato

Institution: Banaras Hindu University

Abstract: In this talk, we achieved significant outcomes regarding the coupled fractional Fourier transform and its kernel. We established pseudo-differential operators associated with the coupled fractional Fourier transform on Schwartz spaces, demonstrating that their composition results in another pseudo-differential operator. Additionally, we explored the composition of two pseudo-differential operators within Sobolev spaces and derived specific norm inequalities related to this. Furthermore, we successfully utilized some findings from the coupled fractional Fourier transform to examine the solutions of n^{th}-order linear non-homogeneous partial differential equations and wave equations. Finally, we provide examples that include graphs and tables to validate our theoretical results.

Hausdorff Dimension in Fractal Analysis

Name: Shaho Mashhouri

Institution: Kanon Momtaz

Abstract: We reveal a surprising independence between arithmetic and fractal properties of real numbers by studying the interplay between irrationality exponents and fractal dimensions. For any prescribed parameters, we explicitly construct Cantor-like sets in which almost every point attains a given irrationality exponent, while the set itself has a specified Hausdorff dimension. We further extend this framework to the effective Hausdorff dimension of individual real numbers. These constructions employ a carefully designed tree method, allowing simultaneous control over Diophantine approximation and fractal complexity.

Our results bridge classical Diophantine approximation with fractal geometry and algorithmic information theory, showing that rational approximation rates and fractal structure can be independently tuned. By extending the metric results of Jarník and Besicovitch, we uncover deep connections between arithmetic properties and geometric or computational complexity. This approach not only clarifies the relation between irrationality and fractal dimensions but also introduces versatile techniques for studying randomness, computability in number theory, and the fine structure of exceptional sets.

A novel approximation method for solving split variational inequality problem beyond monotonicity

Name: Oluwatosin Mewomo

Institution: Tarleton State University

Abstract: In this talk, we present a novel iterative method for solving Split Variational Inequality Problem (SVIP) in real Hilbert spaces. Our proposed method is without any product space formulation and with monotonicity assumption on the SVIP associated operators dispensed. The convergence analysis of these methods and some numerical examples to illustrate this method are discussed.

This is joint work with Grace N. Ogwo and Chinedu Izuchukwu (My Ex- PhD students and Postdoc).

Homotopies and Maps between Eigenvalues of some Generalized Lucas Sequences and the Mandelbrot Set

Name: Arturo Ortiz-Tapia

Institution: Beaumont ISD

Abstract: The eigenvalues of companion matrices associated with generalized Lucas sequences, denoted as L, exhibit a striking geometric resemblance to the Mandelbrot set M. This work investigates this connection by analyzing the statistical distribution of eigenvalues and constructing a variety of homotopies that map different regions of L to structurally corresponding subsets of M. In particular, we explore both global and piecewise homotopies, including a sinusoidal interpolation targeting the main cardioid and localized deformations aligned with the periodic bulbs. We also study a variation of the Jungreis map to better capture angular and radial structures. In addition to visual and geometric matching, we classify the eigenvalues according to their dynamical behavior, identifying subsets associated with hyperbolic, parabolic, Misurewicz, and Siegel disk points. Our findings suggest that meaningful correspondences between L and M must integrate both geometric deformation and dynamical classification. In light of these observations, we also suggest a conjectural homeomorphism between L and a dense subset of the Mandelbrot cardioid boundary, based on the behavior of the sinusoidal homotopy and the eigenvalue accumulation. Finally, we prove that the sinusoidal homotopy defines a homeomorphism (modulo countable exceptions) from L onto the boundary of the Mandelbrot cardioid, and, when composed with Douady's tuning map, extends to any baby cardioid or stable region of M, reinforcing the structural correspondence between these sets.

On Density and Dentability in Norm-Attainable Classes

Name: Joseph Owuor Owino

Institution: United States International University-Africa

Abstract: Characterizations of properties of operators between Banach spaces have been developed over decades. However, the density and dentability of operators, as well as their relationship, have not been characterized in norm-attainable classes. The main objective of this work has been to characterize both density and dentability in norm-attainable classes. Specifically, the objectives were to characterize density in norm-attainable classes, to characterize dentability in norm-attainable classes, and to establish the relationship between density and dentability in these classes. The methodology employed fundamental results such as the Hahn-Banach and Radon-Nikodým theorems, in addition to technical and geometric properties. We have proved that a countable union of dense norm-attainable subclasses of $B(H)$ is dense in $B(H)$. Moreover, we have shown that a finite intersection of dentable norm-attainable classes is dentable and that a dense norm-attainable class is necessarily dentable. This study is significant in mathematical analysis and mathematics at large, particularly in relation to optimization problems and algorithmic concentration in sphere packing. Beyond mathematics, these concepts find applications in population studies. For instance, density analysis helps distinguish between densely and sparsely populated areas, while dentability can reveal linear or nonlinear settlement patterns based on separability conditions. Additionally, density plays a crucial role in the study of stars and the universe, offering insights into various astrophysical processes and the structure of the cosmos. The open problems presented offer opportunities for further research.

Pfaffian equations: a variational perspective

Name: Pablo Pedregal

Institution: Universidad de Castilla-La Mancha

Abstract: Pfaffian equations are part of a classic area well-established in Differential Geometry. From a more analytical viewpoint, it has been traditionally treated in textbooks dealing with Differential Equations focusing on analytical techniques to understand and, eventually, find solutions. As usual, the success of those methods are however limited to explicit situations where computations can be carried out to the end. There are some general existence and uniqueness results as well. Yet the numerical approximation of such solutions has not been, to the best of our knowledge, treated. By means of a variational approach based on a true vector variational problem, we propose a mechanism to examine and numerically approximate such solutions, explore its remarkable properties, and test its practical performance in a number of explicit examples. The method can be implemented in situations where the underlying field defining the Pfaffian equation is not known exactly, but may be part of a broader approximation scheme.

Prediction models for high-dimensional problems: choose the data that matters

Name: Kateryna Pozharska

Institution: Institute of Mathematics of the National Academy of Sciences of Ukraine

Abstract: In the talk we will discuss recovery methods for unknown high-dimensional relations

from incomplete data. Namely, we consider both linear (such as weightel least squares) and non-linear (rLasso, basis pursuit, orthogonal matching pursuit) algorithms based on a restricted number of training data (function values at some points) and figure out difficulties and advantages of each of them in a number of model settings.

The square roots of some classical operators

Name: Marek Ptak

Institution: University of Agriculture in Kraków

Abstract: We give complete descriptions of the set of square roots of certain classical operators, often providing specific formulas. The classical operators included in this discussion are the square of the unilateral shift, the Volterra operator, certain compressed shifts, the unilateral shift plus its adjoint, the Hilbert matrix, and the Cesaro operator.

Conformal welding: Old and New

Name: Alex Rodriguez

Institution: Stony Brook University

Abstract: Conformal welding homeomorphisms are circle homeomorphisms that arise naturally in Teichmuller theory, Mathematical physics and dynamics. It is well known that not every circle homeomorphism is a conformal welding. However, in this talk we will see that every orientation-preserving circle homeomorphisms is the composition of two conformal weldings, which implies that conformal weldings are not closed under composition. Our approach uses the log-singular maps introduced by Bishop, which are conformal weldings. We will also see that for such conformal weldings, the so-called welding correspondence is highly non-injective, which associated Jordan curves of Hausdorff dimensions ranging from 1 to 2.

Coupled Optimal Results in b-Metric Space with Application to Differential Equation

Name: Deb Sarkar

Institution: Amity University Kolkata

Abstract: B-metric space is one of the generalizations of metric space. We introduce the concept of coupling in non-self mapping in this space. Here, we establish some coupled optimal results in b-metric space supported by suitable examples and consequences. Also, an application of non-linear differential equation has been shown.

Generalization of the q-Mittag – Leffler Function and Its Applications in Fractional q-Calculus

Name: Daya Lal Suthar

Institution: Wollo University

Abstract: In this study, we employ the q-calculus framework to present a novel and more general form of the q-Mittag-Leffler function. We investigate numerous significant aspects of this function, including its image formula using the Kober fractional q-calculus operator, recurrence relations, convergence behavior, q-integral transforms, integral representations, and q-derivative formulae. A new five-parameter q-exponential function is also proposed, resulting in an expanded version of the generalized q-Mittag-Leffler function. In addition, we obtain q-integral representations and fractional q-derivatives of the Caputo and Hilfer types for this function. We solve the related q-fractional kinetic equations by employing the q-Laplace and q-Sumudu transforms based on Riemann-Liouville fractional q-calculus operators. Several unique and special situations are offered to highlight the utility of the primary findings. Finally, numerical demonstrations developed in MATLAB 16 corroborate the analytical conclusions by demonstrating the behavior of the proposed functions.

Boundedness of Composition Operators on Higher-Order Besov Spaces

Name: Koichi Taniguchi

Institution: Shizuoka University

Abstract: We study the boundedness of composition operators on inhomogeneous Besov spaces of higher-order smoothness. Composition operators arise naturally in the context of changes of variables and are also referred to as Koopman operators or pull-back. Their boundedness plays an important role in the analysis of dynamical systems, the theory of function spaces on domains, and partial differential equations.

In this work, we provide a characterization of boundedness for composition operators on Besov spaces $B^s_{p,q}$ with $s > 1 + 1/p$ on the one-dimensional Euclidean space. In contrast to the lower-order case $0 < s < 1$, for which the theory is well developed, there have been few results addressing the boundedness of composition operators in the higher-order regime $s > 1$.

Our approach reveals a fundamental connection between composition operators and pointwise multipliers of Besov spaces. We show that, in the higher-order setting, the boundedness of composition operators is intrinsically governed by multiplier properties, and we effectively exploit existing characterizations of pointwise multipliers. As a result, we obtain necessary and sufficient conditions for the boundedness of composition operators on Besov spaces with $s > 1 + 1/p$. We also establish a similar characterization for the boundedness of composition operators on Sobolev spaces.

On isometric rigidity of Wasserstein spaces

Name: Tamás Titkos

Institution: Rényi Institute and Corvinus University

Abstract: In recent decades, there has been rapid development in the theory of optimal transport and its countless applications. One of the most important transport related metric structure is the so-called p-Wasserstein space $\mathcal{W}_p(X)$, where X is a Polish metric space.

A fundamental feature of p-Wasserstein spaces is that X embeds isometrically into $\mathcal{W}_p(X)$, and every isometry of X induces an isometry of $\mathcal{W}_p(X)$ via push-forward. Such isometries are called trivial. The space $\mathcal{W}_p(X)$ is said to be isometrically rigid if all its isometries are trivial. This naturally raises the questions: do non-rigid Wasserstein spaces exist, and if so, what does a non-trivial isometry look like?

In this talk, we survey what is currently known about isometries of p-Wasserstein spaces.

The talk is based on joint works with Zoltán M. Balogh (Universität Bern, Bern), Gy. P. Gehér (Riverlane, Cambridge), G. Kiss (Corvinus University and HUN-REN Rényi Institute, Budapest), and Dániel Virosztek (HUN-REN Rényi Institute, Budapest.)

New local T1 Theorems for bounded and compact singular operators on non-homogeneous spaces

Name: Francisco Villarroya Alvarez

Institution: Santa Clara University

Abstract: We introduce new local $T1$ theorems to characterize Calderon-Zygmund operators

$$T(f)(x) = \int f(t)K(x,t)dt$$

that extend boundedly or compactly on $L^p(\mathbb{R}^n, \mu)$, with $p \in (1, \infty)$ and μ a measure of power growth. These operators are described by two properties:

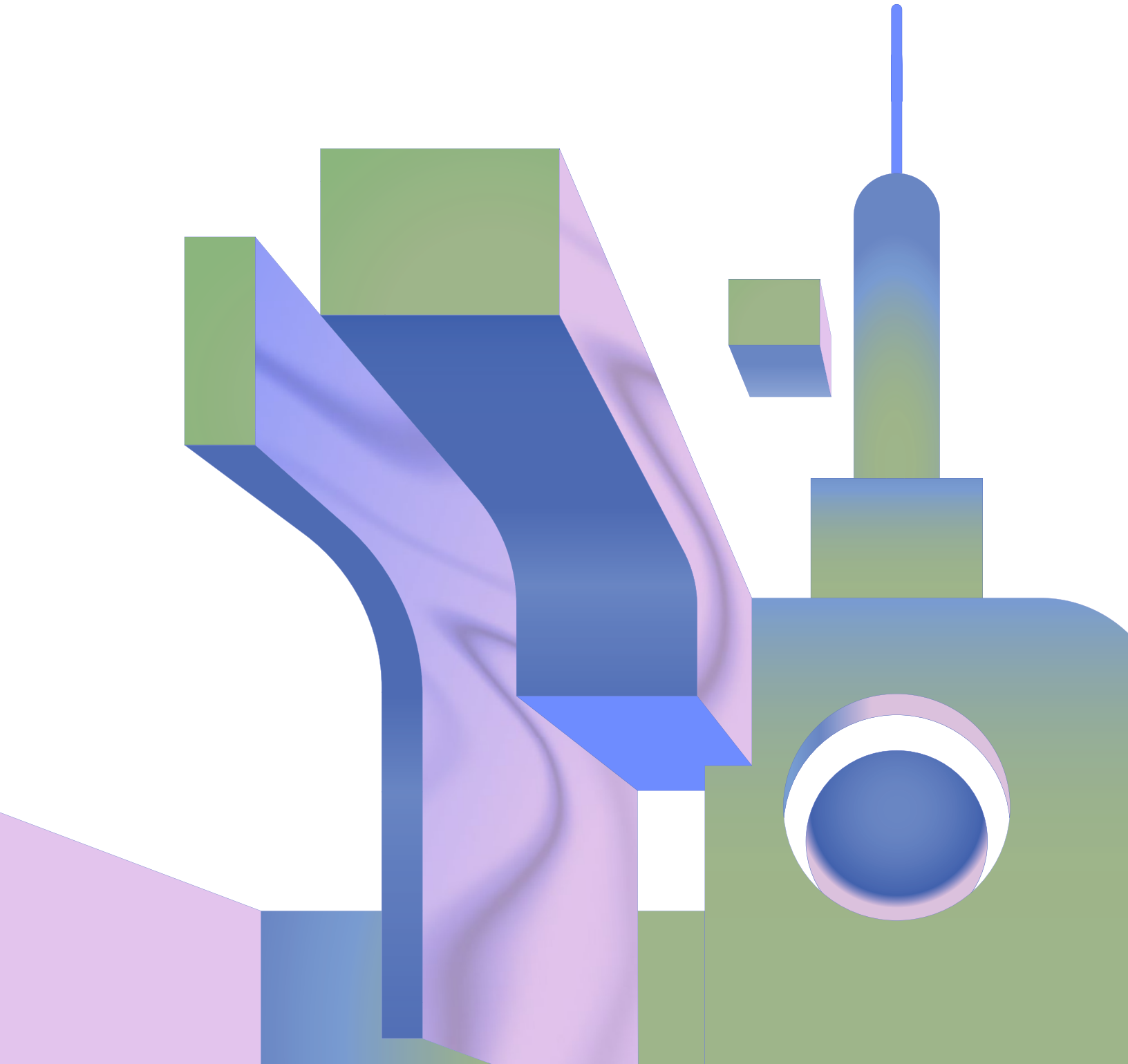
1) an operator kernel K whose generalized derivative decays in the directions perpendicular and parallel to the diagonal, and

2) local testing conditions given by the $L^2(\mu)$-norm of the operator acting over the indicator functions of cubes when localized to their own support.

The results, whose proofs do not require random grids, have weaker hypotheses than previously known local T1 theorems since they only require a countable collection of testing functions. This is relevant for applications to singular integrals supported on fractal measures. As a corollary, we describe the measures μ of the complex plane for which the Cauchy integral defines a compact operator on $L^p(\mathbb{C}, \mu)$.

SHORT COMMUNICATIONS

SECTION 9– DYNAMICS



A Safety-Oriented Mathematical Model of Autonomous Vehicle Adoption for Blind and Visually Impaired Individuals

Name: Emmanuel Addai

Institution: University of Arkansas at Little Rock

Abstract: This study advances safety research and human behavior analytics by developing a mathematical framework to analyze autonomous vehicle (AV) adoption and use among blind and visually impaired individuals, for whom AV systems represent a safety-critical mobility interface rather than a mere assistive convenience. We model AV adoption as a coupled socio-technical system in which trust, behavioral adaptation, and non-visual human – AI interaction directly influence safety outcomes. Using a system of nonlinear differential equations, we incorporate behavioral variables that capture reliance on auditory and haptic feedback, perceived system reliability, and risk sensitivity under visual impairment. Control parameters represent accessibility-focused safety policies, inclusive interface design, and targeted public awareness interventions. Existence, uniqueness, and stability analyses characterize conditions under which AV adoption remains behaviorally stable and safety-resilient for blind users. Sensitivity analysis using Latin Hypercube Sampling and Partial Rank Correlation Coefficients identifies dominant behavioral and policy drivers of safe adoption. Our findings indicate that accessibility-centered safety interventions significantly improve trust calibration and reduce unsafe behavioral responses during periods of system uncertainty or failure. The results highlight the necessity of integrating disability-specific human behavior analytics into autonomous vehicle safety modeling, policy design, and ethical AI deployment. This work positions accessibility for blind and visually impaired individuals as a foundational component of equitable and inclusive transportation safety research.

Pseudo-Anosov-like maps on the infinite ladder surface

Name: Nikita Agarwal

Institution: Department of Mathematics, University of Delhi

Abstract: Let S_g be the closed surface of genus g, $\mathcal{L}$ be the infinite Jacob's ladder surface, and Map(S) denote the mapping class group of a surface S. Let $q_g : \mathcal{L} \to S_g$ be the regular infinite-sheeted cover with deck transformation group $\mathbb{Z}$. In this talk, we show the existence of "pseudo-Anosov-like" maps on $\mathcal{L}$ that arise as the lifts of Penner-type pseudo-Anosov maps on S_g under the cover q_g. Furthermore, we establish that these lifts are topologically transitive, mixing, and support null recurrent dynamics. Moreover, we present concrete examples of infinite families of such maps on $\mathcal{L}$.

Weak chaos and Li-Yorke chaos in the weak topology of Banach spaces for strongly continuous semigroups of operators.

Name: Mohamed Amouch

Institution: Université Chouaib Doukkali

Abstract: In this talk, we introduce and study the concept of weak hypercyclicity for strongly continuous semigroups of operators on Banach spaces. This leads us to introduce the notions of weak chaos and Li-Yorke chaos in the weak topology of Banach spaces for strongly continuous semigroups of operators. We prove several properties of this class of strongly continuous semigroups and provide necessary and sufficient conditions for a C_0 ,semigroup to be Li-Yorke chaotic in the weak topology. Moreover, we explore the connections between this concept and other existing notions in linear dynamics.

Anisotropic Techniques Beyond Smooth Dynamics: The Bilateral Shift Case

Name: Daniel Brandao

Institution: ICMC-USP-Brazil

Abstract: Joint work with Mateus Marra (ICMC-USP). We introduce anisotropic Banach spaces of distributions adapted to the bilateral shift over a finite alphabet. On these spaces, the associated transfer operator is shown to be quasicompact with a spectral gap, and its 1–eigenspace is spanned by the Gibbs state corresponding to some given potential. This functional-analytic framework allows us to establish exponential decay of correlations not only for Hölder observables, but also for a broad class of highly irregular measures and distributions, including measures supported on graphs of Hölder functions. Our results show that anisotropic techniques remain effective well beyond the smooth setting, providing new tools for symbolic and non-smooth dynamical systems.

Cellular automata with a unique active transition

Name: Alonso Castillo-Ramirez

Institution: Universidad de Guadalajara

Abstract: For any group G and any set A, let A^G be the set of all functions $x : G \to A$. A cellular automaton (CA) over A^G is a transformation $\tau : A^G \to A^G$ such that there exists a finite neighborhood $S \subseteq G$ and a local function $\mu : A^S \to A$ satisfying

$$\tau(x)(g) = \mu((g \cdot x)|_S), \quad \forall x \in A^G, g \in G,$$

where $g \cdot x \in A^G$ denotes the shift action of G on A^G given by $(g \cdot x)(h) := x(hg)$, for all $x \in A^G$, $g, h \in G$. The classical setting, which has been widely studied from a dynamical and computational perspective, occurs when $G = \mathbb{Z}^d$, $d \in \mathbb{N}$, and $A = \{0, 1\}$.

We say that a CA $\tau : A^G \to A^G$ has a unique active transition if there exists a local defining function $\mu : A^S \to A$ for τ and a pattern $p \in A^S$ such that, the group identity e is in S and for all $z \in A^S$,

$$\mu(z) = z(e) \Leftrightarrow z \neq p.$$

Intuitively, a CA with a unique active transition acts on A^G almost as the identity function, except when it reads a fixed pattern $p \in A^S$. We write τ_p^a for a CA with unique active transition $p \in A^S$ and $a := \mu(p) \in A$.

In recent joint work with M. G. Magana-Chavez, E. Veliz-Quintero, and L. de los Santos Banos, we noticed that if $p \in A^S$ is constant or symmetric (i.e., $S = S^{-1}$ and $p(s) = p(s^{-1})$, $\forall s \in S$), then τ_p^a is idempotent (i.e., $(\tau_p^a)^2 = \tau_p^a$), and we obtained a full characterization of the idempotency of τ_p^a when p is quasi-constant (i.e. there exists $s \in S$ such that $p|_{S\setminus\{s\}}$ is constant). Moreover, when $G = \mathbb{Z}$ and S is a finite interval of $\mathbb{Z}$ such that $0 \in S$, we showed that τ_p^a is either idempotent or strictly almost equicontinuous as a dynamical system, and we completely characterized each one of these situations in terms of p. However, there are still many open problems regarding this class of cellular automata, such as a full characterization of their idempotency for arbitrary G and $p \in A^S$.

ON the Dynamics of Shift-Pseudoperiodic Functions

Name: Gorachand Chakraborty

Institution: Sidho-Kanho-Birsha University

Abstract: In this work, we study the dynamics of a special type of transcendental meromorphic functions called shift-pseudoperiodic functions. It is proven that the Fatou set of such functions is invariant under certain translations. We show that these functions cannever have Baker wandering domains. Some non-existence criteria of Herman rings for such functions are given. A detailed discussion on completely invariant Fatou components is also provided.

We further describe a class of shift-pseudoperiodic functions having wandering domains. Finally, a brief account of the dynamics of semigroups generated by shift-pseudoperiodic entire functions is presented.

A singular perturbation approach to vector fields on manifolds with boundary

Name: Rodrigo Donizete Euzébio

Institution: Federal University of Goiás

Abstract: In this talk, we propose a novel approach to studying vector fields defined on a manifold $\mathcal{M}$ with boundary by interpreting them as singularly perturbed vector fields whose phase space is forward invariant. In our framework, the boundary of $\mathcal{M}$ is approximated by compact subsets of a normally hyperbolic invariant manifold in the context of geometric singular perturbation theory. The key idea is to replace the lack of smoothness of the vector field on $\partial\mathcal{M}$ with a non-smooth system defined in the interior of $\mathcal{M}$. We then apply a regularization procedure to obtain a smooth singularly perturbed vector field that preserves the desired dynamical properties. The results establish an important connection among vector fields defined on manifolds with boundary, non-smooth vector fields, and singularly perturbed ones, and provide a way to treat the boundary

of the phase space as a normally hyperbolic manifold, allowing the use of classical results such as those from Fenichel theory.

Data-driven modeling of dengue transmission in Indonesia

Name: Muhammad Fakhruddin

Institution: National Research and Innovation Agency (BRIN)

Abstract: We present a data-driven approach to modeling dengue transmission using cumulative surveillance data. Starting from a cumulative incidence function, we introduce a generating operator that reconstructs state variables in a compartmental epidemic model. The framework is applied to a host-vector SEIR-SI model, in which time-dependent transmission rates are implicitly inferred from data. Weekly cumulative dengue cases are approximated using a linear combination of logistic functions, allowing explicit expressions for the exposed, infected, recovered, and susceptible populations to be reconstructed from observed data. Based on the reconstructed dynamics, a time-varying effective reproduction number $R_{\text{eff}}(t)$ is derived and analyzed as an indicator of epidemic trends. Numerical simulations using dengue incidence data from Indonesia demonstrate that the proposed method can reproduce observed outbreak patterns. This work highlights the use of cumulative data as a generator for solution reconstruction in compartmental epidemic models and provides a mathematically tractable tool for data-driven epidemic analysis.

Hyperbolic periodic orbits in four dimensional systems detected via Averaging Theory

Name: Luiz Fernando Gonçalves

Institution: Federal University of Goiás (UFG/Brazil)

Abstract: By making suitable choices for the first integrals, we revisit the four-dimensional system given by [1], presenting a simplified proof of its main result concerning the number of limit cycles and extending its validity to a larger domain. Moreover, we extend this analysis to a wider class of perturbations by applying first and second-order averaging theory.

[1] Llibre, J., Teixeira, M. A.: Limit cycles for a mechanical system coming from the perturbation of a four – dimensional linear center. Journal of Dynamics and Differential Equations, 18(4), 931 – 941 (2006).

[2] Gonçalves, L. F., Garcia, R. A.: Hyperbolic periodic orbits in four dimensional systems detected via Averaging Theory. Submitted to Journal of Differential Equations (2025).

K-Type dynamics of $\mathbb{Z}^d-$actions

Name: Sharan Gopal

Institution: Birla Institute of Technology and Science-Pilani, Hyderabad campus

Abstract: Classical discrete-time dynamical systems are actions of the group $\mathbb{Z}$, where the total order of time allows one to study asymptotic behavior through limits as $n \to \infty$. A generalization is to consider actions of $\mathbb{Z}^d$ for $d \geq 2$. However, the absence of a total order in $\mathbb{Z}^d$ removes the notion of a unique forward direction, making it impossible to consider "$n \to \infty$".

To address this, Oprocha in [Piotr Oprocha. "Chain recurrence in multidimensional time discrete dynamical systems" , Discrete and Continuous Dynamical Systems 20.4 (2007), pp. 1039-1056] introduced a partial order on elements of $\mathbb{Z}^d$. The key insight was that instead of a single total order, one can define multiple partial orders, each corresponding to a different "direction" of progression. Each integer $k \in \{1, 2, \ldots, 2^d\}$ corresponds to one of the 2^d orthants (or "quadrants") in $\mathbb{Z}^d$, and the associated order $\geq^k$ defines a notion of positivity relative to that orthant. For example, in $\mathbb{Z}^2$, $k = 1$ corresponds to the standard first quadrant ($n_1 \geq 0, n_2 \geq 0$), while $k = 2$ corresponds to the second quadrant ($n_1 \leq 0, n_2 \geq 0$), and so on.

Based on this, we introduced and studied dynamical notions of $k-$type chaos and $k-$type topological entropy. We also formulated and proved the $k-$type von Neumann Ergodic Theorem. In this presentation, I will talk on all these notions and related results.

All these works are jointly done by me and my doctoral student Mr. Anshid Aboobacker. The results on $k-$type chaos are published in [Anshid Aboobacker and Sharan Gopal. "k-type chaos of $\mathbb{Z}^d$-actions" . Dynamics of Continuous, Discrete and Impulsive Systems Series A: Mathematical Analysis, 32 (2025), pp. 139 – 153.]

Some combinatorial approaches to the nonexistence of iterative roots

Name: Chaitanya Gopalakrishna

Institution: Indian Statistical Institute Bangalore, India

Abstract: An iterative root of order $n \geq 2$ of a self-map f on a nonempty set is a self-map g on the set such that $g^n = f$. Most existing results on the iterative roots of continuous interval maps rely on tools such as the Intermediate Value Theorem and the monotonicity of bijections. Extending these results to higher dimensions or more general topological spaces is generally complex. In this talk we present some new combinatorial ideas that lead to new results on iterative roots of maps on arbitrary sets and continuous maps on topological spaces. These results, in particular, allow us to generalize some notable findings on iterative roots for continuous interval maps to the broader context of continuous multidimensional maps. The talk is based on two recent joint works with B. V. Rajarama Bhat.

Finite-dimensional approximations of push-forwards on locally analytic functionals

Name: Isao Ishikawa

Institution: Kyoto University

Abstract: We develop a functional-analytic framework for approximating the push-forward induced by an analytic map from finitely many samples. Instead of working directly with the map, we study the push-forward on the space of locally analytic functionals and identify it, via the Fourier–Borel transform, with an operator on the space of entire functions of exponential type. This yields finite-dimensional approximations of the push-forward together with explicit error bounds expressed in terms of the smallest eigenvalues of certain Hankel moment matrices. Moreover, we obtain sample complexity bounds for the approximation from i.i.d. sampled data. As a consequence, we show that linear algebraic operations on the finite-dimensional approximations can be used to reconstruct analytic vector fields from discrete trajectory data. In particular, we prove convergence of a data-driven method for recovering the vector field of an ordinary differential equation from finite-time flow map data under fairly general conditions.

Dynamical Characterization of the r-Chialvo Neuron Map Coupled with a Cosine Memristor

Name: Ajay Kumar

Institution: Indian Institute of Technology Jodhpur

Abstract: In this talk, we introduce a novel discrete neuron map by coupling a cosine-based memristor into a reduced Chialvo neuron map to investigate the dynamical effects of electromagnetic radiation on neuron dynamics. The nonlinear current-voltage characteristics of the memristor enrich the map's behavior, leading to diverse firing regimes, stability behavior, and chaotic attractors with fractal dimensions. This study starts with examining the equilibrium points using theoretical and numerical methods. Also, we determine the conditions on parameters under which the proposed map undergoes a Neimark-Sacker (NS) bifurcation, and further numerical investigation reveals the antimonotonicity structure through both forward and backward bifurcation diagrams. This map exhibits a range of codimension-one and -two bifurcation patterns, including Neimark-Sacker, period-doubling, saddle-node, generalized period-doubling, cusp-point, fold-flip, and various resonance structures (1:1, 1:2, 1:3, and 1:4). We observe that the coexistence of a stable limit cycle, a period-five attractor, and a chaotic attractor, all along with their respective basin of attraction regions. Furthermore, we extend this analysis to the network of neurons under the ring-star configuration and discuss several spatiotemporal patterns. This network investigation shows complex collective behaviors, including imperfect synchronization, clustered patterns, and multi-chimera state phenomena not previously observed in existing Chialvo-based studies. These results highlight the potential of the discrete memristor-based neuron map for advancing theoretical neurodynamics and offer a robust framework for investigating low-dimensional yet dynamically rich neuron systems.

A comparative study investigating the influence of thermoelastic coupling on surface wave propagation in a piezothermoelastic half-space

Name: Anirban Lakshman

Institution: Indian Institute of Information Technology Kalyani

Abstract: This investigation elucidates the propagation characteristics of surface (Rayleigh-type) waves within a homogeneous, transversely isotropic, piezothermoelastic half-space subjected to stress-free boundary conditions, with electrically open or shorted configurations, and thermally insulated or isothermal conditions. The analysis is grounded in the Green-Naghdi Type III (GN-III) and three-phase-lag thermoelastic models. Plane harmonic wave solutions are employed to determine mechanical displacements, electrical potential, and temperature variations. Utilizing these expressions, the corresponding stresses, electrical displacement, and temperature gradient are derived. Four secular equations are formulated for the considered half-space, contingent upon the specified boundary conditions. The trajectory of surface particles is shown to follow an elliptical path in the vertical plane aligned with the direction of wave propagation, with the eccentricity of the ellipse quantified. In cases where no phase difference exists between the vertical and horizontal displacement components, the particle trajectory degenerates into a straight line. A previously established analysis is presented as a specific case within this study. The influence of key wave characteristics, including phase velocity, attenuation coefficient, and specific energy loss, is graphically illustrated for the GN-III and three-phase-lag thermoelastic models, utilizing cadmium selenide material exhibiting hexagonal symmetry. The proposed mathematical framework holds potential for applications in the design and development of temperature sensors and other piezoelectric surface acoustic wave (SAW) devices.

Where Dynamics Meet Order: Recurrence in Riesz Spaces

Name: Marwa Masmoudi

Institution: Tunis el Manar University

Abstract: Ergodic theory is a rich and fascinating area of mathematics, traditionally developed in a measure-theoretic framework. In this presentation, we move beyond the classical setting and explore a measure-free approach based on Riesz spaces. Building on the formulations of Poincaré, Kac, and Kakutani – Rokhlin theorems, we extend fundamental results on recurrence and ergodicity, highlighting their broader significance. This perspective not only unifies classical ideas but also leads to new results in probabilistic contexts that go beyond the traditional framework. The talk is designed to provide both an accessible introduction to the subject and an overview of recent advances, inviting the audience to discover how ergodic theory continues to evolve and expand across mathematical disciplines.

This talk is based on joint works with Y. Azouzi, M. A. Ben Amor, J. Homann and B. A. Watson.

Mean Hausdorff dimension: properties, applications and conjectures

Name: Jeovanny Muentes Acevedo

Institution: Universidad Tecnológica de Bolívar

Abstract: Consider the left shift $\sigma : ([0,1]^n)^{\mathbb{Z}} \to ([0,1]^n)^{\mathbb{Z}}$. A problem in dynamical systems is decide if a system (M, ϕ) can be embedded in σ (see [Lind00] and [LT2019]). The mean

topological dimension of a dynamical system (M, ϕ), denoted by $\mathrm{mdim}(M, \phi)$ (see [Gromov99]), is an invariant under topological conjugacy and an useful tool for this problem. Throughout several articles from Lindenstrauss, Weiss, Gutman, among others, it is proven that any minimal systems with a mean topological dimension less than $\frac{n}{2}$ can be embedded in σ (see [LT2019], and references therein). However, the mean topological dimension is difficult to calculate.

In search of finding other ways to calculate the mean topological dimension, in 2019, Lindenstrauss and Tsukamoto ([LT2019]) introduced the mean Hausdorff dimension of a dynamical system $\phi : M \to M$, where M is a compact metric space with metric d, which we denote by $\mathrm{mdim}_{\mathrm{H}}(M, d, \phi)$. The mean Hausdorff dimension is an upper bound for the mean topological dimension: for any dynamical system (M, ϕ) we have that

$$\mathrm{mdim}(M, \phi) \leq \mathrm{mdim}_{\mathrm{H}}(M, d, \phi).$$

In this talk, we will present the definition and important properties of the mean Hausdorff dimension, some interesting examples and some conjectures (see [Muentes24A], [Muentes24B], Muentes24C], [Muentes24D]).

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On Oscillation theorems of Coles and Kreith

Name: Abdullah Özbekler

Institution: Ankara University

Abstract: In this talk, we present new oscillation results for linear second-order differential equations that are alternative to the well-known theorems of Coles and Kreith. The canonical and noncanonical cases are discussed in a unified way by using a suitable transformation, the so-called "an oscillation-preserving transformation".

Smoothness of local conjugation of normal forms on non-smooth spaces

Name: Victoria Rayskin

Institution: MNSU

Abstract: Local conjugation of normal forms is a frequently used technique in the qualitative analysis of dynamical systems. The question of smoothness of the conjugation arises in many applications. We discuss the preservation of smoothness in neighborhoods of a fixed point or an invariant manifold, with respect to variables and parameters. We also discuss the relation of smoothness to the spectral gap and non-resonance condition. Our development of the blid map localization method allows us to discuss the smoothness of the conjugation on some non-smooth (Banach) spaces. The blid map method can also possibly be applied to the question of partition of unity on non-smooth spaces, which we include in the list of open problems in the conclusion of this talk.

Period Function in Planar Piecewise Hamiltonian Systems: Monotonicity and Critical Periods

Name: Alex Carlucci Rezende

Institution: Universidade Federal de Sao Carlos

Abstract: We investigate the behavior of the period function in a family of planar piecewise Hamiltonian systems. Special attention is given to its monotonicity properties and the occurrence of critical periods. A complete bifurcation diagram is derived, highlighting parameter regions where the period function is strictly increasing or decreasing, as well as regions where it admits at most one simple critical period. The analysis is based on decomposing the period function into contributions from the underlying planar Hamiltonian systems on each side of the discontinuity line, which are then carefully combined to capture the global dynamics.

Distal actions of automorphisms on the space of one-parameter subgroups of Lie groups

Name: Riddhi Shah

Institution: Jawaharlal Nehru University, New Delhi, India

Abstract: In this talk, I will discuss the action of automorphisms of a connected Lie group G on Sub_G, the compact space of closed subgroups of G endowed with the Chabauty topology. The compact space Sub_G^p, the closure in Sub_G of the space of closed one-parameter subgroups of G, is invariant under this action. Automorphisms T of G which act distally on Sub_G^p are characterized as follows:. If $G = \mathbb{R}^d$, a vector group, then T acts distally on Sub_G^p if and only if its image in $\mathrm{PGL}(d, \mathbb{R})$ generates a relatively compact subgroup, and if G is not a vector group, then T acts distally on Sub_G^p if and only if T generates a relatively compact subgroup in $\mathrm{Aut}(G)$. Distal actions of groups of automorphisms on Sub_G^p are also characterized. Some of the results generalize those of Shah and Yadav in case G is not a vector group. (This work is from two papers; one published jointly with Debamita Chatterjee, and the other written jointly with Himanshu Lekharu and Debamita Chatterjee.)

Linear Stability of viscoelastic sub-diffusive plane Poiseuille flow under a transverse magnetic field

Name: Priyanka Shukla

Institution: Indian Institute of Technology Madras

Abstract: This study examines the linear stability and flow behavior of a viscoelastic, sub-diffusive plane Poiseuille flow in the presence of an external magnetic field. Viscoelastic effects are modeled using the fractional upper-convected Maxwell (FUCM) model. Neutral stability curves are obtained for different values of the sub-diffusive exponent, Reynolds number, elasticity, magnetic field strength, and viscosity ratio. The results show that changing the order of the sub-diffusive exponent significantly shifts the most unstable flow mode. To support the linear stability findings, direct numerical simulations are also performed. The evolution of the polymer conformation tensor, which remains symmetric and positive definite, is studied using a Riemannian metric and characterized through its three scalar invariants. Overall, the results provide new insights into the dynamics of complex viscoelastic flows and may be useful for practical applications in engineering and related scientific fields.

Resonance structure of a periodically forced delay equation model of the El Niño Southern Oscillation

Name: Priya Subramanian

Institution: University of Auckland

Abstract: The El Niño Southern Oscillation (ENSO) is a major climate phenomenon characterized by sea surface temperature variations in the Equatorial Pacific Ocean. Conceptual models following the delayed-action oscillator approach simplify its essential physics to tractable mathematical models in the form of delay differential equations (DDEs). We perform a detailed bifurcation analysis of an ENSO DDE model introduced in 1988 by Suarez and Schopf, with an additional forcing term that is motivated by ENSO's tendency to phase-lock with the seasonal cycle. We show that this periodically forced nonlinear scalar DDE exhibits a rich resonance structure of dynamics on invariant tori. Moreover, we demonstrate how chaotic dynamics emerges when resonance tongues start to overlap as one varies the external forcing frequency, which is equivalent to varying the strength of the nonlinearity.

Sliding dynamics and invariant manifolds of 3D piecewise linear systems with parallel tangency lines

Name: Durval Jose Tonon

Institution: Federal University of Goias

Abstract: This paper investigates the sliding and crossing dynamics of three-dimensional piecewise linear systems with parallel tangency lines. A central goal is to characterize certain invariant

manifolds, identifying them as limit cycles or invariant cylinders. In these systems, the sliding vector fields may generate a curve of pseudo-equilibria, indicating the occurrence of a bifurcation of higher codimension. Specifically, we consider systems of the form $\dot{x} = A^{\pm}x + b^{\pm}$, assuming the tangency lines are parallel. For this class, we provide a detailed analysis of the sliding dynamics and present a bifurcation diagram with explicit conditions based on system parameters. The crossing dynamics are also thoroughly examined, and we establish precise parameter-dependent criteria for the existence of limit cycles, invariant cylinders, and scroll-wave-type behavior. Furthermore, we derive an upper bound for the number of crossing limit cycles. Several bifurcations are explored, including those involving homoclinic connections, as well as the emergence and disappearance of limit cycles.

Marangoni convection and instability near the air-liquid interface

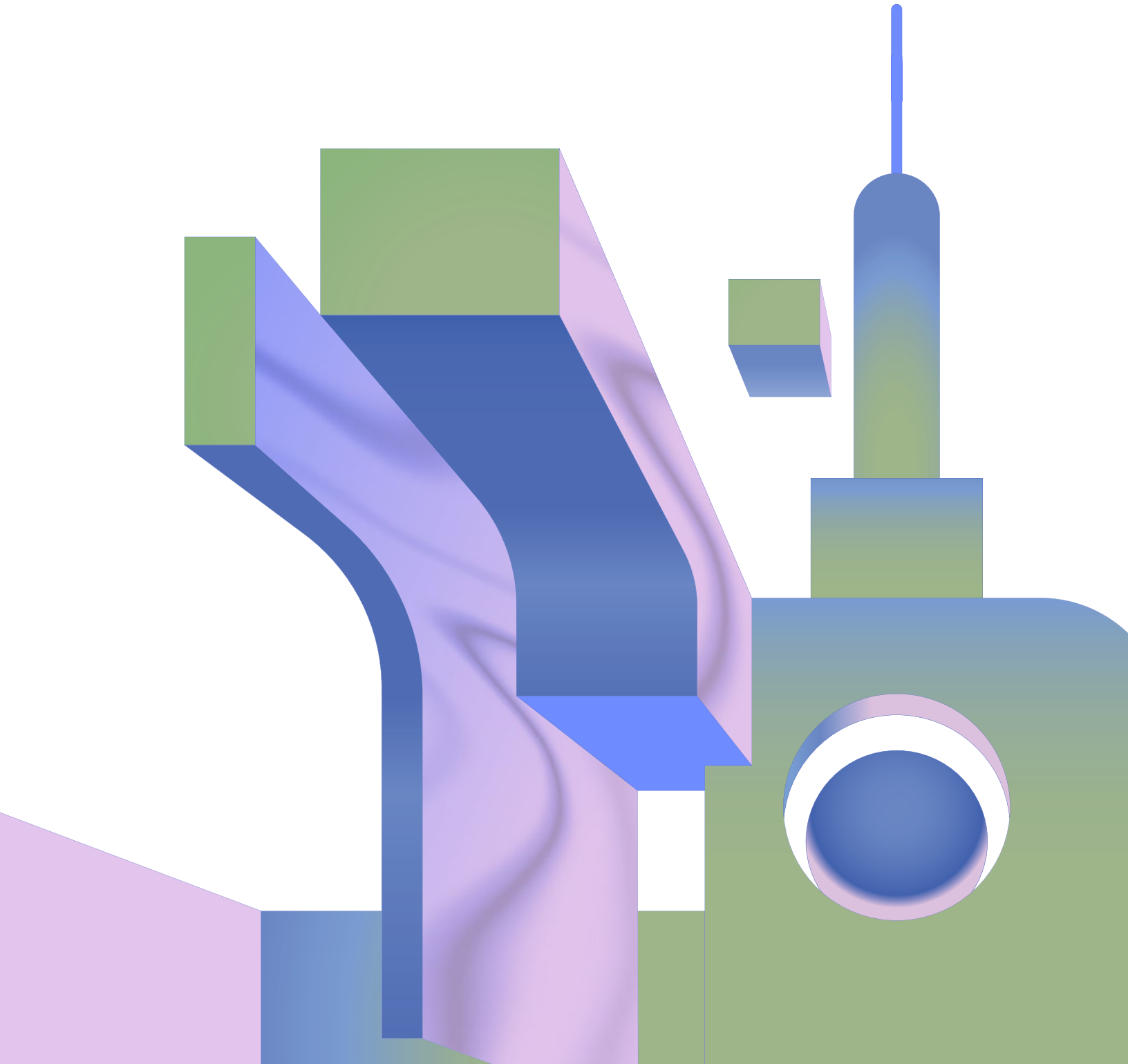
Name: Zuo-Bing Wu

Institution: Institute of Mechanics, Chinese Academy of Sciences

Abstract: In this presentation, steady thermo- and solute-capillary convection, instability, and pattern evolution near the air-liquid interface driven by point heat and mass sources are investigated. First, under the assumption of the conically similar viscous flow, an exact axi-symmetric solution of the steady thermo- and soluto-capillary convection near the air-liquid interface is determined due to the constant heat and mass fluxes. It is shown that the constant heat, mass fluxes, and the radial surface tension cause the divergent motion at the interface and the Marangoni convection beneath the interface. Then, the linear stability of the steady thermo- and soluto-capillary convection in response to the azimuthal disturbance is analyzed. At a given Peclet (or Schmidt), Marangoni (or Prandtl), and elasticity numbers, the steady basic flow loses its stability when Reynolds number is beyond the critical value. The critical patterns of the velocity fields and the isothermal, iso-concentration lines in the three-dimensional flow system in response to the disturbance harmonic wave number are dominated by both the radial and azimuthal surface tensions. This research is supported by the National Science Foundation through the Grants Nos. 11172310, 11472284 and 12272384.

SHORT COMMUNICATIONS

SECTION 10– PARTIAL DIFFERENTIAL EQUATIONS



Exponential attractor and explicit bound on its fractal dimension for a NLS type equation

Name: Brahim Alouini

Institution: University of Monastir

Abstract: In this short communication, we study a damped nonlinear Schrödinger equation (NLS) in the presence of a nonlocal term on the real line. Through this study, we introduce a new approach that will allow us to prove the existence of a global exponential attractor characterizing the asymptotic behavior of the solutions and containing much of the relevant information about the flow, to which we can reduce the qualitative study of the system. Furthermore, this approach will also allow us to explicitly determine a bound on its fractal dimension as a function of the parameters involved in the equation.

A nonlocal problem for a second-order hyperbolic partial integro-differential equation with functional terms

Name: Anar Assanova

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: In this talk, I will discuss nonlocal problem for a second-order hyperbolic partial integro-differential equation with functional terms. Issues of existence, uniqueness, and construction of solutions to the nonlocal problem are investigated. By introducing new unknown functions, the original problem is reduced to a family of problems for first-order integro-differential equations with unknown parameters and integral constraints. An algorithm for constructing solutions to this family of problems is proposed, and its convergence is proved. Sufficient conditions for the existence and uniqueness of solutions to the family of first-order integro-differential problems with unknown parameters and integral constraints are established. Based on the relationship between the nonlocal problem and the corresponding family of problems, conditions for the unique solvability of the nonlocal problem for the second-order hyperbolic partial integro-differential equation with functional terms are obtained.

This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP23485509).

Solvability of a Generalized Tricomi Problem for Fractionally Loaded Mixed-Type Equations

Name: Umida Baltaeva

Institution: Khorezm Mamun Academy, Academy of Sciences of the Republic of Uzbekistan

Abstract: In this talk, I will present recent results on the solvability of a generalized Tricomi problem for mixed parabolic – hyperbolic equations with fractional loading. The problem is

formulated with an integral gluing condition along the line of type change, which naturally arises in models involving memory and nonlocal effects.

I will first discuss the case of a loaded equation associated with the telegraph operator. By reducing the boundary-value problem to an equivalent system of integral equations, I will establish existence and uniqueness results. I will then indicate how these results extend to a broader class of generalized mixed-type equations depending on small parameters.

The results provide a natural extension of classical solvability theory for the Tricomi problem and contribute to the analysis of boundary-value problems for mixed-type equations with fractional and nonlocal terms.

Well-posedness and the Łojasiewicz-Simon inequality in the asymptotic analysis of a nonlinear heat equation with constraints of finite codimension

Name: Ashish Bawalia

Institution: Indian Institute of Technology Roorkee

Abstract: We establish the global well-posedness of the $D(A)-$valued strong solution to a nonlinear heat equation with constraints on a Poincaré domain $\mathcal{O} \subset \mathbb{R}^d$ whose boundary is of class C^2. Consider the following nonlinear heat equation

$$\frac{\partial u}{\partial t} - \Delta u + |u|^{p-2}u = 0,$$

projected onto the tangent space $T_u\mathcal{M}$, where $\mathcal{M} := \left\{u \in L^2(\mathcal{O}) : \|u\|_{L^2(\mathcal{O})} = 1\right\}$ is a submanifold of $L^2(\mathcal{O})$. The nonlinearity exponent satisfies $2 \leq p < \infty$ for $1 \leq d \leq 4$ and $2 \leq p \leq \frac{2d-4}{d-4}$ for $d \geq 5$. The solution is constrained to lie within $\mathcal{M}$, which encodes the norm-preserving constraint. By modifying the nonlinearity and exploiting the abstract theory for $m-$accretive evolution equations, we prove the existence of a global strong solution. Using the resolvent-idea and the Yosida approximation method, we derive regularity results. In the asymptotic analysis, $\mathcal{O}$ is restricted to bounded domains with even p and $1 \leq d \leq 3$. For any initial data in $D(A) \cap \mathcal{M}$, we apply the Łojasiewicz-Simon gradient inequality on a Hilbert submanifold, to demonstrate that the unique global strong solution converges in $W^{2,q}(\mathcal{O}) \cap W_0^{1,q}(\mathcal{O})$ to a stationary state, where $2 \leq q < \frac{2d}{d+4-4\beta}$ and $1 < \beta < \frac{3}{2}$. This work proposes an alternative method for establishing the global existence and analyzing long-term behavior of the unique strong solution to an L^2-norm preserving nonlinear heat equation. It is a joint work with Zdzisław Brzeźniak, Manil T. Mohan and Piotr Rybka.

Energy Decay Analysis in Coupled Systems with Fractional Derivative Damping: A Numerical and PINN Approach

Name: Ahmed Bchatnia

Institution: Faculty of Sciences of Tunis

Abstract: Abstract: This study investigates the energy decay behavior of coupled dynamical systems incorporating fractional derivative damping. We first establish the governing equations of motion for a coupled system with fractional-order viscoelastic damping and analyze its theoretical energy decay properties. A numerical scheme based on finite differences and spectral discretization is developed to validate the analytical results and to study the influence of fractional parameters on system stability. Additionally, a Physics-Informed Neural Network (PINN) framework is proposed to approximate the system dynamics and energy evolution without explicit discretization, offering a data-driven alternative for solving fractional differential equations. Comparative analyses between traditional numerical simulations and PINN predictions demonstrate strong agreement and highlight the efficiency of PINNs in capturing long-term decay trends.

Nonlocal Gradients, Nonlocal Sobolev Spaces, and Variational Problems

Name: Jose Carlos Bellido

Institution: Universidad de Castilla-La Mancha

Abstract: In this talk, we present recent progress on the theory of nonlocal gradients—of which the Riesz fractional gradient is a paradigmatic example—and the associated nonlocal Sobolev spaces. In particular, we provide characterizations of nonlocal gradients for which the corresponding non- local Sobolev-type functional spaces exhibit desirable structural properties, such as continuous and compact embeddings into Lebesgue or Orlicz spaces. We also discuss applications to new nonlocal PDEs and variational principles based on nonlocal gradients.

Nonlinear dynamical behaviors, asymmetric complex networks and fractional differential calculus in modeling and analyzing neurodegenerative disorders and memory effects

Name: Aziz Belmiloudi

Institution: Universite de Rennes, INSA Rennes, CNRS, IRMAR-UMR 6625, 35700 Rennes, France

Abstract: Modeling and analyzing nonlinear dynamical behaviors of complex systems in the framework of fractional-order calculus are becoming increasingly important. There are the basis for further predicting and controlling the complicated threads of most real-world systems (such as ecological, biological and physical systems). Time fractional dynamical models are particularly efficient, when compared to classical integer-order models, for describing the long memory and hereditary behaviors of many complex systems. In particular, they arise naturally in many biological phenomena such as neurobiology, cardiology and viscoelasticity with rich emergence phenomena, such as dynamical abrupt transitions, synchronization and spatiotemporal oscillations.

In this work, we explain a few recent results concerning some phenomena which describe memory

effects present in biological systems, particularly in the cardiac and cerebral systems. We start by giving an overview of the cardiac memory phenomenon, also termed Chatterjee phenomenon, and the memory effects in brain's neural network : they can cause stability or synchronization problems, and give rise to highly complex behavior including oscillations and chaos.

Next, in order to understand and effectively analyze various neurological activities and disorders in brain, we present a new mathematical brain connectivity model (and its mathematical analysis) which takes into account memory characteristics of neurons and their past history, the heterogeneity of brain tissue, and the local anisotropy of cell diffusion. For the connection structure between neurons, the graph theory, in which the discrete Laplacian matrix of communication graph plays a fundamental role, is considered. The main interest of this work is the investigation of dissipative dynamics and long-time behavior of the proposed fractional differential complex neural network model in asymmetrically coupled networks, and also of different Mittag–Leffler synchronization problems for such networked dynamical systems, when different types of interaction are simultaneously present. Finally, we provide conclusions and future perspectives.

Multiplicity of positive solutions for quasilinear problems with mixed local-nonlocal operator and concave-critical nonlinearities

Name: Mousomi Bhakta

Institution: Indian Institute of Science Education and Research Pune (IISER Pune)

Abstract: We study the existence and multiplicity of positive solutions for the following concave-critical problem driven by an operator of mixed order obtained by the sum of the classical p-Laplacian and of the fractional p-Laplacian,

$$-\Delta_p u + \varepsilon(-\Delta_p)^s u = \lambda|u|^{q-2}u + |u|^{p^*-2}u \ \text{ in } \Omega, \quad u = 0 \ \text{ in } \mathbb{R}^N \setminus \Omega, \tag{$\mathbb{P}_{\lambda,\varepsilon}$}$$

where $\Omega \subset \mathbb{R}^N$ is a bounded open set, $\varepsilon \in (0,1]$, $0 < s < 1 < q < p < N$, and $p^* = \frac{Np}{N-p}$, and $\lambda \in \mathbb{R}$ is a parameter. For $\lambda \leq 0$, we show that ($\mathbb{P}_{\lambda,\varepsilon}$) has no nontrivial solution. For $\lambda > 0$, we prove Ambrosetti-Brezis-Cerami type results. In particular, we prove the existence of Λ_ε such that ($\mathbb{P}_{\lambda,\varepsilon}$) has a positive minimal solution for $0 < \lambda < \Lambda_\varepsilon$, a positive solution for $\lambda = \Lambda_\varepsilon$ and no positive solution for $\lambda > \Lambda_\varepsilon$. We also prove the existence of $0 < \lambda^\# \leq \Lambda_\varepsilon$ such that ($\mathbb{P}_{\lambda,\varepsilon}$) has at least two positive solutions for $\lambda \in (0, \lambda^\#)$ provided ε small enough. This extends the recent result of Biagi and Vecchi (Nonlinear Anal. 256 (2025), 113795), Amundsen, et al. (Commun. Pure Appl. Anal., 22(10):3139 – 3164, 2023) from $p = 2$ to the general $1 < p < N$. Additionally, it extends the classical result of Azorero and Peral (Indiana Univ. Math. J., 43(3):941 – 957, 1994) to the mixed local-nonlocal quasilinear problems. Moreover, our results complements the multiplicity results for nonnegative solutions in da Silva, et al. (J. Differential Equations, 408:494 – 536, 2024).

Perturbations of non-autonomous second-order abstract Cauchy problems

Name: Christian Budde

Institution: University of the Free State

Abstract: In this talk we present time-dependent perturbations of second-order non-autonomous abstract Cauchy problems associated to a family of operators with constant domain. We make use of the equivalence to a first-order non-autonomous abstract Cauchy problem in a product space, which we elaborate in full detail. As an application, we provide a perturbed non-autonomous wave equation. This talk is based on joint work with Christian Seifert (TU Hamburg, Germany).

Mathematical and Computational Modeling of the Population Dynamics of Aedes aegypti

Name: Grigori Chapiro

Institution: Federal University of Juiz de Fora

Abstract: Aedes aegypti is the primary vector responsible for the transmission of dengue, Zika, chikungunya, and yellow fever. Effective control strategies require a detailed understanding of the mosquito spatial population dynamics, including its life cycle. Most existing mathematical models describe only the total mosquito population, which limits their ability to capture spatial effects that are crucial from a public health perspective.

In this talk, we present a framework for modeling the spatial population dynamics of Aedes aegypti using partial differential equations. The proposed models incorporate the mosquito life cycle and are analyzed under both homogeneous and heterogeneous scenarios, where model parameters may depend on topography and distinguish between urban features such as streets, houses, and green areas. Analytical relationships are derived linking the carrying capacity of the aquatic phase to experimentally measurable quantities, such as the maximum number of female mosquitoes, eggs, and larvae.

The methodology is applied to different insecticide-based control strategies. For example, numerical simulations suggest that weekly insecticide applications are the most effective method for population control. Moreover, in heterogeneous environments, mosquito populations tend to remain confined within residential blocks, limiting the effectiveness of insecticide-based interventions. Another example focuses on the release strategies for genetically modified mosquitoes. The model allows for the analytical determination of critical release frequencies and the quantity required for population suppression. All analytical predictions are validated through computational simulations, and the optimal release frequencies are shown to be consistent with values reported in the literature.

Sharp quantitative stability estimates in Caffarelli-Kohn-Nirenberg type inequalities

Name: Anh Do

Institution: University of Connecticut

Abstract: Quantitative stability for functional and geometric inequalities plays a significant role in the calculus of variations and evolution partial differential equations. Once the set of all optimizers is fully characterized, natural questions on stability results arise about estimating the distance to the manifold of optimizers via the deficit, which is the difference between the two sides of the inequality. Such stability results have wide-ranging applications, including the justification of Taylor expansions and spectral estimates in mathematical physics, as well as a posterior error analysis in numerical methods.

Since the foundational work of Bianchi and Egnell, there has been growing interest in developing quantitative stability results. In this talk, we present recent advances in the study of the stability for Caffarelli – Kohn – Nirenberg (CKN) inequalities, which encompass and generalize several classical inequalities, including Sobolev and Gagliardo – Nirenberg inequalities. We first provide a complete classification of L^2-stability results for all parameter regimes, extending and completing earlier work by Cazacu, Flynn, Lam, and Lu. In addition, using an alternative method that avoids spherical harmonics decomposition, we establish new L^p-stability results. Motivated by recent work of Dolbeault, Esteban, Figalli, Frank, and Loss, the sharpness of stability constants has emerged as a central topic. Addressing an open question posed by Maz'ya, we obtain sharp stability results for the Heisenberg Uncertainty Principle (HUP) in the setting of second-order and curl-free vector fields. To further generalize these findings, we derive new L^2-stability results for HUP by introducing several weighted Poincaré inequalities with Gaussian measures on hyperbolic spaces, where classical scaling arguments are no longer applicable.

This talk is based on joint work with Guozhen Lu, Nguyen Lam, Nguyen Van Hoang, Debdip Ganguly, Joshua Flynn, and Lingxiao Zhang.

Global dynamics of a spatially heterogeneous diffusive two-strain epidemic model with varying total population

Name: Têlé Jonas Doumate

Institution: University of Abomey-Calavi

Abstract: This work introduces an analytical approach for investigating the dynamics of diffusive two-strain epidemic models with varying total population size. First, assuming a spatially homogeneous environment, we show that the long-term dynamics of the diffusive model mirrors that of the corresponding kinetic epidemic model. In this setting, we establish that the competitive-exclusion principle holds. However, when the environment is spatially heterogeneous, the global dynamics of the diffusive epidemic model is more challenging. Under explicit and biologically meaningful assumptions on the model parameters, we establish results concerning the existence, uniqueness, and global stability of coexistence endemic equilibrium. Our findings highlight the complex interplay between population movement and spatial heterogeneity in shaping the dynamics of multi-strain infectious diseases.

Weak diffeomorphisms for conservation laws

Name: Prerona Dutta

Institution: Xavier University of Louisiana

Abstract: Reformulating hyperbolic conservation laws in a Lagrangian form provides an equivalent description of the problem by means of particle paths. Research in this direction was pioneered by Arnold in 1966, who described the dynamics of an ideal fluid as a geodesic flow on the group of volume-preserving diffeomorphisms of a fixed domain. For systems which describe fluid flow, construction of particle paths follows naturally from the associated velocity field. However, the idea of a particle path can be extended to scalar equations and to systems which do not include velocity fields explicitly. In this presentation, we demonstrate how to find a particle path in the form of a weak diffeomorphism, for any scalar conservation law having a smooth flux not necessarily convex, and establish such a particle path as an extremal of a related action functional.

Regularity of velocity averages in kinetic equations with heterogeneity

Name: Marko Erceg

Institution: University of Zagreb, Croatia

Abstract: We study regularity properties of kinetic equations with spatially heterogeneous coefficients. It is well known that, under suitable non-degeneracy assumptions, velocity averages of weak solutions exhibit compactness and improved regularity. While most existing results rely on spatially homogeneous transport fields, much less is known in the heterogeneous setting.

In this talk, I present a new quantitative regularity estimate for velocity averages of weak solutions to kinetic equations with space-dependent drift terms. The result applies to weak solutions with low integrability and allows very general source terms. As a consequence, we obtain fractional regularity for averaged quantities in space and time. I will also discuss applications to heterogeneous conservation laws with discontinuous flux functions and to isentropic gas dynamics.

This is joint work with Kenneth H. Karlsen (Oslo, Norway) and Darko Mitrović (Vienna, Austria).

Convergence of the energy and correctors for some elliptic problems in a two-component domain with weak data

Name: Rheadel Fulgencio

Institution: University of the Philippines - Diliman

Abstract: In this talk, we discuss the convergence of the energy and the corrector results of the

homogenization results obtained by Donato et al. for the following class of elliptic problems:

$$\begin{cases} -\operatorname{div}(A^\varepsilon(x,u_1^\varepsilon)\nabla u_1^\varepsilon) = f & \text{in } \Omega_1^\varepsilon, \\ -\operatorname{div}(A^\varepsilon(x,u_2^\varepsilon)\nabla u_2^\varepsilon) = f & \text{in } \Omega_2^\varepsilon, \\ u_1^\varepsilon = 0 & \text{on } \partial\Omega, \\ (A^\varepsilon(x,u_1^\varepsilon)\nabla u_1^\varepsilon)\nu_1^\varepsilon = (A^\varepsilon(x,u_2^\varepsilon)\nabla u_2^\varepsilon)\nu_1^\varepsilon & \text{on } \Gamma^\varepsilon, \\ (A^\varepsilon(x,u_1^\varepsilon)\nabla u_1^\varepsilon)\nu_1^\varepsilon = -\varepsilon^{-1}h^\varepsilon(x)(u_1^\varepsilon - u_2^\varepsilon) & \text{on } \Gamma^\varepsilon, \end{cases}$$

where Ω is a two-component domain with components Ω_1^ε (a connected domain) and Ω_2^ε (a disconnected union of small ε-periodic sets), and $\Gamma^\varepsilon = \partial\Omega_2^\varepsilon$ serves as the interface between the components. We prescribe L^1 data and coefficient periodic matrix fields $A(y,t)$ only bounded for bounded t, so that we deal with renormalized solutions, where only their truncated solutions are in H^1.

We present here some important results obtained such as the convergence of the unfolded truncated energies to the truncated energy of the homogenized problem and the strong convergence of the truncated gradients (which was only proven as weak in a previous work). These convergences allow us to obtain some corrector results in the linear case, where A does not depend on t.

Very weak solutions of Dirac operators with distributional coefficients

Name: Narciso Gomes

Institution: University of Cape Verde

Abstract: We discuss the possibility of studying very weak solutions for Dirac operators with distributional coefficients. The approach adapts classical tools from hypercomplex analysis, in particular the CK extension, to this low-regularity setting. These methods are combined with techniques developed by M. Ruzhansky and his collaborators for the analysis of partial differential equations with non-smooth coefficients.

On a perturbed critical semilinear equation with singularity

Name: Sarika Goyal

Institution: Netaji Subhas University of Technology Delhi

Abstract: In this poster, I will discuss necessary and sufficient conditions on the perturbation ρ for the existence of positive least energy solutions of the critical singular semilinear elliptic equation $-\Delta u = \frac{|u|^{2^*(s)-2}}{|x|^s}u + \rho(u)$ with Dirichlet boundary condition in a bounded smooth domain in $\mathbb{R}^n$ containing the origin, where $2^*(s) = \frac{2(n-s)}{n-2}$ with $0 \le s < 2$. Moreover we show that the almost necessary and sufficient condition obtained for the case $s = 0$ in [1] differs conceptually when $0 < s < 2$.

[1] Adimurthi, Mancini, G. and Sandeep, K. A sharp solvability condition in higher dimensions for some Brezis-Nirenberg type equation. Calc Var 14, 275 – 317 (2002). https://doi.org/10.1007/s005260100100

Wellposedness of nonlinear coupled systems modelling MEMS

Name: Runan He

Institution: Instituto de Ciencias Matemáticas (ICMAT)

Abstract: This talk introduces the study of some mathematical models for a Micro-Electro-Mechanical System (MEMS) capacitor, consisting of a fixed plate and a flexible plate separated by a fluid. It investigates the wellposedness of solutions to the resulting quasilinear coupled systems, as well as the finite-time blow-up (quenching) of solutions. The models considered include a parabolic-dispersive system modelling the fluid flow under an elastic plate, a parabolic-hyperbolic system for a thin membrane, as well as an elliptic-dispersive system for quasistatic fluid flow under an elastic plate. Short-time existence, uniqueness and smoothness are obtained by combining wellposedness results for a single equation with an abstract semigroup approach for the system. Quenching is shown to occur, if the solution ceases to exist after a finite time.

Strong convergence of the Jacobian determinant of a regularised flow defined by a one-sided Lipschitz operator

Name: Corentin Houpert

Institution: University of Leicester

Abstract: In the context of the Cauchy problem for a multidimensional linear transport equation with smooth coefficient, solutions are known to depend on the characteristics curves, as well as for the associated conservation equation. More precisely, solutions of the conservation equation depend on the Jacobian determinant of the characteristic curves. However, the theory of characteristics is not working when the coefficient is not smooth. The notion of solution has to be reinvestigated. In the case where the coefficient satisfies the one-sided Lipschtiz condition, existence, uniqueness and weak stability of solutions has been established using the duality between the backward conservation problem and the advective forward problem. An open problem is the strong convergence of the Jacobian determinant of the regularised flow associated with the characteristics curves. This talk provides an answer to this question, which was posed 20 years ago.

Existence of Weak Solutions to Nonlinear Drift – Diffusion Equations and Applications

Name: Sukjung Hwang

Institution: Chungbuk National University

Abstract: In this presentation, we discuss recent existence results for nonlinear diffusion equations, including the porous medium and parabolic p-Laplace equations, with a divergence-type drift term. These results are broadly applicable to reaction – diffusion systems, including Keller – Segel models. We emphasize the identification of scaling-invariant functional classes for the drift, depending on the nonlinear diffusion and the boundary data.

Navier – Stokes Equation in a Cone with Cross-Sections in the Form of 3D Spheres, Depending on Time, and the Corresponding Basis

Name: Muvasharkhan Jenaliyev

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: The report establishes the unique solvability of a boundary value problem for a 3D linearized system of Navier – Stokes equations in a degenerate domain represented by a cone. The domain degenerates at the vertex of the cone at the initial moment of time, and, as a consequence of this fact, there are no initial conditions in the problem under consideration. First, the unique solvability of the initial-boundary value problem for the 3D linearized Navier – Stokes equations system in a truncated cone is established. Then, the original problem for the cone is approximated by a countable family of initial-boundary value problems in domains represented by truncated cones, which are constructed in a specially chosen manner. In the limit, the truncated cones will tend toward the original cone. The Faedo – Galerkin method is used to prove the unique solvability of initial-boundary value problems in each of the truncated cones. By carrying out the passage to the limit, we obtain the main result regarding the solvability of the boundary value problem in a cone.

Boundary properties of the Newtonian potential and related self-adjoint problems

Name: Tynysbek Kalmenov

Institution: Institute of Mathematics and Mathematical Modeling, Almaty, Kazakhstan

Abstract: Let $\Omega \subset R^n$ be an arbitrary bounded domain with smooth boundary $\partial\Omega$. Let $\varepsilon(x,y)$ be the fundamental solution of the Laplace equation

$$-\Delta_x \varepsilon(x,y) = \delta(x-y),$$

We denote the Newtonian potential by

$$u_N(x) = \int_\Omega \varepsilon(x,y)\, f(y)\, dy.$$

Theorem 1. For any $f \in L_2(\Omega)$, the Newtonian potential $u_N(x)$ satisfies the Poisson equation

$$-\Delta_x u = f, \quad x \in \Omega,$$

and the following boundary condition:

$$-\frac{1}{2}u(x) + \int_{\partial\Omega} \left(\frac{\partial \varepsilon(x,y)}{\partial n_y} u(y) - \varepsilon(x,y) \frac{\partial u(y)}{\partial n_y} \right) dS_y = 0, \quad x \in \partial\Omega.$$

Conversely, if $u(x) \in W_2^2(\Omega)$ is a solution of the equation (3) and satisfies the boundary condition (4), then $u(x)$ coincides with the Newtonian potential defined by (2).

Thus, the boundary condition (4) is the boundary condition of the classical Newtonian potential.

It is known that a self-adjoint differential operator is generated by a boundary condition. The main result of this work is the following

Theorem 2. Let L_Q is an invertible self-adjoint differential operator $D(L_Q) \subset W_2^2(\Omega)$, $L_Q u = -\Delta u$, satisfying at $u \in D(L_Q)$ the following boundary condition

$$Qu\big|_{\partial\Omega} = 0,$$

where Q is a linear boundary operator on $\partial\Omega$, defined by the operator L_Q. Then there exists an operator $V : W_2^{1/2}(\partial\Omega) \leftrightarrow L_2(\partial\Omega)$ such that the Green's function of the differential operator L_Q is given by the formula

$$G(x,y) = \varepsilon(x,y) + \int_{\partial\Omega} V\varepsilon(x,\xi)\varepsilon(\xi,y)\, dS_\xi, \qquad (x,y) \in \Omega.$$

Existence and multiplicity results for concave-convex type problems involving the one-dimensional ϕ-Laplacian

Name: Uriel Kaufmann

Institution: FaMAF, UNC

Abstract: Let $\Omega = (a,b) \subset \mathbb{R}$, $0 \leq m, n \in L^1(\Omega)$, $\lambda, \mu > 0$ be real parameters, and $\phi : \mathbb{R} \to \mathbb{R}$ be an odd increasing homeomorphism. In this talk we consider the existence of positive solutions for problems of the form

$$\begin{cases} -\phi\left(u'\right)' = \lambda m(x) f(u) + \mu n(x) g(u) & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases}$$

where $f, g : [0,\infty) \to [0,\infty)$ are continuous functions which are, roughly speaking, sublinear and superlinear with respect to ϕ, respectively. The assumptions on ϕ, m and n are substantially weaker than the ones imposed in previous works. The approach used here combines the Guo-Krasnoselskii fixed-point theorem, the sub-supersolutions method, and some estimates on related nonlinear problems.

Analytical solutions and conservation laws for the first extended modified (3+1)-dimensional integrable Vakhnenko-Parkes equation

Name: Chaudry Khalique

Institution: North-West University

Abstract: In this talk we present analytical examination of the first extended modified Vakhnenko-Parkes equation, namely $uu_{txx} - u_x u_{tx} + u^3 u_t + a u_x + b u_y + c u_z = 0$, where a, b, and c are real valued nonzero constant parameters, using the Lie group analysis approach along with the extended Jacobi elliptic function expansion technique. We determine abundant structures of analytical solutions of this equation. This approach adopts the use of three different auxiliary nonlinear ordinary differential equations to generate the solutions. Thus, we find diverse cnoidal, snoidal, dnoidal, as well as complex snoidal wave solutions. Moreover, we explore the wave dynamics of these periodic solutions in three dimensions and two dimensions using computer software. Finally, we generate conserved vectors associated to the point symmetries of the equation using Ibragimov's theorem via the formal Lagrangian of the model.

An Extended Quasi Two-Phase Mass Flow Model: Numerical Experiments and Physics-Informed Neural Networks (PINN) Architecture Design

Name: Khim B. Khattri

Institution: Kathmandu University

Abstract: The dynamics of solid-fluid mixture flows are strongly influenced by material composition and interactions with obstacles. We perform numerical experiments by varying the solid volume fraction, both with and without obstacles, employing an extended quasi-two-phase mass flow model. The employed model includes coupled mass and momentum balances equations together with virtual mass induced pressure-Poisson equation for bulk mixture flow and describes the new concepts of extended mixture viscosities, pressure, and velocities. These quantities are evolving functions of some dynamical variables, physical parameters, inertial and dynamical coefficients and the drift factors. The model incorporates a mobility induced pressure- and rate-dependent Coulomb viscoplastic deformation and sliding for the mixture, together with Dirichlet and von-Neumann boundary conditions for the numerical solution. The finite volume method is employed for discretization while Marker-and-cell method is used for visualization. Our simulation approaches are capable of acquiring the detailed interacting mixture velocities with obstacle, deposition, the flow over-topping, detachments off the bed, formation of avalanche jets and ballistic projection, and landing on the bed again. Moreover, PINN architecture is formulated by embedding the governing equations directly into the loss function of the neural network, thereby ensuring that the learned solutions remain consistent with the underlying physical laws. These simulations results can be applied in environmental engineering, geohazard mitigation particularly in the design of the defense structures in debris flow/ landslide prone zones.

Nonuniqueness of solutions to the two-dimensional Euler equations with integrable vorticity

Name: Anuj Kumar

Institution: University of California Davis

Abstract: Yudovich established the well-posedness of the two-dimensional incompressible Euler equations for solutions with bounded vorticity. DiPerna and Majda proved the existence of weak solutions with vorticity in $L^p(p > 1)$. A celebrated open question is whether the uniqueness result can be generalized to solutions with L^p vorticity. In this talk, we resolve this question in negative for some $p > 1$. To prove nonuniqueness, we devise a new convex integration scheme that employs non-periodic, spatially-anisotropic perturbations, an idea that was inspired by our recent work on the transport equation. To construct the perturbation, we introduce a new family of building blocks based on the Lamb-Chaplygin dipole. This is a joint work with Elia Bruè and Maria Colombo.

Global well-posedness of one-phase Muskat problem with surface tension

Name: Hyunwoo Kwon

Institution: Brown University

Abstract: We establish the global well-posedness of the one-phase Muskat problem with surface tension for small initial data. This problem describes the motion of the interface separating a wet region from a dry region within a porous medium, a process governed by Darcy's law. Although physically essential, the inclusion of surface tension introduces an additional challenge. We prove the existence of a unique global strong solution for small initial data. Moreover, if the initial data is periodic, then the solution converges to zero as $t \to \infty$. To the best of our knowledge, this work constitutes the first global well-posedness result for the one-phase Muskat problem with surface tension. This talk is based on the joint work with Hongjie Dong (Brown University).

Solving Riemann Problems using Topological Tools

Name: Wanderson Lambert

Institution: Universidade Federal de Alfenas - UNIFAL-MG

Abstract: We present a detailed construction and application of a topological framework to solve Riemann problems for systems of conservation laws. Central to this approach is the concept of the wave manifold, a differentiable three-dimensional manifold whose points represent shock and rarefaction waves. Unlike classical methods, where wave curves in state space may overlap or intersect, the wave manifold disentangles these curves and provides a geometric setting in which admissibility conditions and wave interactions can be systematically analyzed.

We focus on a specific two-component system with quadratic flux function. The wave manifold is constructed explicitly using adapted coordinates and a blow-up transformation that resolves the singularity at coinciding left and right states. The resulting manifold allows us to define and visualize key structures, such as Hugoniot curves, rarefaction foliations, sonic and characteristic surfaces, and regions of shock admissibility. These are explored analytically and graphically to understand their role in constructing Riemann solutions.

A major contribution of this study is the use of topological tools to classify and analyze admissible waves. The wave manifold is subdivided into distinct regions by the characteristic and sonic surfaces, and the boundary of shock admissibility is precisely determined. Composite wave structures, involving both shock and rarefaction elements, are identified and traced through foliations within these regions. The intersection of wave surfaces in the manifold determines the structure of Riemann solutions, which are obtained by combining slow and fast wave families through a geometrically constructed intermediate surface.

We apply this method to solve Riemann problems, highlighting how the topology of the wave manifold encodes admissibility and resolves ambiguities that arise in state space. The visualizations of the wave curves and surfaces offer new insights into the behavior of nonlinear wave patterns, particularly in systems where strict hyperbolicity is lost in regions of the state space.

This work builds upon and extends earlier developments in the topological treatment of conservation laws, offering a complete and computable structure for understanding and solving Riemann problems in quadratic systems. The approach has implications for the study of degenerate systems, composite wave interactions, and the design of numerical methods for complex PDE models.

Regularity results for two-phase free boundary problems for non-standard growth equations with right hand side

Name: Claudia Lederman

Institution: Universidad de Buenos Aires

Abstract: Non-standard growth PDEs constitute a broad class of singular and degenerate nonlinear equations used in the modeling of inhomogeneous and anisotropic media. Their applications range from modern material science to image restoration and temperature sensor design.

We will present recent results on two-phase free boundary problems governed by operators with non-standard growth. We focus on viscosity solutions to free boundary problems for nonlinear elliptic PDEs with non-zero right hand side and obtain regularity results for solutions and their free boundaries.

More precisely, under suitable flatness assumptions we prove that free boundaries are $C^{1,\gamma}$.

In addition, we obtain the Lipschitz continuity of viscosity solutions without relying on a monotonicity formula.

The interest in these problems stems from the diverse applications that motivate their study and from the challenging difficulties they pose due to their singular / degenerate nature.

This is joint work with Fausto Ferrari (University of Bologna, Italy).

Recent progress on the inverse scattering theory for ideal Alfvén waves

Name: Mengni Li

Institution: Southeast University; Universität Würzburg

Abstract: The Alfvén waves are fundamental wave phenomena in magnetized plasmas. Mathematically, the dynamics of Alfvén waves are governed by a system of nonlinear partial differential equations called the magnetohydrodynamics (MHD) equations. Let us introduce some recent results about inverse scattering of Alfvén waves in ideal MHD, which are intended to establish the relationship between Alfvén waves emanating from the plasma and their scattering fields at infinities. The proof is mainly based on the weighted energy estimates. Moreover, the null structure inherent in MHD equations is thoroughly examined, especially when we estimate the pressure term.

Riemann problem and delta shock interactions in generalized Chaplygin gas with source term

Name: Minhajul Minhajul

Institution: BITS Pilani, K K Birla Goa Campus

Abstract: In this talk, we consider the Riemann problem and wave interactions for the one-dimensional generalized Chaplygin gas equations with a nonlinear time-dependent source term. We discuss the construction of the Riemann solution for this nonhomogeneous hyperbolic system and show that the solution contains a singularity under certain conditions in the initial data; that is, a δ-shock wave arises in the solution. Consequently, we derive the speed, position, and strength of the δ-shock using the δ-entropy condition. Finally, we discuss the wave interactions involving the δ-shock wave to establish the global solution by taking three piecewise constant perturbed initial data.

Pseudo Almost Periodic Solution for Some Differential Equations with Piecewise Constant Argument and Applications

Name: Mohsen Miraoui

Institution: Preparatory Institute for Engineering Studies of Kairouan, University of Kairouan, Kairouan, Tunisia

Abstract: In this talk, I will prove several key results regarding the existence and uniqueness of doubly measure pseudo-almost periodic solutions for differential equations with piecewise constant arguments. To achieve this, we will utilize the properties of almost periodic functions

with measure and apply the Banach fixed point theorem. Furthermore, we will illustrate these findings with various examples.

Consequences of Pressure Elimination for Fluid-Structure Interaction Models

Name: Yuhao Mu

Institution: University of Nebraska-Lincoln

Abstract: In this talk we present applications of our new technique for eliminating and recovering the pressure for a fluid-structure interaction model that is valid in general bounded Lipschitz domains, without additional geometric conditions such as convexity of wedge angles. The specific fluid-structure interaction (FSI) that we consider is a well-known model of coupled Stokes flow with linear elasticity. The coupling between these two distinct PDE dynamics occurs across a boundary interface, with each of the components evolving on its own distinct geometry, and with the boundary interface being Lipschitz. We consider both linear and nonlinear versions of this FSI system (i.e., Stokes and Navier-Stokes flow), where we obtain the well-posedness of the continuous PDE in such general geometries. We illustrate some consequences of our pressure-elimination technique, such as numerical approximations, where it provides FEM convergence estimates over polygonal domains. For the nonlinear case, to deal with the Navier-Stokes and associated boundary nonlinearities we adopt an approximating nonlinear semigroup formulation of a certain truncated problem, and give a new proof of maximality of the associated nonlinear semigroup via a mixed variational form. We illustrate the advantages of our method in a FEM for solutions of the static PDE where the approximating fluid subspace does not require the divergence-free condition.

Mixed initial-boundary-transmission problems for complex multi-layered structures

Name: David Natroshvili

Institution: Georgian Technical University

Abstract: We investigate dynamic mixed initial-boundary-transmission problems of the generalized thermo-electro-magneto elasticity theory for complex elastic multi-component structures containing interior and interfacial cracks. Theoretical study of such problems attracts great attention due to the widespread use of modern sensing and actuating devices based on the ability to transform mechanical, electric, magnetic, and thermal energies from one form to another. Therefore, the mathematical models taking into consideration coupling effects between thermo-mechanical and electromagnetic fields in elastic composites became very popular during the last decades In each component of the composed body, we consider Green-Lindsay's generalized model with different material constants. A remarkable feature of this model is that the speed of heat propagation is finite in contrast to infinite speed of heat transfer which occurs in the classical theory. We apply Laplace transform to reduce the dynamic mixed transmission problems to

the corresponding elliptic problems for the so-called pseudo-oscillation differential equations depending on a complex parameter. We apply the potential method and the theory of pseudodifferential equations and analyse smoothness properties and asymptomatic behaviour of solutions to the elliptic pseudo-oscillation problems near the edges of cracks and near the curves where different types of boundary conditions collide. We describe algebraic algorithms for finding explicitly the stress singularity exponents and analyse their dependence on material parameters. We estimate the norms of solutions to the elliptic pseudo-oscillation problems in appropriate function spaces with respect to the complex parameter and by the inverse Laplace transform we reconstruct the solutions of the original mixed dynamic problems. Using the corresponding asymptotic behaviour near the exceptional curves (crack edges and collision curves) we obtain the optimal regularity results of solutions and describe dynamical stress singularities. We analyse in detail arising of oscillating stress singularities depending on the material parameters.

This is a joint work with O.Chkadua and T.Buchukuri.

Acknowledgments. This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSF) (Grant number FR-23-267).

2D rotating Bose – Einstein condensates at the critical speed

Name: Dinh Thi Nguyen

Institution: VNUHCM University of Science

Abstract: We study the minimizers of a magnetic two-dimensional nonlinear Schroedinger (Gross – Pitaevskii) energy functional in a quadratic trapping potential, describing a rotating Bose – Einstein condensate. In the first part, we consider the case of a repulsive interaction potential. We derive an effective Thomas – Fermi-like model in the rapidly rotating limit where the centrifugal force compensates the confinement. The available states are restricted to the lowest Landau level. The coupling constant of the Thomas-Fermi functional is to link the emergence of vortex lattices (the Abrikosov problem). In the second part, we consider the case an attractive interaction potential. When the strength of the interaction approaches a critical value, the system collapses to a profile obtained from the (unique) optimizer of a Gagliardo – Nirenberg interpolation inequality. This was established before in the case of fixed rotation frequency. We extend the result to rotation frequencies approaching, or even equal to, the critical frequency at which the centrifugal force compensates the trap. We prove that the blow-up scenario is to leading order unaffected by such a strong deconfinement mechanism. In particular the blow-up profile remains independent of the rotation frequency.

Existence of weak solutions for nonlinear drift-diffusion equations with measure data

Name: Jung-Tae Park

Institution: Korea University of Technology and Education

Abstract: In this talk, we study nonlinear drift-diffusion equations of porous medium and fast diffusion types with a measure-valued external force. We first consider the case without drift to emphasize the influence of measure data and the nonlinear diffusion structure. Then, we establish the existence of nonnegative weak solutions that satisfy suitable gradient estimates when the drift term belongs to a sub-scaling class associated with the L^1 space. For divergence-free drifts, this requirement can be further relaxed to a scaling class, allowing a broader range of nonlinear diffusion behaviors.

Decay rates for Navier-Stokes and and Navier – Stokes – Coriolis equations in critical Sobolev spaces

Name: Gabriela Planas

Institution: Universidade Estadual de Campinas

Abstract: In this talk, I will present an algebraic upper bound on the decay rate of solutions to the Navier – Stokes and Navier – Stokes – Coriolis equations in critical spaces, obtained via the Fourier splitting method. The estimates are expressed in terms of the decay character of the initial data, yielding solutions that exhibit algebraic decay. The analysis highlights the distinct contributions of the linear and nonlinear components of the equations. The entire proof is conducted within the critical space framework. This represents the first application of the Fourier splitting method to establish decay bounds for a nonlinear equation in a critical space.

Invariant solutions of fuzzy fractional vibration equations

Name: P Prakash

Institution: Periyar University

Abstract: In this work, we consider one dimensional fuzzy fractional vibration equation with large membrane,

$$\frac{1}{\tilde{c}\text{^}2}\frac{\partial\text{^}\beta\tilde{v}}{\partial t\text{^}\beta} = \frac{\partial\text{^}2\tilde{v}}{\partial x\text{^}2} + \frac{1}{x}\frac{\partial\tilde{v}}{\partial x}; 1 < \beta \leq 2, t > 0, x \in [0,1],$$

with

$$\tilde{v}(x,0) = \tilde{p}(x), \quad \tilde{v}'(x,0) = \tilde{c}\tilde{q}(x),$$

where, $\frac{\partial^\beta}{\partial t^\beta}$ is a Caputo fractional derivative. Scaling transformation is used to transform the fuzzy fractional vibration equation into the second order fuzzy fractional ordinary differential equation with variable coefficients. Invariant solutions are derived by solving the second order fuzzy fractional differential equations. Finite difference scheme is used to establish the numerical results. Examples are presented in detail.

Non-uniqueness of $C^{1,\alpha}$ isometric embeddings between contact manifolds

Name: Sandra Ried

Institution: Georgia Institute of Technology

Abstract: Isometric embeddings between a domain manifold and a target manifold are differentiable maps f such that the pullback of the target metric h coincides with the metric g in the domain manifold. This problem can also be formulated as a non-linear PDE via $\nabla f^\top h \nabla f = g$. In the case of contact manifolds, it is additionally required that the embedding preserves a certain restriction on the tangent bundle. We prove that the Nash iteration scheme can be quantified in order to construct infinitely many $C^{1,\alpha}$ isometric embeddings for contact manifolds. In this way, we extend existing results by D'Ambra regarding non-uniqueness for C^1 regularity. The strategy of the proof follows a paper by Conti, De Lellis and Székelyhidi Jr. on the Riemannian case. The main difficulty in the context of contact manifolds is to keep the additional linear constraint coming from the contact setting along the iteration procedure. In the larger program of a quantitative analysis of isometric embeddings between sub-Riemannian manifolds, our result can be seen as an important first step. Another aspect is the flexibility of this convex integration method: the geometric constraint coming from the contact condition is just one special case of a (potentially large) class of admissible constraints, under which this scheme can still be applied. This is joint work with László Székelyhidi Jr.

On the Periodic Homogenization of the Maxwell-Stefan Equations

Name: Francesco Salvarani

Institution: De Vinci Higher Education & University of Pavia

Abstract: We consider the periodic homogenization of the Maxwell-Stefan cross-diffusion system for three species with two equal binary diffusion coefficients. Via two-scale convergence, we derive the macroscopic limit and characterize the effective diffusion operator from cell problems. The limit equations describe diffusive transport of a gas mixture in a porous medium with periodic microstructure. To our knowledge, this constitutes the first rigorous homogenization result on the Maxwell-Stefan system. This work was carried out in collaboration with Claudia Nocita.

Mathematical Modelling of Nonlinear Waves

Name: Angela Slavova

Institution: Institute of Mechanics, Bulgarian Academy of Sciences

Abstract: The study of water waves involves various disciplines such as mathematics, physics and engineering and within this there are many specific areas of direct or associated interest such as pure mathematics, applied mathematics, modelling, numerical simulation, laboratory

experiments, data collection in the field, the design and construction of ships, harbours, the prediction of natural disasters, climate studies and so on.

In this lecture we shall present travelling wave solutions of shallow water waves. Camassa-Holm considered a third order nonlinear PDE of two variables modelling the propagation of unidirectional irrotational shallow water waves over a flat bed, as well as water waves moving over an underlying shear flow. In the special case of the motion of a shallow water over a flat bottom the corresponding system was simplified by Green and Naghdi and related to an appropriate two component first order Camassa-Holm system. Another interesting system of nonlinear PDE is the viscoelastic generalization of Burger's equation. In the above mentioned systems we are looking for travelling wave solutions and we are studying their profiles. To do this we use several results from the classical Analysis of ODE that enable us to give the geometrical picture and in several cases to express the solutions by the inverse of Legendre's elliptic functions.

As an application we shall present propagation of tsunami waves from their small disturbance at the sea level to the size they reach approaching the coast. Even with the aid of the most advanced computers it is not possible to find the exact solutions to the nonlinear governing equations for water waves. For this purpose we introduce Cellular Nonlinear Network (CNN) approach.

Eigenvalue lower bounds for Laplacians

Name: Durvudkhan Suragan

Institution: Nazarbayev University

Abstract: In this talk, we present new results concerning lower bounds on the first eigenvalue for the Laplace operators, especially under variable-component Robin boundary conditions. We not only derive novel results for the Robin Laplacian but also significantly improve existing bounds over those for the Dirichlet Laplacian. The methodology adopted in our study is further extended to establish new lower bounds on the first eigenvalue of the polyharmonic Dirichlet operator. This talk is based on our joint work with Rupert L. Frank (Caltech and LMU Munchen) and Ari Laptev (Imperial College London).

Bifurcation Methods for a Class of Periodic Superlinear Boundary Value Problems

Name: Andrea Tellini

Institution: Universidad Politécnica de Madrid

Abstract: In this talk, I will apply bifurcation methods to an elliptic superlinear problem in one-dimension with periodic boundary conditions.

One of the main novelties of this approach is that it allows the treatment of the case of bifurcation points in which the linearized operator has a two-dimensional kernel, leading to new local and global multiplicity results.

I will consider specific examples where these methods apply, complementing the analytical results with numerical simulations.

This work is in collaboration with Eudardo Muñoz-Hernández (Universidad Complutense de Madrid, Madrid, Spain) and Juan Carlos Sampedro (Universidad Politécnica de Madrid, Madrid, Spain).

Fujita critical exponents for the semilinear parabolic problems

Name: Berikbol Torebek

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: This work explores the critical behavior of the semilinear heat equation

$$u_t + \mathcal{L}_{a,b}u = |u|^p + f(x),\ t > 0,\ x \in \mathbb{R}^d,\ d \geq 2,$$

considering both the presence and absence of a forcing term $f(x)$. The mixed local-nonlocal operator

$$\mathcal{L}_{a,b} = -a\Delta + b(-\Delta)^s,\ a,\ b \in \mathbb{R}_+,\ s \in (0,1),$$

incorporates both local and nonlocal Laplacians. We determine the Fujita-type critical exponents:

$$p_{Crit} = \begin{cases} 1 + \frac{2s}{d}, & \text{if, } f \equiv 0, \\ 1 + \frac{2s}{d-2s}, & \text{if, } f \not\equiv 0, \end{cases}$$

by considering the existence or nonexistence of global solutions. Interestingly, the critical exponent is determined by the nonlocal component of the operator and, as a result, coincides with that of the fractional Laplacian.

In the case without a forcing term, our results improve upon recent findings by Biagi et al. [Bull. London Math. Soc. (2024), 1 – 20] and Del Pezzo et al. [Nonlinear Analysis, 255 (2025), 113761]. When a forcing term is included, our results refine those of Wang et al. [J. Math. Anal. Appl., 488 (1) (2020), 124067] and complement the work of Majdoub [La Matematica, 2 (2023), 340 – 361].

On the Global Regularity of the Navier-Stokes Equations

Name: Brian Vasquez

Institution: University of Tolima

Abstract: We establish a sufficient condition on the initial data that ensures the existence of global smooth solutions to the incompressible Navier-Stokes equations on $\mathbb{R}^d$, for dimensions $d \geq 3$. The solutions constructed exhibit rapid decay at spatial infinity, satisfying the physical energy bounds expected of physically reasonable flows. Furthermore, we demonstrate that, for positive times, the velocity and pressure fields admit an analytic extension to the complex domain, forming a smooth curve of entire vector fields of order two. Our results provide new insights into

the structure and regularity of Navier-Stokes flows under explicit and verifiable conditions on the initial data.

Lifespan estimates for semilinear damped wave equation in a two-dimensional exterior domain

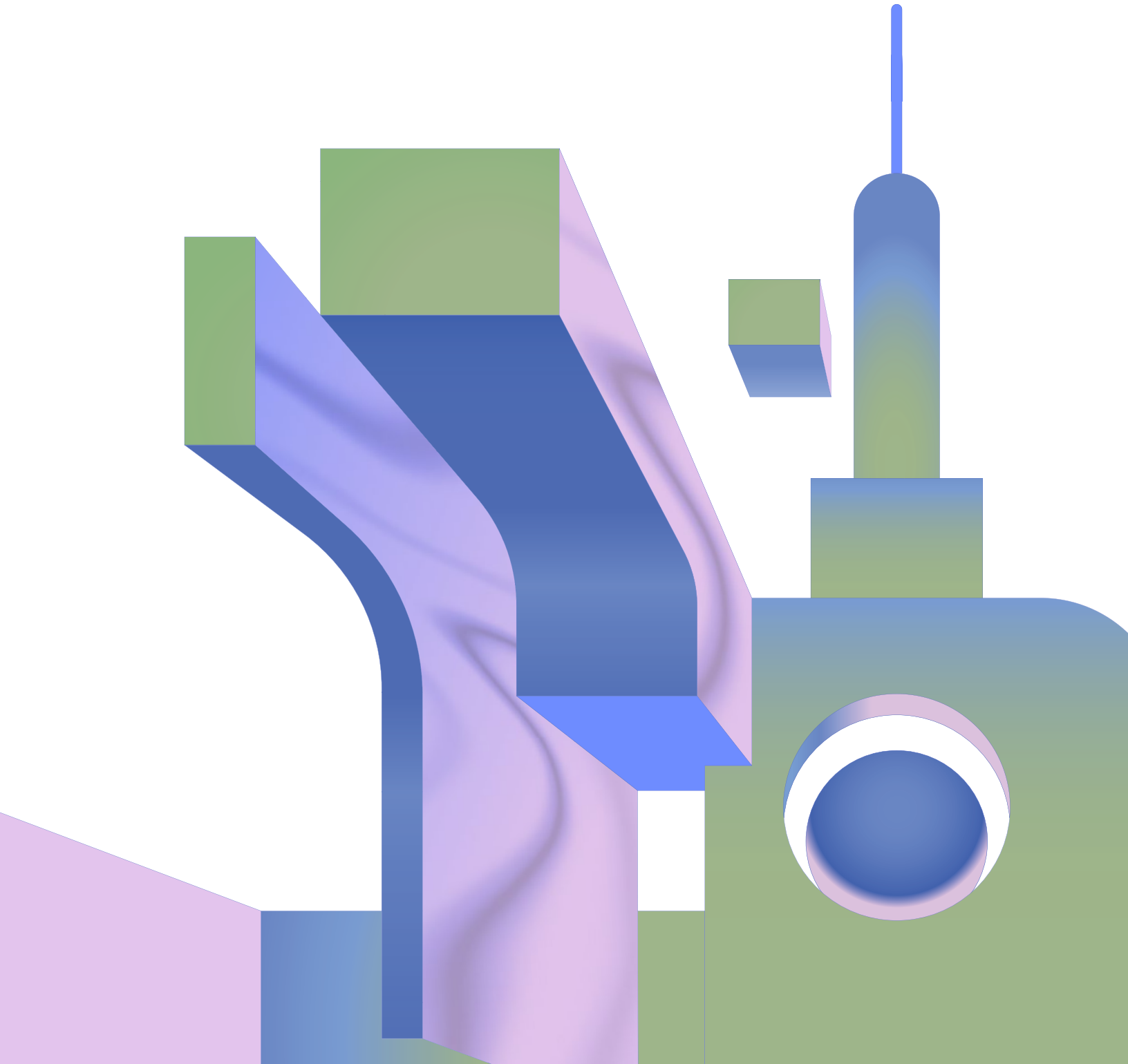
Name: Yuta Wakasugi

Institution: Hiroshima University

Abstract: Lifespan estimates for semilinear damped wave equations of the form $\partial_t^2 u - \Delta u + \partial_t u = |u|^p$ in a two dimensional exterior domain endowed with the Dirichlet boundary condition are dealt with. For the critical case of the semilinear heat equation $\partial_t v - \Delta v = v^2$ with the Dirichlet boundary condition and the initial condition $v(0) = \varepsilon f$, the corresponding lifespan can be estimated from below and above by $\exp(\exp(C\varepsilon^{-1}))$ with different constants C. This paper clarifies that the same estimates hold even for the critical semilinear damped wave equation in the exterior of the unit ball under the restriction of radial symmetry. To achieve this result, a new technique to control L^1-type norm and a new Gagliardo–Nirenberg type estimate with logarithmic weight are introduced.

SHORT COMMUNICATIONS

SECTION 11– MATHEMATICAL PHYSICS



Ramifications of Temperature-Dependent Viscosity and Prandtl Number on MHD Forced Flow Over an Impermeable Symmetric Wedge

Name: Eswara Anniganahally Thammaiah Setty

Institution: GSSSIETW, Mysuru-570016, India

Abstract: The scientific and industrial use of fluids such as air, water, plasma, blood, ethanol, colloidal suspensions etc., is not possible without complete knowledge of their inherent and intricate thermo-physical transport properties. Under such circumstances, boundary layer theory plays a crucial role in understanding the convective heat transfer behavior between solid surface and flowing fluid. In a typical laminar flow, it is well-known that dynamic viscosity varies significantly with temperature. Moreover, Prandtl number which itself is a function of viscosity, varies with temperature too. Thus, the combined role of temperature-dependent viscosity and Prandtl number becomes an interesting physical phenomenon in fluid dynamics research. This research examines how temperature-dependent viscosity and Prandtl number affect the steady, MHD laminar forced flow of incompressible fluid (ethanol) over an impermeable wedge. Utilizing the similarity transformations, the governing coupled nonlinear partial differential equations are converted into system of coupled nonlinear ordinary equations and these flow equations tackled numerically, using the quasilinearized implicit finite-difference approach. The impact of temperature-dependent viscosity/Prandtl number on the local skin friction coefficient, Nusselt number, velocity and temperature fields is analyzed in the presence of a transverse magnetic field, for different wedge angles. The acquired results in the absence of certain key parameters are compared with previously reported works, and found to be in good agreement. The insights gained here are expected to provide a solid framework of accurate numerical calculations for the heat transfer community working on the thermal systems in industrial applications, including lubrication, transportation and food processing etc.

Accelerating Cosmological Dynamics in f(Q) Gravity with Dynamical Stability Analysis

Name: Rahul Vijay Bhagat

Institution: BITS-Pilani, Hyderabad Campus, Hyderabad

Abstract: In this study, we investigate the viability of the $f(Q)$ gravity model within the framework of symmetric teleparallel gravity as an alternative explanation for the late-time acceleration of the Universe. We reformulate the modified Friedmann equations into a system of coupled differential equations, ensuring that the minimal set of equations required for a second-order gravity theory is obtained. These equations are then solved numerically. To constrain the model parameters. we employ Bayesian inference using Markov Chain Monte Carlo (MCMC) techniques, incorporating different observational datasets. Our findings show strong consistency with observational data. The evolution of key cosmological parameters indicates that the model displays quintessence-like behavior at present, with a natural tendency to converge toward the ΛCDM model at late times. To further support this outcome, we perform a critical point analysis, which confirms the existence of a stable de Sitter attractor. The existence of a stable de Sitter attractor confirms the accelerating behavior of the model.

Structural Study of Refractory Compound

Name: Purvee Bhardwaj

Institution: JNCT Professional University Bhopal. MP, India

Abstract: Purvee Bhardwaj JNCT Professional University, Bhopal-462038, (MP) India Email: purveebhardwaj@gmail.com purvee.bhardwaj@jnctpu.edu.in

Abstract

In this work, we have systematically examined high-pressure structural phase transition behavior of the refractory compound Curium Sulfide (CmS). In order to provide a more accurate representation of interatomic forces under compression, an Extended Interaction Potential (EIP) model has been developed that incorporates the zero-point energy effect along with a three-body interaction potential framework. According to the research, a first-order structural transformation is indicated by the phase transition pressure, which is characterized by a dramatic collapse in volume. The theoretical and experimental patterns found in comparable refractory compound are satisfactorily aligned with the predicted transition pressures and related volume collapses. Additionally, the study provides important information about the mechanical stability and stiffness of the compound under various pressure regimes by reporting the elastic constants, their combinations, and pressure derivatives. To clarify the nature of bonding and lattice compressibility in CmS, the pressure dependence of elastic constants, bulk modulus, and shear modulus has been examined and addressed. The current work contributes to the larger study of actinide compounds under extreme conditions by offering a thorough theoretical framework for comprehending the structural, elastic, and thermo-physical properties of the transuranic refractory compound CmS. Key words: High pressure, Crystal structure, Elastic properties, Phase transition. Classification: 06B05: Structure theory, 74E15: Crystalline structure

A Game-Theoretic Quantum Algorithm for Solving Magic Squares

Name: Sarah Chehade

Institution: University of Tennessee, Chattanooga

Abstract: Variational quantum algorithms (VQAs) offer a promising near-term approach to finding optimal quantum strategies for playing non-local games. These games test quantum correlations beyond classical limits and enable entanglement verification. In this work, we present a variational framework for the Magic Square Game (MSG), a two-player non-local game with perfect quantum advantage. We construct a value Hamiltonian that encodes the game's parity and consistency constraints, then optimize parameterized quantum circuits to minimize this cost. Our approach builds on the stabilizer formalism, leverages commutation structure for circuit design, and is hardware-efficient. Compared to existing work, our contribution emphasizes algebraic structure and interpretability. We validate our method through numerical experiments and outline generalizations to larger games.

An Algorithmic Approach to the Cauchy Problem for Einstein's Field Equations

Name: Arthur Fischer

Institution: University of California, Santa Cruz

Abstract: Existence and uniqueness theorems for the Einstein field equations are discussed, using results that utilize first order quasilinear symmetric hyperbolic systems, rather than the usual second order strictly hyperbolic systems. These first order hyperbolic methods were developed by the author together with Professor Jerrold Marsden in the early 1970's and are now widely used in numerical relativity. Using these results, we approach the Cauchy problem for Einstein's field equations in an algorithmic manner. We reduce the problem to two distinct cases. The base case is the harmonic case, or the classical case, in which the Cauchy data satisfies both the constraint equations and a harmonic coordinate condition, which is then resolved by using the harmonic Ricci tensor. This case was done by Professor Yvonne Choquet-Bruhat in the early 1950's using second order hyperbolic methods rather than the first order methods cited above. In our second case, the Cauchy data does not solve any coordinate condition. We reduce this case to the first case by modifying the Cauchy data to satisfy the harmonic coordinate condition, and then find an intermediate harmonic solution. The general non-unique solution to the original problem is then achieved by pulling back this intermediate solution by any diffeomorphism that also pulls back the non-original intermediate harmonic Cauchy data to the original non-harmonic Cauchy data. The fundamental idea behind this approach is that Cauchy data is non-tensorial since Cauchy data involves the time derivative of the metric. Thus isometric spacetimes have non-isometric Cauchy data.

Other aspects of the Cauchy problem are very briefly discussed, including the internal structure of the Ricci tensor, how covariance of the scalar curvature gives rise to the constraints on the Cauchy data, the relation of the Cauchy problem to the Hamiltonian formulation of general relativity, and to the problem of isolating and parameterizing the space of true degrees of freedom for the gravitational field. Our algorithmic approach to the Cauchy problem, together with our use of first order hyperbolic methods, although mainly of theoretical interest, also considerably simplifies numerical relativity, a crucial tool in understanding complex astrophysical phenomena such as black hole interactions and gravitational waves.

Invariant States on Holonomy-Flux Algebras

Name: Christian Fleischhack

Institution: Paderborn University

Abstract: Representations of canonical commutation relations are fundamental for quantum theory. In quantum mechanics, the celebrated Stone-von Neumann theorem shows that, given mild regularity conditions, there is only one representation (up to unitary equivalence). While this is, in general, no longer true in quantum field theory, uniqueness may still be given in the presence of symmetries. So, in loop quantum gravity, diffeomorphism invariance is well known to imply uniqueness of states on the so-called holonomy-flux algebra. The corresponding proof by Lewandowski et al., however, is very lengthy and technical. In our talk, we are going to present

a drastically shorter proof of a more general uniqueness theorem we have obtained recently. This even applies to respective cosmological models.

To be specific, consider some set $\mathfrak{F}$ of bounded functions on the configuration space and the unital C^*-algebra $\mathfrak{A}$ it generates. Moreover, let $\mathfrak{B} \supset \mathfrak{F}$ be a unital subalgebra of $\mathfrak{A}$, and let $\mathfrak{X}$ be a set of selfadjoint derivations (usually generated by Poisson brackets with certain momenta) on $\mathfrak{B}$. The holonomy-flux $*$-algebra $\mathfrak{H}$ is generated by $\mathfrak{B}$ and $\mathfrak{X}$, factorized by the commutation relations. Then, there is at most one state on $\mathfrak{H}$ that fulfills the following two conditions:

a) The algebraic one requires that (i) $\mathfrak{X}(\mathfrak{F})$ and 1 span a dense subset of $\mathfrak{B}$ and (ii) the elements of $\mathfrak{X}$ fulfill the chain rule if applied to $g \circ f$ for $f \in \mathfrak{B}$ and certain analytic g.

b) The geometric one requires the state to vanish on each X^2 with $X \in \mathfrak{X}$.

While the algebraic condition usually is a matter of collecting sufficiently "smooth" functions in $\mathfrak{B}$, the geometric condition is typically given for states that are invariant under symmetries. In particular, states that are invariant under semianalytic diffeomorphisms (for full loop quantum gravity) or under dilations (for homogeneous isotropic loop quantum cosmology) meet this requirement.

Generalized Stuart-Landau oscillator in any dimension

Name: Debashis Ghoshal

Institution: Jawaharlal Nehru University

Abstract: The two-dimensional Stuart-Landau equation provides a paradigmatic model of nonlinear oscillation that exhibits Hopf bifurcation. Using Clifford algebra, we propose a generalization to arbitrary dimensions that retains its essential features, namely, its exact solvability and symmetries. The asymptotic behaviour of possible trajectories, limit cycles and basins of attraction will be discussed. We shall briefly comment on related problems, including coupled oscillators, parametric modulation, reduction of symmetries, etc. This talk is based on joint work with P. Bhuyan Gogoi, R. Ghosh, A. Patel, A. Prasad and R. Ramaswamy (Phys. Rev. E110 (2024) L032202 and Phys. Rev. E112 (2025) 054221).

Conservation Laws for Einstein Equations with a Cosmological Constant

Name: Nishanth Gudapati

Institution: College of the Holy Cross

Abstract: In this work, we consider Lorentzian spacetimes whose Ricci curvature is proportional to the metric. We formulate a Hamiltonian initial value problem for Lorentzian Einstein manifolds with a spacelike rotational isometry. We establish various conservation laws for these manifolds in the sense that we show the existence of various spacetime divergence-free vector field densities.

The central conservation law corresponds to a Hamiltonian energy of the system. Subsequently, we also construct such divergence-free vector field densities corresponding to the symmetries of internal structure of the dimensionally reduced field equations.

This work is relevant to study the asymptotics and stability properties of these spacetimes. The motivation for expressing the conservation laws in the form of spacetime divergence-free vector field densities is that it is particularly convenient to express balance-laws near asymptotic null infinity.

On the moduli space of closed G_2-structures on S^7

Name: Shelia Jones

Institution: Sparks

Abstract: test abstract 2

Analytical model for impact pressure coefficient and object mobilization length in landslides

Name: Parameshwari Kattel

Institution: Tri-Chandra Multiple Campus, Tribhuvan University

Abstract: Motion of a movable obstacle is initiated when the impact pressure exerted by a landslide exceeds the basal frictional resistance of the obstacle and persists as long as the force applied remains dominant. Using a force-energy framework, we derive closed-form expressions for the impact pressure coefficient C_p^0 and the mobilization length L characterizing the flow-obstacle interaction.A dimensionless number called the obstacle mobilization number is introduced as the ratio of the obstacle shear resistance to the flow kinetic energy and is shown to be related to the obstacle Froude number Fr_0. As the obstacle translates a distance L, its kinetic energy is dissipated by basal friction until the obstacle comes to rest. Equating the initial kinetic energy with the frictional work yields an explicit expression for L. Conversely, prescribing L allows the estimation of the impact velocity u_p, providing a practical method for velocity estimate in landslides. The model predicts that C_p^0 decreases strongly to weakly nonlinearly with increasing impact velocity, particle-obstacle density ratio, and grain-covered area, while increasing linearly with basal friction. C_p^0 is highly sensitive to obstacle geometry (shape). The mobilization length scales as $L \propto u_p^2$, decreases with increasing basal friction and the gravitational acceleration component normal to the flow depth. Laboratory chute experiments using Nepalese fruit seeds and food grains confirm sound agreement with our analytical model predictions. Applications include hazard mitigation, protective structure design, and granular transport in process engineering.

Modeling the impact of hyperthermia on tumor growth and glucose diffusion in biological tissues

Name: Ma Khanday

Institution: University of Kashmir, Srinagar

Abstract: This study develops a mathematical model to analyze heat and mass transfer in tumor-affected biological tissues during local hyperthermia therapy. The model focuses on thermogenesis, thermolysis, ATP dynamics, and heat homeostasis to quantify the effects of controlled heating on tumor metabolism and glucose diffusion. Using Pennes' Bioheat equation, temperature variations in finite tissue containing a tumor are estimated, while a modified tumor growth equation incorporating thermal damage simulates tumor progression. The finite difference method and Euler's method are applied to solve the equations under hyperthermia conditions ranging from 39°C to 43°C. The model is validated by comparing simulated tumor and glucose concentration profiles with existing studies. Results demonstrate that higher temperatures significantly reduce tumor proliferation by increasing thermal damage and decreasing glucose availability, ultimately leading to tumor shrinkage. This research highlights the critical role of temperature regulation in tumor treatment and provides a computational tool for optimizing hyperthermia-based cancer therapies.

Hydrodynamics of very large rectangular flexible plate floating on shallow water

Name: Santanu Koley

Institution: Birla Institute of Technology and Science - Pilani, Hyderabad Campus

Abstract: In the present study, the hydrodynamics associated with the water waves interaction with very large rectangular flexible plate floating in shallow water is studied. The incident waves is considered to be oblique in nature. Parabolic approximation technique is used in the solution methodology of the aforementioned boundary value problem. The effect of the compression on the hydroelastic responses of the flexible plate is considered. The main advantage of the present parabolic approximation over the widely used ray theory is that in the ray theory, the amplitude of the waves changes abruptly along the ray which passes through the corners. However, this particular difficulty can be resolved easily through the parabolic approximation approach. The effect of the compressive force and incident wave angle on the plate deflection will be analyzed. The outcome of the present research is helpful to construct various floating marine structures in the nearshore regions.

Discretization of conformally-invariant Dirac-like operators in 3D via natural differential operations, and applications to geometric inverse problems.

Name: Robert Kotiuga

Institution: Boston University

Abstract: Although a well-developed notion of natural differential operators in the context of the deRham complex has existed since the 1950s, it is only recently that a similar notion has

been developed in the context of triangulations of manifolds embedded in R^n and connected to the deRham complex in a functorial manner. In Riemannian geometry, conformally invariant differential operators are associated with the middle dimension of an even-dimensional manifold, and there is no linear counterpart on odd-dimensional manifolds. In this paper we summarize the construction of a nonlinear elliptic Dirac operator on 3-dimensional manifolds with boundary, the variational formulation, and Whitney form discretization, with an emphasis played by the role of discrete differential operations. This formulation is then applied to highly nonconvex inverse problems. Primarily, isotopy classes of near force-free magnetic fields characterized by contact structures and the Giroux correspondence.

The Influence of Caputo time fractional derivative on wave characteristics of heat conduction

Name: Vinayak Kulkarni

Institution: University of Mumbai, India

Abstract: Fourier law (1807) assumes that the heat conduction process in a homogeneous medium, the heat flux vector and temperature gradient appears at the same time instant and consequently thermal signals propagate with an infinite speed. In order to achieve the finite speed of thermal wave, Cattaneo and Vernotte (1958) have reconstructed the Fourier law in terms of the thermal relaxation parameter. Furthermore, to study the lagging behaviour of the heat conduction, Tzou (1995) proposed the dual-phase-lag theory by introducing delay time translations in heat flux vector and in temperature gradient.

The proposed model is an attempt to design a well-posed heat conduction equation considering non-Fourier effects in the context of Caputo time fractional derivative and study the influence of order of fractional derivatives along with phase lag parameter in the wave-like behaviour of heat conduction. The presence of relaxation time converts the corresponding heat conduction equation into a hyperbolic type that characterizes the combined diffusion and wave-like behaviour of heat conduction and predicts a finite speed of thermal wave propagation.

The well posedness of the model has been proved mathematically by showing continuous dependence of the solution on the initial data and energy supply term. Moreover the existence and uniqueness of the solution have been proved subject to stability condition for the constitutive coefficients on the point spectrum. The analytical solutions of governing equations could be achieved by converting the original boundary value problem into an eigenvalue problem by the application of the Integral transforms. The convergence of infinite series solutions has been discussed using local integrability and bounded variation of the functions.

The existing classical and non-classical theories of heat conduction have been recovered by considering the various special cases for the order of fractional derivatives and two different translations under consideration. The micro structural interactions and corresponding thermal changes have been studied due to the involvement of relaxation time and delay time translations. The non-local characteristics of fractional order parameters control the memory effects of temperature changes in the system. Consequently, presenting models could establish the scientific role of fractional order, phase-lags and the relaxation times to categorize the conducting materials in the mechanism of heat transfer.

Generalized law of the wake with dip phenomenon for smooth open-channel turbulent flows: a functional equation approach

Name: Snehasis Kundu

Institution: National Institute of Technology Jamshedpur

Abstract: The mean velocity distribution over the whole flow depth in smooth open channel turbulent flow usually consists of three parts: (i) the logarithmic law in the overlap layer; (ii) the wake law in the outer region; and (iii) the boundary correction. This work presents a simple law, referred to as the generalized law of the wake, which combines all three hypotheses into a single equation. This law, unlike the log-wake law, does not explicitly contain the wake function and the boundary corrections, but shows this in its inherent nature. The equation is derived from a general functional equation with the hypothesis of a wake factor as the linear span of the velocity function at two points. The general functional equation reverts to the functional equation previously proposed by Guo(2023) for the overlap layer as a special case. The general solution of the functional equation is also discussed as the general solution of a delayed-differential equation. The model is validated over a widespread range of experimental and river field data, and satisfactory results are obtained. This law expresses the measured data well over the entire flow domain.

References Guo, J. (2023). The log-law of the wall in the overlap from a functional equation, Journal of Engineering Mechanics 149(2): 06022005-1 – 06022005-3.

Numerical Modeling of Wave Attenuation by Hybrid Green – Grey Coastal Infrastructure

Name: Ikha Magdalena

Institution: Institut Teknologi Bandung

Abstract: Hybrid coastal infrastructure that integrates engineered structures with nature-based solutions has emerged as a promising approach to reducing wave impacts while enhancing coastal resilience and ecosystem sustainability. This study investigates wave attenuation mechanisms in hybrid systems composed of conventional coastal structures, such as submerged breakwaters, piles, or fences, combined with coastal vegetation, including mangroves and seagrass, with a particular focus on tsunami-like long waves representative of the Aceh event. An analytical wave transmission coefficient is derived to quantify wave attenuation induced by the hybrid infrastructure. The governing shallow water equations are then solved numerically to capture wave propagation, transmission, and energy dissipation across hybrid configurations under varying hydrodynamic and geometric conditions. Model performance is validated against available experimental data, with emphasis on wave transformation characteristics relevant to the Aceh tsunami case. The numerical results demonstrate that hybrid configurations provide significantly stronger wave attenuation than single-component defenses, with vegetation contributing additional damping through drag-induced momentum loss and enhanced energy dissipation.

Parametric analyses indicate that wave reduction is governed by the submergence, dimensions, and physical characteristics of the vegetation. These findings highlight the synergistic effects of hybrid coastal infrastructure in reducing wave height, transmission coefficients, and nearshore hydrodynamic energy, providing a quantitative basis for the design of adaptive, cost-effective, and environmentally sustainable coastal protection strategies for sediment-rich and low-lying coastlines exposed to increasing tsunami and climate-driven hazards.

Hydromagnetic Nanofluids for Improved Thermal Regulation in Engineering Systems

Name: Oluwole Daniel Makinde

Institution: Stellenbosch University

Abstract: Effective thermal regulation is critical for the reliability, efficiency, and longevity of modern engineering systems. This research investigates the use of hydromagnetic nanofluids, electrically conducting fluids containing suspended nanoparticles, as advanced working media for enhanced heat transfer and thermal control. By incorporating magnetic fields into the flow environment, the study examines how magnetohydrodynamic (MHD) forces influence momentum and energy transport, nanoparticle dynamics, and boundary layer behaviour over a convectively heated stretching /shrinking surface. The governing nonlinear model equations are obtained, analysed, and solved numerically via the shooting technique with the Runge-Kutta-Fehlberg integration scheme. For a shrinking surface, the model exhibits dual solutions, and a linear stability analysis is performed to identify the stable and physically achievable solution. The unique solution is found for the stretching surface case. The effects of emerging thermophysical parameters on the overall flow structure, thermal management, and the inherent irreversibility are quantitatively discussed through graphs and in tabular form. The findings provide practical insights for optimizing thermal management in systems such as heat exchangers, microfluidic devices, electronic cooling platforms, and energy storage technologies, highlighting the potential of MHD nanofluid-based approaches for next-generation engineering applications.

Wave propagation on a fluid-filled cylindrical shell

Name: Santanu Manna

Institution: Indian Institute of Technology Indore

Abstract: A mathematical investigation of the dynamic characteristics of a cylindrical shell in the presence of an internal fluid is presented. The velocity potential of the internal compressible fluid is obtained through the Helmholtz equation and is subject to the impenetrable boundary. The pressure at the interior of the shell in the presence of the fluid is obtained by inserting the asymptotic solution of the Helmholtz equation into the linearized Bernoulli equation. The kinematics of the shell is governed by the Sanders-Koiter thin shell theory. The implementation of the asymptotic integration technique onto the equations of motion and the general dispersion relation for a propagating wave on a circular cylindrical shell enables the extraction of each

frequency mode under a small value of thickness-to-curvature ratio. The condition of the existence of a non-degenerate dynamics edge effect is examined by the implementation of the asymptotic method at a particular edge of the considered shell. Analytical and numerical analysis of the resulting dispersion relation is performed, and the results are illustrated with their underlying physics.

Modulation of the vector potential of the core of an elliptical vortex of the second rank with the distribution of right- and left-handed matter flows

Name: Algimantas Milyus

Institution: IRG "LITAVEM-3"

Abstract: This paper investigates the dynamics and interaction mechanisms of swirling flows that carry right- and left-hand rotation, maintaining the mass transfer circulation inside an elliptical closed vortex structure. The study focuses on the modulation of the vector potential core in a second-rank elliptical vortex and its effect on the flow polarity distribution and the overall vorticity balance. A theoretical framework is proposed to describe how the modulation of the vortex kern affects the spatial separation and simultaneous propagation of right- and left-handed vortex flows. It is shown that these flows maintain independent coherence while simultaneously contributing to a continuous circulation field inside the vortex. The resulting configuration ensures the topological integrity of the overall vorticity field and supports stable coexistence of bipolar mass transport. A new concept is introduced: protection of autowaves in the vortex dynamics of the elliptical core. These self-sustaining wave structures exhibit morphological features that stabilize the trajectory of matter flows through geometric alignment and mutual "non-interference". The structural morphology of these autowaves ensures continuous, uninterrupted movement of two completely independent matter flows, which suggests a form of internal flow isolation supported by the geometry of the vortex kern. This analysis provides new insights into the role of global vortex vector potential modulation in maintaining the integrity of complex vortex systems in three dimensions. The proposed model may facilitate advanced interpretations of dual helicity, inverse lemniscatibility of the vortex flow in the discontinuity region, and chirality-driven transport phenomena in both natural and artificial vortex dynamics.

A phase space localization operator in negative binomial states

Name: Zouhair Mouayn

Institution: Sultan Moulay Slimane Universitry

Abstract: We investigate the spectral properties of the phase space localization operator P_R, defined by the indicator function of a disk D_R of radius $R < 1$. The localization is performed using a family of *negative binomial states* (NBS), labeled by points z in the unit disk $\mathbb{D}$ and parameterized by $\nu > \frac{1}{2}$.

These states are intrinsically connected to the 1D pseudo-harmonic oscillator (PHO) through superpositions of its eigenfunctions. The superposition coefficients form an orthonormal basis of a weighted Bergman space $A^\nu(\mathbb{D})$, which also emerges as the eigenspace of a 2D Schrödinger operator with a magnetic field (proportional to ν) corresponding to the lowest hyperbolic Landau level.

The eigenvalues $\lambda_j^{\nu,R}$ of P_R were obtained via a discrete spectral resolution within a shared eigenbasis for P_R and the PHO. Using these eigenvalues, we derive a closed-form expression for the variance of the particle count in D_R under the determinantal point process (DPP) defined by the weighted Bergman kernel.

Beyond D_R, the phase space content of P_R was estimated via the NBS photon-counting distribution, revealing a non-zero residual contribution. Using the coherent state transform associated with NBS, we mapped P_R to $A^\nu(\mathbb{D})$ and derived its explicit integral kernel $K_{\nu,R}(z,w)$, which converges to the Bergman kernel $K_\nu(z,w)$ as $R \to 1$.

Homogeneous – heterogeneous Reactions, HALL Current, and Dissipative-Radiative Heat Transfer Effects on MHD Casson Fluid Flow over a Bi-directional Stretching Sheet

Name: Mamata Nandkeolyar

Institution: Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar, India

Abstract: This study presents a numerical analysis of the unsteady three-dimensional flow of a Casson fluid over a bi-directional stretching surface, considering the effects of Hall current, thermal radiation, homogeneous-heterogeneous reactions, viscous dissipation, and an external magnetic field. The flow is induced by the bi-directional stretching of the sheet in its plane. The presence of two different species in the flow region, participating in homogeneous and heterogeneous reactions, adds complexity to the problem. The fluid velocity, thermal, and mass transport are modelled using a set of nonlinear partial differential equations (PDEs) with appropriate boundary conditions. These PDEs are transformed into a set of nonlinear ordinary differential equations (ODEs) using similarity transformations. The transformed ODEs are then solved numerically using the bvp4c solver. The study presents a detailed analysis of the impact of various flow parameters on velocities, temperature, and concentration profiles through graphical representations. The results indicate that the thermal boundary layer thickness increases with higher Hall current, magnetic field strength, and thermal radiation. Conversely, mass transport decreases with higher homogeneous-heterogeneous reaction parameters. The study also calculates the physical quantities such as the coefficients of skin friction and heat and mass transfer.

MHD Trihybrid Nanofluid Flow with Hall Current and Electric Field Effects: Numerical and Neural Network Analysis

Name: Raj Nankeolyar

Institution: National Institute of Technology Jamshedpur

Abstract: This study investigates the importance of Magnetohydrodynamic (MHD) trihybrid nanofluid flow across a stretching surface. The combination of silicone oil-based silver (Ag), magnesium oxide (MgO), and Titanium dioxide (TiO2) nanofluids has attracted attention for its potential to improve fluid performance. The research accounts for the combined influence of Hall current and electric field on the flow, while also exploring the effects of nonlinear thermal radiation and Joule heating. A mathematical model is developed to address the core problem, incorporating nonlinear partial differential equations (PDEs) with suitable boundary conditions. These PDEs are transformed into ordinary differential equations (ODEs) using similarity transformations and solved numerically via the SQLM method. The impact of each parameter is evaluated and presented through graphical illustrations. The study proposes a novel approach for advanced numerical computation by employing a multi-layer perceptron (MLP) feed-forward back-propagation Artificial Neural Network (ANN) integrated with the Levenberg-Marquardt algorithm (LMB). Various parameters were systematically varied using SQLM to create a dataset optimized for refining the ANN-LMB model across different scenarios. Data collection included testing, validating, and training the ANN model. The ANNLMB methodology was validated through regression analysis, mean squared error (MSE) assessment, and histogram evaluations.

Localized Modes of Anti-Plane Shear Wave in an Elastic Ultrathin Layer with spatially varying surface elasticity effects: Asymptotic WKB-method

Name: Arindam Nath

Institution: Harbin Institute of Technology

Abstract: The work deals with localized modes of free anti-plane shear vibration in an elastic, isotropic ultrathin layer with a free upper surface exhibiting spatially varying surface elasticity effects. The constitutive boundary conditions account for variable surface shear stresses and surface inertia within the framework of Gurtin – Murdoch surface elasticity theory at the free upper surface. Using the asymptotic WKB method, a solution of the governing wave equation is constructed in the form of a function that decays away from a straight line along which the wave is localized at the surface. From the first two asymptotic approximations, explicit expressions for the natural frequencies and a parameter characterizing the localization rate are derived. By introducing ratios of the surface shear modulus and surface density to their bulk counterparts as functions of the horizontal coordinate—referred to as internal characteristic dimensions of the free surface or coating—it is shown that incorporation of surface shear stresses and surface inertia leads to a decrease in the natural frequencies. The effect of surface inertia is more prominent compared to surface shear stresses on the natural frequencies. It is also observed that the localization of the surface wave takes place at the point where the surface inertia is maximum.

Expanded Regimes of Area Law for Lattice Yang-Mills Theories

Name: Ron Nissim

Institution: Massachusetts Institute of Technology

Abstract: We extend the parameter regimes under which the area law is proven for pure U(N) lattice Yang-Mills theories, particularly in the large-N limit, in joint work with Sky Cao and Scott Sheffield. In this talk, I will begin by reviewing the U(N) lattice Yang-Mills model and the celebrated area law conjecture, which is believed to explain the physical phenomenon of quark confinement. I will then compare our theorem with classical previously known results, which our work directly improves upon in dimension four and higher for large N. Following that, I will introduce the main tool in our analysis: the master loop equation. I will provide intuition for our result by interpreting the master loop equation as a process of surface exploration. Finally, I will present the technical framework in which the master loop equation is studied as a fixed-point problem, and the challenge to this approach posed by the "merger" term of the master loop equation.

Divisibility of Infinite Dimensional Dynamical Maps

Name: Saikat Patra

Institution: Indian Institute of Science Education and Research Berhampur

Abstract: In this talk, I will discuss completely positive trace-preserving maps, which are widely used in quantum information theory. These are mostly studied using the master equation perspective. A central part in this theory is to study whether a given system of dynamical maps $\{\Lambda_t : t \geq 0\}$ is CP-divisible or not CP-divisible. We study the problem when the underlying Hilbert space is of infinite dimensional. In special case, we describe condition of divisibility for Gaussian channel. For one parameter family of n-mode Gaussian channel and give explicit condition for its P-divisibility and CP-divisibility. We also note that our method of detecting P-divisibility and CP-divisibility for n-mode Gaussian channels is easier and more general than the method was given by [Gerardo Adesso et.al PhysRevLett.118.050401] which only deals with 1-mode Gaussian channels with the same assumptions.

Phase transitions in quantum walks

Name: Mikhail Skopenkov

Institution: King Abdullah University of Science and Technology

Abstract: Quantum walks, introduced by Richard Feynman, are archetypical for studying quantum algorithms. A one-dimensional quantum walk exhibits a phase transition: the wave function oscillates inside some region but exponentially decreases outside. The large-time asymptotic behavior at the transition point is described by the Airy function, as proved by Sunada and Tate in 2012. For the first time, we prove a uniform asymptotic formula in the whole domain and discover another type of phase transition, which also appears in many other models. We prove a general theorem producing uniform asymptotic formulae of this kind from certain conformal mappings.

This is joint work with M. Drmota, F. Kuyanov, and A. Ustinov.

Resurgent quantum gauge theories

Name: Stan Srednyak

Institution: Duke University

Abstract: Motivated by the needs of hadronic spectroscopy, we develop a resurgent approach to quantum gauge theories. This theory involves analysis of variational equations on manifolds in function spaces. These function spaces are spaces of sections of bundles on complex finite dimensional manifolds of infinite type. The finite dimensional manifolds are rigid, being determined by transcendental number fields inherent to the theory. The manifolds in question generalize curves of continuum genus and are tightly related to questions in holomorphic dynamics associated with classical and first quantized versions of the theory. The finite dimensional manifolds of infinite type are complexifications of spacetime and its configuration spaces, and encode dynamical singularities that arise in interacting quantum gauge fields in the course of dynamics intrinsic to bound states. We interpret quantum fields as functional pseudodifferential operators. The theory naturally includes theory of functional analogies of vector bundles on functional manifolds. This connection brings about a range of questions about submanifolds of classical function spaces such as the space of diffeomorphisms of various regularity and spaces of Riemannian metrics. Topological toy models of the theory point to functional versions of the theory of characteristic classes and to intersection theory on function manifolds. Holomorphic aspects of the theory are tightly related to certain questions in holomorphic dynamics, in particular, to resurgence theory. One of the results of our analysis is the formulation of a variational principle for functional bundles, that gives us consistent equations for bound states. Solutions to these equations are highly symmetric, in particular they are factorizable according to a functional version of an irregular Riemann Hilbert problem. Our results include interpretation of spectral numbers in terms of geometry of certain functional manifolds.

Geometric Reconstruction of Dark Energy in Modified Symmetric Teleparallel Gravity: A Mathematical Framework Beyond Riemannian Geometry

Name: Sanjeeda Sultana

Institution: Amity University, Kolkata

Abstract: In this work, we present a novel reconstruction of a dark energy model within the framework of modified symmetric teleparallel gravity, formulated beyond the standard Riemannian paradigm. By integrating entropy-based dark energy formulations with a geometrically generalized theory of gravity that allows for non-metricity Q, we propose a mathematically consistent framework capable of capturing the dynamics of late-time cosmic acceleration. The resulting model exhibits a rich parametric structure, with the equation of state (EoS) parameter and deceleration parameter showing pronounced sensitivity to both the initial conditions and the underlying parameter space. To ensure observational viability, we perform a comprehensive Markov Chain Monte Carlo (MCMC) analysis using combined cosmological datasets, yielding best-fit parameter values that are in excellent agreement with current observational constraints. The reconstructed cosmological evolution is further validated through an independent computation of the cosmic

age, reinforcing the internal consistency of the model. Geometrical diagnostics, including the evolution of the statefinder pairs (r, s) and (r, q), reveal that the model trajectories transit through the ΛCDM fixed point, affirming its concordance with standard cosmological behavior in the appropriate limits. In addition, a detailed examination of the classical energy conditions confirms the model's physical admissibility across a wide range of parameters. This study highlights the potential of non-metric geometric formulations as a fertile ground for advancing theoretical models of dark energy and provides a mathematically rigorous pathway for embedding cosmological phenomena within generalized differential geometric structures.

Cubic Oscillator : Geometric Approach and Zeros of Eigen-functions.

Name: Faouzi Thabet

Institution: Institut Supérieur d'Informatique de Medenine

Abstract: A big challenge in the asymptotic theory of $\mathcal{ODE}$ in complex domains (on a Riemann surface more generally) is to study Stokes graphs mutations under changes of parameters in a data space $\mathcal{D}$. In this talk, we treat the cubic polynomial case. We give a geometric approach to the cubic oscillator $(C.O)$ with three distinct turning points based on $\mathcal{D}/\mathcal{SG}$ correspondence. The existence of quantization conditions, depending on extra data in the potential is related to some particular critical graphs of the quadratic differential $A\,(z-a)\left(z^2-1\right)dz^2$, where A is a non vanishing complex number, and $a \in \mathbb{C} \setminus \{-1, 1\}$. We investigate this geometric approach in two levels : the first level is the study of an inverse spectral problem related to the $(C.O)$, while the second level is devoted to the description of the zeros locations of eigen-functions related to this oscillator. Our results may be considered as a positive answer to a conjecture due to C.M. Bender & al in the case of $(C.O)$.

Simulating Blood Flow Dynamics Across Planetary Gravity Variations Using Physics-Informed Neural Networks

Name: Rajat Tripathi

Institution: National Institute of Technology Jamshedpur (India)

Abstract: In this study, we have analyzed the effects of simulated gravity variations for different planets on blood flow using numerical and machine learning techniques. Although it has already been experimentally proven that the vascular resistance and cardiac output are affected by gravitational variations, proper mathematical modelling and simulation of blood flow under variable gravity conditions for different planets has not been done. The present study addresses this gap by investigating blood flow dynamics under Earth (1g), Mars (0.38g), Moon (0.16g), microgravity (0g), and hypergravity conditions (2g, 3g). A deep learning-based Physics-Informed Neural Network (PINN) is employed to solve the governing equations of blood flow under these diverse gravitational environments. The PINN model is validated against the Keller box method (KBM), showing minimal discrepancy across all gravity scenarios. Absolute error simulations demonstrate that higher numbers of hidden layers and neurons produce more accurate results

that closely match KBM output for each gravitational condition. Graphical representations of blood flow velocity and wall shear stress (WSS) are provided for different influencing parameters across the gravity spectrum. The cases of microgravity and hypergravity are discussed and simulated in detail. Simulation results reveal that planetary-level gravity variations significantly influence blood flow patterns, with microgravity conditions showing purely pressure-driven flow characteristics. Simulation results reveal that increased amplitudes of the pressure gradient enhance blood flow velocity, while an elevated threshold heart pulse frequency reduces it. The outcomes showcase the high precision of the PINN model across diverse gravitational conditions, offering valuable insights for space medicine and terrestrial applications involving altered gravitational environments.

Isometries and metric properties of quantum Wasserstein distances

Name: Dániel Virosztek

Institution: HUN-REN Alfréd Rényi Institute of Mathematics

Abstract: Although the theory of classical optimal transport has been playing an important role in mathematical physics (especially in fluid dynamics) and probability since the late 80s, concepts of optimal transportation in quantum mechanics have emerged only very recently. We briefly review the most relevant approaches and discuss a non-quadratic generalization of the quantum mechanical optimal transport problem introduced by De Palma and Trevisan, where quantum channels realize the transport. Relying on this general machinery, we introduce p-Wasserstein distances and divergences and study their fundamental geometric properties. Finally, we demonstrate that the quadratic quantum Wasserstein divergences are genuine metrics, and summarize our recent results on the isometries of the qubit state space with respect to Wasserstein distances induced by distinguished transport cost operators.

Solving physics equations using orthosymplectic reduction superalgebras

Name: Dwight Williams II

Institution: Morgan State University

Abstract: The orthosymplectic Lie superalgebras $\mathfrak{osp}(1|2)$ and $\mathfrak{osp}(2|2)$ are utilized in finding solutions to Dirac's equation and Maxwell's equations, respectively, through the implementation of reduction algebra techniques. Reduction algebras aid in the decomposition of an algebra's irreducible modules as modules over a subalgebra. We see examples and note a larger study of reduction algebras as quantum-type algebras. The talk is a presentation of work with Matthew Dorang and Jonas T. Hartwig.

Darcy-Forchheimer hybrid nanofluids flow with quadratic convection over a stretched tube

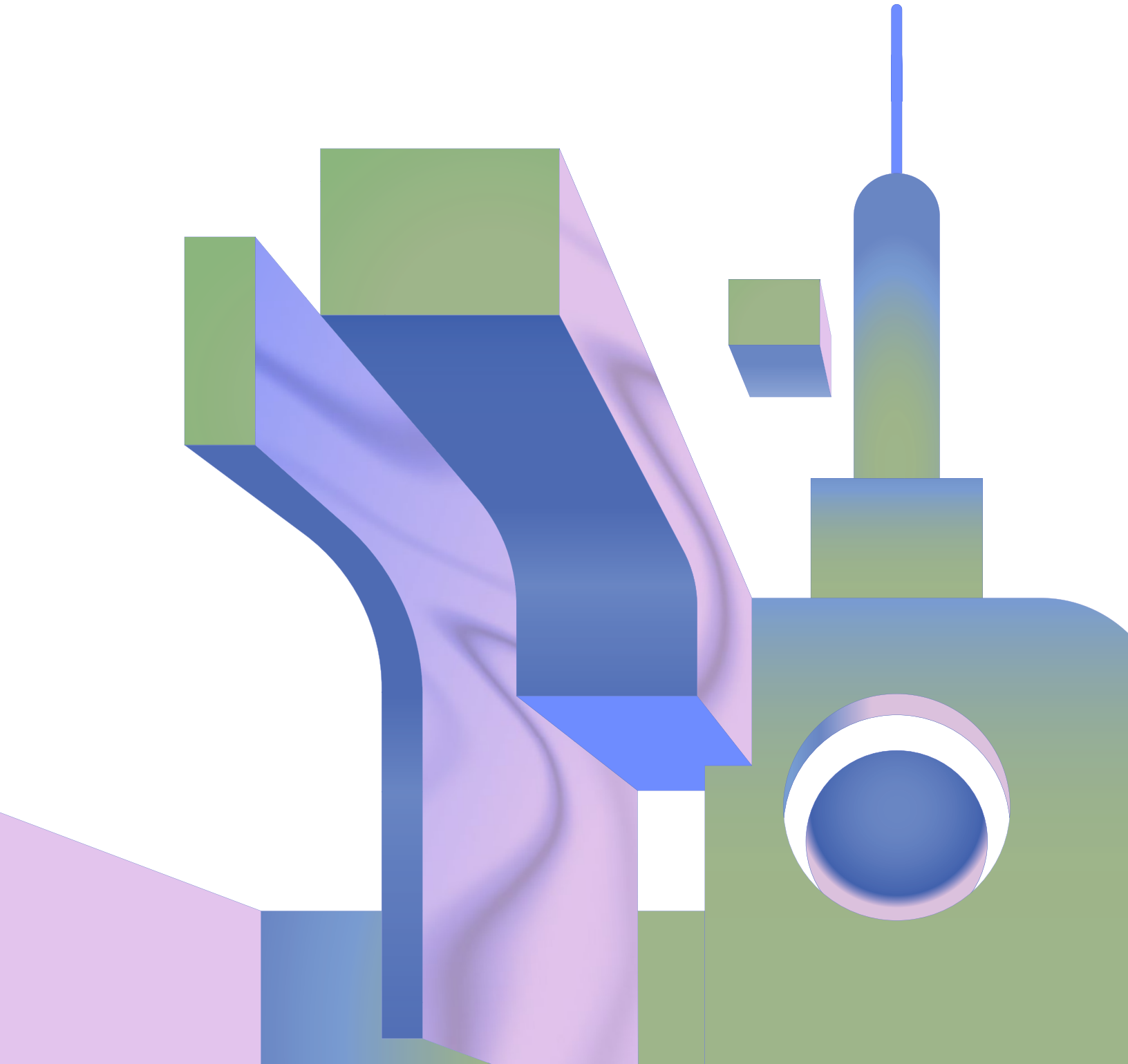
Name: Dr. Islam Zari

Institution: University of Peshawar

Abstract: The study of well-known Darcian fluidic streams and hybrid nanofluids is an essential need of nowadays researchers in regard to their exceptional heat transfer rates and implementations. The significance of hybrid nanofluids in controlling heat transmission cannot be overemphasized. Therefore, this article scrutinizes the Darcy Forchheimer flow of hybrid nanofluid toward a flexible tube. The flow rates near the surface of the cylinder are investigated by applying the DarcyForchheimer theory while examining the heat transfer rate, nonlinear convection expressions are used. The analysis also considers thermal radiation and chemical reactions. One of sophisticated numerical approach Runge-Kutta method (RK4) is selected for the proposed problem's solution. The main novelty of present research is to examine the characteristics of hybrid nanofluids in the context of heat transfer over an extending cylinder for the purposes of enhancement regarding thermal transference and inertial impacts. Results shows that hybrid-based nanofluid provides upsurges in solid volume fraction of nanoparticles accompanied by an enhancement in the heat transfer rate by 4.32%, 5.8%, and 14.46% individually. The outcomes witnessed that hybrid based proposed nanofluids increased thermal transportation processes more effectively than other nanofluids.

SHORT COMMUNICATIONS

SECTION 12–PROBABILITY



Multiscale random matrices and scale invariance in high dimensions

Name: Gustavo Didier

Institution: Tulane University

Abstract: Scale invariance is a striking property that emerges from scaling limits or the renormalization of many stochastic systems (cf. fractional Brownian motion, the critical Ising model, etc.). Scale invariance – and related notions of universality – are cutting-edge topics in the study of stochastic systems with several degrees of freedom, i.e., in high-dimensional probability theory. Furthermore, research on high-dimensional scale invariance impacts several fields of statistical application, including neuroscience, network traffic and machine learning, owing to its inherent connection with large data sets. In this talk, we show that the recently proposed framework of multiscale random matrices – particularly, wavelet random matrices – provides a natural renormalization-type setting for the study of high-dimensional, scale-invariant (fractal) dynamics.

On the Hamilton-Jacobi approach to mean-field spin glasses

Name: Victor Issa

Institution: ENS de Lyon

Abstract: Spin glasses, though originating in statistical physics as models of disordered magnetic systems, have had a remarkable influence across many scientific disciplines. Their key features—frustration, disorder, complex energy landscapes, and multiple metastable states—make them valuable metaphors and analytical tools in diverse fields. For mean-field spin glass models, it is known that the limit of the free energy can be written as the supremum of a functional, this is the celebrated Parisi formula. In this talk, we will discuss the links that exist between this formula and a certain Hamilton-Jacobi equation in Wasserstein space. Using those links, we will derive uniqueness results for maximizers of the Parisi formula for models with scalar and vector spins.

This is based on joint work with Hong-Bin Chen and Jean-Christophe Mourrat.

The smallest singular value of large random rectangular Toeplitz and circulant matrices

Name: Vladislav Kargin

Institution: Binghamton University

Abstract: Joint work with Alexei Onatski (University of Cambridge).

We consider rectangular Toeplitz and rectangular circulant random matrices built from an i.i.d. standard Gaussian sequence. When the dimensions grow proportionally (rows/columns converges to a constant in (0,1]), we prove that the smallest eigenvalue of the normalized sample covariance converges to zero in probability and in expectation. We further bound the convergence rate, showing it is faster than any polylogarithmic rate but slower than any polynomial rate.

For the circulant model we obtain an explicit upper bound depending only on the aspect ratio, implying that for sufficiently small aspect ratios the decay can be arbitrarily slow on a polynomial scale.

Integrable Multi-Species Long-Range Swap Models

Name: Eunghyun Lee

Institution: Nazarbayev University

Abstract: We introduce and study new integrable long-range swap models for multi-species interacting particle systems on the one-dimensional lattice. Particles are labeled by natural numbers, interpreted as species, with larger labels corresponding to stronger particles. Empty sites are treated as particles of species 0.

Each particle waits an independent exponential time of rate 1, and upon activation searches to the right for the nearest weaker particle. When such a weaker particle is found, the two particles exchange their positions, producing a long-range swap. The resulting dynamics define non-local interacting particle systems that extend classical exclusion-type processes.

A key feature of the model concerns how a particle treats sites occupied by particles of the same species during the search for a weaker particle. We construct two distinct integrable versions of the long-range swap dynamics. In the pushing version, a jumping particle treats particles of the same species as stronger, which leads to pushing-type dynamics among same-species particles and generalizes the single-species drop-push model. In the blocking version, particles of the same species are treated as weaker, so that no movement occurs when the nearest weaker particle to the right has the same label, thereby generalizing the usual single-species TASEP when interpreted as a short-range swap model.

Despite their different microscopic behaviors, both dynamics admit a unified algebraic description. Integrability is established through the analysis of two-particle interaction matrices satisfying Yang-Baxter-type relations, ensuring the consistency of the many-particle dynamics. Moreover, this construction yields a new continuous family of integrable long-range swap models, obtained via convex interpolation between the pushing and blocking dynamics.

We also provide explicit formulas for the transition probabilities of finite N-particle systems for arbitrary initial configurations.

Hitting Primes by Dice Rolls

Name: Yaakov Malinovsky

Institution: University of Maryland, Baltimore County

Abstract: Let $S = (d_1, d_2, d_3, \ldots)$ be an infinite sequence of rolls of independent fair dice. For an integer $k \geq 1$, let $L_k = L_k(S)$ be the smallest i so that there are k integers $j \leq i$ for which $\sum_{t=1}^{j} d_t$ is a prime. Therefore, L_k is the random variable whose value is the number of dice rolls required until the accumulated sum equals a prime k times. We first compute the expectation and the

variance of L_1 up to an additive error of less than 10^{-4} . The proof is simple, combining a basic dynamic programming algorithm with a quick Matlab computation and basic facts about the distribution of primes. Next, we show that for large k, the expected value of L_k is $(1+o(1))k \log_e k$, where the $o(1)$-term tends to zero as k tends to infinity.

Joint works with Noga Alon, Lucy Martinez, Doron Zeilberger

Transient analysis of a M/M/1 feedback Queueing System with Differentiated Vacations, Waiting Server, and Balking

Name: Suranga Sampath Miyanawathura Ihala Gamage

Institution: Wayamba University of Sri Lanka

Abstract: This paper investigates a single-server $M/M/1$ feedback queueing system incorporating differentiated server vacations, a waiting server mechanism, and customer balking behavior. Customer arrivals follow a Poisson process with rate λ, while service times are exponentially distributed with rate μ. Upon service completion, a customer either re-enters the system at the end of the queue with probability p or departs permanently with probability q, where $p + q = 1$, thereby introducing a feedback structure that captures repeat service requirements.

After the completion of a busy period, the server does not immediately take a vacation but instead remains idle for an exponentially distributed waiting time with rate ζ. If no arrivals occur during this period, the server initiates a type-I vacation, returning immediately once at least one customer is detected. However, if the system is still empty upon return, the server subsequently takes a shorter type-II vacation. The duration of type-I and type-II vacations are assumed to be exponentially distributed with parameters γ_1 and γ_2, respectively. Customer admission behavior depends on the server's state: arriving customers always join the queue when the server is busy, whereas during server vacations they join with probability β or balk with probability $1 - \beta$.

Using probability generating function techniques and Laplace transform methods, explicit expressions for the system size distribution and several key transient performance measures are derived. The analytical results provide insight into the effects of feedback, vacation differentiation, and balking on system congestion and delay characteristics. The model is applicable to practical service systems such as communication networks, call centers, and healthcare operations, where repeated service, server unavailability, and customer impatience play a significant role.

Solution of stochastic Beltrami equation with one and with several complex variables

Name: Andrej Srakar

Institution: University of Ljubljana

Abstract: Beltrami differential equation plays an important role in different areas of mathematics. Let D be a domain in the complex plane $\mathbb{C}$, and let $\mu : D \to \mathbb{C}$ be a measurable function with $|\mu(z)| < 1$ a.e. Beltrami equation is a complex partial differential equation of the form $f_{\overline{z}} = \mu(z) f_z$. Conditions for the existence and uniqueness of solutions for the Beltrami equation are expressed in terms of maximal dilatation and bounded and final mean oscillation. We introduce a stochastic element in the Beltrami equation using stochastic processes with bounded mean oscillation and solve the equation with one complex variable using rough path techniques and local monodromy representations. For solution with several complex variables we refer to presently developing area of holomorphic differential geometry and study the properties and value distribution of our differential operator in $\mathbb{C}^n$. Stochastic differential equations with (one or several) complex variables are a large and important void in the literature in probability theory and mathematics in general and we provide an important research step in this area. We discuss extensions to Painlevé and Schwartzian stochastic equations.

Probabilistic Nontrivial Solutions to the Equation $X^n = Y^n + Z^n$

Name: Jordan Stoyanov

Institution: Bulgarian Academy of Sciences

Abstract:

Probabilistic Nontrivial Solutions to the Equation $X^n = Y^n + Z^n$

Jordan M. Stoyanov
Bulgarian Academy of Sciences, Sofia, Bulgaria

For an arbitrary random variable X with finite all moments and a natural n, we construct random variables Y and Z such that $X = Y + Z$ and derive a 'Fermat-type' equation, $X^n = Y^n + Z^n$. Notably, we prove that both Y^n and Z^n satisfy the classical Carleman's condition, ensuring that they are moment-determinate. Importantly, these decompositions hold true universally, regardless of whether X and X^n are moment-determinate. It is unusual to see a moment-indeterminate random variable expressed as a sum of two moment-determinate variables. As a consequence we derive another nontrivial statement telling that a non-analytic characteristic function can be represented as a convex mixture of quasi-analytic functions.

These decompositions constitute the key results intended for presentation at the ICM – 2026. Our results encompass both the Hamburger case, where X is on the entire real line, and the Stieltjes case, where X is confined to the positive half-line. While it is easier to work with moment-determinate X or X^n, our research provide new results revealing unusual properties of moment-indeterminate variables. The results are illustrated by examples involving moment-indeterminate powers of random variables that follow normal, exponential, or logistic distributions.

Our results are novel, nontrivial, and essential for understanding deep properties of random variables in terms of their moments and associated characteristic functions.

This work is joint with Gwo Dong Lin (Academia Sinica, Taipei, Taiwan, RoC).

Stochastic currents of fractional Brownian motion: existence and regularity

Name: Herry Suryawan

Institution: Sanata Dharma University

Abstract: By using white noise analysis, we study the integral kernel $\xi(x)$, $x \in \mathbb{R}^d$, of stochastic currents corresponding to fractional Brownian motion with Hurst parameter $H \in (0,1)$. For $x \in \mathbb{R}^d \backslash \{0\}$ and $d \geq 1$ we show that the kernel $\xi(x)$ is well-defined as a Hida distribution for all $H \in (0,1)$. For $x = 0$ and $d = 1$, $\xi(0)$ is a Hida distribution for all $H \in (0,1)$. For $d \geq 2$, then $\xi(0)$ is a Hida distribution only for $H \in (0, 1/d)$. For $d = 1$, $x \neq 0$, and $H \in (0,1)$, we show that $\xi(x) \in \mathcal{G}'$, the space of regular generalized functions. Elements of the space $\mathcal{G}'$ and elements from the negative Sobolev-Watanabe distribution spaces share the property that partial sums of their chaos decomposition are square integrable functions. More precisely, we show that $\xi(x) \in \mathcal{G}_{-s} \subset \mathcal{G}'$ for $x \neq 0$, $H \in (0,1)$, and all $s > 0$.

Comparing Classical and Path Coupling Bounds in Finite-State Markov Chains: A Graph-Coloring Case Study

Name: Iz Tecúm

Institution: Columbia University

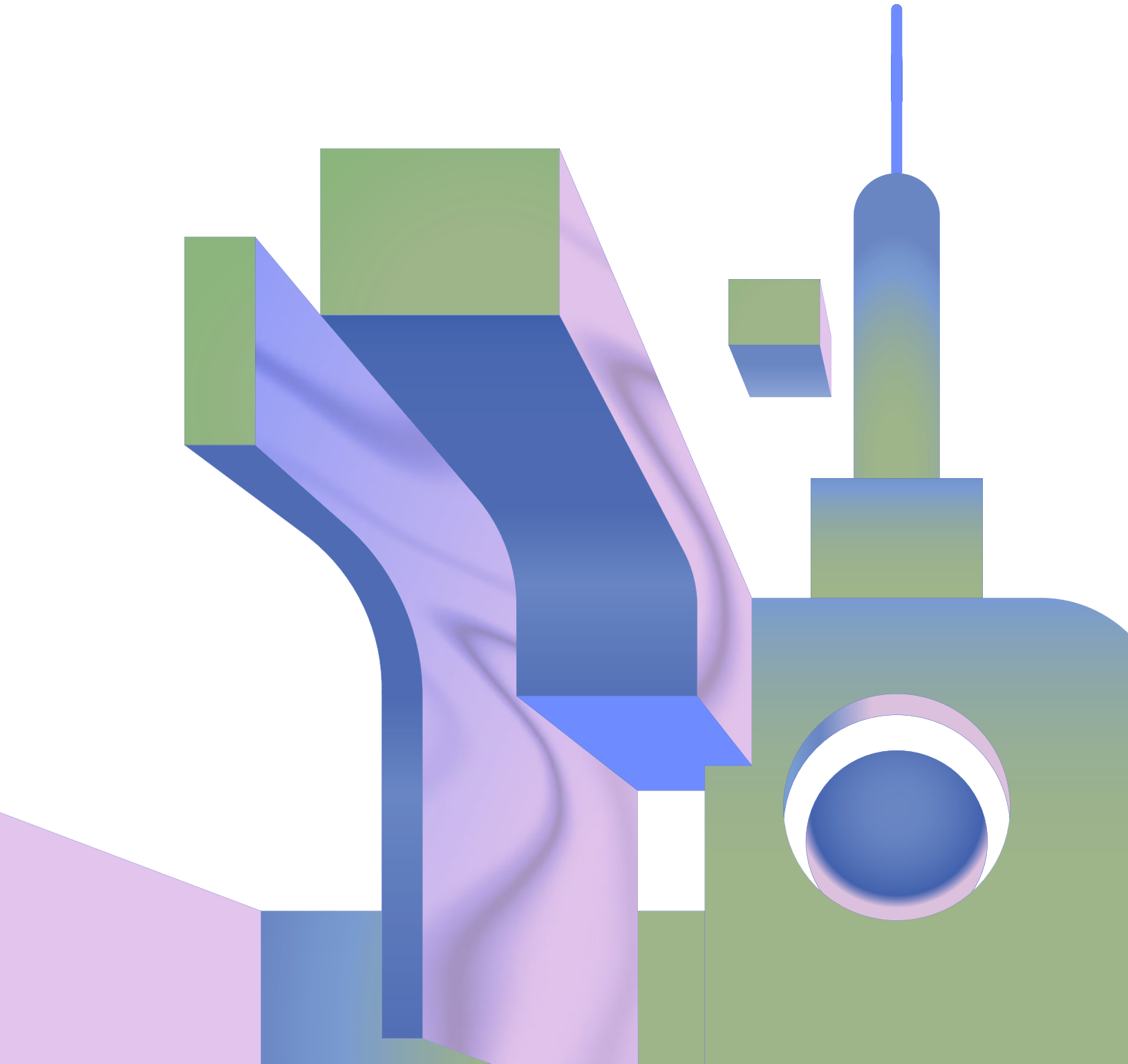
Abstract: Bounding the convergence rate of Markov-chain Monte-Carlo (MCMC) samplers is central to probabilistic computation. Two popular techniques are (i) classical coupling, which constructs a joint process that coalesces, and (ii) path coupling, which verifies a one-step contraction in a chosen metric and lifts it to the whole state space. Quantitative head-to-head comparisons on the "same" chain are rare. This work studies single-site Glauber dynamics for q-colourings of the four-vertex cycle~C_4 ($q \geq 3$). We provide

$$\mathbf{E}[\tau_{\mathrm{cl}}] \leq 6(q-1), \qquad \mathbf{E}[\tau_{\mathrm{pc}}] \leq 2(q-1),$$

where the latter follows from a Hamming path-coupling contraction $\alpha(q) = 1 - \frac{1}{2(q-1)}$. Consequently $t_{\mathrm{mix}}^{\mathrm{pc}}(\varepsilon) < t_{\mathrm{mix}}^{\mathrm{cl}}(\varepsilon)$ for all $q \geq 3$ and $\varepsilon \in (0, 1/2]$. Exact enumeration and 10^3 Monte-Carlo trajectories per start state corroborate the linear dependence on $(q-1)$ and display a constant-factor gap consistent with theory. The four-cycle thus serves as a transparent test-bed showing when path coupling outperforms classical coupling and suggesting metric choices for larger colouring chains.

SHORT COMMUNICATIONS

SECTION 13–COMBINATORICS



The Rest of the Tilings of the Sphere by Regular Spherical Polygons

Name: Colin Adams

Institution: Williams College

Abstract: Determining the set of tilings of the sphere by regular polygons is a problem that dates back to the time of the ancient Greeks. For edge-to-edge tilings, it was completed in 1967. Here, we discuss recent results that finish the problem by determining all non-edge-to-edge tilings of the sphere by regular polygons. This is joint work with Cameron Edgar, Peter Hollander and Liza Jacoby.

A Generalization of H-magic labeling and Its Structural Properties

Name: Yeva Fadhilah Ashari

Institution: Diponegoro University

Abstract: In this talk, we introduce a generalization of H-magic labeling, called (F, H)-sim-magic labeling, that is motivated by the notion of totally magic labeling. For a given graph H, a simple graph G admits an H-covering if every edge in $E(G)$ belongs to a subgraph of G isomorphic to H. An H-magic labeling is a bijection $f : V(G) \cup E(G) \to \{1, 2, \ldots, |V(G)| + |E(G)|\}$ such that for every subgraph H' of G isomorphic to H, $wt_f(H') = \sum_{v \in V(H')} f(v) + \sum_{e \in E(H')} f(e)$ is constant. Given two non-isomorphic graphs F and H, let G be a graph admitting both an F-covering and H-covering. In this case, the labeling f of G is called an (F, H)-sim-magic labeling if f is simultaneously F-magic and H-magic.

We characterize graphs admitting a (K_2, H)-magic labeling in terms of forbidden subgraphs when H is a path, cycle, or star. Furthermore, we present constructions of (F, H)-sim-magic labelings for several graph operations, including join and Cartesian products. In particular, using a super edge-magic labeling of G, we determine a sufficient condition for the join $G + H$ to be $(K_2 + H, 2K_2 + H)$-sim-magic for two connected graphs G and H. We further construct a (C_{2x}, C_{2y})-sim-supermagic labeling of the Cartesian product graph $T \times K_2$ from a $(a, 2)$-edge-antimagic vertex labeling of a tree T, for some $3 \leq x, y \leq |V(T)| - 1$. This construction establishes a connection between an α-labeling of a tree T and a (C_4, C_6)-sim-magic labeling of the Cartesian product $T \times K_2$. These results enlarge the classes of graphs known to be C_m-magic for $m \geq 3$ and provide a useful tool for studying H-magic labeling.

The strong 3-rainbow index of graphs

Name: Zata Yumni Awanis

Institution: National Research and Innovation Agency (BRIN)

Abstract: The concept of a strong 3-rainbow index, first introduced by Awanis and Salman (2022), is a refinement of the classical 3-rainbow index that imposes a stronger connectivity requirement. Specifically, it requires that every set of three vertices in a connected graph be connected by

a rainbow Steiner tree of minimum size. This concept is motivated by applications in secure and efficient communication networks and leads to computationally challenging problems, as determining the strong 3-rainbow index is NP-hard in general.

In this work, we establish the exact values of the strong 3-rainbow index for several classes of graphs, as well as for graphs obtained through certain graph operations. Moreover, we characterize graphs for which this parameter attains certain values. These results contribute to a deeper understanding of strong 3-rainbow coloring and its relationship with graph structure and complexity. Furthermore, they provide a solid foundation for future investigations into generalized strong k-rainbow indices and their potential applications in the design of secure and efficient communication networks.

Optimal Radio k-Labelings of Graphs: Distance-Constrained Labelings

Name: Devsi Bantva

Institution: Lukhdhirji Engineering College, Morbi-363642, Gujarat (India)

Abstract: Let $G = (V, E)$ be a simple, finite, connected graph. A radio k-labeling of G is a function $f : V(G) \to \{0, 1, 2, \ldots\}$ such that $|f(u) - f(v)| \geq k + 1 - d(u, v)$ holds for every pair of distinct vertices u and v of G, where k is a positive integer and $d(u, v)$ denotes the distance between two vertices u and v in G. The span of a labeling function f is defined as $span(f) = \max\{|f(u) - f(v)| : u, v \in V(G)\}$. The radio k-labeling number, denoted by $rn_k(G)$, is defined as $rn_k(G) := \min_f\{span(f)\}$, where the minimum taken over all radio k-labelings f of G. A radio k-labeling f of G is called optimal if $span(f) = rn_k(G)$. This labeling problem is distance-constrained graph labeling as it assigns nonnegative integers (called colors or labels) to the vertices of G, with the assignment constrained by the distances between vertices. This graph labeling problem arises from the radio frequency assignment problem. The radio k-labeling problem generalizes several well-known graph labeling problems. For $k = 1$, radio 1-labeling is famous proper vertex coloring and $rn_1(G) = \chi(G)$. For $k = 2$, radio 2-labeling is distance two labeling and $rn_2(G) = \lambda(G)$. For $k = d - 1$, where d is the diameter of graph G, it is known as radio antipodal labeling, and $rn_{(d-1)}(G) = an(G)$, the radio antipodal number. Finally, for $k = d$, radio d-labeling is called radio labeling and $rn_d(G) = rn(G)$, the radio number. The radio k-labeling problem is considered one of the tough graph labeling problems, and the optimal labeling is investigated for very few graph classes. In this work, we discuss optimal distance two labeling and radio antipodal labeling of the Cartesian product of a tree and a complete graph. We determine the λ-number and the radio antipodal number for the Cartesian product of certain trees with a complete graph. We extend our study to radio labeling of graphs. We discuss optimal radio labeling of trees. We present an improved lower bound for the radio number of trees and a necessary and sufficient condition to achieve the lower bound. Using these results, we determined the radio number for several classes of trees. We discuss optimal radio labelings for the Cartesian product of trees with some other graphs. In summary, this work presents our recent progress on distance-constrained labelings, exploring both variations in the parameter k and across different classes of graphs.

Edge Compound Constructions and Ramsey Minimality for Disjoint Stars

Name: Edy Tri Baskoro

Institution: Institut Teknologi Bandung

Abstract: A graph F is *Ramsey* (G, H)*-minimal* if every red-blue edge coloring of F contains a red copy of G or a blue copy of H, yet this property is lost upon deleting any single edge. Such graphs represent extremal witnesses of unavoidable structure in Ramsey theory.

We develop a unified construction of Ramsey $(nK_{1,2}, H)$-minimal graphs for arbitrary $n \geq 1$ and any 2-connected graph H. The approach is based on an edge – compound method, where edges of a backbone graph are replaced by suitable Ramsey blocks. An orientation-based admissibility condition on the backbone provides a transparent criterion for both the Ramsey property and minimality.

This framework yields infinite families of Ramsey minimal graphs, encompassing cycles and generalized theta graphs, and subsumes several earlier constructions within a single structural perspective. The results illuminate how local coloring constraints and global graph structure interact to force disjoint stars, offering new insight into the fine structure underlying Ramsey minimality.

Equivalence of labeled graphs and lattices

Name: Ashok Bhavale

Institution: PES Modern College of Arts, Science and Commerce (Autonomous), Pune 5

Abstract: In 1973, Harary and Palmer posed the problem of enumeration of labeled graphs on $n \geq 1$ unisolated vertices and $l \geq 0$ edges. In 1997, Bender et al. obtained a recurrence relation representing the sequence $A054548$(OEIS) of labeled graphs on $n \geq 0$ unisolated vertices containing $q \geq \frac{n}{2}$ edges. In 2020, Bhavale and Waphare obtained a recurrence relation representing the sequence of fundamental basic blocks on $n \geq 0$ comparable reducible elements, having nullity $l \geq \lfloor \frac{n+1}{2} \rfloor$. In this paper, we prove the equivalence of these two sequences. We also provide an edge labeling for a given vertex labeled finite simple graph.

An infinite family of hyperovals in polar spaces of rank 3

Name: Bart De Bruyn

Institution: Ghent University

Abstract: The study of finite projective planes started at the end of the 19th century. The original believe that all such planes were Desarguesian turned out to be false. Hall's coordinatization method laid the foundation for constructing nondesarguesian planes from various algebraic structures such as quasifields, semifields, etc. These algebraic connections turned out to be an impetus in their investigation. Ever since Segre's seminal classification result on ovals in odd

order Desarguesian planes, also various substructures of finite planes, such as (hyper)ovals and unitals, were investigated along with their ample applications to other areas such as graph, design and coding theory. There is renewed interest in these substructures, because of their various applications in Ramsey theory, even leading to the solution of a decades-old problem of Erdős by Mattheus and Verstraete. Hyperovals, being sets of points meeting each line in either 0 or 2 points, also played a pivotal role in the computer-assisted nonexistence proof of the projective plane of order 10.

Various generalizations to other structures have been considered, such as to polar spaces which are central objects in Tits' theory of buildings. Buekenhout and Hubaut showed that hyperovals in polar spaces are related to extended generalized quadrangles, which provide several geometric models on which classical and sporadic groups act. Although many constructions already existed in the rank 2 case, the situation was quite different for polar spaces of rank 3, where only a handful of small "sporadic" examples were known (being found by a computer backtrack search).

It is only very recently [1] that the first infinite family of hyperovals in polar spaces of rank 3 was found, more specifically in the Klein quadric by using ovoids of symplectic spaces, resulting in examples that are related to orthogonal and Suzuki groups. These hyperovals are the only known examples of a (potentially) larger family of hyperovals in polar spaces of rank 3. We will discuss this infinite family of hyperovals, their isomorphism problem, and the (ongoing) progress made towards finding additional examples in this larger family.

Bibliography

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Proof of Convergence of a Laplace Expansion Algorithm for Calculating Recursions Satisfied by a Family of Determinants

Name: Russell Hendel

Institution: Towson University

Abstract: In Evan and Hendel's recent proof of an outstanding conjecture on the resistance distances of a family of linear 3-trees, a key technique in the proof was calculating the recursion satisfied by a family of determinants. The underlying algorithm employed to prove the conjecture converged (i.e. terminated) in the particular case studied, and the paper presented an open question on when such a procedure converges in general. The purpose of this paper is to begin to answer this open question by proving convergence of the procedure for an arbitrary family of determinants of banded, square, Toeplitz matrices. Moreover, the algorithm in this paper modifies the algorithm of Evans and Hendel, improving various aspects of the procedure.

Vertex-pancyclism in edge-colored complete graphs with restrictions in color transitions

Name: Felipe Hernández Lorenzana

Institution: Faculty of Sciences, National Autonomous University of Mexico (UNAM)

Abstract: Let H be a graph possibly with loops and G a simple graph. We say that G is an H-colored graph whenever every edge of G has assigned a vertex of H as a color. A cycle C in an H-colored graph G is an H-cycle if and only if the colors of consecutive edges in C are adjacent vertices in H, including the last and first edges of C. An H-colored graph G is said to be vertex H-pancyclic if every vertex of G is contained in an H-cycle of length l for every l in $\{3, \ldots, |V(G)|\}$.

In this talk, we show sufficient conditions for an H-colored complete graph G to be vertex H-pancyclic.

Spectral w-variation of graphs in two places

Name: Debajit kalita

Institution: Tezpur University

Abstract: This work is based on the article [Parameswar Basumatary, Debajit Kalita, Spectral w-variation of trees in two places, Linear Algebra and Its Applications, 718, (2025) 81-103]. A weighted graph G is said to have spectral w-variation in two places if adding an edge of positive weight w between two nonadjacent vertices of G, or increasing the weight of an existing edge by w, results in an increase of two Laplacian eigenvalues of G equally by w while keeping the other eigenvalues unchanged. We characterize the weighted graphs that have spectral w-variation in two places. It is proved that spectral w-variation in two places does not occur by increasing the weight of an existing edge in any weighted tree. Primarily, we determine the weighted trees that have spectral w-variation in two places. As an application, we supply constructions of few classes of weighted trees with weights from the interval $(0, 1)$ in which spectral w-variation occurs in two places.

On graphs with maximal local distance antimagic chromatic number

Name: Tita Khalis

Institution: UIN Syarif Hidayatullah Jakarta

Abstract: Let G be a graph of order p without isolated vertices. A bijection $f : V(G) \to \{1, 2, 3, \ldots, p\}$ is called a local distance antimagic labeling, if $w_f(u) \neq w_f(v)$ for every edge uv of G, where $w_f(u) = \sum_{x \epsilon N(u)} f(x)$. The local distance antimagic chromatic number $\chi_{lda}(G)$ is defined to be the minimum number of colors taken over all colorings of G induced by local distance antimagic labelings of G. In this paper, we present a sufficient condition for a graph G to have $\chi_{lda}(G) = |V(G)|$ and determine some family of graphs G whose $\chi_{lda}(G) = |V(G)|$.

Number families emerging from the lengths of Bernstein-based words

Name: Irem Kucukoglu

Institution: Alanya Alaaddin Keykubat University

Abstract: The field of combinatorics on words, which is a new field of discrete mathematics, focuses on the study of formal languages, words and strings formed by letters or symbols. In this context, Kucukoglu and Simsek defined Bernstein-based words and investigated their properties by algebraic, combinatorial and algorithmic approaches in their recent paper [Construction of Bernstein-based words and their patterns, To appear in Math. Methods Appl. Sci., 2025].

In this presentation, Bernstein-based words and interesting number families emerging from their lengths will be handled. Moreover, some results on computational algorithms for generating special words and their colorful patterns will be presented. It will be also shown how the special words can be analyzed by aid of functions encoding their lengths to the coefficients of a formal power series. Eventually, this talk will end by a brief discussion on the generated special words and their potential applications in computational science and engineering.

Isospectrality of Geometries over Finite Rings

Name: Yishai Levenberg

Institution: Hebrew University of Jerusalem

Abstract: Let R be a Dedekind domain and $\mathfrak{p} \lhd R$ a prime ideal of finite index p. For any $r \in \mathbb{N}$, define $\mathcal{O}_r := R/\mathfrak{p}^r$, and let $\mathbb{P}^d_{\text{fr}}(\mathcal{O}_r)$ denote the flag complex on all free sub-modules of $\mathcal{O}_r^{d+1}$ with incidence relation. Two key examples to keep in mind are $\mathbb{Z}/\langle p^r\rangle$ and $\mathbb{F}_p[t]/\langle t^r\rangle$. The case $r = 1$ is the classical projective finite geometry $\mathbb{P}^d(\mathbb{F}_p)$, which appears as the local vista of vertices in the Bruhat-Tits buildings of $PGL_d(\mathbb{Q}_p)$ and $PGL_d(\mathbb{F}_p((t)))$. The complex $\mathbb{P}^d_{\text{fr}}(\mathcal{O}_r)$ arises naturally when considering geodesic r-spheres in these buildings.

Let $\mathbb{P}^d_{m,n}(\mathcal{O}_r)$ be the sub-graph induced by the free sub-modules of rank m and n. In the first part of the talk we analyze the adjacency matrix of the square-graph of $\mathbb{P}^d_{1,n}(\mathcal{O}_r)$, and discover a structure that allows us to calculate their eigenvalues and, in particular, their spectral expansion. These eigenvalues are independent of the specific choice of $\{R, \mathfrak{p}\}$ and depend only on $\{p, r, d\}$. Hence, for example, $\mathbb{P}^d_{1,n}(\mathbb{Z}/\langle p^r\rangle)$ and $\mathbb{P}^d_{1,n}(\mathbb{F}_p[t]/\langle t^r\rangle)$ are isospectral, and their square-graphs are even isomorphic. However, are the graphs themselves isomorphic?

In the second part of the talk we discuss this question, and show how to distinguish between two such graphs using their automorphism groups. We prove a generalization of the Fundamental Theorem of Projective Geometry and find the automorphism group of $\mathbb{P}^d_{\text{fr}}(\mathcal{O}_r)$ and $\mathbb{P}^d_{m,n}(\mathcal{O}_r)$. We then use size considerations of the automorphism groups to show that $\mathbb{P}^d_{\text{fr}}(\mathbb{Z}/\langle p^r\rangle)$ and $\mathbb{P}^d_{\text{fr}}(\mathbb{F}_p[t]/\langle t^r\rangle)$ are not isomorphic (except for the case $p = r = 2$, in which additional work is required).

Hamiltonicity in directed Toeplitz graphs with $s_1 = 1$ and $s_2 = 3$

Name: Shabnam Malik

Institution: Forman Christian College (A Chartered University) Lahore

Abstract: A directed Toeplitz graph $T_n\langle s_1, \ldots, s_p; t_1, \ldots, t_q\rangle$ with vertices $1, 2, \ldots, n$, where the edge (i, j) occurs if and only if $j - i = s_l$ or $i - j = t_k$ for some $1 \leq l \leq p$ and $1 \leq k \leq q$, is a digraph whose adjacency matrix is a Toeplitz matrix. In this talk, I discuss the hamiltonicity in directed Toeplitz graphs with $s_1 = 1$, $s_2 = 3$ and $s_3 \leq 7$.

Strong Chromatic Index of Some Graphs

Name: Analen Malnegro

Institution: Ateneo de Davao University

Abstract: An edge-coloring of a graph G is an assignment of colors to the edges of G, with one color assigned to each edge. If adjacent edges are assigned distinct colors, then the edge-coloring is said to be a proper edge-coloring. A strong edge-coloring of a graph G is a proper edge-coloring in which edges at distance at most 2 receive distinct colors. The minimum number of colors required for a strong edge-coloring of a graph G is called the strong chromatic index, denoted by $\chi'_s(G)$. In this paper, the authors investigate the strong chromatic index of certain special graphs and of the join of two graphs.

Almost Bipartite non-König-Egerváry Graphs

Name: Eugen Mandrescu

Institution: Holon Institute of Technology

Abstract: This abstract emphasizes structural properties of almost bipartite non-König – Egerváry graphs, focusing on the interplay between their unique odd cycle and several fundamental vertex sets. A graph is König – Egerváry if the sum of its independence number and matching number equals its order, while almost bipartite graphs are characterized by containing exactly one odd cycle. We show that for each almost bipartite non-König – Egerváry graph, every maximum matching necessarily saturates the maximum possible number of edges in its unique odd cycle. A set of vertices B is critical in the graph G =(V, E) if |B| - |N(B)| = max|X| - |N(X)| : X is a subset of V, where N(X) is the open neighborhood of X. We prove that for an almost bipartite non-König – Egerváry graph, its core (the intersection of all maximum independent sets) coincides with its kernel (the intersection of all critical independent sets), a property previously established for bipartite and unicyclic non-König – Egerváry graphs. In addition, we introduce the notions of corona (the union of all maximum independent sets) and diadem (the union of all critical independent sets). We derive a formula for the number of vertices whose removal transforms an almost bipartite non-König – Egerváry graph G into a König – Egerváry graph, showing that this number equals the difference |corona(G)| - |diadem(G)|. Finally, we show that this number equals the order of the graph G if and only if the graph itself is an odd cycle. These results extend the known structural theory of independent sets from bipartite and unicyclic graphs to a broader class of graphs.

Long paths need not minimize H-colorings among trees

Name: Emily McMillon

Institution: Rice University

Abstract: Given a graph G and a target graph H, an H-coloring of G is an adjacency-preserving vertex map from G to H. By appropriate choice of H, these colorings can express, for instance, the independent sets or proper vertex colorings of G.

Sidorenko proved that for any H, the n-vertex star admits at least as many H-colorings as any other n-vertex tree, but the minimization question remains open in general. For many graphs H, path graphs are among the trees with the fewest H-colorings, but work of Leontovich and subsequently Csikvari and Lin shows that there is a graph E_7 on seven vertices and a target graph H for which there are strictly fewer H-colorings of E_7 than of the path on seven vertices.

We introduce a new strategy for enumerating homomorphisms from path-like trees to highly symmetric target graphs that allows us to make the previous observations completely explicit and extend them to infinitely many n beyond $n = 7$. In particular, we exhibit a target graph H with the property that for each sufficiently large n, there is a tree E_n on n vertices that admits strictly fewer H-colorings than the path on n vertices.

Vertex energy for extended adjacency matrix of a graph and some newer bounds

Name: Sk. Md. Abu Nayeem

Institution: Aliah University

Abstract: The extended adjacency matrix of a graph G with n vertices is defined as a real symmetric $n \times n$ matrix $\mathcal{A}$, where the (i, j)-th entry of $\mathcal{A}$ is given by the arithmetic mean of the ratio of the degrees of vertices v_i and v_j and its reciprocal if v_i and v_j are adjacent, and zero otherwise. Specifically, for adjacent vertices v_i and v_j with degrees d_i and d_j, the entry is $\frac{1}{2}(\frac{d_i}{d_j} + \frac{d_j}{d_i})$. The extended energy of the graph is subsequently defined as the sum of the absolute values of the eigenvalues of this matrix.

In the present work, we introduce the concept of extended vertex energy as the diagonal elements of the matrix $|\mathcal{A}| = \left(\mathcal{A}^2\right)^{1/2} = Q|\Lambda|Q^T$, where $Q\Lambda Q^T$ is the spectral decomposition of $\mathcal{A}$. From there, we establish some new upper bounds of the extended energy of a graph involving order, size, largest, and smallest degree. We show that those are improvements of some existing bounds. Through direct manipulation, we obtain some more upper and lower bounds of the extended energy, which are either better or incomparable with the existing bounds. Finally, some improved bounds of the Nordhaus-Gaddum type are also presented.

A Coding - Theoretic Characterization of Intron Regions in DNA Sequences

Name: Elif Segah Oztas

Institution: Karamanoğlu Mehmetbey University

Abstract: DNA sequences consist of gene regions known as exons and introns. Exon regions are spliced and directly participate in protein synthesis, whereas intron regions are non-coding segments that are excluded from this process.

In our previous work, we introduced a novel coding-theoretic model for the mathematical representation of genomic regions and validated its effectiveness on a limited dataset. In the present study, we extend this model by proposing an improved version of the algorithm and by conducting a comprehensive evaluation on a significantly larger dataset. The proposed algorithm models DNA segments as algebraic codes and examines their structural parameters, with particular emphasis on error-correction properties.

Our results reveal that genomic regions corresponding to introns are consistently mapped to algebraic codes with zero error-correction capability. This outcome provides a mathematically precise criterion for distinguishing non-coding regions and demonstrates that algebraic invariants from coding theory offer a robust analytical tool for genomic classification.

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Combinatorial invariants derived from codes over algebraic structures

Name: Rameez Raja

Institution: National Institute of Technology Srinagar, Hazratbal, Srinagar-190006, Jammu and Kashmir, India

Abstract: Let $\lambda = (\lambda_1, \ldots, \lambda_r)$ be a partition of a positive integer n, where each λ_i is referred to as a part of λ. A finite Abelian p-group of rank r associated with this partition can be expressed as

$$G = \mathbb{Z}/p^{\lambda_1}\mathbb{Z} \oplus \cdots \oplus \mathbb{Z}/p^{\lambda_r}\mathbb{Z},$$

where p is a prime number.

Interestingly, the same partition λ, when viewed through the action of a permutation group on a simple graph, also encodes a numerical semigroup. From this perspective, we construct a specific lattice-based code $\mathcal{C}_\lambda$, which serves as a unifying structure connecting these algebraic and combinatorial objects namely, finite Abelian groups, numerical semigroups, and partitions.

A powerful combinatorial tool used in the representation theory of groups and algebras called as *standard Young tableaux* emerges naturally from the structure of $\mathcal{C}_\lambda$. While existing constructions of standard Young tableaux associated with numerical semigroups typically rely on the *gaps* of the semigroup, our approach offers a novel and more efficient method. In particular, we derive these tableaux using the *lengths of bit strings* of codewords from $\mathcal{C}_\lambda$, which provides a fresh

and structured way to encode combinatorial invariants associated with partitions, numerical semigroups and finite Abelian groups.

Classification of subsets of finite fields of characteristic 2 with respect its closedness

Name: Vadiraja Gopadi Ramachandra Bhatta

Institution: Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, India

Abstract: The r-value of a subset in a finite additive group quantifies its degree of closedness. Subsets of $\mathbb{F}_{2^n}$ were categorised using these values and cardinality. Additionally, we use values found in $\mathbb{F}_{2^{n-1}}$ to list the r-values of $\mathbb{F}_{2^n}$. Schure triples and sum-free sets can be investigated using these values.

Binary code generated by the hyperbolic quadrics of a symplectic polar space of even order

Name: Binod Kumar Sahoo

Institution: National Institute of Science Education and Research, Bhubaneswar, India

Abstract: Let V be a vector space of dimension $2n$, $n \geq 2$, defined over the finite field of order q and let f be a nondegenerate alternating bilinear form on V. Denote by $W(2n-1,q)$ the symplectic polar space of rank n associated with (V,f).

Suppose that q is even. A nonsingular quadric in PG$(2n-1,q)$ with quadratic form κ is called a quadric of $W(2n-1,q)$ if f equals the polarization f_κ of κ defined by $f_\kappa(\bar{v},\bar{w}) = \kappa(\bar{v}+\bar{w}) - \kappa(\bar{v}) - \kappa(\bar{w})$ for $\bar{v},\bar{w} \in V$. Under the action of the projective symplectic group PSp$(2n,q)$, the set of all quadrics of $W(2n-1,q)$ splits into two orbits: the set of all hyperbolic quadrics of $W(2n-1,q)$ and the set of all elliptic quadrics of $W(2n-1,q)$. Let $\mathcal{H}$ denote the binary code generated by the hyperbolic quadrics of $W(2n-1,q)$. It is known that $\mathcal{H}$ equals the binary code generated by the elliptic quadrics of $W(2n-1,q)$. In this talk, we characterize the codewords of minimum and maximum weights in $\mathcal{H}$ and its dual code $\mathcal{H}^\perp$.

This is a joint work with Devjyoti Das, Bart De Bruyn and N. S. Narasimha Sastry.

Enumeration of Domino Tilings of Certain Planar Regions on the Square Lattice

Name: Manjil Saikia

Institution: Ahmedabad University

Abstract: Over the years, combinatorialists have been interested in enumerating tilings of certain finite regions on the plane. For instance, the number of lozenge tilings of a regular hexagon on the triangular lattice is known due to the work of MacMahon, while the number of domino tilings of an Aztec Diamond on the square lattice is known due to the work of Elkies, Kuperberg, Larson, and Propp.

These two results have inspired mathematicians over the years to explore related questions and study more general regions on the plane. We continue this direction of study and prove several exact enumeration formulas for domino tilings of certain planar regions, which are generalizations of Aztec diamonds. In particular, we prove exact enumeration results for Double Aztec Rectangles and generating function results for quartered Aztec Diamonds. Our work generalizes several known results.

Dynamical notions along filters

Name: Md Moid Shaikh

Institution: Maharaja Manindra Chandra College

Abstract: H. Furstenberg and B. Weiss first applied dynamical systems (topological dynamics) in Ramsey Theory, starting the extremely fruitful use of ergodic methods in combinatorics, which has provided many fundamental results over the years. One of the reasons why these methods have been so successful is because, in many cases, dynamical descriptions of Ramsey-theoretical problems are simpler than the algebraic or combinatorial ones; in other cases, the dynamical notions that arise from the study of combinatorial problems are interesting enough to be studied for themselves. Later, starting with the work of V. Bergelson and N. Hindman, several ergodic notions found an equivalent characterization in terms of special kinds of ultrafilters: for example, central sets where related to minimimal idempotents. In recent years, several papers have faced the problem of localizing known dynamical notions and results: for example, dynamical and combinatorial results near 0 and near an idempotent. Patra studied the interplay between algebra and dynamics near zero and it has been extended to near idempotents. In 2009, O.Shuungula, Y. Zelenyuk, and Y. Zelenyuk introduced the notion of largeness along a filter which generalizes the notions of largeness near 0 and near an idempotent and many othere notions of largeness.

In this present work, we want to explore a setting that unifies and extends all those that have been developed so far, namely the notion of dynamics along a filter. We show that many classical definitions and properties of notions of large sets can be extended to dynamics along a filter. We study some basic properties of $\mathcal{F}$-syndetic, piecewise $\mathcal{F}$-syndetic, collectionwise $\mathcal{F}$-piecewise syndetic, $\mathcal{F}$-quasi central and $\mathcal{F}$-central sets and their relations with $\mathcal{F}$-uniformly recurrent points and ultrafilters. we provide some applications of our results to the partition regularity of nonlinear Diophantine equations along filters.

Between l and $l+2$: Cycles in 2-player Strong Ramsey Games

Name: Saksham Sharma

Institution: University of Cambridge

Abstract: Let the strong Ramsey game $R(K_n, H)$ be where two players P_1 and P_2, each acting as both attacker and defender, are alternately claiming previously unclaimed edges of a complete graph K_n on vertex set $[n] = \{1, 2, 3, ..., n\}$. The first player to claim a set of edges that contains a subgraph, isomorphic to a given target graph H, is said to win (otherwise the game may end in a draw). Bounded-time, strong Ramsey games are defined to be (DHT 2017 [**?**]; AGXY 2025 [**?**]) the game defined by the parameter

$$L(K_n, H) := \min\{T : \text{Player 1 can force a win by their } T\text{-th move}\}.$$

This work is focused on the cycled target graphs given by $H = C_\ell$. AGXY 2025 [**?**] showed that for each fixed $\ell \geq 3$ and all sufficiently large n,

$$L(K_n, C_\ell) \leq \ell + 2,$$

by first constructing a long path of length $\ell - 2$ whose endpoints cannot be mirrored by the opponent. It is natural to ask next: beyond the (trivial) lower bound $L(K_n, C_\ell) \geq \ell$, can a strategy be devised by player P_2 to further delay P_1's win, and if so, by how many moves? Our results provide an (additional-move) improvement in the case of triangles as the target graph, *i.e.*, for all $n \geq 4$,

$$L(K_n, C_3) \geq 4, \tag{1}$$

using the local-threat elimination strategy, whereby P_2 ensures to not let P_1 achieve the C_3 configuration in its third move. Depth-limited minimax is used for $(H, T) = (C_4, 5)$ to show that P_1 cannot force C_4 by their 5th move for $n \geq 18$, whereas P_1 can force a C_4 by their 6th move for all $n \geq 22$. Therefore,

$$L(K_n, C_4) = 6 \qquad (n \geq 22) \tag{2}$$

Similarly, for $(H, T) = (C_5, 6)$ and $(C_5, 7)$, P_1 cannot force C_5 by their 6th move for any $n \geq 22$, but can force C_5 by their 7th move for all $n \geq 26$, thus,

$$L(K_n, C_5) = 7 \qquad (n \geq 26),$$

Taken together with the explicit upper bound $L(K_n, C_\ell) \leq \ell + 2$ for fixed ℓ and all sufficiently large n, these findings motivate the refined conjecture that, among cycles with $\ell \geq 4$, $L(K_n, C_\ell) = \ell + 2$ and all sufficiently large n. It also answers our question as to whether P_2 can delay P_1's win: for $\ell = 5$ with sufficiently large n, $L(K_n, C_\ell) \neq \ell + 1$, suggests that P_2 can delay P_1's win by two moves more than the trivial lower bound.

Moving and stacking squares for greater visibility

Name: Milos Stojakovic

Institution: University of Novi Sad

Abstract: We consider unit square symbols that need to be placed at specified y-coordinates. Our hope is to optimize the drawing order of the symbols as well as their x-displacement, constrained within a rectangular container, to maximize the minimum visible perimeter over all squares.

If the container has width and height at most 2, there is a point that stabs all squares. In this case, we prove that a staircase layout is arbitrarily close to optimality and can be computed in $O(n \log n)$ time. If the width is at most 2, there is a vertical line that stabs all squares, and in this case we give a 2-approximation algorithm (assuming fixed container height) that runs in $O(n \log n)$ time. As a minimum visible perimeter of 2 is always trivially achievable, we measure this approximation with respect to the visible perimeter exceeding 2. We show that, despite its simplicity, the algorithm gives asymptotically optimal results for certain instances.

On Families of Graphs with Constant Modular Irregularity Strength

Name: Kiki Sugeng

Institution: Universitas Indonesia

Abstract: Let $G = (V, E)$ be a finite and connected graph with order n. An edge k-labeling $\phi : E \to \{1, 2, \ldots, k\}$ is called modular irregular labeling of a graph G if the weight function, $\sigma : V(G) \to \mathbb{Z}_n$, defined by a bijective $\sigma(u) = wt_\phi(u) = \sum_{uv \in E(G)} \phi(uv) \pmod n$ with $\mathbb{Z}_n$ is the group of integers modulo n. The function $\sigma(u)$ is called a modular weight of the vertex u. The modular irregularity strength of a graph G is a minimum number k such that the graph G has a modular irregular labeling. In this talk, we discuss several classes of graphs that have constant modular irregularity strength. Specifically, a family of graph that can be modified from complete graphs and multipartite graphs.

Some Cohen-Macaulay graphs arising from finite commutative rings

Name: Ashitha Tom

Institution: Deva Matha College, Kuravilangad, Kottayam, Kerala, India-686633

Abstract: The investigation of Cohen-Macaulay rings holds a significant place in commutative algebra. These rings possess unique characteristics that have led to numerous applications in algebraic geometry. Consequently, distinguishing between Cohen-Macaulay and non-Cohen-Macaulay graphs is of considerable importance. Determining whether a given ring is Cohen-Macaulay is generally challenging, partly due to the constraints of symbolic computation. Thus, discovering alternative characterizations of Cohen-Macaulayness remains an intriguing problem.

The construction of edge rings from graphs establishes a link between commutative algebra and graph theory. Let $G = (V, E)$ be a simple graph with $|V(G)| = n$. Consider the polynomial ring $S = \mathbb{K}[x_1, \ldots, x_n]$ in n variables over a field $\mathbb{K}$. The squarefree quadratic monomial ideal associated with G is given by

$$I(G) = \big(x_i x_j \mid \{i, j\} \in E(G)\big)$$

and is referred to as the *edge ideal* of G. The quotient ring $\mathbb{K}[G] = S/I(G)$ is then known as the *edge ring* of G. In 1990, Villareal demonstrated that if the edge ring $\mathbb{K}[G]$ is Cohen-Macaulay, then the graph G is Cohen-Macaulay over $\mathbb{K}$.

For a given commutative ring R, the total graph of R is defined as a simple graph where the vertex set consists of elements of R, and two distinct vertices x and y are adjacent if their sum $x + y$ is a zero-divisor in R. This presentation aims to give a characterization of the Cohen-Macaulay total graph. Such a classification provides a broad family of Cohen-Macaulay and non-Cohen-Macaulay graphs, leading to an extensive class of edge rings that are Cohen-Macaulay.

Properly colored pancyclicity in edge-colored multigraphs with given degrees

Name: Carlos Vilchis-Alfaro

Institution: School of Mathematical Sciences, Nankai University

Abstract: A c-edge-colored multigraph is a multigraph such that each edge is colored with one of the c available colors and no two parallel edges have the same color. A properly colored cycle is a cycle with no consecutive edges having the same color. In this talk, we will discuss sufficient color degree conditions for the existence of Hamiltonian cycle in edge-colored multigraphs, in which between any pair of vertices there are at most $c - 1$ parallel edges. Furthermore, we will discuss whether, under the same color degree conditions, it is possible to ensure that the graph is properly pancyclic, as Bondy's metaconjecture states.

Basic Properties of the Ranks of Tensors

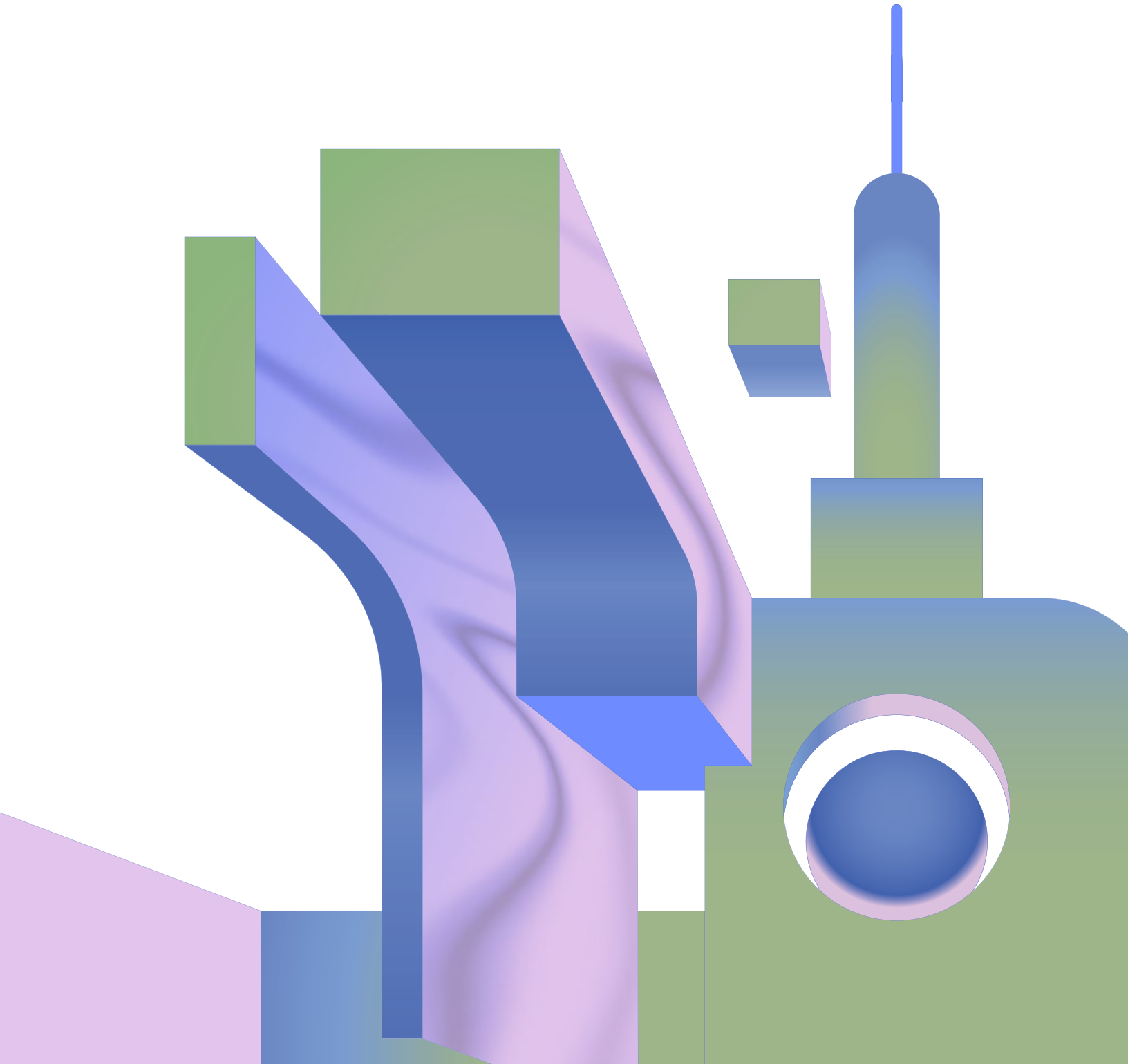
Name: Thomas Karam

Institution: Shanghai Jiao Tong University

Abstract: Tensors are higher-dimensional generalisations of matrices, and likewise the main notion of complexity on matrices - the rank - may be extended to tensors. For a long time the main such extension that was considered was the tensor rank. Throughout the past decade however, new notions have arisen. For instance, the slice rank originated in a reformulation by Tao in 2016 of the underlying tool in the breakthrough papers of Croot-Lev-Pach and Ellenberg-Gijswijt (both published in the Annals of Mathematics) on the cap-set problem. The partition rank was then defined one year later by Naslund in a similar context, and several other ranks have blossomed since then. It has now become clear that there is no single canonical notion of rank on tensors, and that the most useful notion instead depends on the application at hand. In sharp contrast with the matrix case, the properties of the ranks of tensors are still poorly understood. This is largely due to the lack of tools leading to lower or upper bounds on these ranks. We will present several basic properties of the ranks of tensors, including suitable generalisations of the following two facts: that a rank-k matrix must contain a k by k submatrix, and that a matrix has only one minimal-length decomposition up to a change of basis. As in many situations aimed at generalising a property of the rank of matrices to the ranks of tensors, the naive extension of the original property fails in a major way, yet still admits a rectification which is simultaneously not too complicated to state and in a spirit that is very close to that of the original property from the matrix case.

SHORT COMMUNICATIONS

SECTION 14– MATHEMATICS OF COMPUTER SCIENCE



On the E-base of Finite Lattices: Semidistributive, Modular, and Geometric Lattices

Name: Kira Adaricheva

Institution: Hofstra University

Abstract: Implicational bases (IBs) are a well-known representation of finite closure spaces and their closure lattices. Implications go by many names in a broad range of fields, e.g., attribute implications in Formal Concept Analysis, functional dependencies in database theory, or Horn clauses in propositional logic.

In lattice theory, implications translate into join covers, i.e., sets of relations $j \leq j_1 \vee \cdots \vee j_k$, $k \geq 1$, on the set of join-irreducible elements of a lattice.

The representation by an IB is not unique, and a closure space usually admits multiple IBs. Among these, the canonical base, the canonical direct base as well as the D-base aroused significant attention due to their structural and algorithmic properties.

The study of free lattices was influential in bringing up an IB of a new sort, which was called the E-base. It is a refinement of the D-base that, unlike the aforementioned IBs, does not always accurately represent its associated closure space. This leads to an intriguing question: for which classes of (closure) lattices do closure spaces have a valid E-base?

Finite lower bounded lattices are known to form such a class. In recent publication https://arxiv.org/abs/2502.04146, we prove that for semidistributive lattices, the E-base is both valid and minimum.

Among other results, we look into E-base in a few classes of closures spaces with the Exchange Axiom and we characterize those modular and geometric lattices that have valid E-base. Finally, we prove that any lattice is a sublattice of a lattice with valid E-base.

Permutation resemblance

Name: Li-An Chen

Institution: Boise State University

Abstract: Constructing bijection maps with strong resistance against differential attacks has been an important problem in cryptanalysis. More precisely, given a polynomial $f \in \mathbb{F}_q[x]$, the differential uniformity of f, δ_f, is defined by the maximum number of solutions in $\mathbb{F}_q$ to the equation $f(x+a) - f(x) = b$, where (a, b) run through all elements of $\mathbb{F}_q^* \times \mathbb{F}_q$. The lower the value of δ_f, the more resistant f is to differential attacks when used as an S-box. Functions with the optimal differential uniformity are called almost perfect nonlinear (APN) over $\mathbb{F}_{2^e}$ (where $\delta_f = 2$), and are called planar over finite fields of odd characteristics (where $\delta_f = 1$).

It is desirable that $f \in \mathbb{F}_q[x]$ not only has low differential uniformity but is also a permutation polynomial over $\mathbb{F}_q$, which means that the evaluation map $x \mapsto f(x)$ is a bijection. In general, such optimal functions are rare. For example, the existence of APN permutations over $\mathbb{F}_{2^e}$ for even $e \geq 8$ has remained open since 2010, following the celebrated discovery of the only known class of APN permutations over $\mathbb{F}_{2^6}$ by Browning et al.

Motivated by the problem of constructing permutation polynomials with low differential uniformity, we introduce the notion of permutation resemblance, which measures the distance of a function from being a bijection. For a function $x \mapsto f(x)$ over a finite group $(\mathcal{G}, +)$, the permutation resemblance of f, P-Res(f), is defined by the minimum cardinality of the image set of $f - h$, where h runs through all bijection maps over $\mathcal{G}$.

In this talk, we present our recent results on permutation resemblance. In particular, we formulate an integer program that computes P-Res(f), and rephrase the problem of finding a permutation polynomial with the lowest differential uniformity into an integer program. Moreover, we show that we can significantly reduce the problem size of the latter, while compromising the optimality, by computing the P-Res(f) first.

Hierarchical quasi-cyclic codes from Reed-Solomon and polynomial evaluation codes

Name: Kathryn Haymaker

Institution: Villanova University

Abstract: In this communication, we introduce a family of algebraically constructed hierarchical quasi-cyclic codes. These codes are built from Reed-Solomon and polynomial evaluation codes using a 1964 construction of superimposed codes by Kautz and Singleton. Using a novel ordering of the codewords and evaluation points, we show both the number of levels in the hierarchy and the index of these q-ary-derived codes are determined by the field size. We compute explicit code parameters and properties as well as some additional bounds on parameters such as rank and distance. In particular, starting with Reed-Solomon codes of dimension two yields hierarchical quasi-cyclic codes with Tanner graphs of girth 6. Finally, we present a table of small code parameters and note that some of these codes meet the best known minimum distance for binary codes, with the additional hierarchical quasi-cyclic structure.

On the orbit membership problem for solvable groups of affine transformations on a finite group

Name: Muhammad Imran

Institution: University of Birmingham and Universitas Indonesia

Abstract: The constructive orbit membership problem for a permutation group acting on a set is defined as follows: given two elements (or points) of the set, determine one or all group elements that map the first point to the second. In this paper, we study this problem in the context of *affine transformations*, which are compositions of automorphisms and translations of a group. We show that for a solvable group of affine transformations acting on a *sufficiently preprocessed* finite group, the constructive orbit membership problem can be reduced, in randomized polynomial time, to instances of the discrete logarithm problem and the computation of multiplicative orders in finite fields. This special case of the constructive orbit membership problem captures several important computational problems that underlie the security of various cryptographic

protocols, particularly in the domain of group-based cryptography. Notable examples include the semidirect discrete logarithm problem, the generalized discrete logarithm problem in arbitrary finite non-abelian groups, the automorphism search problem (the generalization of the conjugacy search problem), and the decomposition problem. Therefore, we also examine the implications of our results for the security of cryptographic protocols that rely on these underlying problems.

Mathematics with Observers

Name: Boris Khots

Institution: self-employment

Abstract: Nikolai Khots, Dmitriy Khots, Boris Khots ABSTRACT We give here short overview of the main parts of Mathematics with Observers, introduced on base of infinity idea denial. We introduce Observers into arithmetic, and arithmetic becomes dependent on Observers. And after that the basic mathematical parts also become dependent on Observers. We call Mathematics with Observers both Observers in arithmetic and the other parts of mathematics based on this arithmetic. We show that almost all classic geometry theorems are satisfied in Mathematics with Observers geometry with probabilities less than 1. We proved that same plane has couples (point and straight line not containing this point) where Euclidean geometry works, other couples where Gauss Bolyai-Lobachevsky geometry works, and other couples where Riemann geometry works Based on Physics data we developed Mathematics with Observers interpretation of the main laws of Fluid Mechanics, Yang-Mills theory. In particular, we make analysis of Navier-Stokes equations and solution existence of these equations. Mathematics with Observers allows us to treat the classic Maxwell and Yang-Mills equations as the stochastic equations. We proved solution existence of Yang-Mills equations. The currently open problem of the "mass gap existence" is solved in the frame of the new theory. ICM 2026 Short Communications Speaker - Nikolai Khots

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Additive group codes and duality on group algebras over chain rings

Name: Edgar Martinez-Moro

Institution: University of Valladolid

Abstract: Given a finite group G and an extension of finite chain rings $S|R$, one can consider the group rings $\mathscr{S} = S[G]$ and $\mathscr{R} = R[G]$. The group ring $\mathscr{S}$ can be viewed as an R-bimodule, and any of its R-submodules naturally inherits an R-bimodule structure; in the framework of coding theory, these are called additive group codes, more precisely a (left) additive group code is a linear code which is the image of a (left) ideal of a group algebra via an isomorphism which maps G to the standard basis of S^n, where $n = |G|$. We will show a symmetric, nondegenerate trace – Euclidean inner product on $\mathscr{S}$. Two additive group codes $\mathcal{C}$ and $\mathcal{D}$ form an additive complementary pair (ACP) if $\mathcal{C} + \mathcal{D} = \mathscr{S}$ and $\mathcal{C} \cap \mathcal{D} = \{0\}$. For two-sided ACPs, we prove that the orthogonal complement of one code under the trace – Euclidean duality is precisely the image of the other under an involutive anti-automorphism of $\mathscr{S}$, linking coding-theoretical ACPs with module orthogonal direct-sum decompositions, representation theory, and the structure of

group algebras over finite chain rings.

Multi-Headed Transformer Architectures as Time-dependent Wasserstein Gradient Flows

Name: Alex Massucco

Institution: University of Cambridge

Abstract: In recent years, transformer architectures have revolutionized the field of language processing, opening the door to previously unforeseen possibilities. However, from a theoretical point of view, the mathematical models proposed in the literature often lack direct contact with the actual architectures and depend on strong simplifying assumptions. In this paper, we reduce this gap by modelling the data flow in multi-headed transformer architectures as time-dependent gradient flows for a suitable interaction energy capturing the design of the attention mechanism. The explicit dependence on time allows us to consider different weights for each head and for each layer, without imposing constraints on the initialization method. Moreover, we prove that the ω-limit of the gradient flows are stationary points of the interaction energy functional. Finally, we analyse the stability of the gradient flows considering perturbations of both the initial data and the weights. Specifically, on the one hand, we study the robustness of the proposed models with respect to noisy inputs, establishing a continuous dependence of the gradient flows on the initial data and uniqueness of the flows. On the other hand, we prove the Γ-convergence of the perturbed interaction energy to the unperturbed one, leading to the convergence of the corresponding gradient flows.

Construction of a Family of Quantum Codes Using Sub-exceding Functions via the Hypergraph Product and the Generalized Shor Construction

Name: Luc rabefihavanana

Institution: Department of Mathematics and Computer Science, University of Antananarivo

Abstract: In this paper, we introduce a new family of stabilizer quantum codes constructed from the classical codes L_k and L_k^+, which are defined via sub-exceding functions. By combining the hypergraph product method with the generalized Shor construction, we obtain quantum codes exhibiting a rich combinatorial structure and promising properties, particularly in terms of locality, low-density parity-check (LDPC) structure, and asymptotic parameters.

Quantum error-correcting codes play a central role in protecting quantum information and ensuring the reliability of quantum computing systems. In previous work, we introduced the classical linear codes L_k and L_k^+ based on sub-exceding functions and showed that they exhibit good performance in terms of minimum distance, decoding efficiency, and structural simplicity.

More precisely, for any integer $k \geq 3$, the binary linear code L_k has parameters $[2k, k]$, with a minimum distance equal to 3 for $k = 3$ and 4 for $k \geq 4$. The code L_k^+ has parameters $[3k, k]$, and

its minimum distance is equal to 5 for $k = 4$ and 6 for $k \geq 5$. These properties indicate that both codes satisfy essential requirements such as fast information processing, reliability, and flexibility, making them suitable for quantum code constructions.

The main objective of this work is to extend these classical constructions to the quantum setting by developing a new family of quantum codes based on L_k and L_k^+. Using the hypergraph product technique together with the generalized Shor construction, we derive, for any positive integer k, a family of quantum LDPC codes with parameters $[[6k^2, k^2, d]]$,where the minimum distance d is equal to 3 for $k = 3$ and 4 for $k \geq 4$.

This construction provides a new combinatorial framework for the design of quantum LDPC codes and opens perspectives for further research on parameter optimization and decoding methods.

Convergence of Knowledge Commons: Mutual Lessons from Mathematics and the Life Sciences

Name: Moritz Schubotz

Institution: FIZ Karlsruhe - Leibniz Institute for Information Infrastructure

Abstract: We summarize progress by the International Mathematical Knowledge Trust (IMKT) toward realizing the vision of a Global Digital Mathematics Library (GDML) and compare developments in the mathematical knowledge commons with those in the life sciences.

The GDML strategic plan describes a system designed to “create a network of information that can be easily explored and manipulated” and argues that substantial portions of mathematical knowledge can become linked open data through a combination of machine-learning methods and editorial curation. The IMKT Charter articulates this vision of a mathematical knowledge commons grounded in open standards, persistent identifiers, and interoperable services.

Fields like biodiversity informatics demonstrate how persistent identifiers (e.g. GBIF, Genbank, UniProt, iNaturalist) and community ontologies (e.g. Darwin Core, Gene Ontology) can enable fine-grained semantic annotation (e.g. Pensoft, Plazi, Biodiversity PMC) and integration (e.g. GloBI, TRY) across heterogeneous data sources. Similar ideas underpin medical information commons, astronomy’s Virtual Observatory, chemistry’s PubChem and, more generally, the FAIR (Findable, Accessible, Interoperable, Reusable) principles, where governance and standardized metadata enable interoperability among diverse data collections.

A major milestone for mathematics is the transition of zbMATH to zbMATH Open, which now provides an openly accessible index of essentially the full peer-reviewed mathematical literature and research software, enriched with curated metadata, expert reviews, and links to external services such as arXiv, MathOverflow, OEIS, and DLMF. Although many entries link to full text, standardized deep linking to specific formulas, theorems, or conceptual entities remains under development. Additionally, it will be useful to link curated repositories such as LEAN’s mathlib, LMFDB, and MaRDI.

Recent work on AI-based formula and concept discovery introduces semantic entities into mathematical metadata. This directly supports the GDML vision of combining automated semantic

extraction with expert validation to make mathematical knowledge more navigable, interoperable, and machine-actionable.

Together, these developments mark substantial progress toward a global mathematical knowledge commons.

Towards computing canonical lifts of ordinary elliptic curves in medium characteristic

Name: djiby sow

Institution: université cheikh anta diop de dakar, sénégal

Abstract: Let E/F_q be an elliptic curve over a finite field. Schoof's method [**?**] gives a polynomial time algorithm to count the number of points of E. The complexity was later improved by Atkin and Elkies to give the SEA algorithm. %[**?**, **?**, **?**]. The algorithm can be seen as an incarnation of ℓ-adic étale cohomology: if $\chi(t)$ is the characteristic polynomial of the Frobenius π_q, $\chi(t) \mod \ell$ is computed modulo several primes ℓ by looking at the action of π_q on (a subgroup of) the ℓ-torsion $E[\ell]$. The CRT algorithm allows to reconstruct $\chi(t)$ once we have enough precision (as bounded by the Hasse-Weil bound). One can compute~ $\chi \mod \ell$~ in ~$\tilde{O}\left((\ell + \log q)\ell \log q\right)$, hence reconstruct χ in $\tilde{O}\left(\log^4 q)\right)$.

In 2000, a second class of algorithms was introduced by Satoh [**?**], using the Lubin-Serre-Tate Theorem. $\mathcal{E}/F_q$ (with $q = p^n$) be an ordinary abelian variety. A classical result due to Lubin, Serre and Tate Let $q = p^n$, let Z_q be the ring of Witt vectors of F_q, and $Q_q = \text{Frac}(Z_q)$ the unique unramified extension of Q_p of degree~n. Then [**?**] establishes the existence of a unique (up to isomorphisms) elliptic curve $E^{\uparrow}$ over Z_q for every ordinary elliptic curves E/F_q such that the modulo p reduction of $E^{\uparrow}$ is E and $\text{End}(E^{\uparrow}) \cong End(E)$ as a ring. The curve $E^{\uparrow}$ is called the *canonical lift of* E. Then the trace of the Frobenius morphism is deduced using *crystalline cohomology*.

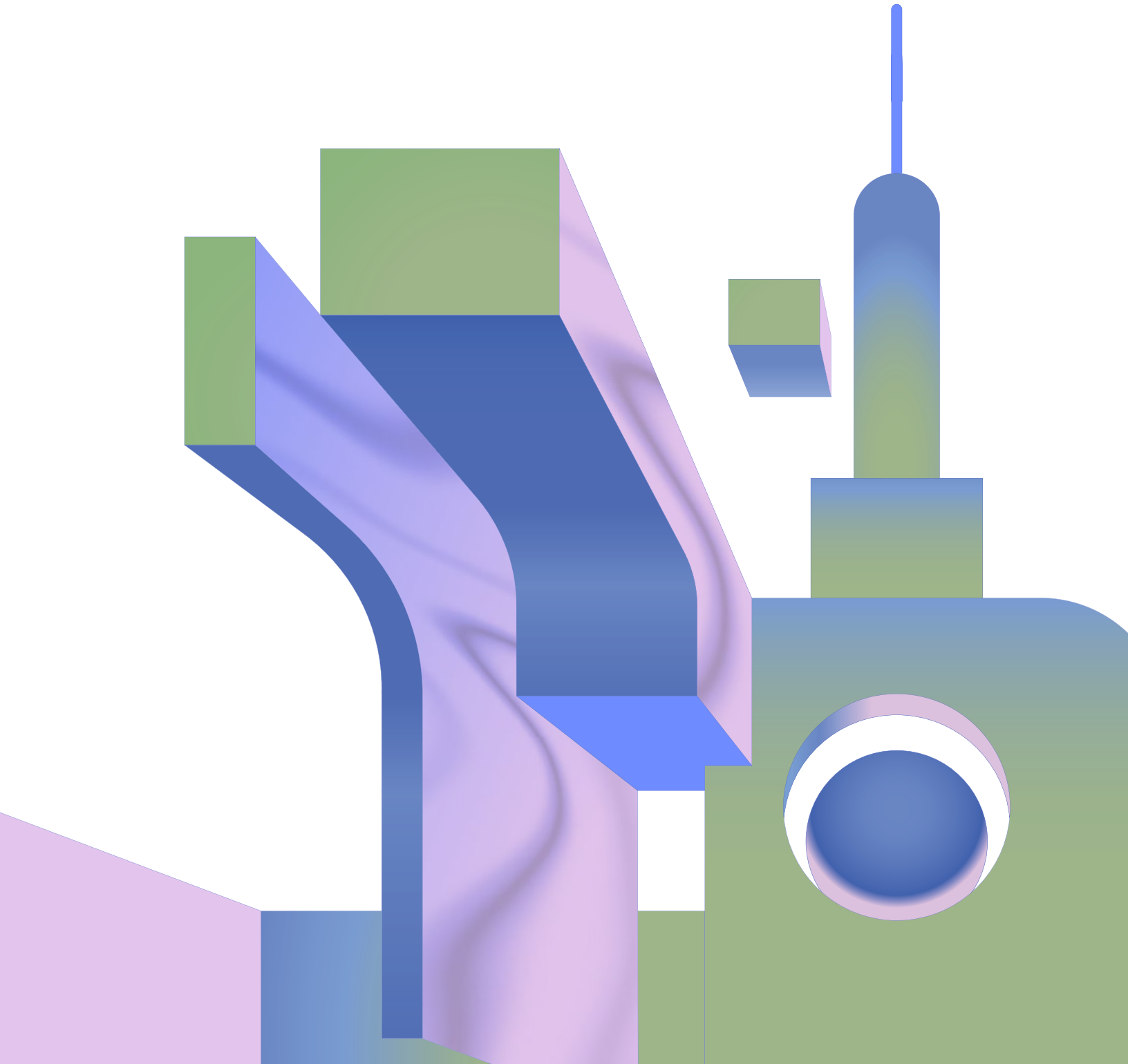
Let p be a prime; using modular polynomial Φ_p, Satoh et al [**?**, **?**, **?**] developed several algorithms to compute the canonical lift of an ordinary elliptic curve E over F_{p^n} with j-invariant not in F_{p^2}.When p is constant, the best variant has complexity$\tilde{O}(nm)$ bit operations to lift E to p-adic precision~m.As an application, lifting E to precision $m = O(n)$ allows torecover its cardinality in time $\tilde{O}(n^2)$. However, taking p into account the complexity is$\tilde{O}(p^2nm)$, so Satoh's algorithm can only be appliedto small~p.

We are interested in the dependency of p of the algorithm. We will now assume that $p > 2$ for simplicity. The modular polyn

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SHORT COMMUNICATIONS

SECTION 15–NUMERICAL ANALYSIS AND SCIENTIFIC COMPUTING



A Robust Convergence Analysis of SDFEM for Two-Dimensional Singularly Perturbed Degenerate Parabolic Convection-Diffusion Problem

Name: Aasna Aasna

Institution: Department of Mathematics,University of Delhi, Delhi

Abstract: A streamline-diffusion finite element method (SDFEM) is applied to a coarse part of the spatial domain for a two-dimensional singularly perturbed degenerate parabolic problem defined on a unit square. Whereas the standard Galerkin finite element method (GFEM) is used on the dense part of the space domain to approximate the solution. Shishkin grids are constructed to partition the space domain into rectangular-shaped bilinear elements. The time-dependent derivative is discretized using the general θ- method, for $\theta \in [1/2, 1]$, on a uniform temporal mesh. The solution of the considered problem contains two parabolic boundary layers on the left boundaries at $x = 0$ and $y = 0$. We derive the parameter uniform error estimates of $|||u_I - U_h|||_{SD}$ in the streamline-diffusion norm $|||\cdot|||_{SD}$ for a suitable choice of stabilization parameter and show that the numerical solution U_h is super-close to the bilinear interpolate u_I of an exact solution u. These error estimates confirm that the total error $|||u - U_h|||_{SD}$ is not optimal. We introduce a discrete version of the SD-norm, and obtained an improved convergence result in the discrete norm $|||\cdot|||_{SD,d}$. The proposed method yields parameter-uniform stability and convergence results both within and outside the layer region. Finally, all theoretical results are verified by taking some numerical experiments.

Lagrangian-Eulerian formulations for numerical treatment of hyperbolic systems of balance and conservation laws several dimensions on cubical and tetrahedral meshes

Name: Eduardo Abreu

Institution: Universidade Estadual de Campinas - Unicamp Brazil

Abstract: We present a construction and rigorous numerical analysis of Lagrangian-Eulerian schemes for effective computation of three-dimensional scalar (and systems of) hyperbolic conservation laws on structured cubical and tetrahedral meshes. We also provide several numerical 1D/Multi-D examples to verify the theory and discuss the capabilities of the novel approach, for instance, Compressible Euler flows with positivity of the density, the classical Orszag-Tang problem in magneto-hydrodynamics, which is well-known to satisfy the notable involution-constrained partial differential equation $\nabla \cdot B = 0$ (this condition is verified numerically by the proposed approach, i.e., without any imposition of an additional constraint in the formulation), and a non-strictly hyperbolic three-phase flow system in porous media with a resonance point. We will also discuss high-performance computing of the new approach in a MPI environment and its performance via the typical strong scaling metric. We start by deriving fully-discrete and semi-discrete schemes for a generic three-dimensional hyperbolic conservation law, which is based on a novel concept of no-flow curves/surfaces/manifolds, which is effective for computational implementation: The first Lagrangian evolution step automatically handles the hyperbolic fluxes and, the second step, a Eulerian remap, which allows the use of a single structured cubical and tetrahedral mesh grid, thus eliminating the need for moving meshes while retaining local con-

servation. Due to the no-flow framework, there is no need to employ/compute the eigenvalues (exact or approximate values) - in fact there is no need to construct the relevant Jacobian of the hyperbolic flux functions, and thus giving rise to an effective and novel weak CFL-stability condition, which is effective for computing practice. The method is Riemann-solver-free and, hence, time-consuming field-by-field type decompositions are avoided in the case of multidimensional systems, for instance, the positivity of density for compressible Euler Flows and conservation laws with discontinuous space-time dependent flux functions, Orszag-Tang vortex system and a nonstrictly hyperbolic three-phase flow system (with a resonance point) and the 2D shallow water equations with variable topography and discontinuous data in a geometric intrinsic formulation. This scheme has also been successfully applied to nonlocal and balance hyperbolic problems.

An Optimal Eighth-Order Scheme for Nonlinear Equations with Known Multiplicity and Applications to Soil Nutrient Response, Hanging Object, and Kepler's Equation

Name: Saima Akram

Institution: Government College Women University Faisalabad, Faisalabad, Pakistan

Abstract: In recent years, considerable attention has been devoted to developing advanced iterative techniques for solving nonlinear equations with multiple roots of known multiplicity, particularly methods of higher order involving derivatives. However, constructing higher-order iterative schemes that are free from derivatives remains a challenging task, leaving a notable gap in the existing literature. To address this, we propose a novel three-step, eighth-order Traub-Steffensen-type iterative method that avoids derivatives by employing first-order divided differences. The second and third steps are further refined using weight functions of one and two variables, respectively, ensuring both accuracy and efficiency. The proposed scheme requires only four functional evaluations per iteration and achieves the optimal eighth-order convergence in accordance with the Kung-Traub conjecture, with an efficiency index of 1.6818. A rigorous convergence analysis confirms the theoretical order, while extensive numerical experiments performed using Mathematica 8, Maple 22, and MATLAB 2014a demonstrate the stability, accuracy, and superior performance of the scheme compared to existing eighth-order approaches. To establish its practical effectiveness, the method is applied to a range of real-world nonlinear problems with multiple roots, including the soil nutrient response model, the hanging object problem, kepler's equation, eigenvalue problems, and various standard test functions. Comparative studies reveal significant improvements in computational order of convergence, residual error, and the difference between successive iterates. Furthermore, basins of attraction are analyzed to visualize the regions of convergence and to examine the sensitivity of the method to initial guesses. This graphical analysis further highlights the wider convergence domains. Overall, the developed derivative-free eighth-order scheme provides a powerful and efficient tool for solving nonlinear equations with multiple roots of known multiplicity, combining theoretical order of convergence with strong numerical performance in various applications.

Stability analysis and a second-order finite difference method for fourth-order neutral Volterra integro-differential equation

Name: Ilhame Amirali

Institution: Duzce University

Abstract: This work's objective is to introduce a numerical method for solving a neutral Volterra integro-differential equation that involves fourth- and second-order derivatives. First, the stability properties of exact solution are analyzed. To solve this problem numerically, on the uniform mesh, the finite difference method, including the composite trapezoidal rule for the integral part of the equation, is used. The method has been demonstrated to be second-order convergent in the discrete maximum norm. In order to verify the efficiency of the suggested method, numerical examples are given.

An Atomic Approach to Particular Solutions of Higher-Order Cauchy – Euler Equations

Name: Skander Belhaj

Institution: University of Manouba, Tunisia

Abstract: We present a recent and original contribution to the theory of higher-order non-homogeneous Cauchy – Euler differential equations. A new concept of atoms defined on finite sets of real numbers is introduced and used to construct explicit particular solutions without reducing the equation to constant-coefficient form. The proposed atomic method works directly in the original variable and exploits the intrinsic scaling structure of the Cauchy – Euler operator. In addition to exact solutions, the approach naturally yields accurate approximate particular solutions when only approximate roots of the characteristic polynomial are available. Theoretical convergence results are established, and numerical experiments confirm the stability and efficiency of the method. This work, provides a flexible analytical – numerical framework that complements classical techniques and is well suited for structured forcing terms and higher-order equations.

An improved finite difference scheme for magnetohydrodynamic flows

Name: Canan Bozkaya

Institution: Middle East Technical University

Abstract: This work presents the development and analysis of a finite difference scheme for boundary value problems governed by modified Helmholtz-type equations. The formulation is motivated by magnetohydrodynamic duct flow models, in which the coupled governing equations for the velocity and induced magnetic fields are reformulated as decoupled modified Helmholtz equations. The proposed finite difference approach significantly reduces the discretization errors inherent in classical schemes by employing specially constructed difference formulas

for first-order derivatives subject to mixed boundary conditions, as well as for second-order derivatives in one- and two-dimensional settings. Accordingly, truncation errors are removed at the level of the finite difference approximations used for the derivative terms. Numerical results demonstrate that the proposed scheme delivers more reliable solutions than the standard finite difference method on relatively coarse meshes, while mesh refinement remains necessary to accurately capture the solution behavior at large values of physical parameters.

A second-order invariant-region-preserving scheme for a transport-flow model of polydisperse sedimentation

Name: Raimund Bürger

Institution: Universidad de Concepción

Abstract: A polydisperse suspension is a mixture of a number N of species of small solid particles, which may differ in size or density, dispersed in viscous fluid. The sedimentation of such a mixture gives rise to the segregation of species and flow of the mixture due to density fluctuations. In two space dimensions, and for equal-density particles, this process can be described by a hyperbolic system of N nonlinear conservation laws for the particle volume fractions coupled with a version of the Stokes system for the volume-averaged flow field of the mixture. A second-order numerical scheme for this transport-flow model is formulated by combining a finite-difference approximation of the Stokes system with a finite volume (FV) scheme for the transport equations, both defined on a Cartesian grid on a rectangular domain. The FV scheme is based on a central weighted essentially non-oscillatory (CWENO) reconstruction [M. J. Castro and M. Semplice, Int. J. Numer. Methods Fluids, 89 (2019), pp. 304-325] applied to the first-order local Lax-Friedrichs (LLF) numerical flux. By the application of scaling limiters to the CWENO reconstruction polynomials (following [X. Zhang and C.-W. Shu, J. Comput. Phys., 229 (2010), pp. 3091-3120]) and utilizing that the Stokes solver generates a discretely divergence-free (DDF) velocity field, one can prove that the FV scheme has the invariant region preserving (IRP) property, i.e., the volume fractions are nonnegative and sum up at most to a set maximum value. Numerical examples illustrate the model and the scheme.

Adaptive coarse spaces for high-contrast and multiscale coefficients for problems in H(grad).

Name: Juan Gabriel Calvo Alpizar

Institution: Universidad de Costa Rica

Abstract: We present a domain decomposition preconditioner for second-order elliptic partial differential equations that handles coefficients with high-contrast and multiscale properties, and is suitable for irregular subdomains. We will present partition of unity functions and appropriate eigenvalue problems that enrich usual coarse spaces. We demonstrate that the condition number of the preconditioned systems is bounded with a bound that is independent of the contrast, and include selected numerical experiments that confirm the robustness of our preconditioner.

THE Method of Probabilistic Solution for 3D Dirichlet Generalized and Classical Harmonic Problems in Some Finite Bodies with Cavities

Name: Tinatin Davitashvili

Institution: Ivane Javakhishvili Tbilisi State University

Abstract: In this paper, we investigate the application of the method of probabilistic solutions (MPS) to numerical solving of Dirichlet generalized and classical harmonic problems in some finite bodies with cavities. The term "generalized" indicates that a boundary function has a finite number of first kind discontinuity curves. The suggested algorithm for numerical solution of boundary problems consists of the following stages: a) application of the MPS, which in its turn is based on a computer modeling of the Wiener process; b) finding the intersection point of the trajectory of the simulated Wiener process and the surface of the problem domain; c) developing a code for numerical implementation and verifying the accuracy of the results; d) finding of the probabilistic solution of generalized problems at any fixed points of the considered domains. The algorithm does not require approximation of a boundary function. To illustrate the effectiveness and simplicity of the proposed method five examples are considered. Numerical results are presented and discussed.

An Unconditionally Stable Algorithm for The Time-Fractional BBMB Equation and Convergence Analysis

Name: Neetu Garg

Institution: National Institute of Technology Calicut

Abstract: In this work, we develop an efficient numerical approach to deal with the time-fractional Benjamin-Bona-Mahony-Burger equations. The Benjamin-Bona-Mahony-Burger equation is a significant tool to describe the unidirectional propagation of long waves in specific nonlinear dispersive models. We utilize the Crank-Nicolson method in time with exponential B-splines in space. We establish convergence and stability of the proposed scheme. Due to the unavailability of the exact solution, the double mesh method is used for error estimates. The numerical simulations validate the theory, and a comparison with existing methods displays the efficacy of the proposed technique.

Average Kernel Sizes - Computable Sharp Accuracy Bounds for Inverse Problems

Name: Nina M Gottschling

Institution: Oak Ridge National Laboratory

Abstract: The reconstruction of an unknown quantity from noisy measurements is a mathematical problem relevant in most applied sciences, for example, in medical imaging, radar inverse scattering, or astronomy. This underlying mathematical problem is often an ill-posed (non-linear) reconstruction problem, referred to as an ill-posed inverse problem. To tackle such problems, there exist a myriad of methods to design approximate inverse maps, ranging from optimization-based approaches, such as compressed sensing, over Bayesian approaches, to data-driven techniques such as deep learning. For all stable approximate inverse maps, there are accuracy limits that are strictly larger than zero for ill-posed inverse problems, due to the accuracy-stability tradeoff [Gottschling et al., SIAM Review, 67.1 (2025)] and [Colbrook et al., Proceedings of the National Academy of Sciences, 119.12 (2022)]. The variety of methods that aim to solve such problems begs for a unifying approach to help scientists choose the approximate inverse map that obtains this theoretical optimum. Up to now there do not exist computable accuracy bounds to this optimum that are applicable to all inverse problems. We provide computable sharp accuracy bounds to the reconstruction error of solution methods to inverse problems. The bounds are method-independent and purely depend on the dataset of signals, the forward model of the inverse problem, and the noise model. To facilitate the use in scientific applications, we provide an algorithmic framework and an accompanying software library to compute these accuracy bounds. We demonstrate the validity of the algorithms on two inverse problems from different domains: fluorescence localization microscopy and super-resolution of multi-spectral satellite data. Computing the accuracy bounds for a problem before solving it, enables a fundamental shift towards optimizing datasets and forward models.

MHD Flow and Heat Transfer Enhancement in Micropolar Casson Hybrid Nanofluid: Nanofluid Versus Hybrid nanofluid

Name: Abid Hussanan

Institution: University of Education, Lahore, Multan Campus, Pakistan

Abstract: Hybrid nanofluids are considered advanced nanofluids due to their enhanced thermal properties and significant benefits that contribute to increasing the heat transfer rate. Therefore, scientists and researchers are incorporating various solid particles into base fluids to enhance the material's thermal conductivity. This study presents the heat transfer and magnetohydrodynamic (MHD) flow characteristics of a micropolar Casson hybrid nanofluid composed of Sodium Alginate (SA) with the Prandtl number $\mathrm{Pr} = 6.45$, as the base fluid and copper (Cu) and aluminum oxide (Al_2O_3) nanoparticles. The research aims to enhance heat transfer performance and fluid stability through the interactive effects of hybrid nanoparticles. A mathematical model is developed to investigate the effects of magnetic fields on rheological parameters, with governing equations formulated for a steady flow over a stretching surface. The converted ordinary differential equations are solved numerically using the Runge-Kutta-Fehlberg (RKF) method to determine the impacts of magnetic, Casson, and micro-rotation parameters on velocity and temperature profiles. Comparative results reveal that hybrid nanofluids demonstrate more heat dissipation and enhanced thermal management properties over traditional nanofluids.

On the Local Convergence of a Two-Step Combined Newton-Secant-Kurchatov Type Method under Two Different Continuity Conditions

Name: Jai Prakash Jaiswal

Institution: Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur (CG)-495009, India

Abstract: In this paper, we explore a double-step method for solving nonlinear equations containing a differentiable and non-differentiable operator. Our approach is built upon the combination of three different methods. We have analyzed the local convergence of the suggested method, considering both Lipschitz and L-average conditions & established the superquadratic (≈ 2.414) order of convergence. Finally we have pictured a comparison of the numerical results in comparison with several existing methods.

A Posteriori Error Control and Adaptive Space – Time Discretization for Nonlinear Degenerate Equations

Name: Ayesha Javed

Institution: Hasselt University

Abstract: Using a fully space – time variational formulation, we develop a numerical approximation scheme for a class of nonlinear parabolic equations. In this approach, the spatial and temporal discretization are addressed simultaneously, allowing for a flexible mesh in space and time, but leading to large fully discrete systems. Additional challenges are encountered in cases when the diffusion is nonlinear, or even degenerate. The scheme relies on a splitting strategy, in which the nonlinear dependencies are considered as algebraic equations, at the expense of new unknowns. This is applied directly to the space – time formulation, leading to an equivalent system that is more suitable for handling degeneracies. Based on this reformulation, we employ a stabilized iterative linearization scheme and establish its convergence in the space – time setting. A central contribution of this work is the development of guaranteed a posteriori error estimators, based on locally equilibrated flux reconstructions on space – time vertex patches. The resulting estimators are fully computable and provide a clear separation between linearization and discretization errors. This enables a reliable adaptive strategy in which the mesh refinement is activated only when the discretization error dominates. In this way, the global number of unknowns is reduced significantly when compared to non-adaptive schemes. Numerical experiments demonstrate that the proposed adaptive space – time method efficiently concentrates the computational effort in regions exhibiting strong space – time variations, yielding accurate solutions at significantly reduced computational cost.

On the numerical implementation for solving impulsive differential equations with loadings

Name: Zhazira Kadirbayeva

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: We consider the following linear problem for impulsive differential equations with loadings:

$$\frac{dy}{dt} = A_0(t)y + \sum_{i=1}^{m} M_i(t) \lim_{t\to\theta_i+0} \dot{y}(t) + \sum_{i=1}^{m} A_i(t) \lim_{t\to\theta_i+0} y(t) + f(t), \quad t \in (0,T), \tag{1}$$

$$\sum_{j=0}^{m+1} D_j y(\theta_j) = d, \quad d \in R^n, \quad y \in R^n, \tag{2}$$

$$B_i \lim_{t\to\theta_i-0} y(t) - C_i \lim_{t\to\theta_i+0} y(t) = \varphi_i, \quad \varphi_i \in R^n, \quad i = \overline{1,m}, \tag{3}$$

where $(n\times n)$-matrices $A_j(t)$, $(j = \overline{0,m})$, $M_i(t)$, $(i = \overline{1,m})$, and n-vector-function $f(t)$ are piecewise continuous on $[0,T]$ with possible discontinuities of the first kind at the points $t = \theta_i$, $(i = \overline{1,m})$. D_j, $(j = \overline{0,m+1})$, B_i, and C_i, $(i = \overline{1,m})$ are constant $(n \times n)$ - matrices, and φ_i, $(i = \overline{1,m})$ are constant n vector functions, $0 = \theta_0 < \theta_1 < \theta_2 < \ldots < \theta_{m-1} < \theta_m < \theta_{m+1} = T$.

The aim of this paper is to develop and investigate an efficient numerical method for solving a multipoint boundary value problem for impulsive differential equations with loadings (1)–(3). The proposed technique is based on the Dzhumabaev parametrization method, which enables the transformation of the original boundary value problem into a system of algebraic equations combined with a set of Cauchy problems. Such a reformulation substantially simplifies the numerical realization of the problem, reduces computational complexity, and provides a convenient framework for constructing accurate approximate solutions. Moreover, the resulting approach allows for flexible implementation and can be effectively applied to a wide class of impulsive differential equations with multipoint boundary conditions.

An Arrow – Hurwicz – Inspired Finite Element Approach for Steady Navier – Stokes and MHD Equations Without Saddle-Point Solvers

Name: songul kaya merdan

Institution: Middle East Technical University

Abstract: We propose a new Arrow – Hurwicz-type finite element method for the numerical approximation of the steady incompressible Navier – Stokes and MHD equations. The method is motivated by artificial compressibility techniques commonly used for unsteady flows and is designed to avoid the solution of saddle-point systems arising from the incompressibility constraint. Rigorous analysis is carried out, establishing uniform boundedness of the discrete solutions and convergence to the exact solution under a standard small-data assumption ensuring uniqueness. In addition, a two-grid variant of the proposed algorithm is introduced to further enhance computational efficiency. Numerical experiments demonstrate that the method achieves a significant acceleration in convergence compared to classical approaches, while maintaining accuracy and incurring no additional computational cost.

An Optimal Iterative Family for Solving Multiple Roots of Nonlinear Equations

Name: Sanjeev Kumar

Institution: Thapar Institute of Engineering & Technology, Patiala, Punjab

Abstract: In this study, we develop a new family of fourth-order iterative methods for the numerical solution of nonlinear equations possessing multiple roots. It is well known that many optimal higher-order schemes suffer from severe instability or loss of convergence when the first derivative vanishes or becomes extremely small in the neighbourhood of the root. The proposed iterative family effectively overcomes this drawback while preserving an optimal fourth-order convergence rate for roots of arbitrary multiplicity. A rigorous local convergence analysis is carried out to establish the theoretical validity of the method and to confirm its fourth-order convergence. Furthermore, extensive numerical experiments involving benchmark problems from applied science and engineering are presented to assess the performance of the proposed scheme. The results demonstrate superior accuracy, efficiency, and robustness when compared with existing methods. In particular, the proposed family exhibits reliable convergence even in the critical case where f′ (x) = 0 or is nearly zero near the solution, a scenario in which many classical and modern techniques fail. Consequently, the proposed methods constitute a robust and efficient computational framework for solving nonlinear equations with multiple roots.

A Hybrid High-Order Finite Element Method for a Nonlocal Nonlinear Problem of Kirchhoff Type

Name: Gouranga Mallik

Institution: Vellore Institute of Technology, Vellore

Abstract: We present a hybrid high-order (HHO) finite element method for a class of nonlocal nonlinear problems of Kirchhoff type. The proposed method supports arbitrary-order polynomial approximations on structured and unstructured polytopal meshes. We prove well-posedness of the resulting nonlinear discrete problem and establish optimal-order convergence in a discrete energy norm. The nonlinear system is solved using Newton's method applied to a sparse matrix system. Numerical experiments are presented to validate the theoretical results.

Interpolation formulas for alpha-harmonic functions on the unit circle

Name: Rada Mutavdzic Djukic

Institution: University of Belgrade, Faculty of Mechanical Engineering

Abstract: The α-harmonic functions are solutions of a weighted Laplace equation; in the special case $\alpha = 0$ they are just the harmonic functions. It is known that an α-harmonic function u on the unit disc $\mathbb{D}$ is uniquely determined by its values on the boundary $\partial\mathbb{D}$. In fact, $u(z)$ can be given as a contour integral over $\partial\mathbb{D}$ with a modified Poisson kernel. When this integral is difficult to

evaluate, approximating $u(z)$ with an interpolatory formula, as a weighted sum of values of u at n nodes on $\partial\mathbb{D}$, can be an attractive alternative. Our objective is to develop the interpolatory formulas of this kind whose degree of exactness is highest possible. We will also prove their convergence as $n \to \infty$ and discuss the locations of their nodes.

A method for solving a multipoint boundary value problem with a nonlinear integro-differential operator

Name: Sandugash Mynbayeva

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: The study is focused the applicability of Dzhumabaev parametrization method to multipoint boundary value problems for the Duffing-type integro-differential operator equation:

$$\frac{d^2x}{dt^2}+\alpha\frac{dx}{dt}+\beta x^3+\gamma x^5 = \eta cos(\omega t)+\varphi_1(t)\int\limits_0^T \psi_1(\tau)x(\tau)d\tau+\varphi_2(t)\int\limits_0^T \psi_2(\tau)\frac{\partial x(\tau)}{\partial\tau}d\tau+p(t),\ t\in(0,T),$$

$$\sum_{j=0}^{N} b_{ij}x(t_j)+\sum_{j=0}^{N} c_{ij}\left.\frac{\partial x}{\partial t}\right|_{t=t_j}+g_i\left(x(t_0),\dots,x(t_N),\left.\frac{\partial x}{\partial t}\right|_{t=t_0},\dots,\left.\frac{\partial x}{\partial t}\right|_{t=t_N}\right)=d_i,\ i=1,2,$$

where x is displacement; α, β, γ, η, ω are arbitrary constants; and $\varphi_k(t)$, $\psi_k(\tau)$, $k=1,2$, and $p(t)$ are continuous on $[0,T]$, b_{ij}, c_{ij} are given numbers, $g_i : R^{2(N+1)} \to R$ is continuous.

The original problem is reformulated as an equivalent parametric multipoint problem, which was then decomposed into two subproblems: a nonlinear special Cauchy problem and a system of nonlinear algebraic equations. The special Cauchy problem is addressed via linearization at fixed parameter values and solved through a sequence of stepwise linear approximations. The solutions obtained are subsequently employed to construct the right-hand side of the algebraic system and its associated Jacobi matrix. On this basis, a new approach for solving the original problem is developed. The efficiency and convergence of the proposed approach were confirmed through a numerical examples.

Dual Reciprocity Boundary Element Analysis of Magneto-Thermo-Bioconvective Flow in a Porous Square Cavity Saturated with Oxytactic Microorganisms

Name: Fatma Sidre Oğlakkaya

Institution: Osmaniye Korkut Ata University

Abstract: This study investigates magnetohydrodynamic (MHD) thermo-bioconvection of oxytactic microorganisms in a differentially heated, two-sided lid-driven porous cavity, considering the combined effects of thermal gradients, lid motion, magnetic fields, and porous media. The impact of key parameters on flow structure, temperature distribution, oxygen concentration, and

microorganism density is analyzed in detail. The governing two-dimensional, steady, laminar, incompressible Newtonian flow equations are formulated under the Boussinesq approximation. The transport of oxytactic microorganisms is modeled using an augmented continuum framework. Numerical simulations are carried out using the Dual Reciprocity Boundary Element Method (DRBEM), which transforms domain integrals arising from source terms into equivalent boundary integrals through a dual reciprocity formulation. This method offers high computational efficiency and accuracy by reducing the dimensionality of the problem and requiring discretization only at the boundaries, making it especially suitable for complex coupled transport phenomena in porous media. Results show that the strength and orientation of the magnetic field, along with lid velocity and direction, significantly alter bioconvective flow patterns and species distribution. Higher concentrations of oxygen and microorganisms are observed near the upper cavity region. The findings highlight the sensitivity of bioconvective transport to multi-physical interactions and suggest potential applications in bio-engineering and industrial systems involving active suspensions.

From Bernstein Polynomials to Generalized Bézier Models: Theory, Structure, and Interpretable Imaging Applications

Name: Faruk Özger

Institution: Iğdır University

Abstract: Faruk ÖZGER Department of Computer Engineering, Iğdır University, 76000-Iğdır, Türkiye farukozger@gmail.com

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Abstract.

This work revisits Bernstein polynomials as the mathematical foundation of Bézier curves and extends their role toward a shape-aware computational framework for medical image analysis. While classical Bézier models are central to geometric design, their fixed polynomial structure limits adaptability in applications that require robustness to noise, controllable deformation, and interpretability—key demands in medical imaging and clinical decision support systems.

We introduce analytically grounded generalizations of Bézier curves and surfaces based on extended Bernstein-type blending functions equipped with explicit shape control parameters. These constructions preserve essential geometric properties, including convex hull containment, endpoint interpolation, and numerical stability via De Casteljau – type recursion, while enabling flexible local and global deformation. From a computational perspective, the resulting models admit efficient algorithms suitable for large-scale numerical optimization and inverse problems.

The work demonstrates how these generalized Bézier representations naturally integrate into medical image analysis pipelines, particularly for anatomical boundary modeling, contour regularization, and shape-constrained segmentation. Their parametric transparency allows domain knowledge to be encoded directly into the geometric representation, offering an interpretable alternative to purely black-box learning models. Furthermore, connections to Bernstein – Kantorovich operators provide convergence guarantees and robustness properties that are critical

when dealing with noisy or low-resolution clinical data.

This work positions generalized Bézier modeling as a unifying bridge between computational geometry, numerical analysis, and medical image computing, enabling robust, interpretable, and mathematically principled shape representations for next-generation computer science applications.

A meshfree RBF-FD technique to solve fractional Schamel – KdV equation for ion-acoustic solitary waves

Name: B Sagar

Institution: University of Central Florida

Abstract: The Schamel – KdV equation plays a vital role in studying the effect of electron trapping on the nonlinear interaction of ion-acoustic waves in plasma and dusty plasma. This work presents a numerical scheme-based radial basis function-finite difference (RBF-FD) method to solve the time-fractional Schamel – KdV equation. In the discretization process, a finite difference technique is used to discretize the temporal derivative, while the multiquadric RBF is used to approximate the spatial derivatives. The theoretical convergence and stability analysis of the time-discrete scheme are also established. Numerical experiments are executed through some illustrated problems, and the obtained results are compared with that acquired by the tanh method and Kudryashov method solutions to show the high accuracy and plausibility of the proposed technique. Also, the graphical representations are given to demonstrate the physical interpretation of the resulting wave structures.

Modeling and Numerical Approximation of Bilayer Water and Gas Flows in Pipelines

Name: Sarswati Shah

Institution: George Mason University

Abstract: We present a new model for bilayer water flows along pipelines. The bottom layer consists of an incompressible liquid state, governed by the shallow-water equations. The top layer is a compressible gaseous fluid, which exchanges momentum with the lower layer. During the talk, we will present the derivation of the model along with a description of its hyperbolic properties. We also propose a high-resolution, non-oscillatory, semi-discrete central scheme to approximate solutions. This scheme extends existing semi-discrete central methods for hyperbolic conservation laws. The system is integrated in time using a second-order Runge-Kutta scheme with strong stability preservation. Along with a detailed description of the scheme and a demonstration of these two properties, we present several numerical experiments that show the robustness of the algorithm. This is a joint work with Gerardo Hernández Dueñas.

The Lean Landscape of AI-assisted Asymptotic Analysis

Name: Omar Shehab

Institution: In transition

Abstract: Recent advances in AI-assisted theorem proving have shown that modern proof assistants, when coupled with large language models, can support professional-level reasoning in mathematics. Yet asymptotic analysis—the language of limits, scaling, and regimes underlying algorithms, numerical methods, and computational complexity—remains largely informal and outside the reach of current systems. This gap is striking, given that asymptotic reasoning governs scalability, convergence, and hardness in both theory and applications. We argue that the Lean ecosystem has reached a level of maturity where AI-assisted, formally verified asymptotic analysis is now feasible, while also highlighting the epistemic risks that arise when formalization itself becomes automated and distributed. State-of-the-art AI theorem provers excel at bounded arguments but lack the conceptual machinery required for dominance reasoning, limit processes, recurrence relations, probabilistic asymptotics, and average-case ensembles. At the same time, emerging AI systems can already propose correct domain decompositions and asymptotic inequalities when guided appropriately. What remains missing is a principled framework that turns such proposals into certified, reusable proof objects.

Lean provides a natural verification backbone: its mature real analysis, limit theory, and expanding automation allow sophisticated asymptotic arguments to be expressed and checked. However, formal verification should not be conflated with conceptual correctness. Formal code can trivialize results through misspecified definitions or succeed for unintended reasons. As AI systems generate increasing volumes of formal proofs, these epistemic failure modes become more salient, not less. Looking ahead, AI-assisted asymptotic analysis will develop in a fundamentally distributed manner. Multiple groups may formalize conceptually equivalent results using incompatible abstractions, creating redundancy and semantic fragmentation despite local correctness. Addressing this requires advances in formal epistemology: methods for detecting conceptual equivalence, tracking provenance, and ensuring interoperability across formal developments.

The convergence of a mature Lean ecosystem and AI systems capable of long-horizon reasoning makes asymptotic analysis a natural next frontier. Success will depend not only on automation, but on preserving meaning and interoperability as mathematics becomes increasingly machine-mediated.

M-matrices and discrete problems with nonlocal boundary conditions

Name: Artūras Štikonas

Institution: Vilnius University

Abstract: The talk is based on some recent joint results obtained with Vytautas Būda (ISM University of Management and Economics, Vilnius), Mifodijus Sapagovas (Vilnius University) and Olga Štikonienė (Vilnius University). We present a finite difference method for the Poisson equation with nonlocal boundary conditions, and consider the case where the matrix of the resulting system of linear equations is an M-matrix. Necessary and sufficient conditions for the problem to be described by an M-matrix are formulated using the parameters of the nonlocal

boundary conditions. The proof is based on the explicit form of the inverse matrix for the classical case. We consider examples of one-dimensional and two-dimensional problems. Another approach is to explore the spectrum of such problems. This also allows us to find the values of the nonlocality parameters for which a finite difference scheme is described by an M-matrix. However, for problems with nonlocal conditions, the dependence of the spectrum on the nonlocality parameters can be very complicated. In the two-dimensional case, this is easier to investigate if we can separate the variables, but not all nonlocal conditions allow this.

Finite Difference Scheme for two-dimensional Poisson equation with the multiple integral boundary condition

Name: Olga Štikonienė

Institution: Vilnius University

Abstract: In this talk, we present a numerical method for solving the two-dimensional Poisson equation on a rectangular domain with a nonlocal boundary condition given by a double integral. The presence of this non-classical boundary condition prevents the use of standard techniques such as separation of variables, making the problem challenging from both analytical and numerical perspectives. We introduce a finite difference approach in which the integral term is approximated using the two-dimensional trapezoidal rule. By reformulating the nonlocal boundary condition in terms of interior grid points and partitioning the computational domain into boundary and interior components, we reduce the original problem to a set of Poisson problems with classical boundary conditions. The solutions of these auxiliary problems are then combined to construct the solution of the original nonlocal problem. This strategy leads to a significant reduction in computational complexity, as it requires solving a linear system of much smaller dimension than that of the full discretization. Under suitable assumptions on the kernel, we establish the validity of the proposed approach and illustrate its effectiveness.

Constructive Analysis of Boundary Value Problems for Nonlinear Integro-Differential Equations

Name: Svetlana Temesheva

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: This study focuses on a family of nonlinear two-point boundary value problems (BVPs) for systems of integro-differential equations:

$$\frac{\partial V}{\partial t} = f\left(x, t, \psi(t) + \int_0^x V(\xi, t)d\xi, V\right), \quad V \in \mathbb{R}^n, \quad (x,t) \in \Omega, \tag{3}$$

$$g\left(x, V(x,0), V(x,T)\right) = 0, \quad x \in [0,\omega], \tag{4}$$

where $\Omega = [0,\omega] \times (0,T)$, the functions $f : [0,\omega] \times [0,T] \times \mathbb{R}^{2n} \to \mathbb{R}^n$ and $g : [0,\omega] \times \mathbb{R}^n \times \mathbb{R}^n \to \mathbb{R}^n$ are continuous.

We propose a constructive algorithm for finding solutions based on a modified version of D.S. Dzhumabaev's parametrization method. The approach involves partitioning the time interval and introducing additional parameters as the values of the desired solution at the nodes of the partition, effectively reducing the original problem to an equivalent family of multipoint BVPs. Conditions for the feasibility and convergence of the proposed algorithm are established. These conditions also serve as sufficient conditions for the existence of an isolated solution within a specified neighborhood. A key feature of the study is its application to a class of nonlinear hyperbolic equations with mixed derivatives and nonlocal boundary conditions.

Attention-Based Physics-Informed Neural Network for Solving Time-Fractional Black-Scholes Equations

Name: Neha Yadav

Institution: Dr. B.R. Ambedkar NIT Jalandhar

Abstract: This work presents a novel Physics-Informed Neural Networks (PINNs) framework augmented with an attention mechanism to solve time-fractional Black-Scholes partial differential equations - a challenging class of equations characterized by the nonlocality of fractional derivatives. Conventional numerical methods often encounter difficulties in discretization and suffer from high computational costs when addressing such problems. To overcome these limitations, our hybrid approach integrates the L1 finite difference scheme for approximating fractional derivatives with automatic differentiation for integer-order terms, facilitating end-to-end learning of both market dynamics and fractional behaviors without reliance on traditional grid-based solvers.

To enhance convergence and adaptability, an attention mechanism is incorporated combined with a novel adaptive weighting strategy. This results in improved learning stability and predictive accuracy, outperforming existing attention-based PINN architectures. The framework is validated against benchmark problems with known analytical solutions, demonstrating superior accuracy and robustness. Additionally, proposed model is applied on real-world financial data where analytical solutions are unavailable, showcasing its practical utility in derivative pricing.

Our findings demonstrate that the proposed method offers a high-precision, scalable alternative to traditional solvers, while also advancing the integration of fractional calculus and deep learning. This work contributes to the development of interpretable and robust models in computational finance, highlighting the potential of physics-informed machine learning in addressing complex financial systems.

A Novel Finite Difference Scheme on Uniform Mesh for Integro-Differential Equations with Small ε -Parameters

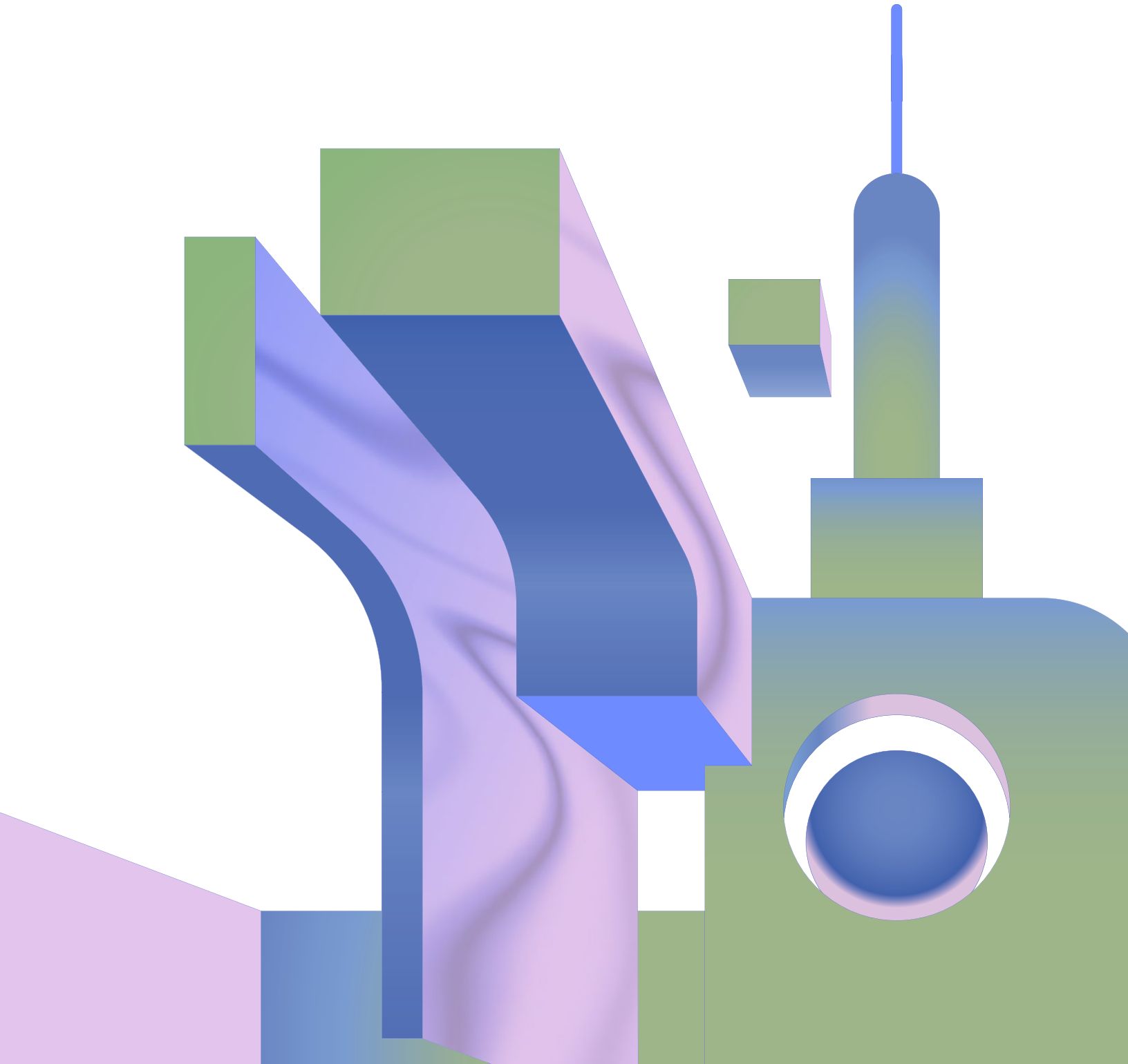
Name: Ömer Yapman

Institution: Erzincan Binali Yıldırım University

Abstract: This study presents a computational method of the first order for solving Volterra – Fredholm integro-differential equations with boundary layers. A numerical finite difference scheme is constructed on a uniform mesh. This is achieved by using the composite right-sided rectangle formula for the integral part, and interpolating quadrature rules and linear exponential basis functions for the differential part. It is demonstrated that the numerical scheme achieves first-order accuracy and uniformly converges with respect to the small ε -parameter. The efficacy of this approach is demonstrated by examining the performance of the numerical scheme in a single example.

SHORT COMMUNICATIONS

SECTION 16–CONTROL THEORY AND OPTIMIZATION



Tracking problem in nonlinear optimization of oscillation processes

Name: Elmira Abdyldaeva

Institution: Kyrgyz-Turkish Manas University

Abstract: In optimal control theory, there exists a class of problems in which the control objective is to minimize the deviation of a controlled process from a prescribed trajectory over the entire control horizon. Such problems are referred to as tracking problems. This paper investigates the solvability of a tracking problem within the framework of nonlinear vector optimization of oscillatory processes described by integro-differential equations in partial derivatives with a Fredholm integral operator, under the assumption that the scalar functions of external and boundary actions depend nonlinearly on the components of the vector controls. The analysis is carried out using the maximum principle for distributed parameter systems. The resulting optimality condition leads to a system of equality relations with respect to the components of both the distributed vector control and the boundary vector control. Therefore, the components of the optimal distributed and boundary controls are determined as solutions of a system of two nonlinear integral equations. A methodology for studying the unique solvability of this nonstandard system is developed. In particular, by introducing new functions defined on a closed domain, the system of two nonlinear integral equations is reduced to an equivalent scalar nonlinear integral equation. The unique solvability of the resulting scalar equation is investigated using the contraction mapping principle, and sufficient conditions for the existence of a solution are established. Based on these results, the optimal distributed and boundary vector controls are constructed, the optimal process is determined, and the minimum value of the cost functional is computed. Thus, for the case of distributed and boundary vector controls, a methodology for constructing a complete solution to the tracking problem in nonlinear optimization of oscillatory processes described by integro-differential equations in partial derivatives with a Fredholm integral operator is proposed.

Tseng's Type Methods in Continuous and Discrete Time for Quasi-Variational Inequalities

Name: Lkhamsuren Altangerel

Institution: German-Mongolian Institute for Resources and Technology

Abstract: Quasi-variational inequalities are a significant extension of classical variational inequalities, where the constraint set depends on the solution itself. They were initially introduced by Bensoussan et al. in 1973 in the context of impulse control problems and have since evolved into powerful mathematical tools with applications in economics, engineering, operations research, and partial differential equations.

This talk presents an approach for obtaining approximate solutions to quasi-variational inequalities in a real Hilbert space by modifying Tseng's scheme, which was originally designed for variational inequalities. The study explores the existence of equilibrium points and investigates convergence results related to dynamical systems. Linear convergence for discretized systems is examined through examples, illustrations, and special cases.

An Integrated Approach on the Flow Increment Facility Location Problem under Budget Constraint

Name: Ram Chandra Dhungana

Institution: Kathmandu University

Abstract: The frequency of natural and human-induced disasters has been increasing and we are always under threat. This has led to a strong need for evacuation planning that is not only efficient but also able to guarantee the safety of the people, other living beings, property, and the ecosystem. The designing of evacuation strategies is the process of making decisions concerning to the objectives that are multiple and, in most cases, conflicting, for example, the minimizing of total evacuation time, the optimizing of the number of people that has to be shifted at safe places, and the providing of support facilities, which are essential, under limited resources within the heterogeneous type of integrated evacuation network.

The research work here demonstrates a comprehensive framework of evacuation optimization that integrates multi-objective network flow concepts at its core. The model put forward is the one that determines in a joint manner the most advantageous locations of the facilities as well as the flow assignments to realize not only the evacuation that is efficient but also balanced. Moreover, to elevate network performance to even higher levels, a cost-aware contraflow strategy is presented which, by considering the switching and traffic management costs, along with the increasing capacity, reverses the arcs that are unused so as to facilitate the flow of traffic in an integrated approach. The inclusion of these genuine constraints in the model provides a means to evaluate the compromises that exist between efficiency, cost, and the feasibility of operations during disaster response.

Optimality conditions based on the Fréchet/limiting second-order subdi erentials

Name: Thi Viet An Duong

Institution: Thai Nguyen University of Sciences

Abstract: In this talk, we present some new results on second-order optimality conditions for minimization problems, where the objective functions are assumed to be C^1-smooth/$C^{1,1}$-smooth. For doing so, we apply the concept of Fréchet/limiting second-order subdifferentials from variational analysis to the Lagrangian function of the problem under investigation. Our results extend and refine several existing ones.

Pointwise Hölder Continuity of the Joint Spectral Radius and the Geometry of Extremal Norms

Name: Jeremias Epperlein

Institution: Universität Passau

Abstract: The joint spectral radius of a compact set of square matrices measures the exponential growth rate of the norm of long products from this set. Since its introduction by Rota and Strang in 1960, it found applications for example in the study of switched linear systems or the regularity of wavelets. It is also an interesting quantity from a purely theoretical point of view due to its connections with ergodic optimization and symbolic dynamics.

A central dichotomy in its study is between reducible and irreducible matrix sets, which require fundamentally different techniques. A set is irreducible, if it admits no non-trivial jointly invariant subspace. In this case a key tool is provided by so-called extremal norms, i.e. the norms whose unit ball is jointly invariant under all matrices in the set, multiplied by the inverse of the joint spectral radius.

Understanding the sensitivity of the joint spectral radius under perturbations is crucial in applications. In joint work with Fabian Wirth we proved that the joint spectral radius depends pointwise Hölder continuously on the matrix set. This generalizes both the single-matrix case, as well as Wirth's earlier results for the irreducible case, where local Lipschitz continuity holds.

In dimension two we can even show local, instead of pointwise, Hölder continuity away from zero. The obstruction to extending our argument to higher dimensions is tied to the geometry of extremal norms and in particular to certain extremal projection constants from finite-dimensional Banach space theory. We will discuss both the methods behind the regularity results and the obstructions related to the projection constants.

Backward-Backward Splitting with Warped Yosida Regularization for Monotone Inclusions

Name: Pankaj Gautam

Institution: Indian Institute of Technology Roorkee, India

Abstract: In this talk, we introduce the notion of warped Yosida regularization and study the asymptotic behaviour of the trajectory of dynamical systems generated by warped Yosida regularization, which includes Douglas-Rachford dynamical system. We analyze an algorithm where the inclusion problem is first approximated by a regularized one and then the preconditioned regularization parameter is reduced to converge to a solution of the original problem. We propose and investigate backward-backward splitting using degenerate preconditioning for monotone inclusion problems. The applications provide a tool for finding a minima of a preconditioned regularization of the sum of two convex functions.

A Multi-Stage Capacity Expansion Stochastic Model for Power Generation

Name: Mohammad Babul Hasan

Institution: University of Dhaka, Banghadesh

Abstract: Bangladesh's rapid electricity demand growth calls for resilient and cost-effective power expansion planning. This thesis develops a multi-stage stochastic programming model that jointly optimizes generation, transmission, and sub-transmission investments under uncertainties in demand, fuel prices, and renewable output. Renewable capacity factors are generated using Monte Carlo simulation, with scenarios structured into a multi-stage decision tree. Compared with a conventional two-stage model, the proposed approach reduces expected costs by approximately 30%, increases the renewable energy share to nearly 40%, and significantly mitigates load shedding. Sensitivity analyses highlight sub-transmission upgrades and renewable incentives as critical levers. The framework provides planners with a practical and adaptive tool for designing sustainable and flexible power system expansion strategies.

A Three-stage Green Multi-objective Multi-item Fixed-charge 5-dimensional Transportation Problem Under an Intuitionistic Fuzzy Environment

Name: Ekata Jain

Institution: Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat, India

Abstract: Sustainable transportation has emerged as a key global concern, driving the need for optimization models that promote environmentally responsible logistics planning and management. This study introduces a three-stage green multi-objective, multi-item fixed-charge five-dimensional transportation problem (GMMFC-5DTP) that explicitly incorporates sustainability considerations into transportation decision-making. A notable contribution of this work is the novel inclusion of driver behavior in carbon emission estimation, demonstrating that driver-specific characteristics have a substantial impact on emission levels. To realistically capture uncertainty in transportation parameters, trapezoidal intuitionistic fuzzy numbers are employed. Due to the model's high dimensionality and uncertain environment, advanced evolutionary optimization techniques are required. Accordingly, the non-dominated sorting genetic algorithms NSGA-II and NSGA-III are applied. In support of these algorithms, a feasible initial population generation strategy and a feasibility-preserving mutation operator are proposed, representing important methodological contributions. The effectiveness of the framework is validated through a numerical illustration. The results indicate that NSGA-III significantly outperforms NSGA-II, generating a much richer and more evenly distributed set of Pareto-optimal solutions for the three-stage GMMFC-5DTP. The findings further emphasize the critical influence of vehicle type, routing choices, and driver behavior on carbon emissions, offering practical insights for sustainable transportation planning. Overall, the proposed approach delivers clear and effective guidance for achieving greener and more efficient transportation decisions under uncertainty.

Backstepping control and stabilization of stochastic nonlinear discrete-time systems with time delays

Name: Mathiyalagan Kalidass

Institution: Bharathiar University

Abstract: The stabilization for nonlinear discrete-time strict-feedback systems with Poisson noise and time delays is investigated. A backstepping control framework is proposed to design a stabilizing controller for the considered stochastic system which helps to overcome the causality contradiction that appears in the controller design. Under Lipschitz continuity assumptions on the nonlinearities, sufficient condition for exponential mean-square stability of the closed-loop system is derived using Lyapunov-Krasovskii theory. The results are novel and has some new contributions to the discrete-time strict-feedback stochastic systems with delays. Finally, numerical examples are presented to illustrate the effectiveness of the proposed control strategy.

On a method for Solving the Riccati Equation

Name: Akylbek Kerimbekov

Institution: Kyrgyz Russian Slavic University

Abstract: The Riccati differential equation, encountered in various fields of science and engineering since 1724, has attracted the attention of mathematicians and engineers. With the advent of optimal control theory in the 20th century, interest in the Riccati equation significantly increased. When solving the problem of synthesizing optimal control, the Riccati equation appears in either differential or algebraic form. However, finding an explicit solution to the Riccati equation is possible only in special cases. This is because, despite extensive research spanning over 300 years, no algorithm has yet been developed for constructing particular solutions of the Riccati equation!

This paper presents the results of investigations into additional properties of the Riccati equation. It has been established that there exist certain Riccati equations whose particular solutions can be determined using known analytical methods, for example, via particular solutions of linear non-homogeneous differential equations. Such Riccati equations possess specific properties, and we refer to the set of such equations as the class of coefficient-conjugate Riccati equations. Furthermore, it has been proven that if a particular solution of a coefficient-conjugate equation is known, then it is possible to find a particular solution of a Riccati equation with arbitrarily given coefficients.

It should be noted that if a particular solution of the Riccati equation is known, then, based on the well-known properties of the Riccati equation, one can also find particular solutions of second-order linear differential equations and second-order linear systems with variable coefficients.

It has been shown that the developed algorithm for constructing particular solutions of coefficient-conjugate scalar equations can be generalized to matrix differential Riccati equations.

Similar results have been obtained for both scalar and matrix algebraic Riccati equations.

In conclusion, an example of solving an optimal control synthesis problem is presented, where the solution of the Riccati equation can be determined without significant difficulties.

Optimality Conditions for Minimax and Maxmin Problems

Name: Enkhbat Rentsen

Institution: Institute of Mathematics and Digital Technology, Mongolian Academy of Sciences

Abstract: Minimax and maxmin problems have an important role in optimization, global optimization, game theory, and operations research. The classical minimax theorem of von Neuman deals with the equality conditions of maxmin and minimax values. In a general case, since the maxmin and minimax values are not always equal, therefore, the optimality conditions for both problems might be different. In this talk, we formulate new optimality conditions for the minimax and maxmin problems. Illustrative examples are given for the problems

An EPQ Model for Electronics Industry to Determine Optimal Scheduling Times

Name: Shubham Tripathi

Institution: National Institute of Technology Jmshedpur

Abstract: The consumer electronics industry operates in a highly dynamic environment, characterized by rapid technological advancements, short product lifecycles, and intense market competition. Effective production scheduling is paramount for manufacturers to minimize operational costs and sustain profitability. Traditional inventory models often fall short in capturing the unique complexities of this sector, particularly concerning the swift onset of product obsolescence and the necessity for dynamic pricing strategies. This paper introduces an extended Economic Production Quantity (EPQ) model specifically designed to address above challenges within the electronics manufacturing context by mathematical modelling of an inventory system characterised by : (1) price difference dependent demand, (2) constant rate of production, (3) inventory level dependent selling price, and (4) non- instantaneous deterioration . The primary objective is to determine optimal production starting and stopping times that minimize the total system cost per unit time. The comprehensive total cost function considers setup, production, holding, deterioration (obsolescence) costs, shortage, and sustainability costs (e.g., related to production emissions). The mathematical model distinguishes between two critical scenarios based on the timing of obsolescence relative to production completion: Case 1, where obsolescence begins after production stops, and Case 2, where obsolescence starts during or before production ceases. The objective function is formulated using differential equations to describe inventory levels across various time intervals. MATHEMATICA 12.0 Software is employed to solve the complex system of non-linear equations derived from differentiating the total cost function, thereby obtaining the optimal scheduling policies. By providing a robust framework for optimizing production schedules under these realistic and industry-specific conditions, this research offers valuable managerial insights. It assists electronics manufacturers in effectively managing inventory depreciation due to obsolescence, mitigating shortage risks, and making informed pricing decisions in a highly competitive and dynamic market. The inclusion of sustainability

costs further enhances the model's relevance for modern, responsible manufacturing practices, paving the way for more efficient and environmentally conscious supply chain management in the electronics sector.

D&A: Resource Optimisation in Personalised Pagerank Computations Using Multi-Core Machines

Name: Kai Siong Yow

Institution: Universiti Putra Malaysia

Abstract: Resource optimisation is commonly used in workload management, ensuring efficient and timely task completion utilising available resources. It serves to minimise costs, prompting the development of numerous algorithms tailored to this end. The majority of these techniques focus on scheduling and executing workloads effectively within the provided resource constraints. In this talk, we tackle this problem using another approach. We propose a novel framework D&A to determine the number of cores required in completing a workload under time constraint. We first preprocess a small portion of queries to derive the number of required slots, allowing for the allocation of the remaining workloads into each slot. We introduce a scaling factor in handling the time fluctuation issue caused by random functions. We further establish a lower bound of the number of cores required under this scenario, serving as a baseline for comparison purposes. We examine the framework by computing personalised PageRank values involving intensive computations. Our experimental results show that D&A surpasses the baseline, achieving reductions in the required number of cores ranging from 38.89 to 73.68 across benchmark datasets comprising millions of vertices and edges.

Propagation phenomenon for parabolic equations with memory and its application to observability

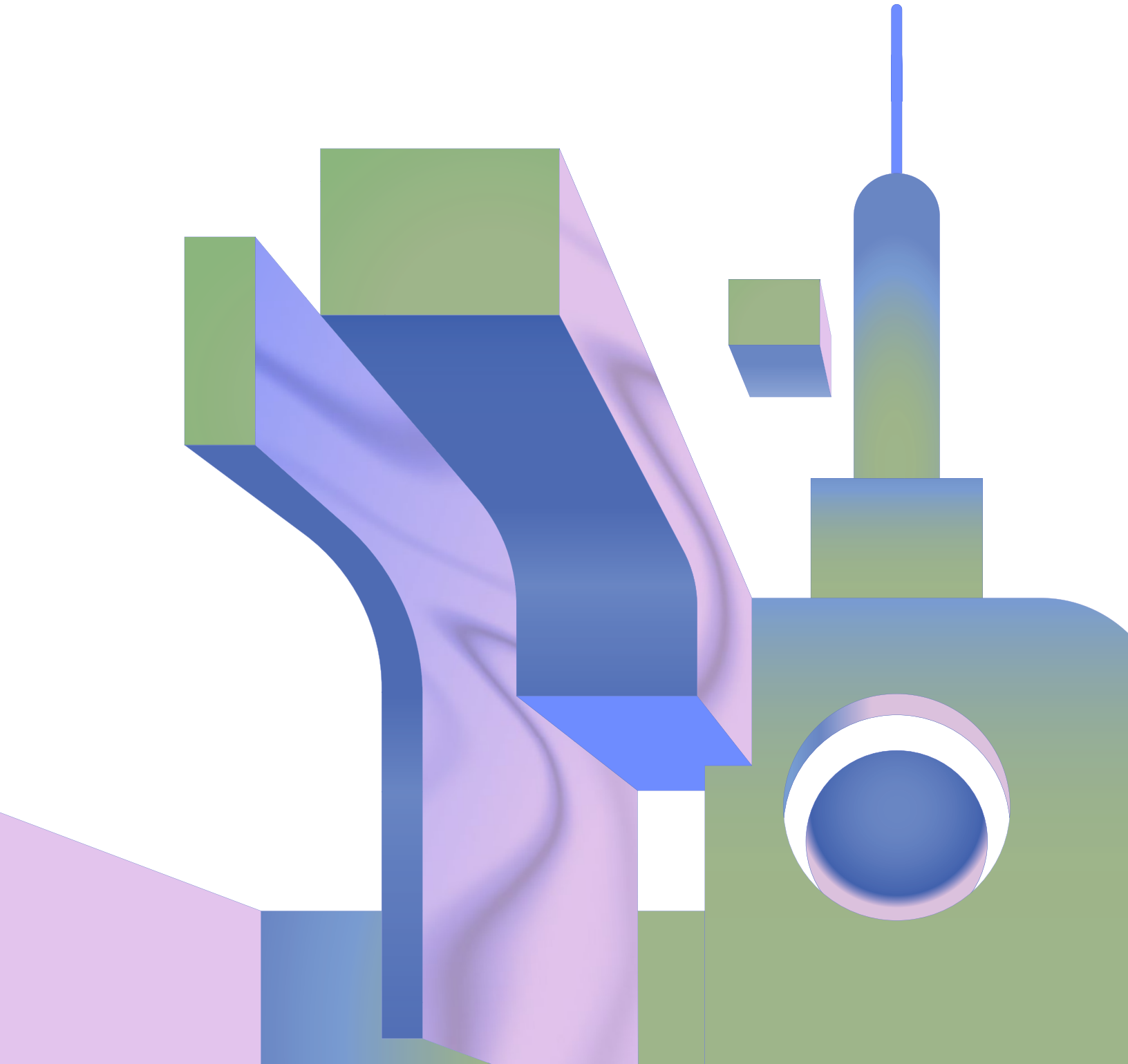
Name: Yubiao Zhang

Institution: Jilin University

Abstract: In this talk, we present the propagation of singularities for parabolic equations with memory, which reveals how singularities of solutions propagate bidirectionally along the time direction. To analyze this property, we develop a parabolic-hyperbolic decomposition method. As a key application, we establish an exact two-sided observability inequality, which allows the stable reconstruction of initial data—in an optimal Sobolev space—from partial measurements. Moreover, we derive a a necessary and sufficient geometric condition on the observation domain for such observability inequality to hold. This talk is based on joint works with Gengsheng Wang and Enrique Zuazua.

SHORT COMMUNICATIONS

SECTION 17–STATISTICS, MACHINE LEARNING, IMAGE AND SIGNAL PROCESSING



Hyperfinite Neural Networks

Name: Irfan Alam

Institution: University of Toronto Scarborough

Abstract: We study neural networks with infinite width by modeling the width with a hyperfinite number from nonstandard analysis. Such hyperfinite neural networks, when trained for a hyperfinite amount of time via gradient descent (with respect to the square loss) with an infinitesimal step size, allow us to recover results about the neural tangent kernel (NTK), while providing new perspectives about them. In particular, our method allows us to transfer approximate versions of infinite-width NTK results to the situation of finite networks of large (finite) widths. These results offer a first basis of the use of nonstandard methods in machine learning, which we expect will be used to build further results in the NTK and deep learning literature.

A New Shifted Lomax-X Family of Distributions Generated via the T-X Transformation: Properties and Applications to Risk and Financial Data

Name: Mintodê Nicodème Atchadé

Institution: National University of Sciences, Technologies, Engineering and Mathematics, Abomey, Benin

Abstract: The modeling of heavy-tailed risks is a central concern in actuarial and financial sciences. In this work, we introduce a new shifted Lomax-X (SHL-X) family of distributions constructed using the T-X transformation, which is known for its capacity to generate flexible distributional structures. Our construction is motivated by the limitations of the classical Lomax distribution in adapting to complex real-world data with skewness and heavy tails. A notable special case, the shifted Lomax-Weibull (SHL-W) distribution, is analyzed in detail. We study the mathematical properties of the SHL-W model, including its moments, quantile function, entropy, and hazard behavior, to provide insight into its structure and potential for practical use. The parameters of the model are estimated using the method of maximum likelihood. Through simulation studies, we assess the performance of the estimators in terms of bias and mean squared error under various sample sizes. To demonstrate practical applicability, the SHL-W distribution is fitted to real insurance claims data. The results show that the new model offers improved goodness-of-fit and tail flexibility compared to traditional models, supporting its use in pricing, risk assessment, and financial modeling. This study contributes a versatile new family of distributions with strong theoretical underpinnings and demonstrable effectiveness in applications where modeling extreme or skewed values is essential.

Conformal Uncertainty, Categorically Explained

Name: Michele Caprio

Institution: The University of Manchester

Abstract: Conformal Prediction (CP) is a model-agnostic framework for distribution-free uncertainty quantification. Given (i) an exchangeable sample $y_1, \ldots, y_n \in Y$, (ii) a significance level $\alpha \in [0, 1]$, and (iii) a function $\psi : Y^n \times Y \to \mathbb{R}$ that measures how well each observation conforms to the rest of the data, CP produces a Conformal Prediction Region (CPR) for y_{n+1} with coverage at least $1 - \alpha$.

Despite its recent prominence in statistics and machine learning research, the mathematical nature of the uncertainty represented by CPRs remains opaque: CP regions are ordinal indicators of uncertainty (larger regions indicate higher uncertainty), yet lack a cardinal interpretation (twice as large regions do not imply twice the uncertainty).

Contributions. We provide a category-theoretic characterization of CP that reveals its latent cardinal uncertainty quantification capabilities.

1. We introduce two categories

• **UHCont**, whose objects are topological spaces and morphisms are upper hemicontinuous set-valued functions (also called correspondences); and

• **WMeas$_{\text{uc}}$**, whose objects are compact Polish spaces and morphisms are weakly measurable, uniformly compact-valued correspondences.

The CP method defines a morphism in both categories.

2. **Theorem (informal).** If Y is compact Hausdorff, ψ is jointly continuous on $Y^n \times Y$ and invariant to permutations in Y^n, and α does not hit the discrete split-conformal levels, then deriving a CPR is equivalent to first obtaining a set $\mathcal{M}$ of probability measures on Y, and then extracting from $\mathcal{M}$ an Imprecise Highest-Density Region (IHDR)—a set-valued analogue of classical confidence intervals. Equivalence here is formalized by a commuting diagram in **UHCont** and **WMeas$_{\text{uc}}$**.

The set $\mathcal{M}$ is used to cardinally quantify uncertainty, e.g. via the generalized Hartley measure. We provide an example where $Y = [0, 1]^d$ represents the space of images.

3. As a byproduct, CP is shown to bridge Bayesian, frequentist, and imprecise-probabilistic paradigms: under standard posterior predictive consistency assumptions, a diagram linking the CPR, the posterior predictive α-level set, and the IHDR commutes asymptotically.

This formulation CP within a unified categorical framework for uncertainty; see arXiv:2507.04441.

On the use of the concentration function to compare predictive distributions in ARMA models

Name: Cristian Cruz Torres

Institution: National Autonomous University of Honduras

Abstract: In this study, we propose the use of the concentration function as a novel tool for assessing the adequacy of predictive distributions in a Bayesian framework. The methodology relies on a rolling-origin evaluation strategy, in which the available time series is partitioned into two segments: the first is used for model estimation, while the second is used for out-of-sample prediction. The concentration function is then constructed for each set of forecasts, providing a distributional assessment of predictive performance across competing models. In this framework, the model with the least inequality in its concentration function is interpreted

as offering superior predictive fit. To complement this curve-based analysis, we compute two well-established inequality measures—the Gini concentration coefficient and the Pietra index—which provide further evidence and consistency regarding model performance. These measures allow for a comprehensive evaluation of how closely predictive distributions align with observed outcomes. The proposed methodology is validated through a simulation study, in which its ability to discriminate between models is assessed under controlled conditions. We illustrate its practical applicability by analyzing real-world data, thus demonstrating the usefulness of concentration functions and associated inequality measures as diagnostic tools for Bayesian predictive evaluation.

A Unified Approach for Independence Testing in Mixed-Type Data

Name: Marija Cuparić

Institution: Faculty of Mathematics, University of Belgrade

Abstract: We consider the problem of testing independence in mixed-type data that combine count variables with absolutely continuous variables. After introducing test statistics in the bivariate setting for assessing independence between the components of a bivariate mixed-type vector, we extend them to the multivariate context to accommodate both testing independence between vectors of different types and possibly different dimensions, and testing total independence among all components of vectors with different types. The construction relies on a novel transformation that combines the probability generating function and the characteristic function to fully characterize the joint distribution of such data. We establish the asymptotic properties of the resulting tests and, through an extensive power study, demonstrate that the proposed approach is both competitive and flexible. Potential applications in variable selection problems are also discussed.

When Two Pairwise Comparisons Determine or Bound the Third

Name: Olga Demler

Institution: ETH, Zürich

Abstract: Let $\epsilon = P(A > B)$, $\eta = P(B > C)$, and $\zeta = P(C > A)$, where A, B and C are real-valued random variables. It is possible to define a space (ϵ, η, ζ) under general conditions, and this space is a proper subset of the unit cube. A natural question arises: under what conditions can the third comparison be inferred from the other two?

This framework is motivated by clinical trials, where ϵ, η, ζ, represent comparisons of time to death in a cancer trial for treatments A, B, C. In practice, trials comparing A vs. B and B vs. C exist. However, an additional trial comparing C vs. A is usually not performed. The field of network meta-analysis seeks to estimate these missing comparisons from available trial data. Standard methods in this field assume transitivity, which holds true for univariate statistics such as comparisons of means. However, $P(A > B)$ is a head-to-head comparison and can be non-transitive; that is, B outperforms A and C outperforms B does not imply C outperforms A. Thus,

for head-to-head comparisons, determining whether it is possible to reliably estimate missing third comparison based on the available data is non-trivial. In this work, we address this problem across several scenarios.

Trybula characterized the (ϵ, η, ζ) space. We show that it is a proper subset of the unit cube. This allows us to bound the unobserved comparison. Additionally, by restricting this space to the Weibull and Gaussian families, two common scenarios in clinical research, we achieve tighter bounds.

Hazard ratio (HR) is another head-to-head comparison. HRs are often estimated with Cox regression, which assumes the proportionality of hazards (PH), i.e. the ratio of hazards in two treatment arms is constant. In this work, we prove that the PH assumption implies transitive behavior, HRs are mutually recoverable, and we derive the third HR from the other two. Furthermore, if PH assumption holds, win proportions ($P(X > Y)$=win proportion) are monotonic transformations of HRs, hence the third WP is also recoverable from the other two.

Our findings demonstrate that the geometry of the $(\varepsilon, \eta, \zeta)$ space and certain scenarios allow us to bound the unobserved comparison. Extending this approach to other families of distribution functions remains an open direction for future research.

The Geometry of Three Pairwise Comparisons: Extension to Discrete Random Variables with Ties

Name: Anna Győrffy-Kerekes

Institution: ETH Zürich, Switzerland

Abstract: In many applied disciplines, including engineering and economics, inference is frequently based on pairwise comparisons rather than univariate summaries. These head-to-head comparisons - unlike univariate statistics - may be non-transitive. The violation of transitivity has been observed across diverse fields. In sports, the cyclic dominance pattern where player A tends to defeat B, B tends to defeat C, and C tends to defeat A, is often treated as a paradoxical curiosity. In economics, non-transitivity constitutes a fundamental violation of rational preference, addressed by the Arrow and Debreu Theorems. In evolutionary biology, analogous cyclic interactions have been proposed as a mechanism sustaining species diversity, a hypothesis supported by experimental evidence.

The mathematical structure underlying such phenomena was discussed in the 1930s and 1940s by mathematicians of the Scottish Café school, including Steinhaus. Later, his student, Stanisław Trybuła, provided a complete characterization of the comparison space for three random variables.

In this work, we report two contributions. First, intuitively, one might expect the Trybula space to be symmetric with respect to the three coordinates. We confirmed this geometric intuition by providing a reformulation of Trybula's Theorem that exhibits explicit symmetry. Second, we extended Trybula's result to discrete random variables with ties. Our prior work has shown how the Trybula result can be used in the context of clinical trials to rule out non-transitivity between treatments. However, in the case of clinical trials, one of the assumptions of Trybula, that the probability of ties is zero, can be frequently violated if we work with discrete time. E.g., deaths

are reported per day, per week, or per month. Our work resolves this issue by extending the Trybula result for discrete random variables with ties.

Accelerated and Distributed Langevin Dynamics For Bayesian Learning

Name: Mohammad Rafiqul Islam

Institution: Florida State University

Abstract: We introduce new developments in sampling theory based on higher-order Langevin Monte Carlo and decentralized stochastic gradient Langevin methods. Building on recent advances in Langevin dynamics of arbitrary order, we establish non-asymptotic Wasserstein convergence guarantees that improve the dependence of mixing times on dimension and accuracy. In parallel, we extend the EXTRA framework from decentralized optimization to Langevin-based sampling, thereby removing network-induced bias in distributed Bayesian inference. Our results enhance two directions—higher-order dynamics and consensus-based sampling—offering rigorous iteration complexity bounds together with provable scalability in multi-agent networks.

Robust Active Contour Model for Image Segmentation Based on Fractional Order Differentiation

Name: Subit Kumar Jain

Institution: National Institute of Technology Hamirpur

Abstract: Active contour models based on the level-set framework have gained widespread recognition for their ability to effectively segment a wide range of images. This approach excels in handling complex topology changes during curve evolution while the previous algorithms cannot deal with them. One of the primary benefits of active contour models is their capability to achieve precise segmentation of objects within images, irrespective of their diverse characteristics such as intricate backgrounds, varying shapes, and positions, all without necessitating the training of the model. In this paper, we have introduced a novel approach known as the fractional active contour model, specifically designed to effectively segment images that exhibit noise and inhomogeneity in intensity. To address both noise and inhomogeneity, we have devised a model that seamlessly integrates image denoising and segmentation tasks, enabling us to tackle these challenges simultaneously. The efficacy of our proposed coupled system of partial differential equations, which utilizes fractional order differentiation, has been verified through experiments conducted on clean, noisy, and ultrasound images. The proposed model demonstrates superior performance compared to other existing active contour models, both visually and quantitatively, as evidenced by significant improvements in measures such as Hausdorff distance and the dice similarity coefficient.

Adversarial Generalization of Unfolding (Model-based) Networks

Name: Vicky Kouni

Institution: Paris Dauphine - PSL University

Abstract: Unfolding networks are interpretable networks emerging from iterative algorithms, incorporate prior knowledge of data structure, and are designed to solve inverse problems like compressed sensing, which deals with recovering data from noisy, missing observations. Compressed sensing finds applications in critical domains, from medical imaging to cryptography, where adversarial robustness is crucial to prevent catastrophic failures. However, a solid theoretical understanding of the performance of unfolding networks in the presence of adversarial attacks is still in its infancy. In this paper, we study the adversarial generalization of unfolding networks when perturbed with l_2-norm constrained attacks, generated by the fast gradient sign method. Particularly, we choose a family of state-of-the-art overaparameterized unfolding networks and deploy a new framework to estimate their adversarial Rademacher complexity. Given this estimate, we provide adversarial generalization error bounds for the networks under study, which are tight with respect to the attack level. To our knowledge, this is the first theoretical analysis on the adversarial generalization of unfolding networks. We further present a series of experiments on real-world data, with results corroborating our derived theory, consistently for all data. Finally, we observe that the family's overparameterization can be exploited to promote adversarial robustness, shedding light on how to efficiently robustify neural networks.

Balancing Spectral Bias in Physics-Informed Neural Networks via Loss Design

Name: Ying Liang

Institution: Duke University

Abstract: We study the frequency bias of neural networks in function approximation and Physics-Informed Neural Networks (PINNs), highlighting how differential operators reshape spectral learning dynamics. Standard neural networks have a natural bias towards learning smooth, low-frequency functions, making it difficult for them to capture high-frequency details. For PINNs, this problem is exacerbated because the derivative operations in the PDE loss amplify errors in these high-frequency components, leading to an unbalanced training process that often fails on complex, multiscale problems. Motivated by this, we propose a new loss formulation that balances frequency components during training by weighting the loss function with Green's function, a solution that intrinsically accounts for the physics and boundary conditions of the system. We compare its performance with standard PINNs on PDEs with multiscale features. Our results demonstrate that this new approach significantly improves the network's ability to learn high-frequency features, leading to more accurate and robust solutions for complex physical systems.

Nonparametric estimation of the renewal function on mixing random fields

Name: Andriamampionona Livasoa

Institution: Department of Mathematics and Informatics, University of Antananarivo

Abstract: In queuing theory, the renewal function is considered in many papers and several researchers have contributed to this function. In this presentation, we study the nonparametric and asymptotically unbiased estimator of the renewal function based on mixing random fields indexed by $\mathbb{Z}^d$. Many applications can be founded such as the contamination of a contagious disease between individuals (people, animals or plants) on the Earth (dimension 2) or in the Oceans (dimension 3). It will spread faster between individuals depending on their proximity. The expectation of the average time for the first k individuals to be affected by the disease before a time t in a given region will depend generally of a certain mixing law. The estimator is constructed from the separation method of $\mathbb{Z}^d$ with which we obtain weakly dependent blocks of random fields. It consists to separate this domain into collection of disjointed blocks alternately of large size and small size. We focus on the almost sure convergence and asymptotic normality of the renewal function estimator based on stationary, ergodic and strongly mixing random fields.

Bolstering stochastic gradient descent with model building

Name: Özgür Martin

Institution: Mimar Sinan Fine Arts University

Abstract: Stochastic gradient descent method and its variants constitute the core optimization algorithms that achieve good convergence rates for solving machine learning problems. These rates are obtained especially when these algorithms are fine-tuned for the application at hand. Although this tuning process can require large computational costs, recent work has shown that these costs can be reduced by line search methods that iteratively adjust the step length. We propose an alternative approach to stochastic line search by using a new algorithm based on forward step model building. This model building step incorporates second-order information that allows adjusting not only the step length but also the search direction. Noting that deep learning model parameters come in groups (layers of tensors), our method builds its model and calculates a new step for each parameter group. This novel diagonalization approach makes the selected step lengths adaptive.

Neural network observers for a forced localization task in undersampled MRI

Name: Angel Pineda

Institution: Hofstra University

Abstract: Modelling human performance in forced localization tasks is a challenge for anthropomorphic model observers because of the many possible locations along with capturing human perception and variability. This is particularly challenging in anatomical images where the modeling requires generalization to out-of-distribution images such as in varying undersampling in magnetic resonance imaging (MRI). In this study, we modeled human forced localization (FL) performance using images with varied percentage of low frequencies fully collected in 5X MRI undersampling, ranging from 0% (aliasing) to 20% (blurring). We used a modified EfficientNet-B1 architecture trained to directly predict coordinates (FLNet) as well as using a biologically inspired V1Block, which incorporates Gabor filters to mimic early stages of human visual processing as a preprocessing to FLNet (V1FLNet). We used additive noise in FLNet and Poisson noise in the channel outputs of V1FLNet to match human performance. When trained on images with a specific number of low frequencies collected, both neural networks surpassed average human accuracy but diverged from human-like performance on out-of-distribution data. Training on both 0% and 20% data, leading to interpolation in the generalization led to better results than training on one condition. An adaptive model which trained at all frequencies but was only matched at 20% for human data did the best in terms of modeling human performance. In this study, we were able to surpass and predict average human performance. Both models predicted the decrease in performance for the fully aliased image. V1FLNet in its current implementation had similar generalizability as FLNet.

Multivariate Dependencies in Multiplex Graphons

Name: Anda Skeja

Institution: Uppsala University

Abstract: Pairwise interlayer dependence measures are insufficient to characterize multivariate dependence in random multiplex graphs. A simple example is the XOR construction: generate two layers independently and define a third as their edgewise XOR. The first two layers are marginally independent but dependent conditional on the third, so the dependence is intrinsically multivariate and missed by pairwise summaries. This motivates invariants of the full joint distribution that capture higher-order dependence. We construct such invariants and develop an estimation theory for them within the well-studied class of exchangeable multiplex graphs.

By exchangeability, an ℓ-layer multiplex ($\ell \geq 2$ fixed) admits a multiplex graphon $\mathbf{W}_\ell = \{W_\gamma\}_{\gamma\in\{0,1\}^\ell}$ with $W_\gamma(x,y) \geq 0$ and $\sum_\gamma W_\gamma(x,y) = 1$ for $(x,y) \in [0,1]^2$, encoding the local law of the $\{0,1\}^\ell$-valued edge-state vector under a shared latent parametrization.

Our contributions are twofold. First, we introduce the joint graphon entropy

$$H(\mathbf{W}_\ell) := -\iint_{[0,1]^2} \sum_{\gamma\in\{0,1\}^\ell} W_\gamma(x,y)\log_2 W_\gamma(x,y)\,\mathrm{d}x\,\mathrm{d}y,$$

show invariance under measure-preserving relabelings (so $H(\mathbf{W}_\ell)$ is well-defined on multiplex graph limits), and use it to define graphon-level multivariate information measures. In particular, we introduce a nonnegative graphon total correlation (and a conditional variant) that vanishes exactly when the ℓ layers are independent in latent space, and a signed graphon interaction information that separates redundancy from synergy and detects XOR-type dependence.

Second, we construct a nonparametric estimator $\widehat{H}(\mathbf{W}_\ell)$ of $H(\mathbf{W}_\ell)$ and the derived invariants from a single observed n-vertex multiplex with ℓ layers. For multiplex graphons $\mathbf{W}_\ell$ with Hölder(α) components ($\alpha \in (0,1]$),

$$\left|\widehat{H}(\mathbf{W}_\ell) - H(\mathbf{W}_\ell)\right| = O_{\mathbb{P}}\big(R_n \log(1/R_n)\big), \qquad R_n^2 = n^{-\frac{2\alpha}{\alpha+1}} + \frac{\log n}{n} + n^{-\alpha},$$

with the same rate for graphon total correlation and graphon interaction information; here R_n^2 is the standard Hölder(α) L^2 graphon rate (also for multiplex graphons with fixed ℓ). Together, this yields graphon-invariant multivariate dependence functionals estimable from one multiplex graph.

Toward a Mathematical Theory of Deep Learning: Lessons from Personal Research

Name: Weijie Su

Institution: University of Pennsylvania

Abstract: A century ago, breakthroughs like relativity and quantum mechanics emerged from or developed alongside rigorous mathematical theories. Today's AI revolution presents a stark contrast: progress remains predominantly empirical while mathematical theory lags significantly behind. In this short communication, I will share perspectives on current efforts to establish theoretical foundations for deep learning, drawing from my personal research experiences. We will examine the strengths and limitations of various approaches—including toy models, phenomenological models, and conditional-theory approaches—and explore why certain methods succeed in capturing specific behaviors while failing to provide comprehensive understanding. The short communication concludes by highlighting opportunities for the mathematics community to contribute to advancing the theoretical foundations of deep learning.

Small area estimation of mortality for countries with limited and scarce data – Nepal as a case study

Name: Jyoti U. Devkota

Institution: Kathmandu University

Abstract: Introduction: Vital Statistics are scarce in developing countries. The system of continuous registration of vital events is not efficient in such countries. Hence there is an urgent need to develop mathematical techniques that address this problem. Data on fertility and migration are scarce. National data on mortality are still scarcer, due to its somber nature. Further mortality data for small places are practically nonexistent. But these data serve as development indicators and provide guidelines to policy makers and planners. The reason behind the sorry state of such data is the lack of awareness, incentives and remote geographical locations. Materials and Methods: This paper is developed keeping this knowledge gap in mortality data into consideration. Life tables explain the mortality experience of a cohort. It is an important component in

the computation of average life expectancy at birth and age specific death rates. In this paper, a parsimonious regression model for survivorship function l_x on age and time variables is developed. The inherent pattern of l_x, based on census data from 1971 to 2011 is identified. Results and Discussion: The behavior of the regression coefficients and the model efficiency parameters are analyzed. Then this model is calibrated for small places. The mortality of two small places of Nepal namely, Kathmandu and Manang are estimated. The developed model is validated on the abundant and good quality data of Germany and the state of Niedersachsen. Conclusion: It is said that something is better than nothing. The developed technique and the model discussed here, estimated deficient mortality data with a high degree of accuracy. This was true, not only for developing countries like Nepal and India, but also for developed countries like Germany.

Hotel Pricing with Spatial Impact: A Comprehensive Overview of Spatial Regression Models

Name: Füsun Yalçın

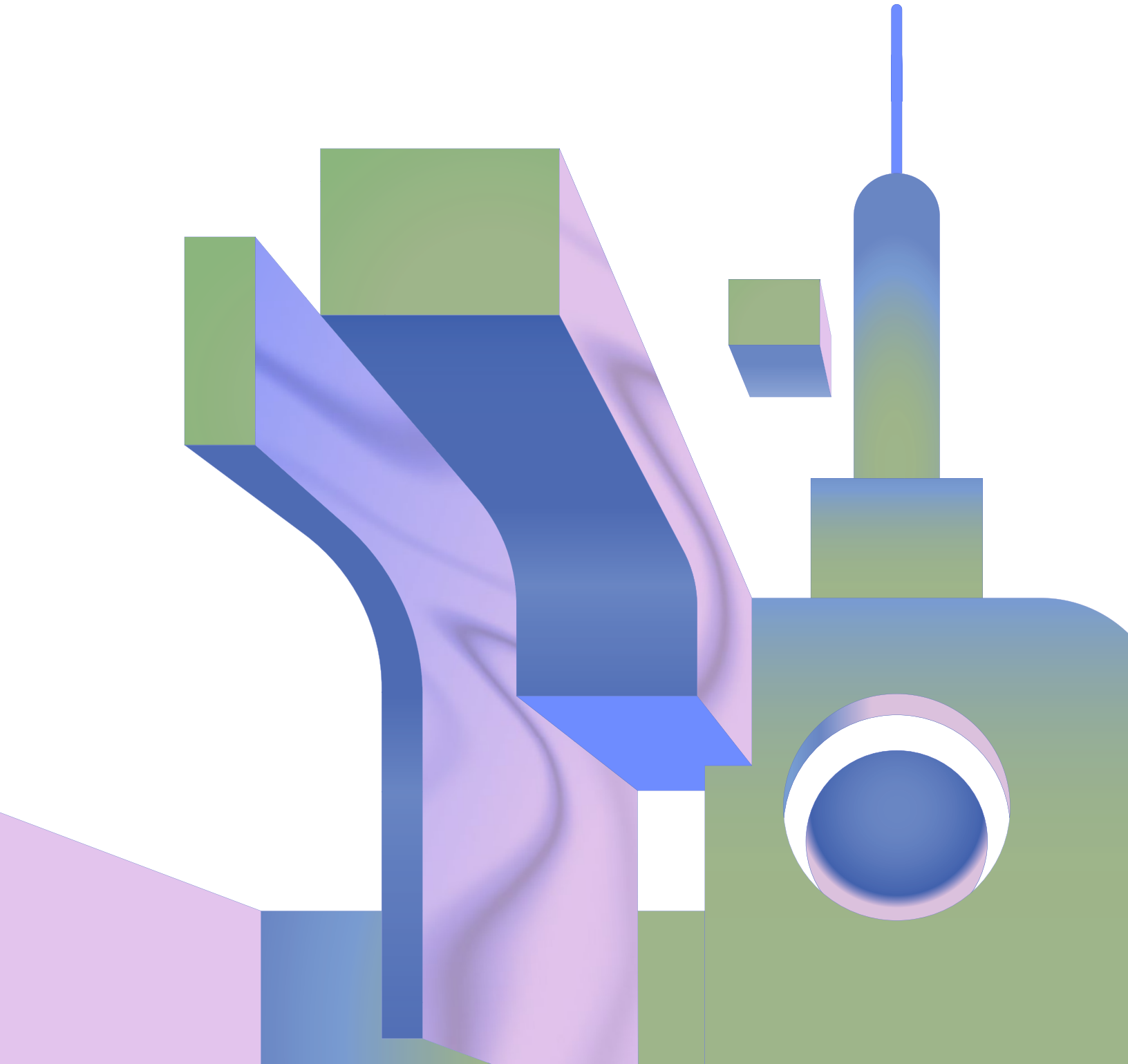
Institution: Akdeniz University

Abstract: Regression analysis is a common multivariate statistical method and mathematical model that is employed to understand the extent to which variables affect each other. Spatial regression is a highly effective method for understanding the effects of variables when location is hypothesised to have an impact on the location from which the data is collected. Yalcin and Mert conducted a study on nearly 1,500 data points in order to ascertain the characteristics affecting hotel prices, thereby demonstrating the efficacy of the location of the hotel [Determination of hedonic hotel room prices with spatial effect in Antalya, To appear in Economía, sociedad y territorio, 2018].

The aim of this presentation is to provide a comprehensive overview of spatial regression models and the detection of spatial effects. The discussion will cover the construction of spatial weight matrices for the inclusion of spatial effects in models, as well as selection criteria for spatial models. All of the above topics will be explained using examples first presented in the paper by Yalcin and Mert.

SHORT COMMUNICATIONS

SECTION 18–STOCHASTIC AND DIFFERENTIAL MODELLING



On a Keller-Segel type equation to model Brain Microvascular Endothelial Cells growth's patterns

Name: Benjamin Ambrosio

Institution: Le Havre Normandie University

Abstract: In this talk, after briefly mentioning fundamental and practical mathematical questions which are important in the context of seeking new therapeutics for neurodegenerative diseases, I will focus on the following Partial Differential Equation (PDE) of Keller-Segel type,

$$(1)\begin{cases} u_t &= f(u) - b\nabla\cdot(u\nabla v) + d_u\Delta u \\ v_t &= cu - ev + d_v\Delta v \end{cases} \tag{5}$$

Equation (1) can reproduce two dimensional patterns which are typically observed in vitro under microscopy during brain microvascular endothelial cells growth. I will highlight the mathematical mechanisms leading to the appearance of such patterns, and how some of these mechanisms can be observed in a 2x2 reduced coupled system of Ordinary Differential Equations (ODEs). I will also discuss how the model can help to characterize between healthy and diseased microscopic angiogenic patterns. I will provide theoretical results and numerical illustrations, on positivity of solutions for (1), the variety of patterns observed as a parameter varies, and bifurcation paths for the stationary solutions of the ODE which are relevant to understand the full PDE. Beyond these results, this article provides insights and perspectives on how to identify a few relevant parameters to characterize the diseased states and the underlying biochemical pathways. It also highlights a few new directions in a mathematical perspective. The biological observations were possible thanks to a collaboration with the Elahi Lab, a Neurology Lab at the Medical School at Mount Sinai in New-York. This talk relies on a joint work from 2024/2025 with A.F. Farroudji (Sorbonne Paris Nord), E. Stratigakou-Polychronaki and F.M. Elahi (Mount Sinai).

Traveling wave solutions in a delayed hybrid reaction-diffusion and difference SIR epidemic model with protection phase.

Name: Abdennasser Chekroun

Institution: Tlemcen university

Abstract: We consider a general class of diffusive Kermack-McKendrick SIR epidemic models with an age-structured protection phase with limited duration, for example due to vaccination or drugs with temporary immunity. The characteristics method reduces the model to a coupled system of a reaction-diffusion equation and a continuous difference equation with a time-delay and a nonlocal spatial term caused by individuals moving during their protection phase. We study the existence and non-existence of non-trivial traveling wave solutions. We get almost complete information on the threshold and the minimal wave speed that describes the transition between the existence and non-existence of non-trivial traveling waves that indicate whether the epidemic can spread or not. We discuss how model parameters, such as protection rates, affect the minimal wave speed. The difficulty of our model is to combine a reaction-diffusion system with a continuous difference equation. By using the Schauder's fixed point theorem, we

reduce the problem of the existence of non-trivial traveling wave solutions to the existence of an admissible pair of upper and lower solutions.

No-arbitrage conditions and pricing from discrete-time to continuous-time strategies

Name: Dorsaf Cherif

Institution: University Tunis El Manar

Abstract: A general framework is developed for continuous-time financial market models defined from simple strategies through conditional topologies that avoid stochastic calculus and do not necessitate semimartingale models. We then compare the usual no-arbitrage conditions of the literature, e.g. the usual no-arbitrage condition NFL and the recent AIP condition. With appropriate pseudo-distance topologies, we show that they hold in continuous time if and only if they hold in discrete time. Moreover, the super-hedging prices in continuous time coincide with the discrete-time super-hedging prices, even without any no-arbitrage condition.

An optimal stock selling rule with constraints

Name: Emily Crawford Das

Institution: University of North Georgia

Abstract: This talk is about an optimal stock selling rule with trading constraints. The goal is determining the time to sell the equity to maximize a discounted reward function. A geometric Brownian motion model represents the underlying stock price movement, and the trading permission process is given in terms of a two-state Markov chain. The optimal policy is determined by a threshold level obtained from solving an associated set of Hamilton-Jacobi-Bellman (HJB) equations (quasi-variational inequalities), from which a closed-form solution is obtained. A verification theorem is provided. Numerical experiments are also included to demonstrate the dependence of the optimal policy and value functions on input parameters.

Analytical modeling of foam flow with nanoparticles in porous media

Name: Tatiana Danelon de Assis

Institution: Federal University of Juiz de Fora

Abstract: Foam injection techniques have become increasingly relevant for controlling gas mobility in subsurface applications such as CO_2 storage, enhanced oil recovery, and environmental remediation. A central challenge in these processes is maintaining foam stability under reservoir conditions. Recent studies indicate that the addition of nanoparticles can substantially improve foam resistance and overall performance. Despite growing experimental evidence, there is a

lack of analytical investigations. In this work, we develop new mathematical models describing nanoparticle-stabilized foam flow in porous media. The first model assumes foam in local equilibrium and is described by a non-strictly hyperbolic system of conservation laws. We prove existence and uniqueness of a global solution of the associated Riemann problem, which consists of sequences of shock, rarefaction, and contact waves. The analytical solution provides a rigorous basis for investigating macroscopic quantities related to sweep efficiency. The second model accounts for bubble population balance through a source term describing foam generation and destruction, and incorporates nanoparticle retention leading to permeability reduction. This yields a more complex, nonconservative formulation. By exploiting the structure of the resulting system of ordinary differential equations, we derive a semi-analytical steady-state solution. The model captures two competing retention mechanisms (viscosity enhancement and permeability loss) and demonstrates mathematically that neglecting one or both effects leads to systematic underestimation of pressure.

Stationary Distribution of Lumpable Quasi Birth and Death Processes

Name: Dwi Ertiningsih

Institution: Universitas Gadjah Mada

Abstract: This research explores extensions to the successive lumping method for Markov chains and processes, originally constrained by the requirement of entrance states. Successive lumpability enables the stationary distribution of a Markov chain to be derived by computing the stationary probabilities of a sequence of reduced chains. While the entrance state condition ensures feasibility in this approach, its strictness limits applicability. Here, we investigate methods to relax or bypass this requirement, including the construction of artificial entrance states and leveraging structural properties of specific Markov processes.

Martingale problem for two-dimensional stochastic heat flow

Name: Mamadsho Ilolov

Institution: Center of Innovative Development of Science and New Technologies, NAST

Abstract: We consider a two-dimensional time-fractional stochastic differential equation

$$\partial_{0t}^{\alpha} u(t,x) = \frac{1}{2}\Delta u(t,x) + \lambda u(t,x)\dot{W}(t,x), t > 0, x \in R^2,$$

where ∂_{0t}^{α} - Caputo fractional derivative order α, $0 < \alpha \leq 1$, $\dot{W}$- white noise in $[0,\infty) \times R^2$, λ is the noise intensity coefficient.

Using the idea of Bertini - Cancrini we consider the regularized system of equations

$$\partial_{0t}^{\alpha} u^{\beta_0,\beta_\varepsilon}(t,x) = \frac{1}{2}\Delta u^{\beta_0,\beta_\varepsilon}(t,x) - \beta_\varepsilon u^{\beta_0,\beta_\varepsilon}(t,x)\dot{W}(t,x), t > 0, x \in R^2, \quad (6)$$

where $\beta_0 \geq 0$ and β_ε defined as

$$\beta_\varepsilon = \sqrt{\frac{2\tau}{-log\varepsilon} + \frac{\rho + O(1)}{(-log\varepsilon)^2}}, \quad \rho \in R.$$

It was proved that, if the initial function $u(0,x) = u_0(x) \in L^2(R^2), \psi \in L^2(R^2$.

Then the variation $< \int_{R^2} u^{\beta_0,\beta_\varepsilon}(t,x)\psi(x)dx >_t$ converges to some random variable when $\varepsilon \to 0$.

Thus, the density of the the random field from (1) is found.

Moreover, it is proved that the higher order moments are finite, so, the field of the random point should be a random field.

Finally, the weak convergence of the random field is proved for the case of directed polymers.

Thus, the solution of equation (1) will be the limit Z represented in the form of

$$\int_{R^2} Z(t,x)\psi(x)dx - \int_{R^2} Z(0,x)\phi(x)\psi(x)dx =$$

$$= \frac{1}{\Gamma(1-\alpha)} \int_0^t (t-s)^{-\alpha} \int_{R^2} \frac{1}{2}\Delta Z(s,x)\psi(x)dxds +$$

$$+ \frac{1}{\Gamma(1-\alpha)} \int_0^t (t-s)^{-\alpha} \int_{R^2} \beta Z(s,x)\dot{W}(dx,ds),$$

where $\phi \in C_c^+(R^2), \psi \in C_b^2(R^2)$.

It has been proved that the stochastic integral in the last term is the martingale and its quadratic variation can be written in terms of Z.

Also, the conditions of uniqueness of this martingale were found.

Oscillation of an Impulsive Differential Equations System with Piecewise Constant Argument

Name: Fatma Karakoc

Institution: Ankara University

Abstract: In this talk, we investigate existence of oscillatory solutions of a system of impulsive differential equations with piecewice constant arguments. First, we introduce the corresponding difference equation which is the main tool for the investigations. Then sufficient conditions for the oscillation of the solutions are obtained. Moreover, the results are compared with the non-impulsive case. Finally, numerical examples are given to illustrate the validity of the results.

Riemann Problems for Non-Strictly Hyperbolic Systems Arising in Three-Phase Foam Flow

Name: Luis Lozano

Institution: Laboratory of Applied Mathematics (LAMAP), Federal University of Juiz de Fora (UFJF)

Abstract: We study the Riemann problem for a system of nonlinear conservation laws arising in the modeling of three-phase flow with foam in porous media. The system is non-strictly hyperbolic due to the presence of an interior umbilic point, where the characteristic speeds of different families coincide, leading to nonclassical wave interactions and difficulties in constructing admissible weak solutions.

Assuming foam in local equilibrium, modeled through a constant mobility reduction factor, we analyze a three-phase flow system with large viscosity contrasts. Within this framework, we develop a systematic method to construct Riemann solutions using wave curve analysis, Hugoniot loci, and traveling wave criteria for shock admissibility. This approach enables the classification of solution structures for foamed gas and water injection across a wide range of initial states.

The results provide analytical insight into wave interactions near the umbilic point and clarify mechanisms leading to oil bank formation in displacement processes. The analytical predictions are supported by numerical simulations and are relevant to both the qualitative theory of conservation laws and the calibration and validation of numerical solvers used in porous media flow.

Mathematical Modeling of the Synergistic Anti-Cancer Effects of Combined Vesicular Stomatitis and Vaccinia Viruses

Name: Joseph Malinzi

Institution: University of Eswatini

Abstract: This research investigates the synergistic effects of combining Vaccinia (VV) and Vesicular stomatitis (VSV) oncolytic viruses for cancer treatment. A mathematical model, based on an experiment where the combination of VV and VSV demonstrated synergistic oncolytic activity in vitro and in vivo, is constructed and analysed. The model is subsequently fitted to the experimental data and parameters are estimated. The model's transient and qualitative behavior is characterized, generating new biological hypotheses to inform experimental validation and improve strategies for more effective tumor reduction. Global sensitivity analysis has been conducted to determine the parameters that most significantly influence the treatment outcome and several numerical simulations have been carried out to investigate the effect of different factors. Optimal time delays, representing the initial delivery timing of VV and VSV, which minimize tumor cell count during virus administration, have been determined. This is joint work with Raluca Eftimie, Anotida Madzvamuse, Rachid Ouifki, Amina Eladdadi and Helen Byrne.

Nonlinear Dynamics of a Ratio-Dependent Population System: Stability Analysis, Bifurcations and Chaotic Behavior

Name: Huseyin Merdan

Institution: TOBB University of Economics and Technology

Abstract: We present the complex dynamics of a prey-predator system modeled using a Leslie-type framework. The analysis begins with an examination of the system's stability properties. This is followed by an exploration of bifurcation phenomena and the emergence of chaotic behavior within the model. To validate and extend the theoretical analysis, numerical simulations are performed. The findings are subsequently interpreted from a biological perspective, emphasizing their ecological relevance.

Stochastic predictability and applications in credit risk theory

Name: Ana Merkle

Institution: University of Belgrade, Faculty of Mathematics

Abstract: In this talk, we will explore the concept of stochastic predictability introduced in [A. Merkle, Causal predictability and weak solutions of the stochastic differential equations with driving semimartingales, Statistics and Probability Letters, 197(C) (2023)]. This notion is grounded in the stochastic definition of causality within continuous-time models and captures a form of dependence between stochastic processes and filtrations. We will also examine some of the properties that have been developed since its introduction. Examples will be provided to illustrate the application of the concept of stochastic predictability to local martingales, along with its connections to well-established ideas in probability theory, stochastic differential equations, and related fields. In addition, we will apply this framework to diffusion-type processes, with particular emphasis on the uniqueness of weak solutions to Ito stochastic differential equations and those driven by semimartingales. The talk will conclude with a focus on applications in financial mathematics, especially in the modeling of credit risk.

Traffic Dynamics and Control in Conserved Fractal Network

Name: Muskan Muskan

Institution: Marwadi University, Rajkot

Abstract: In an urban-scale traffic system, traffic networks are formed in a city as it comprises roads and intersections defining the connectivity between them. Road networks play a crucial role in connecting urban centers and improving the connectivity of isolated areas where transportation is unavailable. Despite the complexity of modeling traffic flow on a network in recent years, many different robust and influential theories have been presented in the last decade. The urban road transportation system is investigated at the network level with the help of a macroscopic fundamental diagram (MFD). Utilizing the conventional macroscopic model, the MFDs were obtained successfully for low density, but it failed to predict the traffic behavior at high densities

due to traffic instabilities. To overcome this issue, a simplified speed-matching model has been proposed where the MFD has been reproduced for all density ranges. In real traffic dynamics, traffic control serves as an indispensable component in optimizing the traffic flow, especially on networks. To analyze the varied complexity of traffic dynamics, the percolation back bone fractal network is characterized via cell-transmission model. Considering a generalized flow-density relation, dynamic model is modified to scrutinize the impact of transition rates on traffic flow in a conserved network. The macroscopic fundamental diagrams attained through numerical simulation are investigated for homogeneous as well as heterogeneous transition rates. For first-generation fractal network, unimodal or bimodal traffic currents are observed with respect to mean density. Further, for second-generation fractal network, two types of density waves are observed depending upon the number of vehicles present in system: uniform equilibrium state and oscillatory state. It is observed that the transition rates corresponding to singly-connected nodes can control the traffic dynamics to ensure a uniform stationary flow, which cannot be achieved via the doubly-connected and quadruple connected nodes.

Mathematical Modeling and Analysis of Control Measures in Dengue Disease Transmission Dynamics

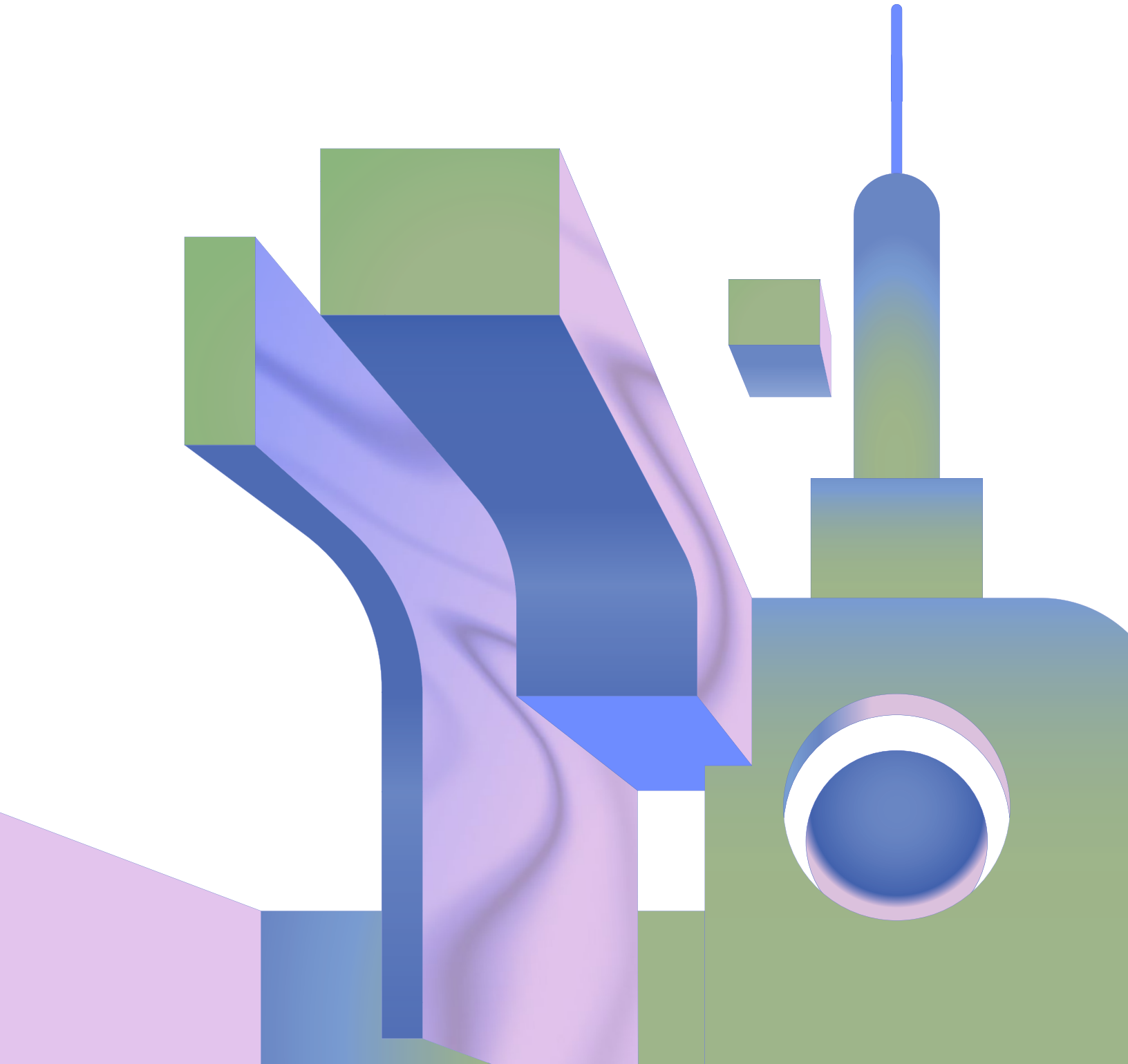
Name: Ganga Ram Phaijoo

Institution: Kathmandu University

Abstract: Dengue disease is a vector-borne disease. It is endemic in tropical and subtropical regions worldwide. The disease is caused by any one of the four serotypes of the dengue virus, which is spread to humans through the bites of the infected Aedes mosquitoes. Several disease-control strategies, which help to bring the disease transmission under control, are introduced in this work. A SEIR-SEI compartmental model is proposed to study the impact of these control measures on the transmission dynamics of the dengue disease. The next-generation matrix method has been used to compute the basic reproduction number, Ro of the model, which serves as a metric to measure persistence of the disease. The disease-free equilibrium of the model is found to be asymptotically stable when $Ro < 1$ and unstable when $Ro > 1$. A sensitivity analysis is performed to identify the model parameters that significantly affect the disease transmission. Numerical simulations are carried out to evaluate the impact of various control strategies on the disease dynamics graphically. The results highlight the importance of the control measures in reducing the value of Ro below unity, thereby achieving effective control in the disease transmission.

SHORT COMMUNICATIONS

SECTION 19–MATHEMATICAL EDUCATION AND POPULARIZATION OF MATHEMATICS



Lessons on the Icosahedron

Name: Nebojša Ikodinović

Institution: University of Belgrade, Faculty of mathematics

Abstract: Through lessons on the icosahedron, we aim to address three key questions of teaching: What? For whom? How? We seek answers that lie somewhere between the big ideas of renowned mathematics educators, which have not yet been fully integrated into teaching practice, and experiences from contemporary classrooms, which often fall outside established theoretical frameworks. These answers are summarized as concise didactic principles and illustrated through exercises for mathematics students in an undergraduate course on the methodology of teaching mathematics. The first principle – the principle of minimality – is illustrated through a description of a workshop conducted by students with pupils aged 14. The workshop task was to estimate the minimal edge length of an icosahedral box that can hold 0.5 kilograms of sugar (using cardboard, geometric tools, scissors, glue, kitchen scales, and a packet of sugar). This principle aligns with the Moore model of learning and the Feynman model of simplicity. The second principle – the principle of adaptation – is illustrated through an analysis of the students' work in which they were tasked with preparing three lectures on the same topic: a school-level lecture, a popular lecture, and an academic lecture. The topics they could choose from included the truncated icosahedron, the Dymaxion (Fuller's) world map, the tensegrity icosahedron, the great icosahedron. The principle follows the sociocultural approach, based on the ideas of Vygotsky, which emphasizes the importance of social interaction and the context in which learning occurs. The third principle – the principle of activity – is illustrated by the task of examining the symmetry group of the icosahedron using both concrete and abstract models. Students were seeking the most effective ways of learning group theory and studying Klein's famous Lectures on the Icosahedron, in the spirit of the ideas of Pólya, Skemp and others.

FUNDAPROMAT: Spreading the Joy of Mathematics

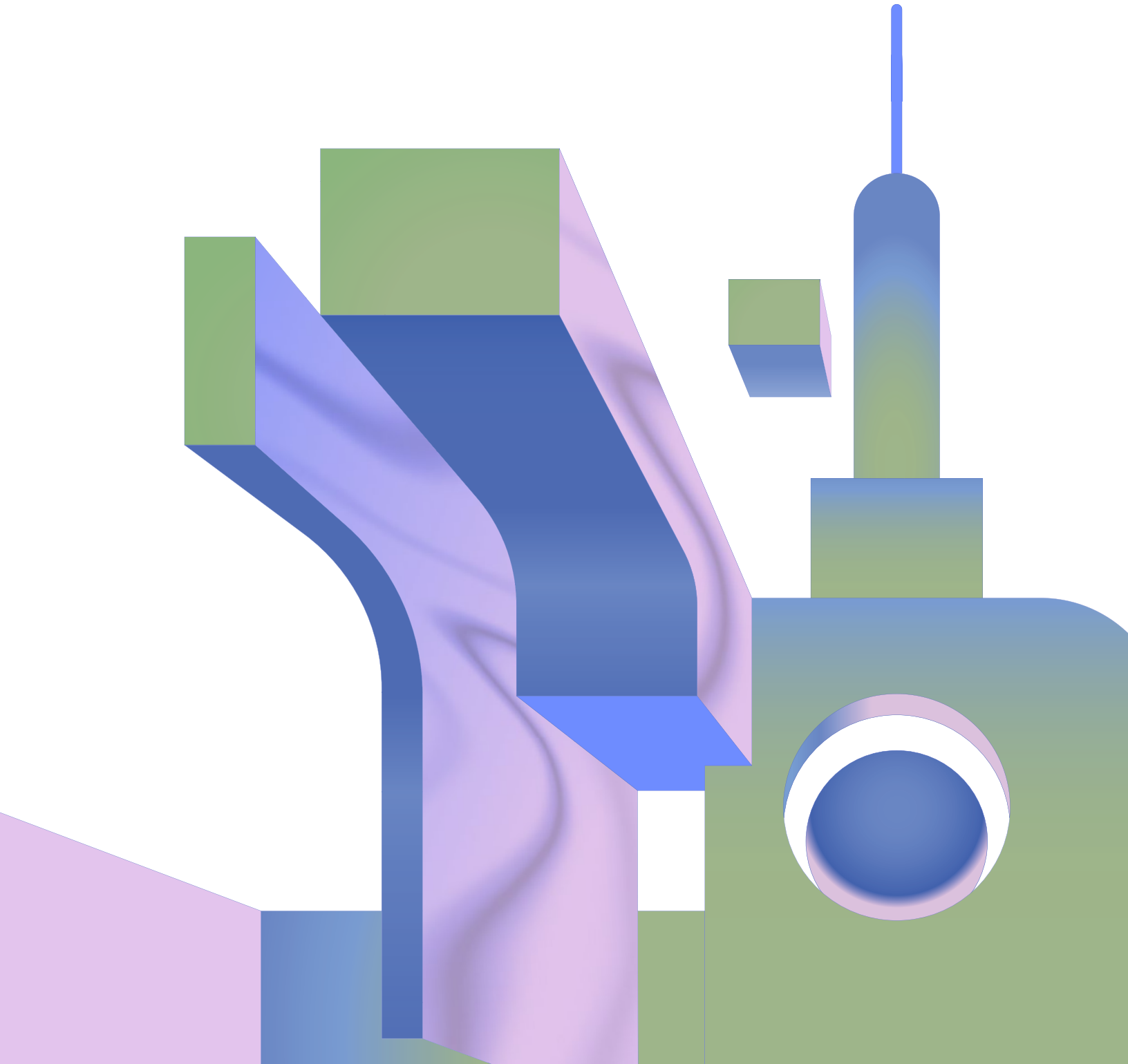
Name: Jeanette Shakalli

Institution: Panamanian Foundation for the Promotion of Mathematics (FUNDAPROMAT)

Abstract: The Panamanian Foundation for the Promotion of Mathematics (FUNDAPROMAT) is a private non-profit Foundation based in the Republic of Panama whose mission is to change the world's perception so that one and all can experience mathematics as accessible, relevant and inherently joyous. So far the Foundation has organized more than 700 free math outreach events, both virtual and in-person, with more than 70,000 participants, including Panamanians and internationals from all over the world. In this short presentation, Dr. Shakalli will briefly describe what we do in FUNDAPROMAT, how we do it and why we do it. Dr. Shakalli will also share the teaching resources that students, teachers and parents can download for free on the FUNDAPROMAT website https://www.fundapromat.org/en.

SHORT COMMUNICATIONS

SECTION 20– HISTORY OF MATHEMATICS



The grandeur and the sorrow behind the first set-theoretical paper and the emergence of the Dedekind letters

Name: Demian Nahuel Goos

Institution: UNR

Abstract: This talk presents a detailed analysis of the circumstances that lead to Georg Cantor's first paper on set theory in 1874. Particular attention is paid to Cantor's correspondence with Richard Dedekind and the exchange of ideas between the two scholars. The undisclosed use of remarks of Dedekind's in Cantor's 1874 paper led to tensions and a tacit dispute over the authorship of the mathematical results contained therein. In this context, this talk announces the discovery of the Dedekind letters of Cantor's Nachlass, which were believed to be lost. Two of those unedited letters from 1873 were used to confirm that some of the mathematical results in Cantor's 1874 paper were due to Dedekind. This matter, although very probable, had not yet been definitively confirmed and has led to greater tensions among historians who have dealt with Cantor and Dedekind. Further analyses of the relationship between the two mathematicians, the development of the mathematical ideas, and the authorship of the 1874 article are presented.

The history and present of infinitesimals

Name: Linjie Song

Institution: Tsinghua University

Abstract: We discuss the history of infinitesimals in five periods. Then we find that a key problem is to establish a system dealing with infinitesimals. We further show that there may be a new approach to fundamentally solve this problem.

(i) The rudiment of the idea of infinitesimals was born before calculus was established.

(ii) Thanks to the use of infinitesimals, calculus methods had made great progress in the period of establishing and developing calculus.

(iii) In the rigorization of analysis period, the mainstream modern calculus system was formed, in which differential (or infinitesimals) becomes unnecessary.

(iv) Refactoring with a rigorous logical foundation, non-standard analysis showed that Leibniz' use of infinitesimals was maintained.

(v) Infinitesimal analysis is currently an active field featuring both mathematical innovations and historical re-appraisal.

Expressions of Factorisation in Japan During the EDO Period

Name: Noriko Tanaka

Institution: Naragakuen University

Abstract: There were several schools of mathematics in Japan during the Edo period (1603 - 1868). The most famous and popular school was the Seki school [関流] of the renowned mathematician Seki Takakazu [関孝和] (?-1708). In addition to the Seki school, there were various other schools such as Takuma school [宅間流], Shisei-Sanka school [至誠賛化流], Saijyo school [最上流] etc.

And the mathematical books were written in different expressions in different schools. The Seki school's way of expressing mathematics is inspired by the motif of Sangi [算木], which was introduced from China to Japan. Takuma school does not use Sangi expressions of arithmetic sticks. Negative numbers are written as fu (フ) in Japanese katakana [カタカナ], and numbers are one(一), two(二), three(三) in Japanese kanji [漢字].

We shall examine a book dealing with mathematical expressions at Takuma School, specifically concerning factorisation. It is not known how factorisation was written in Japanese mathematics during the Edo period. Regarding how factorisation was written in vertical-writing mathematics. We read all five volumes of Oka's "Kijutsu Kairohō [起術解路法] (Takuma School's Collection of Method of Resolving the Path of Techniques)" . Volumes 4 and 5 of this book cover factorisation. "Kijutsu Kairohō" volumes 4 presents all problems using plane figures, yet factorisation is employed to solve every single one. Some expressions are highly complex and are presented without ( ) expression.

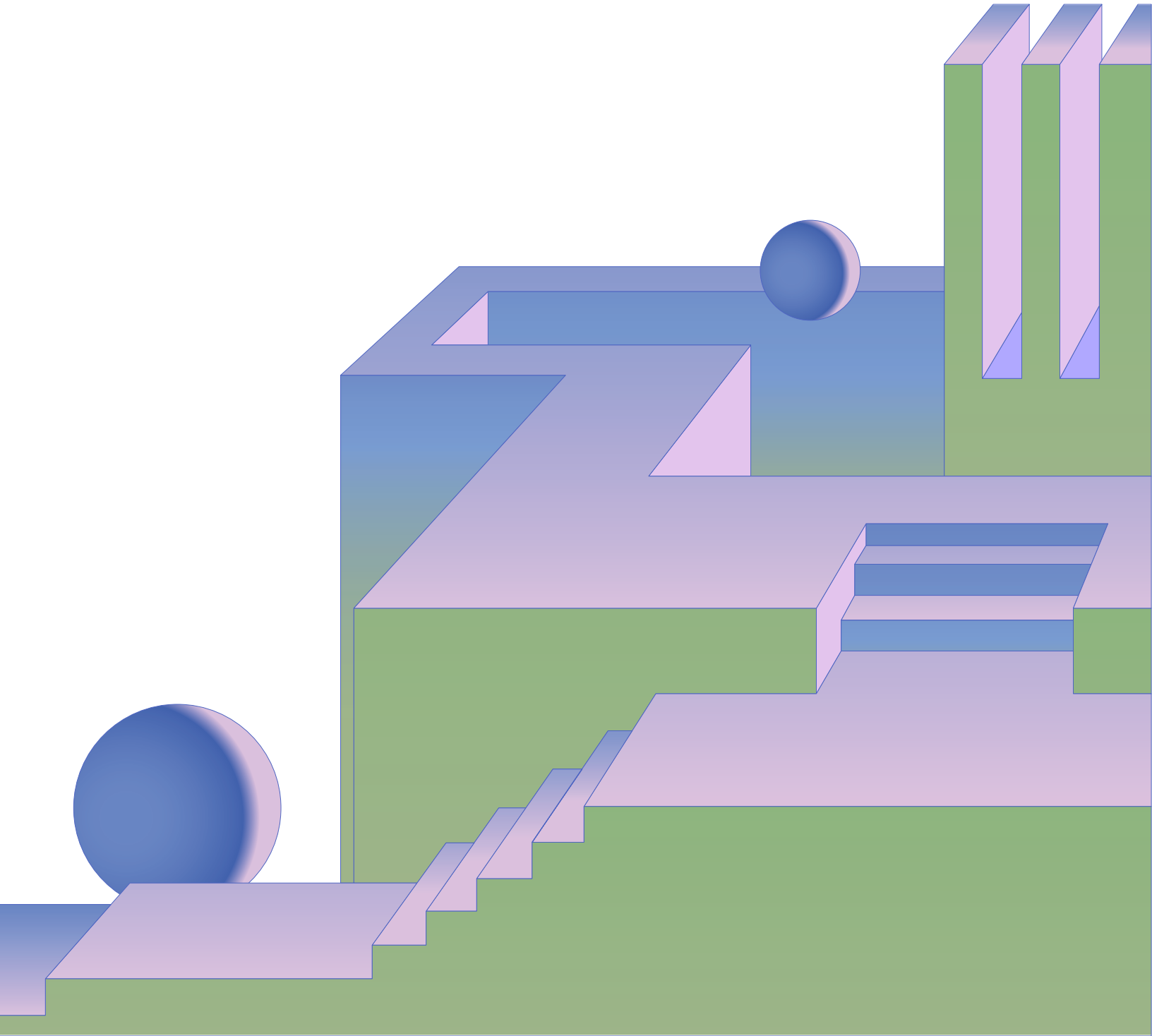
When students solved an excellent mathematical problem, they thanked the gods or Buddha, wrote the problem and the formula for solving it on a wooden panel called sangaku[算額] (votive mathematical tablets), and dedicated it to a shrine or a temple. In the Edo period, shrines and temples were the most crowded places, not only for festivals, celebrations, and funerals, so by displaying sangaku there, students could show many people the problems that could be solved.

The Sangaku at Takuma School in Zenkoji Temple[善光寺] features a problem requiring factorisation to solve. This problem was highly complex, and presenting it to the public at the renowned temple served as a form of publicity for the Takuma School and its affiliated student.

I am interested in mathematical schools other than the Seki school. I will also focus on the spread of the school's students in Japan.

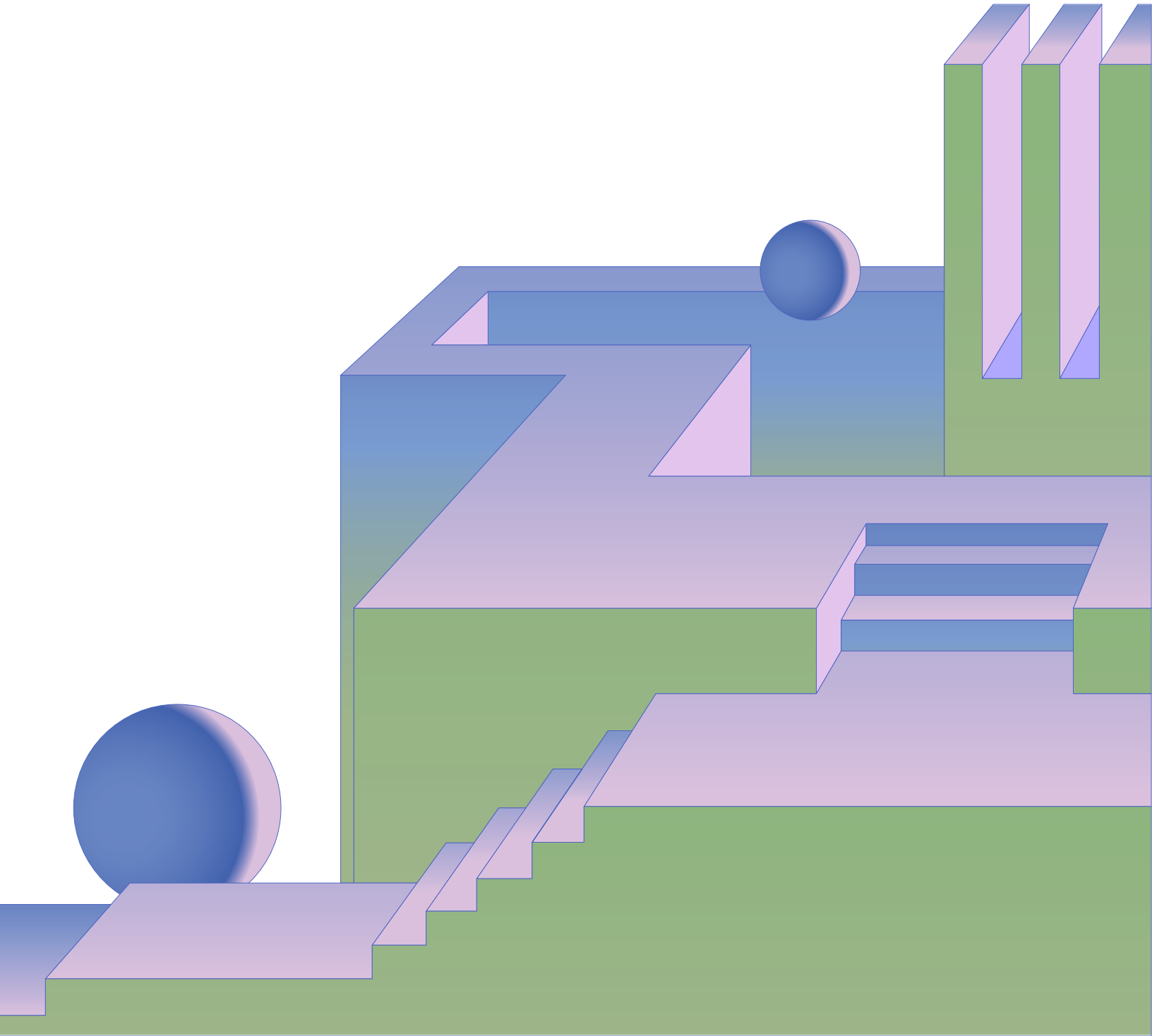
POSTERS

2026 INTERNATIONAL CONGRESS OF MATHEMATICIANS



POSTERS

SECTION 1–LOGIC



Collapsing of Minimality Conditions in Divisible Ordered Abelian Groups

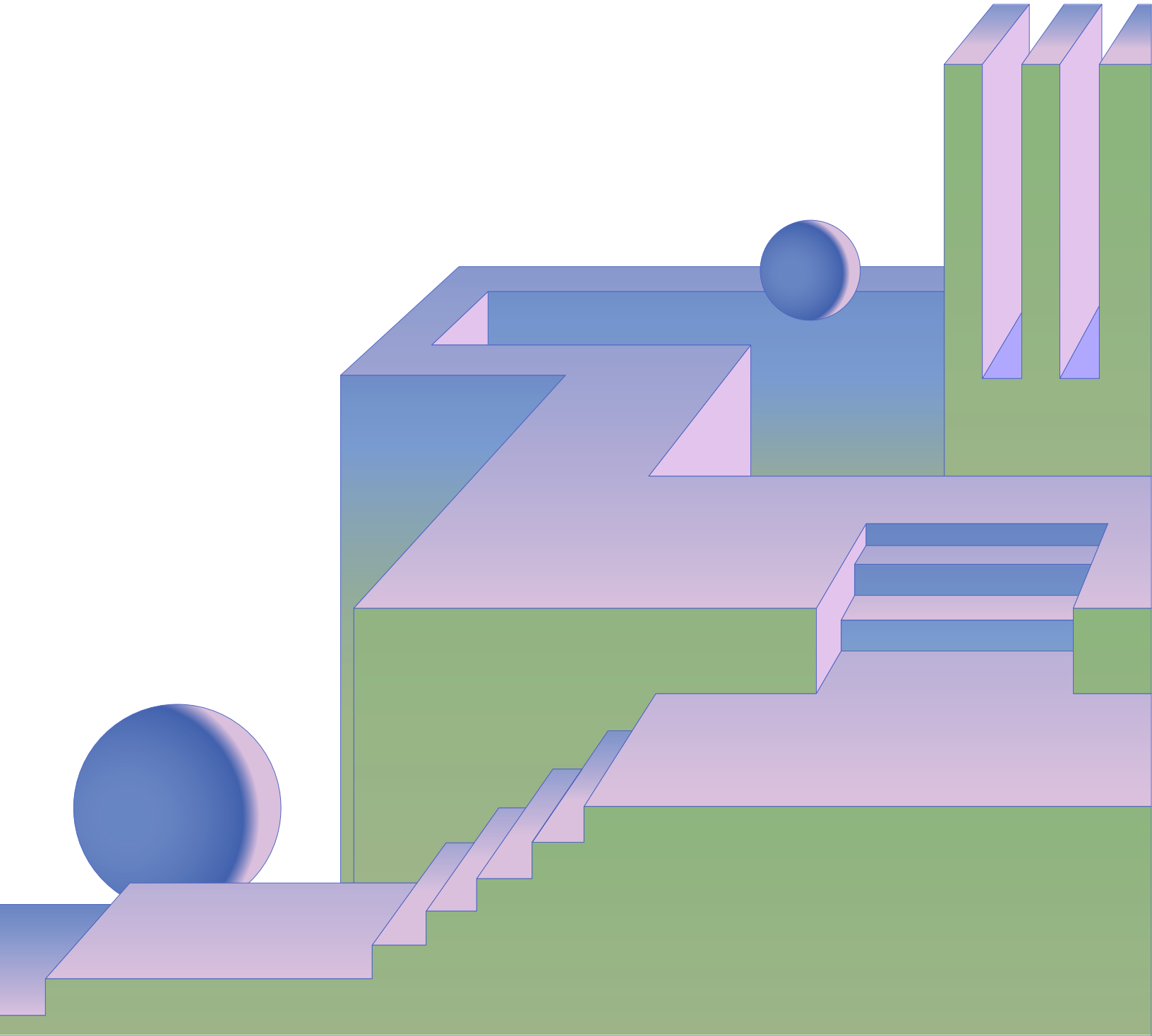
Name: Jacob Stern

Institution: CUNY Graduate Center

Abstract: For expansions of linear orders many different notions of minimality may be considered. Among the most restrictive of these is weak o-minimality while among the least restrictive is dp-minimality, but there are also many other interrelated notions. We expand on machinery introduced by Guingona and Flenner to show that in the context of divisible ordered abelian groups many of these notions coincide. In particular we show that a locally convexly orderable expansion of a divisible ordered abelian group is weakly o-minimal. This proves the equivalence of several intermediate minimality notions and gives several nice algebraic properties of such structures.

POSTERS

SECTION 2–ALGEBRA



Gotzmann thresholds of monomials: a general method and its application

Name: Vittoria Bonanzinga

Institution: Mediterranea University of Reggio Calabria

Abstract: The study of Hilbert functions and their growth conditions is central to commutative algebra, with Gotzmann ideals representing a critical class where the Hilbert function attains Macaulay's lower bound. A longstanding open problem is the explicit characterization of Gotzmann monomials—monomials whose associated Borel-stable ideal is Gotzmann.

For a monomial u_0 in $n-1$ variables, the Gotzmann threshold $\tau_n(u_0)$ is the smallest integer t such that $u_0 x_n^t$ is a Gotzmann monomial in n variables. While this threshold is fully understood for $n \leq 4$, the case $n \geq 5$ has remained elusive. This work presents an efficient, general procedure to compute $\tau_n(u_0)$ for any n and any monomial u_0.

Our method leverages a combinatorial characterization of Gotzmann monomials via the equality of maxgen monomials of gaps and cogaps. Key ideas include the introduction of a truncation morphism and an iterative map to compute the cost of upward paths in the lexicographic order of monomials, effectively reducing the problem to the analysis of associated polynomial functions.

As a significant application, we apply this procedure to the critical monomial $u_0 = x_2^d$, deriving the first explicit formula for the Gotzmann threshold in five variables:

$$\tau_5(x_2^d) = \left(\binom{\binom{d}{2}}{2} + \binom{d+1}{3} + \binom{d}{2}\right) - \left(\binom{d}{3} + \binom{d+3}{4}\right) - d.$$

Based on the explicit formulas for $n \leq 5$, we conjectured that for $n \geq 6$, $\tau_n(x_2^d)$ is a polynomial in d of degree 2^{n-2} with dominant term equal to that of an $(n-2)$-iterated binomial coefficient. This conjecture has since been independently confirmed through different approaches, including recursive formulas and combinatorial algorithms.

On a Finite-Iteration Method for Solving SLAE

Name: Roman Filippov

Institution: Plekhanov Russian University of Economics

Abstract: A.S. Iskhakov, G.B. Lazarev, S.M. Skovpen, N.A. Sukhotskaya, R.G. Filippov Abstract Historically, iterative methods for solving systems of linear algebraic equations (SLAE) with a stationary matrix have been regarded as approximate methods that cannot yield a zero error for the unknown vector in a finite number of iterations. However, in control theory, for a linear system characterized by the same equation, there exists a method for transferring the state vector from an arbitrary position to a specified one in a finite number of steps, which implies obtaining the zero vector. This result is achieved through a system transformation aimed at obtaining a nilpotent matrix, raising it to a power at the final step, and subsequently zeroing out its elements, which explains the finiteness of the process. This idea is implemented in the proposed iterative method for exact solution of SLAEs in a number of iterations equal to the matrix size minus one.

The method is based on a procedure for forming the matrix spectrum equal to a set of arbitrarily specified numbers. Localizing this set at unity generalizes the Gaussian elimination method, which produces a triangular matrix with a unit diagonal, and leads to a dense unipotent matrix that can be expressed as the sum of an identity matrix and a nilpotent matrix. The computational operations reduce to deriving and solving spectral equations that follow from Vieta's relations between the specified spectrum and the leading principal minors of the matrix with respect to unknowns that, in the general case, replace arbitrarily selected matrix elements. Depending on the specific choice of elements, the spectral equations may be either linear or nonlinear. Iterations with a nilpotent matrix, upon reaching an exponent value equal to the matrix size, firstly annihilate the solution component associated with an arbitrary initial vector, and secondly make the sum of the power series of the nilpotent matrix equal to the inverse of the unipotent matrix; multiplication by the right-hand side then yields the exact solution of the SLAE. When the system is specified symbolically, the iterations lead to Cramer's formulas.

Nilpotent associative algebras

Name: Ikboljon Karimjanov

Institution: Andijan State University

Abstract: The present work is devoted to the classification of nilpotent associative algebras whose nilindex does not exceed n − 3. In particular, filiform, naturally graded quasi-filiform, and nilpotent associative algebras of nilindex n − 3 are classified up to isomorphism. Furthermore, a complete description of nilpotent associative algebras with characteristic sequences (n − m,m) and (n − p,1,⋯,1) is provided.

Sets of lengths of integer-valued polynomials on prime ideals

Name: Sarah Nakato

Institution: Kabale University

Abstract: Let D be a domain with quotient field K and finite residue fields. For a non-empty infinite subset $S \subseteq D$, the ring of integer-valued polynomials on S is defined as

$$\mathrm{Int}(S, D) = \{f \in K[x] : f(S) \subseteq D\}.$$

$\mathrm{Int}(S, D)$ is far from being a unique factorization domain. A key invariant that describes non-unique factorizations is the set of lengths. That is, the set of all natural numbers n such that $f \in \mathrm{Int}(S, D)$ has a factorization of length n. Sets of lengths fully describe the factorization behaviour of the structure, and we can deduce certain invariants from them. Such investigations give information about the arithmetical and algebraic properties of the algebraic structures under consideration.

In this poster, we focus on the ring $\mathrm{Int}(M, D)$, where M is a maximal ideal of the principal ideal domain D.

We present two main results:

1. Every finite non-empty set N of natural numbers greater than 1 occurs as a set of lengths of a polynomial $f \in \mathrm{Int}(M, D)$.
2. $\mathrm{Int}(M, D)$ is not a transfer Krull domain.

Joint work with Zaituni Kansiime, Sholastica Luambano, Hadijah Nalule, and Yvette Ndayikunda.

On Complete Integral Closedness, Skew-Injectivity, and π-Injectivity of Modules

Name: Muamar Musa Nurwigantara

Institution: Universitas Gadjah Mada

Abstract: Let M be a torsion-free module over an integral domain D with its quotient field $K \neq D$. In our sense, M is strongly completely integrally closed if the set $O_K(N) = \{k \in K \mid kN \subseteq N\}$ is equal to D for all non-zero D-submodules N of M. In the sense of Tuganbaev, M is completely integrally closed if every N-essential homomorphism from N to M can be extended to an endomorphism on M. We discuss the relationship between these definitions of complete integral closedness, and also their relationships to skew-injectivity and π-injectivity.

Representations and Cohomology of the Alternating Group of Degree 4

Name: Andriiana Plakosh

Institution: Institute of Mathematics of the National Academy of Sciences of Ukraine

Abstract: Authors: Yu. A. Drozd and A. I. Plakosh

Let A4 be the alternating group of degree four. We study integral representations of the alternating group A4 whose underlying abelian groups are free of finite rank (so-called A4-lattices).

While a classification of 2-adic representations of A4 was obtained by Nazarova, this description is not well suited for computing cohomology of A4-lattices. We propose a different approach. Since the group ring is Gorenstein, every non-projective 2-adic representation arises as a representation of a certain overring A, which is a Bäckström order, so we can relate its representations to those of a valued graph (or species).

Using this approach we obtain a description of the Auslander-Reiten quiver of the category of A-lattices and give a complete description of all indecomposable integral representations of A4. In particular, we explain the non-uniqueness of decompositions of representations into direct sums of indecomposable modules.

Since in this case the Auslander-Reiten translation coincides with the syzygy, this description allows us to compute the Tate cohomology groups of all A4-lattices.

Enumerating log rational curves on $\mathbb{P}_{\mathbb{P}^r}(\mathcal{O}^s \oplus \mathcal{O}(-a))$

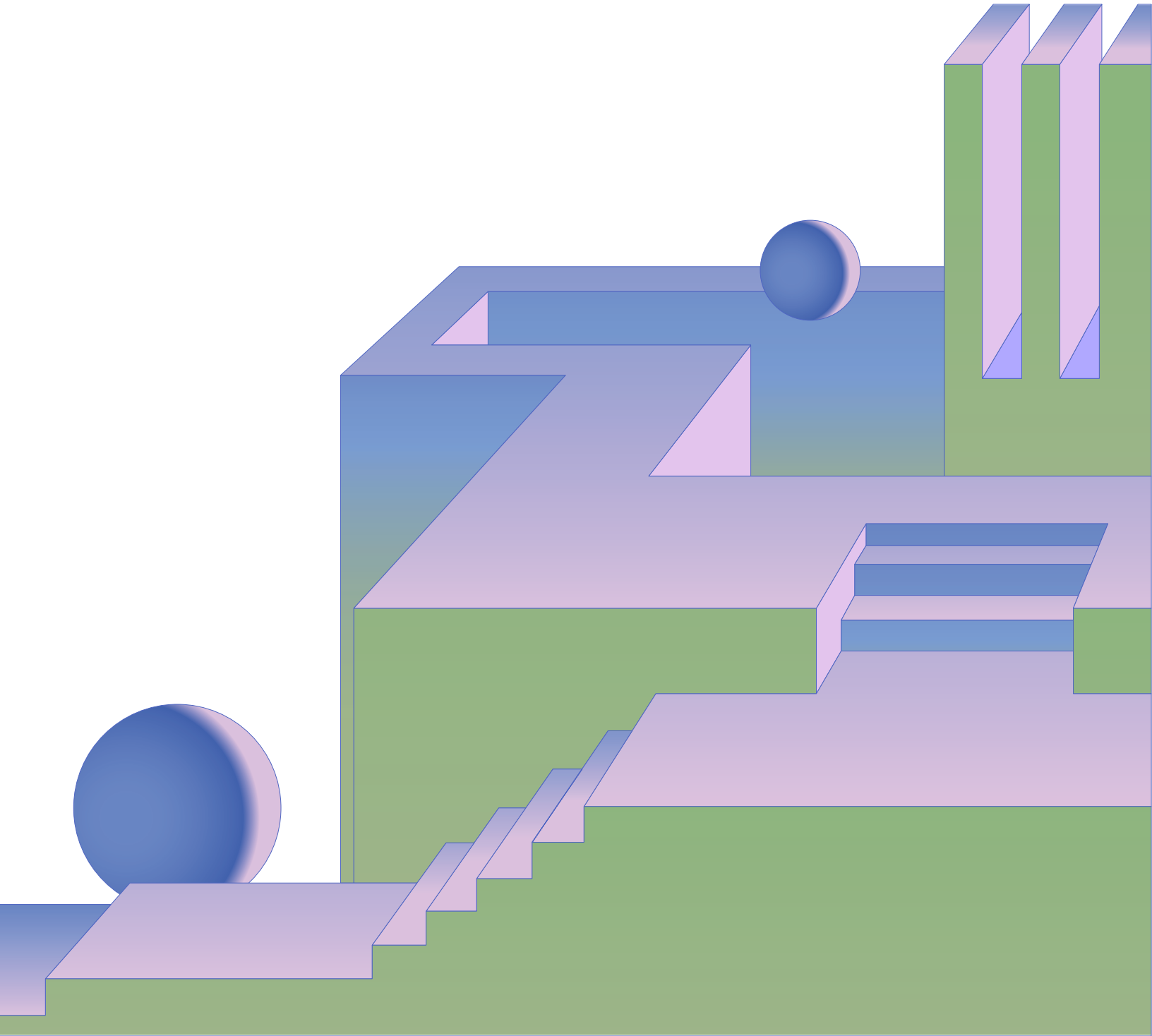
Name: Naufil Sakran

Institution: Tulane University

Abstract: In this work, we study the enumerativity of Gromov – Witten invariants for a family of projective bundles of the form $\mathbb{P}_{\mathbb{P}^r}(\mathcal{O}^s \oplus \mathcal{O}(-a))$. These varieties include important examples such as blow-ups of projective spaces and Hirzebruch surfaces. Using the space of logarithmic quasimaps, we compute the corresponding Tevelev degrees, which count the number of rational curves satisfying prescribed incidence and tangency conditions. Our result provide explicit formula for the Tevelev degree.

POSTERS

SECTION 3– NUMBER THEORY



Mobius equivariant maps between fields

Name: Sunil Chebolu

Institution: Illinois State University

Abstract: Inspired by the classical Cauchy functional equation, we study the following problem: given a field F, classify all functions f from F to F that satisfy

$$f((x+y)/(x- y)) = (f(x)+f(y))/(f(x)- f(y)) \quad \text{for all} \quad x \neq y \text{ in } F.$$

We give a complete solution to this problem and, more generally, classify all maps that are equivariant with respect to a Mobius transformation of the form $(ax+by)/(cx+dy)$ on any field.

Our results yield a new characterization of the field with five elements and the introduction of a novel group of transformations on a field that contains the automorphism group as a subgroup.

This is joint work with Jonathan Love, Apoorva Khare, Anindya Sen, and Akaki Tikaradze.

Symmetry and the Riemann zeta function

Name: Joseph Dillon

Institution: N/A

Abstract: Derived by B. Riemann in 1859, the Xi function $\Xi(s)$ is a variant of the zeta function $\zeta(s)$ that is holomorphic in the complex plane and satisfies the symmetric reflection formula $\Xi(- s) = \Xi(s)$. This work leverages symmetries of the square of its modulus $|\Xi(s)|^2$ to characterize the oscillations of the square of the modulus of the zeta function $|\zeta(s)|^2$ on the critical line $\mathrm{Re}(s) = \frac{1}{2}$. Specific results include that $\zeta'(s)$ can only equal zero on the critical line $\mathrm{Re}(s) = \frac{1}{2}$ at nontrivial zeros of $\zeta(s)$ on the critical line $\mathrm{Re}(s) = \frac{1}{2}$ having multiplicity greater than one and that $|\zeta(s)|^2$ and $|\zeta'(s)|^2$ are related by the inequality $0 \leq j(t)^2|\zeta(\frac{1}{2}+it)|^2 \leq 16|\zeta'(\frac{1}{2}+it)|^2$ on the critical line $\mathrm{Re}(s) = \frac{1}{2}$, for $s = \sigma + it \in \mathbb{C}$, $j(t) = 2\log(\pi) - \psi(\frac{1}{4}+\frac{it}{2}) - \psi(\frac{1}{4}-\frac{it}{2})$ and $\psi(s)$ the logarithmic derivative of the gamma function $\Gamma(s)$.

A variant of the congruent number problem

Name: Jerome Dimabayao

Institution: University of the Philippines Diliman

Abstract: A positive integer n is called a θ-congruent number if there is a triangle with sides a, b and c for which the angle between a and b is equal to θ and its area is $n\sqrt{r^2-s^2}$, where $0 < \theta < \pi$, $\cos\theta = s/r$ and $0 \leq |s| < r$ are relatively prime integers. The case $\theta = \pi/2$ refers to the classical congruent numbers. It is known that the problem of classifying θ-congruent numbers is related to the existence of rational points on the elliptic curve $y^2 = x(x+(r+s)n)(x-(r-s)n)$. In this work, we deal with a variant of the congruent number problem where the cosine of a fixed angle is $\pm\sqrt{2}/2$.

Some Aspects of Probability Related to the Riemann Hypothesis

Name: Andrey Feuerverger

Institution: University of Toronto

Abstract: We will review a few of the many aspects of probability theory which have played an important role in number theory, including various statistical models for primes and for arithmetic functions, the role of random matrix theory for the Riemann hypothesis, and recent work by Adam Harper, among other topics. Some new results, including an application to the Erdos-Kac Theorem, as well as an application to mathematical statistics which leads to an unusual transformation associated with the zeta function will be discussed. (This is joint work with Greg Martin of the University of British Columbia.)

Trees and valuation sequences generated by polynomials and rational functions over $\mathbb{Z}_p$

Name: Olena Kozhushkina

Institution: Ursinus College

Abstract: We study the properties of p-adic valuation sequences generated by polynomials and rational functions with p-adic integer coefficients. Such sequences can be represented as tree diagrams with nodes containing information about the valuation. For polynomials, as well as rational functions, the valuation sequences are either periodic (bounded) or unbounded. This dichotomy translates into the trees being finite or infinite. Whether a tree is infinite is directly related to the solvability of the polynomial over the p-adic integers. Moreover, for polynomial sequences, the p-adic integer root manifests as an infinite branch. We will show the properties of the valuation trees determined directly from the coefficients for lower degree polynomials and how this work extends to rational functions. For periodic sequences, we determine the period length and introduce a formula that predicts the values of such sequences. This work is done jointly with M. Saburov, A. Ali, J. Long, and J. Trulen.

Performance of Classical Factorization Algorithms for Structured Integers

Name: Isabella Li

Institution: Lexington High School

Abstract: Integer factorization underpins modern public-key cryptography, particularly the Rivest-Shamir-Adleman cryptosystem. This paper presents a comprehensive comparative analysis of classical factorization algorithms applied to structured integers, specifically Mersenne and Fermat

numbers. We examine four fundamental methods: trial division, Fermat's factorization, Pollard's $p-1$ algorithm, and the Quadratic Sieve.

Our empirical study reveals distinct performance patterns that illuminate the theoretical foundations of each method. Trial division demonstrates efficiency only for integers with small prime factors, while Fermat's method excels when factors are close to the square root of the target integer. Pollard's $p-1$ algorithm achieves superior performance when prime factors possess smooth predecessor values. The Quadratic Sieve exhibits increasing advantage as integer magnitude grows, though practical implementation challenges emerge for numbers exceeding forty digits. We provide rigorous correctness proofs for the Quadratic Sieve's congruence-of-squares step and present detailed runtime analyses demonstrating the practical implications of theoretical complexity bounds. Our results offer guidance for algorithm selection based on the structural properties of composite integers and establish benchmarks for factorization performance on special number families.

Number theory in Pell's Equation

Name: Dr. Ruma Manandhar

Institution: Nepal Open University

Abstract: Let d and N are integers, the equation u^2–$dv^2 = N$ in two variables u and v is known as Pell's equation. If $d < 0$, then u^2–dv^2 is always positive If $N < 0$, then the equation has no solution. If $N > 0$, then the number of solutions is finite If $d = a^2$ (perfect square, $a \in Z$) then u^2–$dv^2 = (u - av)(u + av) = N$ implies the number of solutions must be finite. If $d > 0$ that is not a perfect square, then u^2–$dv^2 = N$ has the infinite numbers of solutions. The objectives of the poster are: Investigate the mathematical structures present in Pell's Equation, demonstrate solution technique via continued fractions, explore the connections with Algebraic Number Theory. To fulfill these objectives researcher worked in Lagrange's Theorem, Continued Fraction, and Fundamental Unit in the integers ring of a quadratic field as a methodology of the study. The findings of the study are: Long periods in the continued fraction generally lead larger fundamental Solution. The solution growth is exponential in n with $u_n \approx (u_1 + v_1\sqrt{d})n, n \in \mathbb{N}$, and Pell's Equation provides highly precise approximations of $\sqrt{d}$. The conclusions of the study are: Pell's Equation provides "infinite integer solutions" through continued fractions. It forms a bridge between classical number theory and modern algebraic number theory. The fundamental unit $\varepsilon = u_1 + v_1\sqrt{d}$ arises from the fundamental solution of the Pell's equation: u^2–$dv^2 = 1$. Hence, the fundamental solutions of Pell's equation generate all solutions, and the fundamental unit generates the infinite part of the unit group.

A Computational Comparison of Lang-Trotter and Hardy-Littlewood Constants for CM Elliptic Curves

Name: Anish Ray

Institution: University of Houston

Abstract: In 2021, Daqing Wan and Ping Xi investigated the connection between the Lang-Trotter conjecture for CM elliptic curves and the Hardy–Littlewood conjecture on primes represented by quadratic polynomials. Assuming the Hardy-Littlewood conjecture, they derived an alternative asymptotic formula for the Lang-Trotter conjecture involving an explicit constant $\overline{\omega}_{E,r}$, and showed that the two conjectures are in fact equivalent. To reconcile their formulation with the classical version, they further conjectured that this constant coincides with the classical Lang–Trotter constant $C_{E,r}$. We verify this conjectural equality for twenty CM elliptic curves defined over $\mathbb{Q}$. These examples cover all thirteen distinct $\overline{\mathbb{Q}}$-isomorphism classes of CM elliptic curves, for which the necessary Galois-theoretic data is available through the work of Campagna and Pengo. Our computations provide new evidence supporting the conjecture and illustrate how recent structural results on Galois representations and entanglement fields can be leveraged to perform such verifications. Although we do not establish the conjecture in full generality, our work constitutes the first systematic test across all rational CM j-invariant classes.

Distribution of Values of Gaussian Hypergeometric Functions

Name: Neelam Saikia

Institution: Indian Institute of Technology Bhubaneswar

Abstract: In the 1980s, Greene introduced a theory of hypergeometric functions over finite fields defined in terms of Jacobi sums and multiplicative characters. His construction provides a finite field analogue of the classical hypergeometric series studied by Gauss, Kummer and others. Remarkably, these finite field hypergeo- metric functions satisfy transformation formulas, symmetry relations, and special value identities that closely parallel their classical counterparts. Over the years, Greene's functions have emerged as powerful tools in arithmetic geometry and number theory. They play central roles in the study of Apéry-style supercongruences, the Eichler-Selberg trace formula, Galois representations and the zeta-functions of arithmetic varieties over finite fields. In many cases, the special values of these functions provide arithmetic information, including traces of Frobenius of elliptic curves and point counts on algebraic varieties. In this presentation, we show the statistical behaviour of values of a natural family of finite field hypergeometric functions as the size of the finite field tends to infinity. Specifically, we discuss their value distributions over large finite fields and analyze the limiting behaviour using tools from the theory of harmonic Maass forms and mock modular forms. By establishing a pre- cise connection between these hypergeometric values and automorphic objects, we show that the normalized values in this family become equidistributed with respect to the semicircular (i.e. Sato-Tate) measure. This is joint work with Ken Ono, Sudhir Pujahari and Hasan Saad.

Modular symmetries and identities for rank-type partition statistics

Name: Rishabh Sarma

Institution: The Pennsylvania State University

Abstract: Partition-theoretic objects and statistics refine classical partition identities, expose

deeper structure and often produce rich generating functions with both combinatorial and analytic significance. Many of these generating functions also exhibit modular or mock modular behavior and can be expressed using theta functions, eta products, or related automorphic objects. These connections allow tools such as modular transformations and Hecke operators, to be applied to combinatorial problems, and to explain congruence and asymptotic phenomena. In this poster, we present the modular behavior of different rank and crank statistics under special congruence subgroups of $\mathrm{SL}_2(\mathbb{Z})$ leading to phenomena of symmetry among the elements of p-dissection of the generating functions of these statistics. Alongside, we present explicit identities expressing these dissections in terms of generalized eta functions with cyclotomic coefficients. The latter is accomplished using an algorithmic approach in Maple and Sage comprising of techniques coming from automorphic forms. The statistics that we consider are the rank and crank of partitions, their overpartition analogues and the M_2-rank and crank of partitions without repeated odd parts and overpartitions.

Recent progress in the number of solutions to ternary purely exponential Diophantine equations

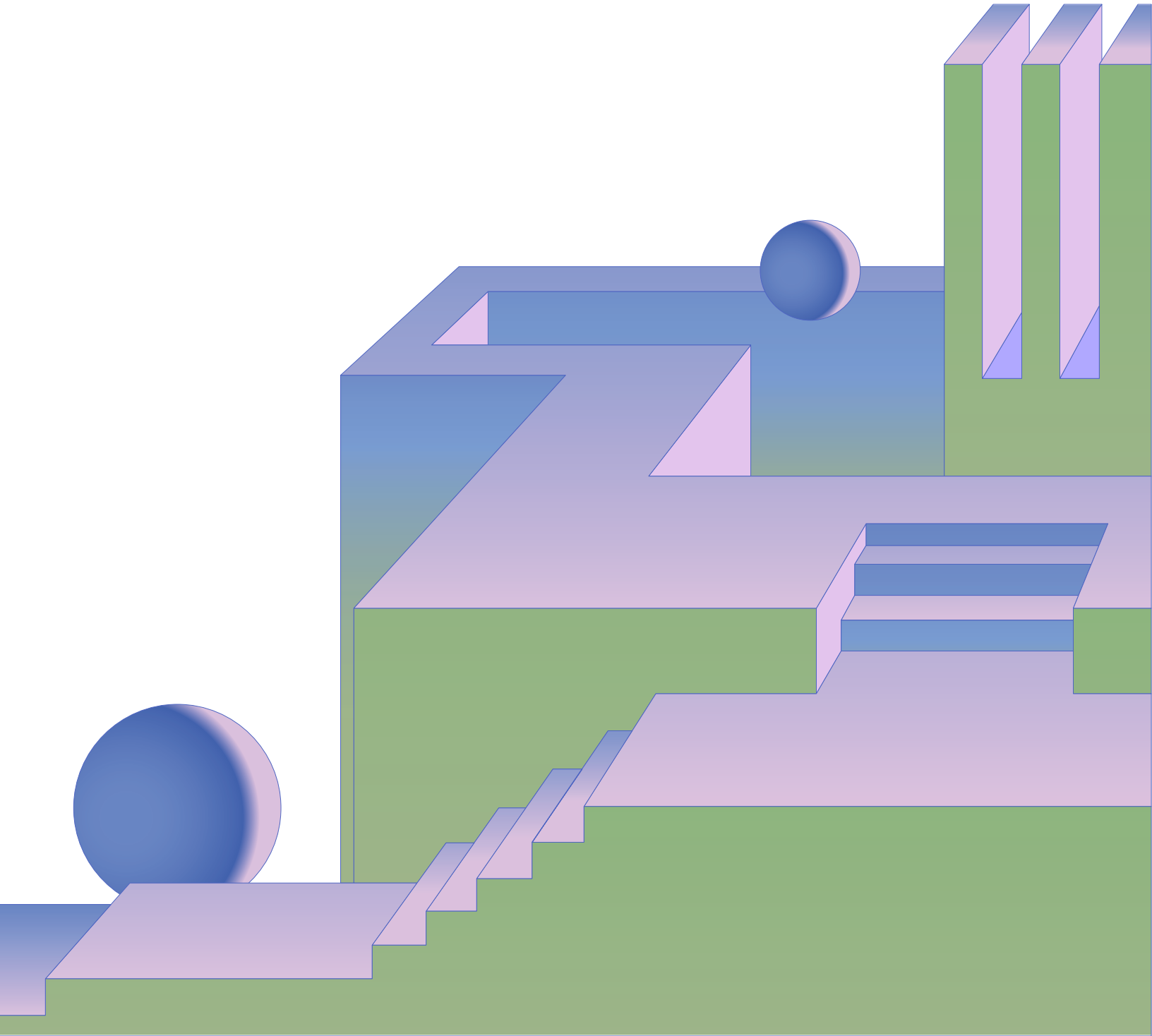
Name: Robert Styer

Institution: Villanova University

Abstract: It is conjectured that the ternary purely exponential Diophantine equation $a^x + b^y = c^z$, for fixed a, b, c integers greater than one, has at most one solution (x, y, z) in positive integers (except for a list of known exceptions). In the last five years, much progress has been made on this conjecture. For a fixed c, there are at most finitely many pairs (a, b) with more than one solution. For some low values of c, most recently for $c = 13$ and $c = 7$, there is at most one solution (except for the known exception $\{a, b\} = \{3, 10\}$). In a different direction, it has recently been shown that for small a, b less than 10, there is at most one solution (except for the known exceptions). We review recent progress on this conjecture.

POSTERS

SECTION 4– ALGEBRAIC AND COMPLEX GEOMETRY



Infinite tensors meet model theory

Name: Alessandro Danelon

Institution: University of Michigan

Abstract: We study the structures of tensors as the underlying dimension tends to infinity. Remarkably, once a suitable symmetry is taken into account (typically the infinite general linear group GL), these structures can be described in finite terms. A prime example is the space of infinite-by-infinite matrices of rank at most r: their defining equations are the (r+1)x(r+1)-minors, and all these are generated by one single minor up to the action of GL.

In this talk we introduce tensor spaces, a natural object that encodes an infinite tensor together with an intrinsic group of symmetries. After extending the notions of oligomorphic and omega-categorical to the linear setting, tensor spaces can be viewed as the linear analogue to the model theory of permutation groups. The theorem of Ryll-Nardzewski states that a countable structure is oligomorphic if and only if its theory is ω -categorical. We will present the linear analogue of the theorem of Ryll-Nardzewski for the case of tensor spaces equipped with two quadratic forms. The results are joint work with Andrew Snowden.

Conductor-Discriminant Inequality for Tamely Ramified Cyclic Covers of the Projective Line

Name: Connor Stewart

Institution: CUNY Graduate Center

Abstract: We consider $\mathbb{Z}/n$-covers $X \to \mathbb{P}^1$ defined over discretely valued fields K with excellent valuation ring $\mathcal{O}_K$ and perfect residue field of characteristic not dividing n. Two standard measures of bad reduction for such curves X are the Artin conductor of the minimal regular model of X over $\mathcal{O}_K$ and the valuation of the discriminant of an integral Weierstrass equation for X. We prove an inequality relating these two measures. Specifically, if X is given by an affine equation $y^n = f(x)$ with $f(x) \in \mathcal{O}_K[x]$, and if $\mathcal{X}$ is its minimal regular model over $\mathcal{O}_K$, then the negative of the Artin conductor of $\mathcal{X}$ is bounded above by $(n-1)v_K(\mathrm{disc}(\mathrm{rad}(f))$. This extends previous work of Ogg, Saito, Liu, Srinivasan, and Obus–Srinivasan on elliptic and hyperelliptic curves. (Joint work with Andrew Obus and Padmavathi Srinivasan.)

A Simplified Rotation Algorithm of a Vector in Three Dimensions

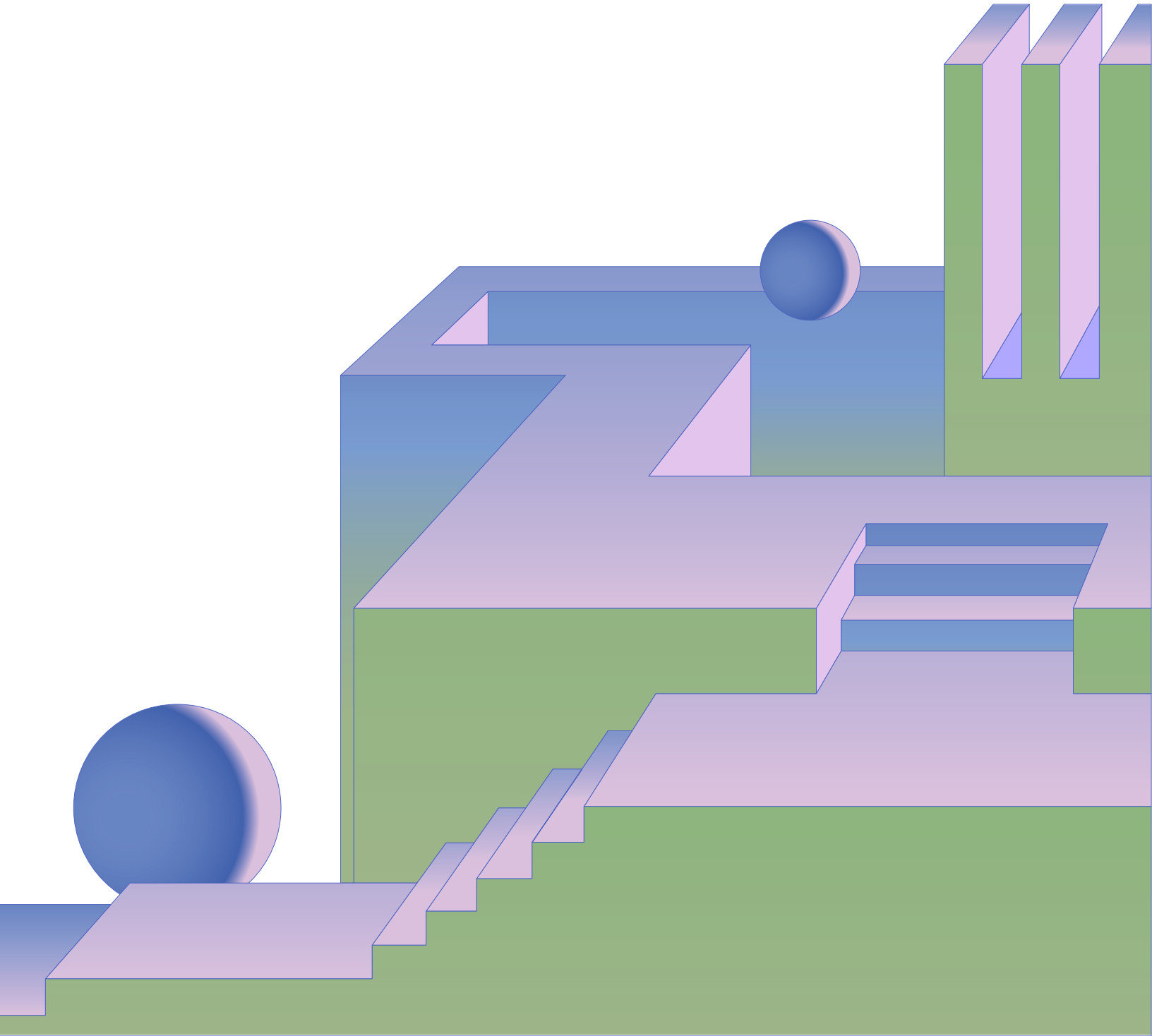
Name: Sanji Sun

Institution:

Abstract: This presentation describes a practical rotation algorithm a vector (a_1, b_1, c_1) on the surface of a unit sphere, to a new vector positioned at (a_2, b_2, c_2).

POSTERS

SECTION 5– GEOMETRY



Weitzenböck remainder Spectrum on rational homogeneous varieties

Name: Lucas Almeida

Institution: Univesity of Campinas (Unicamp)

Abstract: We provide a precise description for the spectrum of invariant $(1,1)$-forms viewed as operator acting on spinor bundles over rational homogeneous varieties. By means of this description, we describe the spectrum of the Weitzenböck remainder of Dirac operators on rational homogeneous varieties. In particular, we provide an explicit formula for its smallest eigenvalue. As a consequence, we obtain a new lower bound for the spectrum of the square of the Spin^c Dirac operator, expressed in terms of Lie-theoretic data.

Study of Clairaut Anti-invariant Riemannian maps from Sasakian manifolds

Name: Garima Goel

Institution: Punjabi University

Abstract: We investigate anti-invariant Riemannian maps from Sasakian manifolds into Riemannian manifolds, with particular emphasis on the situation where the structure vector field lies in the horizontal distribution. It is shown that such maps cannot be totally geodesic. We also establish necessary and sufficient conditions for these maps to be harmonic. Further, we study anti-invariant Riemannian maps with horizontal structure vector fields from Sasakian space forms admitting a Ricci soliton. In addition, we examine Clairaut anti-invariant Riemannian maps from Sasakian manifolds to Riemannian manifolds and derive criteria under which an anti-invariant Riemannian map becomes Clairaut. Moreover, we analyze Clairaut anti-invariant Riemannian maps from Sasakian space forms whose fibers constitute a Ricci soliton, proving that in this case the potential vector field is conformal. Finally, a non-trivial example is provided to illustrate anti-invariant and Clairaut anti-invariant Riemannian maps from Sasakian manifolds to Riemannian manifolds, while ensuring that the structure vector field remains horizontal.

Sharp Minkowski Type Inequality in Cartan-Hadamard 3-Spaces

Name: Fang Hong

Institution: McGill University

Abstract: We proved a sharp Minkowski type inequality between total mean curvature, area surface and volume for convex surfaces in Cartan-Hadamard 3-spaces via harmonic mean curvature flow, and improves the known estimates for total mean curvature in hyperbolic 3-space. In particular, we sharpened Ghomi-Spruck's result. As a corollary, we also got a comparison theorem between total mean curvature in Cartan-Hadamard 3-spaces with that of the geodesic sphere in hyperbolic 3-space with constant curvature.

A study of lightlike submanifolds of indefinite statistical manifolds

Name: Varun Jain

Institution: Multani Mal Modi College

Abstract: Information geometry, which integrates methods from differential geometry and statistics, has become an essential tool in various areas of mathematics. A statistical manifold is defined as a Riemannian manifold equipped with a pair of mutually dual, torsion-free affine connections. In this paper, we investigate lightlike submanifolds of indefinite statistical manifolds. In contrast to the classical theory of statistical submanifolds, a lightlike submanifold of an indefinite statistical manifold does not, in general, inherit a statistical structure. To address this issue, we derive necessary conditions under which a lightlike submanifold can be regarded as a lightlike statistical submanifold. Moreover, we obtain an explicit formula for the statistical sectional curvature and establish sufficient conditions ensuring that the induced statistical Ricci tensor on a lightlike submanifold of an indefinite statistical manifold is symmetric.

Compact Holonomy and Riemannian Metrizability in Finsler Geometry

Name: Sendrasoa Laurence Lantonirina

Institution: University of Antananarivo

Abstract: We revisit a classical principle in differential geometry: compactness of holonomy can force a connection to be metric. Building on Vey's holonomy–metrization philosophy for torsion-free linear connections, we present a unified criterion adapted to nonlinear connections arising in Finsler geometry.

First, a Vey-type criterion states that a torsion-free linear connection ∇ on M is the Levi–Civita connection of a Riemannian metric g if and only if its holonomy groups are relatively compact.

Next, in the Grifone formalism on $TM \setminus \{0\}$, let (M, F) be a Finsler manifold with Grifone connection Γ. Assuming vanishing strong torsion, we prove that (M, F) proceeds from a Riemannian structure if and only if the associated holonomy groups are relatively compact.

We then obtain the Berwald counterpart: for a positively definite Berwald manifold with canonical connection D and vanishing weak torsion, D comes from a Riemannian structure if and only if its holonomy groups are relatively compact.

As a complementary input we cite Muzsnay–Nagy: on a positively definite Finsler manifold of dimension > 2, (relatively) compact holonomy forces (M, F) to be Riemannian. Consequently, zero constant curvature with $\dim M > 2$ implies that (M, F) is Riemannian, while for nonzero constant curvature and $\dim M > 2$ we obtain the equivalence: (M, F) is Riemannian if and only if $\mathrm{Hol}(x)$ is relatively compact. Together these results provide a concise holonomy-based criterion for detecting when nonlinear Finsler data encode a Riemannian metric.

Infinitesimal Bending of Dual Curves and Its Geometric Characterizations

Name: Marija Najdanović

Institution: University of Priština in Kosovska Mitrovica, Faculty of Sciences and Mathematics

Abstract: The geometry of dual curves in three-dimensional dual space is based on dual vector algebra and E. Study's research on line geometry and kinematics. He proved that the set of all oriented lines in Euclidean 3-space is in one-to-one correspondence with the set of points on the dual unit sphere in dual 3-space, and that a differentiable curve on the dual unit sphere represents a ruled surface. This correspondence allows the geometry of ruled surfaces to be represented by the geometry of dual spherical curves on the dual unit sphere. Consequently, infinitesimal deformations of ruled surfaces can be studied through the corresponding deformations of dual curves.

We consider a special class of deformations of dual curves, the so-called infinitesimal bending, which preserves the dual arc length with a given precision. We obtain several useful properties of the dual bending field and curvature-based functionals of dual curves. We also present a necessary and sufficient condition for the infinitesimal bending of a dual curve to lie on the dual unit sphere. Several examples of dual spherical curves together with the corresponding ruled surfaces are illustrated graphically.

Quadratic Killing tensors on symmetric spaces

Name: An Ky Duy Nguyen

Institution: La Trobe University

Abstract: We will present some recent results on the structure of the algebra of Killing tensors on Riemannian symmetric spaces. The fundamental question (Bolsinov-Matveev-Miranda-Tabachnikov, 2018), is whether any Killing tensor field on a Riemannian symmetric space is decomposable, that is, is a polynomial in Killing vector fields. For spaces of constant curvature, the answer is in the positive, as has been known for quite some time. The same is true for the complex projective space (Eastwood, 2023). For other rank one symmetric spaces, the answer is almost always in the negative (Matveev-Nikolayevsky, 2024). We show that for several classes of symmetric spaces, all quadratic Killing tensors are decomposable. This is a joint project with my PhD supervisors Y. Nikolayevsky (La Trobe University, Australia) and V. Matveev (University of Jena, Germany).

On the dimension of the nullity space of the curvature tensor on Riemannian manifold

Name: Princy Randriambololondrantomalala

Institution: University of Antananarivo

Abstract: Let (M, g) be a n-dimensional Riemannian manifold with the Lévi-Civita connection ∇ and denote by R its curvature. For each point $x \in M$, the curvature nullity space at $x \in M$ (with respect to the Lévi-Civita connection) is defined as

$$N_R(x) = \{X \in T_xM \mid R(X, Y) = 0 \text{ for all } Y \in T_xM\}.$$

Suppose that ν is a map defined by $\nu_x = dim(N_R(x)) \neq 0$, for all $x \in M$. We establish the map $x \mapsto N_R(x)$ as a smooth distribution on M. By Chern and Kuiper's well known results, N_R is completely integrable in a neighborhood where ν is constant. On the open dense subset $\mathfrak{R}$ of regular points of the distribution N_R, N_R is integrable on $\mathfrak{R}$ in the sense of Hermann because it is involutive and locally finitely generated. Next, every point of M is regular, because of (3) in the introduction of the article of R. Maltz (The nullity spaces of the curvature operator) in 1966 saying that if ν is constant in a deleted neighborhood of a point $p \in M$, then ν admits the same value at p. Then, the nullity distribution is integrable on M in the sense of Hermann, yielding a generalized foliation on M whose leaves are totally geodesic submanifolds of M by (1) of R. Maltz. Define G, the open set on which ν takes its minimum value. The results of T. Murphy and F. Wilhelm at Random manifolds have no totally geodesic submanifolds (2019): for a generic Riemannian manifold M of dimension $n \neq 3$, any totally geodesic submanifold of M is trivial, i.e it is geodesic or the whole manifold. Then for such manifold, $dim(N_R) \in \{1, n\}$. In particular, for $n = 3$, $dim(N_R) \in \{1, 3\}$ because if there is a $x \in M$ such that $dim(N_R)(x) = 2$, then $N_R(x) = \langle X_1, X_2 \rangle_{\mathbb{R}}$ is a sub-vector space of dimension 2 of the tangent space T_xM on x of M. There is a $X_3 \in T_xM$ such that $T_xM = \langle X_1, X_2, X_3 \rangle_{\mathbb{R}}$. For all $\alpha, \beta \in \mathbb{R}$, we have $R_x(\alpha X_1 + \beta X_2, X) = 0$ for all $X \in T_xM$, so $R_x(\alpha X_1 + \beta X_2, \langle X_3 \rangle_{\mathbb{R}}) = \{0\}$. It yields that $X_3 \in N_R(x)$ because R_x is anti-symmetric. (4) of R. Maltz says that the union of geodesics tangent of the distribution N_R is the boundary of G. So, M is with boundary if N_R has a constant dimension by reasoning in contradiction according to (4).

Study of holomorphic Riemannian maps from nearly Kaehler manifolds

Name: Rashmi Sachdeva

Institution: Punjabi University, Patiala

Abstract: This paper investigates holomorphic Riemannian maps from nearly Kaehler manifolds to almost Hermitian manifolds. We define holomorphic Riemannian maps and establish their key geometric properties. It is shown that the vertical and horizontal distributions of such maps are invariant under the almost complex structure and are minimal. We derive a necessary and sufficient condition for these maps to be harmonic. Further, we examine the interaction between holomorphic Riemannian maps and Ricci soliton structures on the domain manifold. In particular, when the potential vector field is vertical (resp. horizontal), the fibers (resp. image) admit Ricci soliton or Einstein structures. The relations between scalar curvatures of the domain and target manifolds are also established, leading to characterizations of expanding, steady, and shrinking cases.

On the Roter type of Generalised Wintgen Ideal Legendrian Submanifolds

Name: Aleksandar Šebeković

Institution: State University of Novi Pazar

Abstract: I. Mihai obtained an inequality relating intrinsic normalised scalar curvature and extrinsic squared mean curvature and normalised normal curvature of Legendrian submanifolds M^n in Sasakian space forms $M^{2n+1}(c)$. In this paper, for the class of generalised Wintgen ideal Legendrian submanifolds M^n of Sasakian space form of dimension $M^{2n+1}(c)$, we study relationship between some properties concerning their Deszcz symmetry and their Roter type.

Geometry of Point Particles. Symbolic Computer Verification of the Atiyah' s Conjecture for Five Points in the Euclidean Plane

Name: Dragutin Svrtan

Institution: University of Zagreb, Science Faculty - Department of Mathematics, Zagreb, Croatia

Abstract: In 2001 Sir M. F. Atiyah formulated a conjecture C1 and later with P. Sutcliffe two stronger conjectures C2 and C3. These conjectures, inspired by physics (spin-statistics theorem of quantum mechanics), are geometrically defined for any configuration of n points in the Euclidean three space. The conjecture C1 is proved for $n = 3$ in [1] and for $n = 4$ in [2], and C1' and C3 in [3]. After two decades we succeeded in verifying C1 for arbitrary five points in the Euclidean plane. Our computer symbolic certificate produces a new remarkable universal ('one hundred pages long') positive polynomial invariant (for any five planar points), in terms of newly discovered shear coordinates. This refines the original Atiyah's conjecture and we are optimistic for its verification for n greater than five, (Atiyah was less optimistic ... 'It remains a conjecture for 300 years (like Fermat)' (see Atiyah: Edinburgh Lectures 2010). In the year 2013 Atiyah's conjectures were put on the new list of Nine open problems (from [4]) ('probably' easier than the remaining six of famous Seven Clay millennium problems).

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[1] M. Atiyah The geometry of classical particles, Surveys in Differential Geometry, International Press, 7, (2001)

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[3] D. Svrtan, A proof of All three Euclidean Four Point Atiyah-Sutcliffe Conjectures, https://www.mat.univie.ac.at/ slc/wpapers/s73vortrag/svrtan.pdf

[4] Open problems in Honor of Wilfried Schmied, https://legacywww. math.harvard.edu/conferences/schmid 2013/problems/index.html

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Bonnet–Myers-type Theorems via Bakry–Émery Ricci Curvature of Exponential Decays

Name: Homare Tadano

Institution: Yamaguchi University

Abstract: We present several Bonnet–Myers-type theorems by assuming some exponential decays of the m-Bakry–Émery Ricci curvature when m is a positive constant, a negative constant, or infinity. Our results are new even when the m-Bakry–Émery Ricci curvature is reduced to the Ricci curvature and greatly improve previous Bonnet–Myers-type theorems via m-Bakry–Émery Ricci curvature in the literature.

Area-minimizing capillary cones

Name: Raphael Tsiamis

Institution: Columbia University

Abstract: We construct non-flat capillary minimal cones with bi-orthogonal symmetry groups in every dimension and for any contact angle. These cones interpolate between rescalings of a singular solution to the one-phase problem and the free-boundary cone obtained by halving a Lawson cone along a hyperplane of symmetry. The existence and uniqueness of such cones are proved by solving a nonlinear free boundary equation parametrized by the contact angle and obtaining monotonicity properties for the solutions. The constructed cones are minimizing in ambient dimension 8 or higher, for appropriate contact angles, demonstrating that the regularity theory for minimizing capillary hypersurfaces can have singularities in codimension 7 and completing the capillary regularity theory for contact angles near $\pi/2$. Our method explicitly exhibits the full capillary bridge connecting minimal surfaces to one-phase free boundaries, consequently producing new examples of singular minimizing free boundaries for the Alt-Caffarelli functional.

On Shape and Energies of Geometric Objects

Name: Ljubica Velimirovic

Institution: Faculty of Sciences and Mathematics, University of Nis

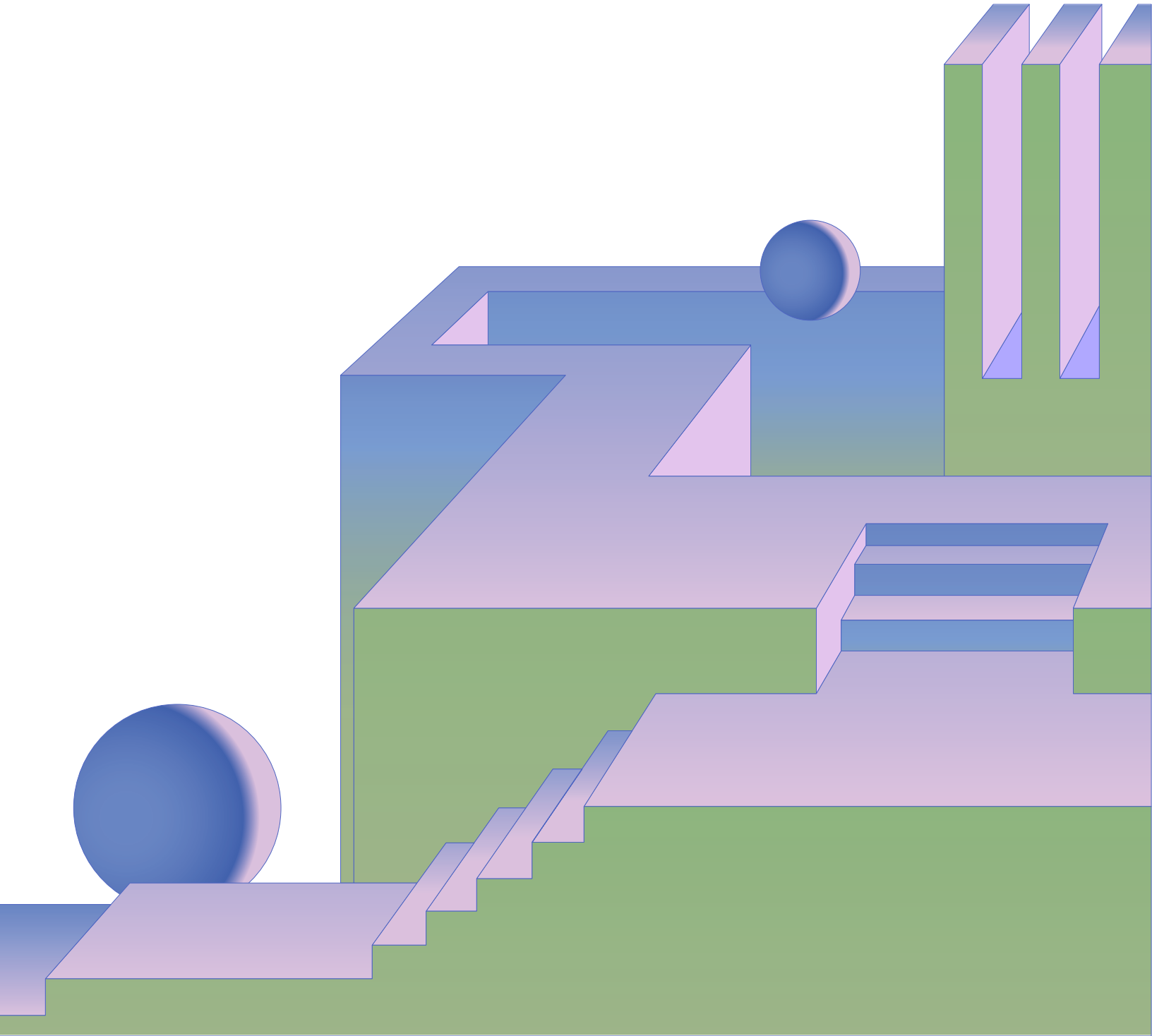
Abstract: Ljubica S Velimirovic (University of Nis, Serbia), Marija S Najdanovic (University of Pristina in Kosovska Mitrovica, Serbia), and Svetozar R Rancic (University of Nis, Serbia) The relationship between the shape of geometric objects and their energies is a fundamental concept that explains their properties and behavior in various fields, including nature, engineering, and art. Energy-minimizing shapes, like spheres for droplets or spherical cells are common because they are efficient and stable. Applications range from designing energy-absorbing thin-walled structures to understanding the properties, demonstrating the universal principle that form follows function and energy optimization.

The poster is based on the book with the same title authored by L. Kauffman, L. Velimirovic, M. Najdanovic and S. Rancic

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POSTERS

SECTION 6–TOPOLOGY



Graph manifolds with positive Artinian presentations

Name: Lorena Armas-Sanabria

Institution: Universidad Autonoma del Estado de Morelos y SECIHTI

Abstract: The fundamental group of any closed and orientable 3-manifod admits an Artinian presentation, this is a presentation in terms of generators and relations such that the product of the relations satisfy a certain condition called the Artin relation. In fact, any group presentation satisfying such a relation represents the fundamental group of some closed and orientable 3-manifold.

We determine the 3-manifolds which admit a positive Artininan presentation, that is, a presentation where all the exponents that appear in the relations are positive. It turns out that in the generic case, all these manifolds are graph manifolds. We describe explicitly these manifolds. In some exceptional cases, the manifolds obtained are connected sums of Seifert and graph manifolds.

This is a joint work with Juan Pablo Díaz, Mario Eudave-Muñoz y Gabriela Hinojosa.

The Chordal Distance Transform of Geometric Loops and its Persistent Homology

Name: James Binnie

Institution: Cardiff University

Abstract: From contours of 2D shapes to knotted proteins, many areas of statistics and physical sciences are concerned with data in the form of geometric loops - embeddings of the circle into a Euclidean space. It is desirable to find a representation of the geometry of these loops that is invariant under Euclidean symmetries, and indifferent to how the loops are parametrised. In this joint work with Ka Man Yim (Oxford) and Otto Sumray (MPI-Dresden), we propose a novel representation of a loop's geometry by representing the distance matrix of the loop as a Morse function on a Möbius band - the second finite subset space of the circle. By considering the persistent homology of this function, we obtain a representation of the loop's geometry that has the desired symmetry invariance. We show that this feature map is stable with respect to perturbations, give a geometric interpretation of the features obtained and explore analogues involving higher order finite subset spaces.

On Projective and Flat Persistence Modules

Name: Giriraj Ghosh

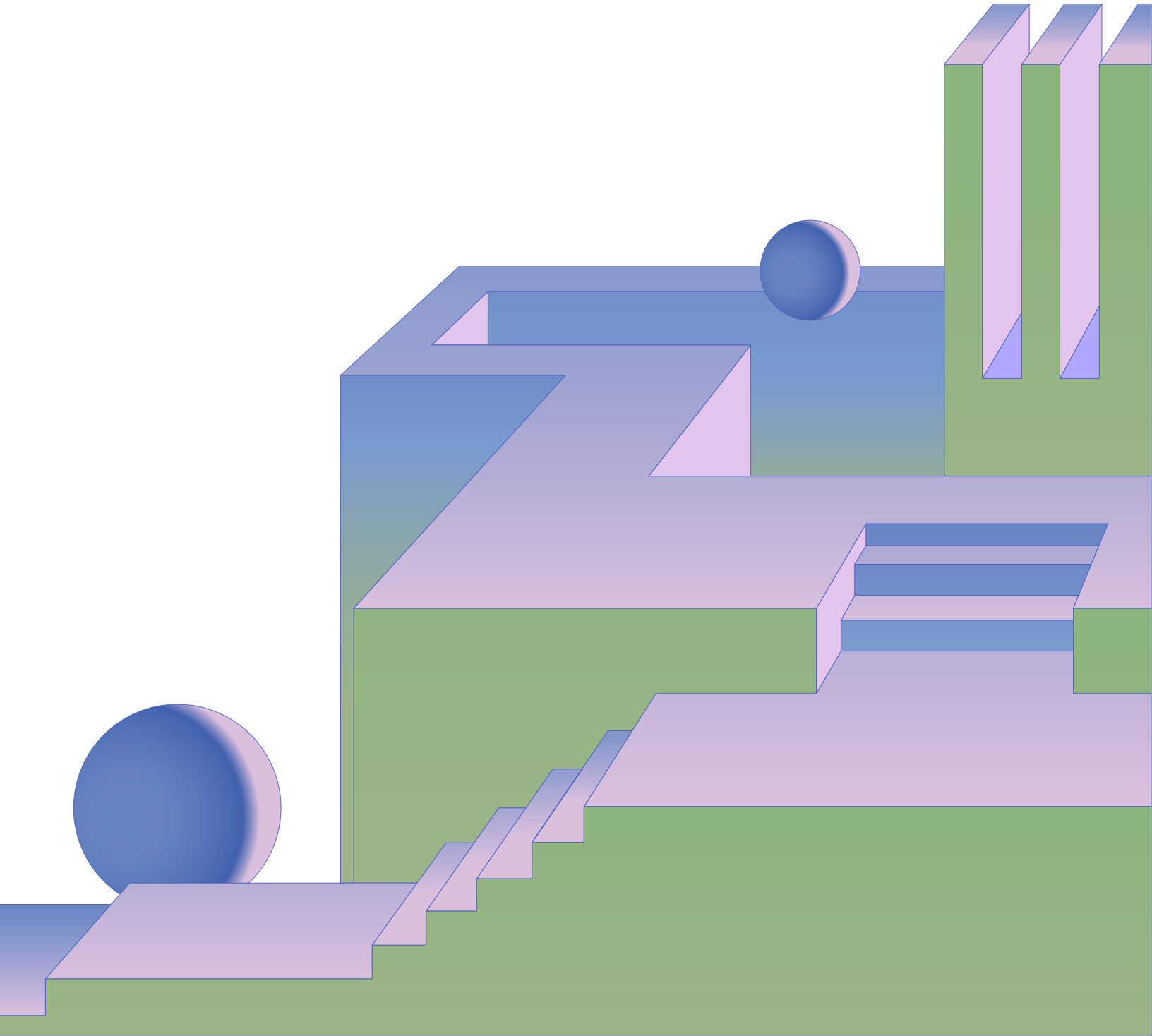
Institution: Indian Institute of Technology Kharagpur

Abstract: In recent years, persistence modules have been viewed as graded modules with gradation over a preordered set serving as the indexing set. We provide sufficient criteria for a projective module over a PID to be free when the indexing set is a lattice. With a lattice as the indexing set, we obtain criteria ensuring that a given persistence module is not projective. When

the indexing set is a preordered set, we establish the flatness of a well-known family of persistence modules. We end the article with two algorithms to compute a basis of free persistence modules with indexing sets $\mathbb{Z}$ (set of integers) and $\mathbb{Z}^2$.

POSTERS

SECTION 7– LIE THEORY AND GENERALIZATIONS



The spin Dolbeault-Dirac operator on the quantum Grassmannian $Gr(2,4)$.

Name: Fredy Diaz Garcia

Institution: National Autonomous University of Mexico

Abstract: In this poster, I will present some partial results about the construction of a Dolbeault-Dirac type operator for the quantum Grassmannian $Gr(2,4)$. As a first step, the main idea is to use a quantum version of Berstein-Gelfand-Gelfand resolution of $U_q(\mathfrak{sl}(4))$-modules and then dualize it to get a Dolbeault complex of differential forms for the quantum flag manifolds of irreducible type. By tensoring this resolution by a suitable $U_q(\mathfrak{l})$-module and dualizing it we get our called spin Dolbeault-complex and the Dirac operator. In order to study the spectral properties of this Dirac operator we construct a quantum version of a Casimir operator to get a weak version of a Parthasarathy formula. This is a work in progress join with Elmar Wagner.

The classification of right alternative and noncommutative Jordan superalgebras

Name: Abror Khudoyberdiev

Institution: Institute of Mathematics Uzbekistan Academy of Sciences

Abstract: In this talk, we present the algebraic classification of complex three-dimensional right alternative and noncommutative Jordan superalgebras. In particular, we obtain the classification of three-dimensional Kokoris and standard superalgebras. Moreover, due to one-to-one correspondences between suitable classes of superalgebras, we also derive classifications of generic Poisson-Jordan and generic Poisson superalgebras.

As a byproduct, we obtain the classification of the varieties of three-dimensional anticommutative superalgebras, three-dimensional $\mathfrak{perm}$ superalgebras, binary $\mathfrak{perm}$ superalgebras, associative superalgebras, binary associative superalgebras, $(-1,1)$-superalgebras, and binary $(-1,1)$-superalgebras.

Corank-one orthosymplectic reduction superalgebras

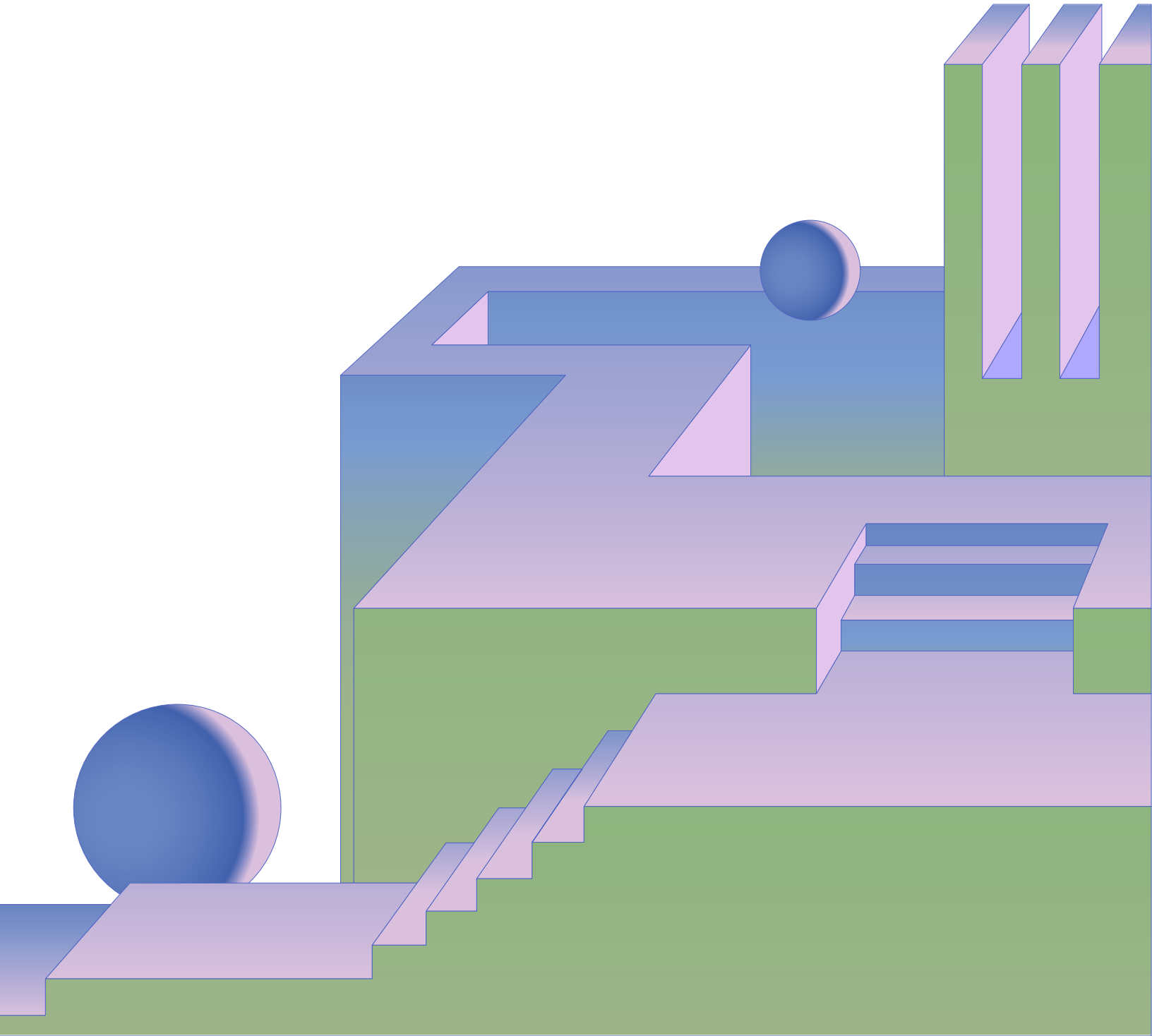
Name: Marcus McLaurin

Institution: Morgan State University

Abstract: The Lie superalgebra $\mathfrak{osp}(1|2)$ of rank one embeds in the Lie superalgebra $\mathfrak{osp}(2|2)$ of rank two. The induced homomorphism between universal enveloping superalgebras yields the corank-one orthosymplectic reduction superalgebra of type C. We present a complete set of generators and relations of the reduction superalgebra and share its importance to super representation theory, specifically in decomposition problems. This work is advised by Dwight Anderson Williams II.

POSTERS

SECTION 8–ANALYSIS



Dimension, Dynamics, and Comparison in C*-Algebras

Name: M. Ali Asadi-Vasfi

Institution: Purdue University

Abstract: This poster presents joint work with N. Christopher Phillips on a dynamical version of the radius of comparison for C*-algebras. The classical radius of comparison, introduced by Andrew Toms, is a numerical invariant that measures the extent to which comparison of positive elements in a C*-algebra is determined by traces. Our goal is to understand what happens when the algebra is equipped with a group action, so that comparison is influenced not only by the algebra itself, but also by the dynamics. We introduce a dynamical radius of comparison for C*-dynamical systems and study how it interacts with crossed products and regularity properties of actions. The poster will explain the motivation behind the invariant, its basic properties, and examples showing how dynamics can change comparison phenomena. More broadly, this work contributes to the study of how dimension-type invariants, traces, and symmetry interact in the structure theory of C*-algebras.

Nonlocal Ordered Mean Curvature with Integrable Kernel

Name: Animesh Biswas

Institution: Missouri State University

Abstract: This poster focuses on the recently developed concept of nonlocal curvature. For any set E, the nonlocal curvature at a boundary point x is defined as the difference between the weighted volume of a sphere of fixed radius r, centered at x, lying outside the set, and the weighted volume of the portion of the sphere lying inside the set. The weighting is determined by a radially symmetric, integrable, nonincreasing convolution kernel. Much of the existing literature studies nonlocal curvature associated with kernels that have a nonintegrable singularity, a setting that requires at least first order regularity of the boundary. Nonlocal curvature of this type appears in a variety of applications, including image processing, curvature-driven motion, and material deformation. In this poster, we investigate the ordered nonlocal mean curvature problem when the kernel is integrable. The classical ordered mean curvature problem was introduced by Li and Nirenberg. Using Alexandrov's moving plane method, we show that the solution is symmetric with respect to a hyperplane. This work was carried out in collaboration with Mikil Foss and Petronela Radu from the University of Nebraska-Lincoln.

On I-convergence, I-limit point and I-cluster point of sequences of bi-complex numbers

Name: Shyamal Debnath

Institution: Tripura University

Abstract: In 1892, C. Segre introduced the notion of bi-complex numbers that form an algebra isomorphic to the literariness. The most comprehensive study of analysis in bi-complex numbers

is available in Price's book. In 2023, Bera and Tripathy introduced the statistical convergence of sequences of bi-complex numbers. They further explored various properties from both algebraic and topological perspectives. Hence, the investigation into the ideal convergence of sequences of bi-complex numbers is a natural progression.

In this presentation, we introduce the concept of I and I_* − convergence of sequences of bi-complex number. We study some basic properties and implication relations of the newly defined convergence concepts. We introduce the notions of I and I_*-Cauchy sequences of bi-complex number and investigate the relations between them. Also, we introduce the notion of I − limit point, I − cluster point and prove certain properties of both the notions.

On Nonsmooth Global Implicit Function Theorems for Locally Lipschitz Functions from Banach Spaces to Euclidean Spaces

Name: Guy Degla

Institution: Institut de Mathématiques et de Sciences Physiques

Abstract: In this work, we establish a generalization of the Galewski-Rădulescu nonsmooth global implicit function theorem to locally Lipschitz functions defined from infinite dimensional Banach spaces into Euclidean spaces. Moreover, we derive, under suitable conditions, a series of results on the existence, uniqueness, and possible continuity of global implicit functions that parametrize the set of zeros of locally Lipschitz functions. Our methods rely on a nonsmooth critical point theory based on a generalization of the Ekeland variational principle.

Structure of Projections in algebras generated by n-potent operators

Name: Priyadarshi Dey

Institution: Millsaps College

Abstract: An operator T on a Banach space is called *n-potent* if $T^n = T$ for some integer $n \geq 2$. Such operators generalize projections and naturally arise in operator theory.

In this poster, we describe the structure of projection operators contained in the finite-dimensional algebra

$$\text{comb}(T) = \text{span}\{T, T^2, \ldots, T^{n-1}\}.$$

We show that every projection in $\text{comb}(T)$ corresponds uniquely to a subset of the nonzero spectrum $\sigma(T) \setminus \{0\}$. As a consequence, the collection of these projections forms a Boolean algebra isomorphic to the power set of $\sigma(T) \setminus \{0\}$. We outline the spectral decomposition of n-potent operators and illustrate the results through explicit examples, including the case $n = 5$. This is joint work with Monika and Zachary Easley.

On the Injectivity of the Spherical Mean value operator

Name: Sajith Govindan Kutty Menon

Institution: SSCollege Areekode (University of Calicut) Malappuram Kerala 673639 India

Abstract: We would like to discuss the injectivity problem of the spherical mean value operator on the Heisenberg type groups. Following the method developed by Strichartz on the L^p Harmonic analysis on Heisenberg group H^n, we were able to establish some injectivity results with Ratnakumar on general $K-$ orbital averages on Heisenberg groups where (H^n, K) is a Gelfand pair. Our motivation was from the results of S Thangavelu on the Gelfand pair $(H^n, U(n))$. Recently this problem was revisited by E K Narayanan , Sanjay et al. They have studied similar problems in the set up of $H-$type groups. Our aim is to look further on spherical means on some specific groups of $H-$type and also on the problems of set of injectivity. We would like to discuss some interesting open problems of Integral Geometry in this direction.

Fractional Maps of Generalized Beta Functions and Their Applications to Astrophysical Reaction Rates

Name: Hussaini Joshua

Institution: University of Kerala, India

Abstract: Fractional calculus generalizes classical integrals, yet its application to generalized beta functions with exponential symmetries remains largely unexplored. In this work, we derive closed-form solutions for fractional maps involving Euler's generalized beta functions, under certain convergence conditions. Our results provide series and integral representations, extending known integrals for extended beta functions and provide explicit results for Saigo, Kober and Riemann-Liouville cases. We show that Euler's generalized beta functions can be considered as a suitable choice for the kernels in a fractional Boltzmann equation, to model non-Markovian particle kinetics, anomalous diffusion in plasmas, and energy-dependent reaction rates in cosmic ray propagation and stellar nucleosynthesis. The behavioural study of the functions shows that it covers a wide spectrum of distributions including stable, unstable and chaotic behaviours which validate the theoretical findings, showing parameter sensitivity and practical utility in non-local plasma dynamics.

Directional Poincaré inequality on compact Lie groups

Name: Andre Kowacs

Institution: ICMC - Universidade de São Paulo

Abstract: In [Ark. Mat. 54 (2016), pp. 555–569] Stefan Steinerberger introduced a "refinement" of the Poincaré inequality on the torus which he called the "Directional Poincaré inequality". In this talk I will present how recently me and Professor Dattori (ICMC-USP) extended this refinement (in a sense) to compact Lie groups and to tube-type vector fields on the torus. We also showed how this inequality is strongly connected to the global solvability of the associated vector field.

Counterexamples to the Berger – Coburn and Bauer – Coburn – Isralowitz conjectures for Toeplitz operators on Fock space

Name: Sam Looi

Institution: Caltech

Abstract: The Bargmann-Fock space is the Hilbert space of entire functions square-integrable with respect to Gaussian measure on complex n-space. For a measurable symbol g, the Toeplitz operator T_g acts by multiplication followed by projection.

In 1991, Berger and Coburn established two-sided estimates leaving only the endpoint unresolved: for $t > 1/4$, boundedness of T_g implies boundedness of the heat transform, and for $t < 1/4$, the reverse. The endpoint $t = 1/4$ is singled out by the Weyl calculus, where the Weyl symbol of T_g coincides with its heat transform. They conjectured that boundedness of the heat transform at $t = 1/4$ is necessary and sufficient for boundedness of T_g. Analogously, Bauer, Coburn, and Isralowitz conjectured (2010) that vanishing at infinity of the heat transform at $t = 1/4$ is necessary and sufficient for compactness of T_g.

We disprove both conjectures in every complex dimension, both directions, using three counterexample symbols.

Perturbation Ideals and Fredholm Theory in Banach Algebras

Name: Tshikhudo Lukoto

Institution: University of Limpopo

Abstract: In 1971, Lebow and Schechter in [1] introduced the notion of perturbation classes where one of the important result discovered is that the perturbation of $G(A)$, the group of invertible elements in a Banach algebra $\mathcal{A}$, is equal to Rad$(\mathcal{A})$, the radical in $\mathcal{A}$, and we denoted this result as

$$\mathcal{P}(G(A)) = \text{Rad}(\mathcal{A}).$$

This important result will be used to characterize more perturbation ideals of sets that generate the familiar spectra in Fredholm theory, which includes, Fredholm elements, Weyl elements and Browder elements relative to some closed ideal. At first we classify the set in question as either regularity or semiregularity, a concept which is set out in [2].

References

[1] A. Lebow and M. Schechter, Semigroups of Operators and Measures of Noncompactness, *Journal of Functional Analysis* **7** (1971), 1-26.

[2] V. Müller, Spectral Theory of Linear Operators and Spectral Systems in Banach Algebras, Operator Theory Advances and Applications, Vol. 139, *Birkhäuser Verlag, Basel-Boston-Berlin*, 2007.

A Story-Based Introduction to Time Scale Calculus

Name: Shekhar Singh Negi

Institution: North Eastern Regional Institute of Science and Technology

Abstract: Time scale calculus provides a unified framework for studying dynamic systems that evolve in continuous, discrete, or hybrid time. The theory combines ideas from differential equations and difference equations within a single mathematical structure.

In this poster, the author presents a simple illustrative situation in which a traveler moves along a road of time and tries to understand how events progress from one moment to another. Through this narrative setting, the fundamental operators of time scale calculus naturally appear and help describe the movement between successive moments of time and the changes of a function along a general time scale.

This story-based presentation aims to provide an intuitive and visual perspective of the basic structure of time scale calculus while keeping the mathematical ideas clear and accessible.

Pseudodifferential Operators on Noncommutative Tori

Name: Carolina Neira Jimenez

Institution: Universidad Nacional de Colombia

Abstract: In this poster we present a survey of some developments on pseudodifferential operators on noncommutative tori. We describe available constructions of those operators: by means of a C^*-dynamical system, by using an analogue of the Fourier series representation of a function in the (commutative) torus $C^\infty(\mathbb{T}^n)$, as Rieffel deformations of the standard pseudodifferential operators on $C^\infty(\mathbb{T}^n)$, and in association to certain spectral triples.

Some fixed point theorems in strictly convex Menger PM-spaces

Name: Rale Nikolic

Institution: Military academy, University of Defence, Serbia

Abstract: In this presentation recently obtained results in strictly convex Menger PM-spaces will be presented. One part of these results have been obtained using the notions of normal and convex structure where it is proved existence of a common fixed point for two self-mappings, where one of these mappings is also non-expansive. The second part of presented results relates to fixed point theorems for non-self mappings with nonlinear probabilistic F-contraction in strictly convex Menger PM-spaces. We introduce the notion of nonlinear probabilistic F-contraction and we prove existence and uniqueness of a fixed point for non-self mappings which fulfill this

contractive condition in strictly convex Menger PM-spaces. All these results generalize some previously obtained results of these types.

Directional Maximal Operators and Kakeya-Type Sets

Name: Blanca Radillo-Murguia

Institution: Baylor University

Abstract: The problem of the boundedness of maximal operators associated to a given set of directions $\Omega \subseteq \mathbb{S}^1$ has been an open question. In this poster, we will discuss recent results that provide a condition on the set Ω to show the admissibility of Kakeya-type sets, extending prior work of M. Bateman and N. Katz. This condition guarantees that the associated directional maximal operator is unbounded on L^p spaces. This work is joint with P. Hagelstein and A. Stokolos.

Stable Close-to-Convexity and Radius of Full Convexity for Sense-Preserving Harmonic Mappings

Name: Ankur Raj

Institution: Kamala Nehru College, University of Delhi

Abstract: Given a sense-preserving harmonic function defined in the open unit disk with its analytic part restricted to the class of starlike functions, several techniques are developed to construct stable close-to-convex harmonic mappings. Each technique is demonstrated through illustrations. Moreover, the radii of full convexity are computed for sense-preserving harmonic functions with the analytic part belonging to certain subclasses of univalent functions. The obtained bounds are sharp.

Proportional Calculus and Proportional Differential Equations: Theory and Applications

Name: Mayuree Sompui

Institution: Khon Kaen University

Abstract: *proportional calculus*, where the derivative is defined as a convex combination of a function and its classical derivative. With this definition, we establish fundamental differential and integral identities, including proportional product rule, quotient rule, or Leibniz rule. These reduce to well-known classical formulas when the proportional parameter α is 1, showing that the new operator is consistent with standard calculus.

The framework is then applied to solving linear and nonlinear first-order proportional differential equations, as well as second-order linear homogeneous equations with constant coefficients,

analytically. By examples and graphical illustrations, we demonstrate how changes in the parameter α can capture intermediate behaviors and memory-like effects often missed by classical integer-order models. The results show that proportional calculus provides a flexible alternative for modeling systems with hereditary or nonlocal characteristics, standing naturally between classical and fractional approaches.

Spectral Rigidity of Commutators: Dynamical Stability vs Nilpotency

Name: Hranislav Stanković

Institution: University of Niš

Abstract: We investigate the spectral properties of the matrix derivation $\Delta_A(T) = AT - TA$ in $M_n(\mathbb{C})$ under the assumption that the iterated commutators satisfy a second-order linear relation $\Delta_A^2(T) + \alpha\Delta_A(T) + \beta T = 0$ for real coefficients α, β.

We prove that the nilpotency of both T and $\Delta_A(T)$ is fundamentally determined by the "spectral squeezing" effect imposed by the growth rates of the underlying dynamical system. We provide a complete classification of spectral outcomes based on the equilibrium types of the orbit:

1. Whenever the parameters (α, β) force an exponential collapse (Sink, Source, or Spiral dynamics), the spectral radii $r(T)$ and $r(\Delta_A(T))$ are forced to vanish, ensuring total nilpotency.

2. In the Mixed and Linear cases, we establish the structural nilpotency of the derivation $\Delta_A(T)$.

3. In the Hyperbolic (Saddle) case, we identify a "dimension-gap" resonance condition where nilpotency depends on the arithmetic ratio of the growth rates relative to the dimension n.

4. We show that the purely oscillatory (Center) case provides spectral freedom, allowing for non-nilpotent commutators.

This dynamical framework provides a robust generalization of the classical Kleinecke-Shirokov theorem and introduces an intuitive geometric method for investigating spectral rigidity in operator theory.

Oblique Dual Frame Completion in Euclidean Spaces: A Product Matrix Approach

Name: Gino Angelo Velasco

Institution: University of the Philippines Diliman

Abstract: Frames provide stable and redundant representations of vectors in Euclidean spaces. We study the oblique dual frame completion problem, that is, constructing dual frames when some vectors are prescribed in advance, particularly in the case where the dual frame lies in a different subspace. We establish conditions for existence and uniqueness, and develop explicit constructions using a product matrix approach. These results extend known dual frame completion results and provide a flexible framework for structured signal reconstruction. This is joint work with Roza Aceska and Jerielle Malonzo.

Construction of Mercedes-Benz Frames via QR Factorization

Name: Long Wang

Institution: Kennesaw State University

Abstract: Finite tight frames are widely used in many applications. An important problem is the construction of finite tight frames containing specified elements, as required in real-world applications. As the main result, this paper presents an algorithm based on QR factorization for completing a Mercedes – Benz frame containing specified elements, and two examples of Mercedes – Benz frames are constructed to illustrate our approach.

Restriction and Kakeya maximal estimates in Four Dimensions

Name: Yufei Zhan

Institution: University of Pennsylvania

Abstract: In joint work with Tainara Borges, Tiklung Chan, Mingfeng Chen, Diankun Liu, Yakun Xi, and Yufei Zhan, we combine the planebrush argument of Katz and Zahl with the decoupling–incidence method of Wang and Wu to obtain improved bounds for the Fourier restriction and Bochner–Riesz problems in $\mathbb{R}^4$, extending the admissible range to $p > 2 + \frac{200}{251}$. In addition, by exploiting the two-ends Furstenberg estimate in the plane, we derive a Kakeya maximal estimate in $\mathbb{R}^4$ at dimension 3.054.

Weighted estimates for some class of quasilinear operators

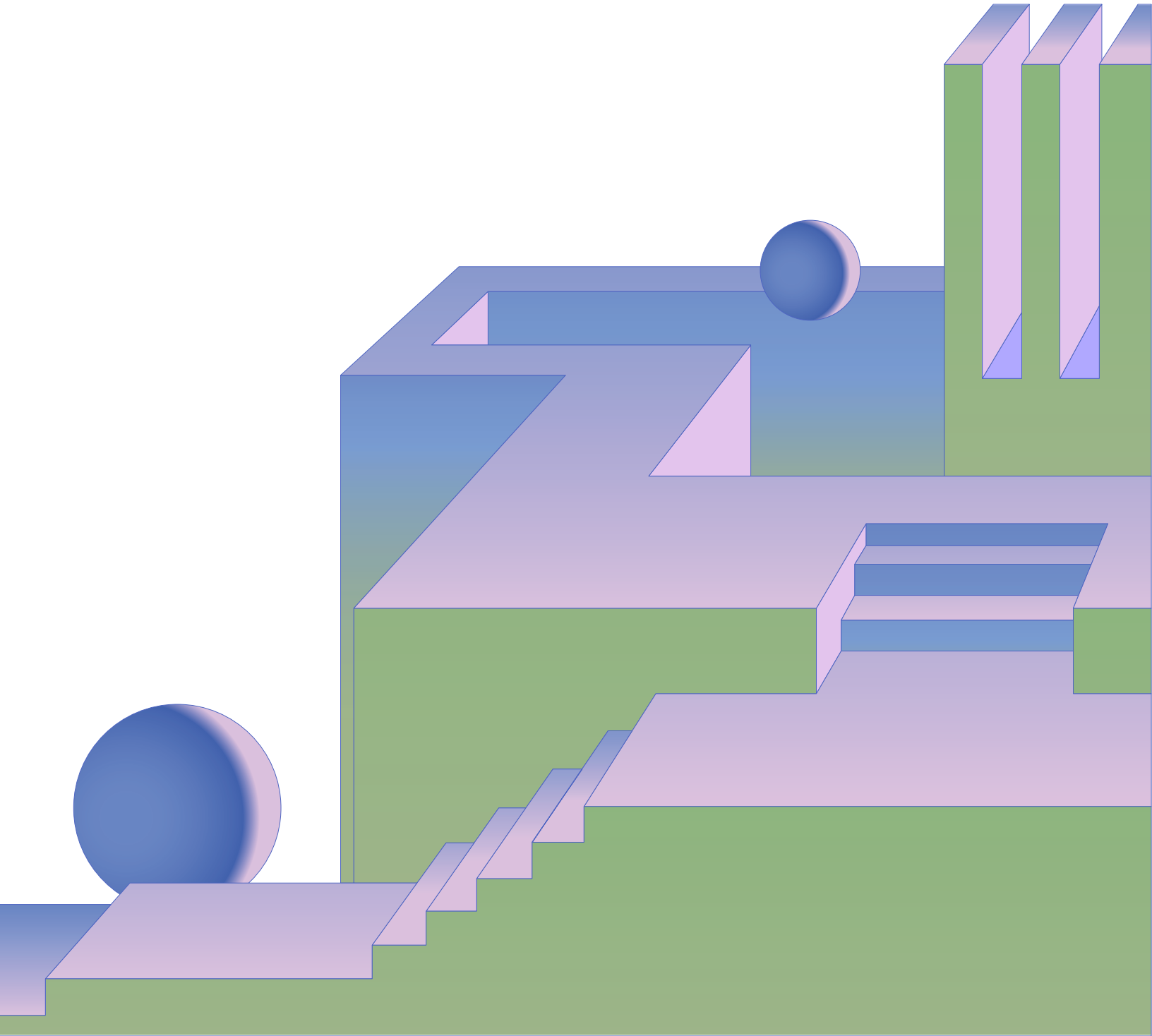
Name: Nazerke Zhangabergenova

Institution: L.N. Gumilyov Eurasian National University

Abstract: The criteria for the fulfillment of continuous and discrete inequalities involving Hardy operators are one of the key problems in the theory of weighted inequalities. These inequalities have become well-known after study boundedness properties of the multi-dimensional Hardy operator acting from the weighted Lebesgue space to the local Morrey-type space. The study of discrete inequalities for the class of matrix operators can be considered a new direction of research. In general, since the stability criterion in the weighted Lebesgue space for a discrete operator with a matrix kernel is not defined, various conditions are imposed on the matrix, which allows for obtaining broader results compared to the case without a matrix. In this work, we consider discrete quasilinear operators with matrices satisfying certain conditions. The results obtained for quasilinear inequalities can be applied to the description of bilinear Hardy inequalities.

POSTERS

SECTION 9– DYNAMICS



Besov Spaces and Statistical Properties of the Shift

Name: Pedro Augusto da Silva Morelli

Institution: ICMC-USP

Abstract: We define distributions on an abstract measure space endowed with a sequence of partitions and introduce analogues of Besov spaces with negative smoothness in this setting. In particular, we describe these spaces of distributions using unconditional Schauder bases consisting either of Haar wavelets or of pairs of Dirac masses (dipoles). This framework allows us to obtain duality results between Besov spaces of negative smoothness and Hölder spaces of functions with respect to an appropriately defined pseudo-metric and employ the functional approach to study the statistical properties of the one-sided shift by understanding the spectrum of the transfer operator.

Hyperbolicity and Hausdorff measures for renormalization of dissipative gap mappings

Name: Márcio Gouveia

Institution: São Paulo State University, Biosciences, Languages, and Exact Sciences Institute

Abstract: In this talk, we study the dynamics of gap mappings, which are discontinuous interval mappings with two strictly increasing branches that have a gap between their ranges. They are one-dimensional dynamical systems, which arise in the study of certain higher dimensional flows, for example the Lorenz flow and the Cherry flow. We will present some results such as hyperbolicity of renormalization acting on C^4 dissipative gap mappings, and show that the topological conjugacy classes of infinitely renormalizable gap mappings are C^1 manifolds. Furthermore, in the dynamics of this kind of map rises a quasi-minimal set. We then resorted to a more general definition of dimension proposed by Felix Hausdorff in his original paper to understand the sizes of these sets under an appropriate lens.

Large deviations and applications in homogeneous dynamics

Name: Taehyeong Kim

Institution: Brandeis University

Abstract: The Birkhoff Ergodic Theorem can be viewed as a dynamical version of the law of large numbers. A natural question that arises is how rapidly the measure of the exceptional set decays, leading to the study of large deviations. In this talk, we present large deviation estimates for diagonalizable actions on homogeneous spaces and discuss an application to the effective uniqueness of the measure of maximal entropy. This is an ongoing joint work with Elon Lindenstrauss and Ron Mor.

Spectral Decomposition and Skew-Product for Group Actions

Name: Keonhee Lee

Institution: Chungnam National University

Abstract: We develop a spectral decomposition theory for group actions on compact metric spaces that substantially extends the classical paradigm of hyperbolic dynamics. Traditional spectral decomposition theorems—originating with Smale and later generalized to flows and lattice actions—are fundamentally centered on a single transformation or on structural properties specific to abelian or differentiable settings. In contrast, our work formulates an intrinsically group-theoretic and directional framework that captures genuinely multi-generator dynamics without reducing the system to a distinguished element.

Our first result shows that if a group action admits a central element whose induced transformation is topologically Anosov, then the closure of compact orbits decomposes into finitely many disjoint compact invariant transitive sets. This yields a purely topological analogue of Smale's decomposition theorem at the level of group actions, removing the need for differentiable hyperbolicity or manifold structure. The argument reveals that spectral decomposition can be derived from directional hyperbolicity embedded within the algebraic structure of the acting group.

To address intrinsic multi-directional phenomena, we introduce directional notions of expansivity, shadowing, periodicity, and nonwandering behavior associated with a prescribed subset of the acting group. These concepts allow us to isolate and analyze asymptotic dynamics along selected directions while retaining full group symmetry. Our principal innovation is a skew-product construction that encodes directional itineraries and establishes a precise correspondence between directional recurrent sets of the original action and classical recurrent sets of the associated skew-product system. This mechanism transforms a genuinely multi-parameter recurrence problem into a one-step dynamical framework where spectral techniques become available.

As a consequence, we obtain finite spectral decomposition results for directional nonwandering sets under purely topological hyperbolicity assumptions, including in noncommutative settings where previous approaches are not applicable. The resulting theory provides a unified conceptual bridge between classical hyperbolic dynamics and modern group-action dynamics.

This work is joint with C. A. Morales and N. Nguyen. The paper will appear in Discrete and Continuous Dynamical Systems (DCDS).

Smoothness, tangency and uniqueness of horospherical foliations of geodesic flows

Name: Edhin Mamani

Institution: Federal University of Minas Gerais

Abstract: This poster deals with the study of some geometric and regularity properties of the geodesic flow associated with a compact Riemannian manifold M. When M has negative curvature, its geodesic flow is uniformly hyperbolic. In particular, it has two dynamically defined foliations (with special properties) of the unit tangent bundle of M, which are invariant by the geodesic flow.

For Riemannian metrics more general than metrics with negative curvature, the geodesic flow is not longer uniformly hyperbolic and there is no dynamical foliations of the unit tangent bundle. Though, for metrics without conjugate points (those admitting some zero and positive curvature), there always exist two geometrically defined foliations of the unit tangent bundle of M, which are invariant by the geodesic flow, called horospherical foliations. Despite the lack of hyperbolic structure, horospherical foliations still have some properties of the dynamical defined foliations. Assuming that the universal cover satisfies a geometric property called visibility, the continuity of some local objects called Green bundles and the existence of a periodic hyperbolic geodesic, we prove that Green bundles are tangent to the horospherical foliations. Moreover, the horospherical foliations are the unique Lagrangian invariant continuous foliations of the unit tangent bundle. These results are generalizations of some known results given in the negative curvature case. In such case, the horospherical foliations are exactly the dynamical defined foliations and Green bundles are the invariant subspaces given by the hyperbolic structure. Furthermore, our work also generalizes to the n-dimensional setting, the results of Gelfert-Ruggiero and Barbosa-Ruggiero given for compact higher genus surfaces without conjugate points. This is joint work with Rafael Ruggiero.

A Discrete-Time Nonlinear Phytoplankton-Zooplankton Model with Toxin Release

Name: Sobirjon Shoyimardonov

Institution: V.I.Romanovskiy Institute of Mathematics of the Uzbekistan Academy of Sciences

Abstract: This study investigates a two-dimensional phytoplankton–zooplankton interaction model originally proposed by Chattopadhyay et al. (2002), incorporating toxin production effects in plankton dynamics. The continuous-time system describes the growth of phytoplankton through logistic dynamics and its consumption by zooplankton via a general functional response, while zooplankton dynamics are influenced by nutrient intake, natural mortality, and toxin-induced inhibition.

To capture more realistic ecological processes and temporal variability, we formulate a discrete-time analogue of the model using the forward Euler discretization scheme. This approach allows for the analysis of population dynamics under seasonal or generational time steps, which are common in aquatic ecosystems. The model includes nine biologically meaningful combinations of functional responses for grazing and toxin effects, as classified in the original study. Each case reflects different ecological assumptions regarding feeding behavior and toxin interaction mechanisms.

We conduct a comprehensive qualitative analysis of the resulting discrete system. In particular, we determine the existence and multiplicity of interior fixed points and derive conditions for their local stability. The analysis reveals that the number and nature of equilibria strongly depend on both system parameters and the choice of functional responses. Furthermore, we investigate the occurrence of key bifurcation phenomena, including flip (period-doubling), fold (saddle-node), and Neimark–Sacker bifurcations, which lead to oscillatory and complex dynamical behaviors.

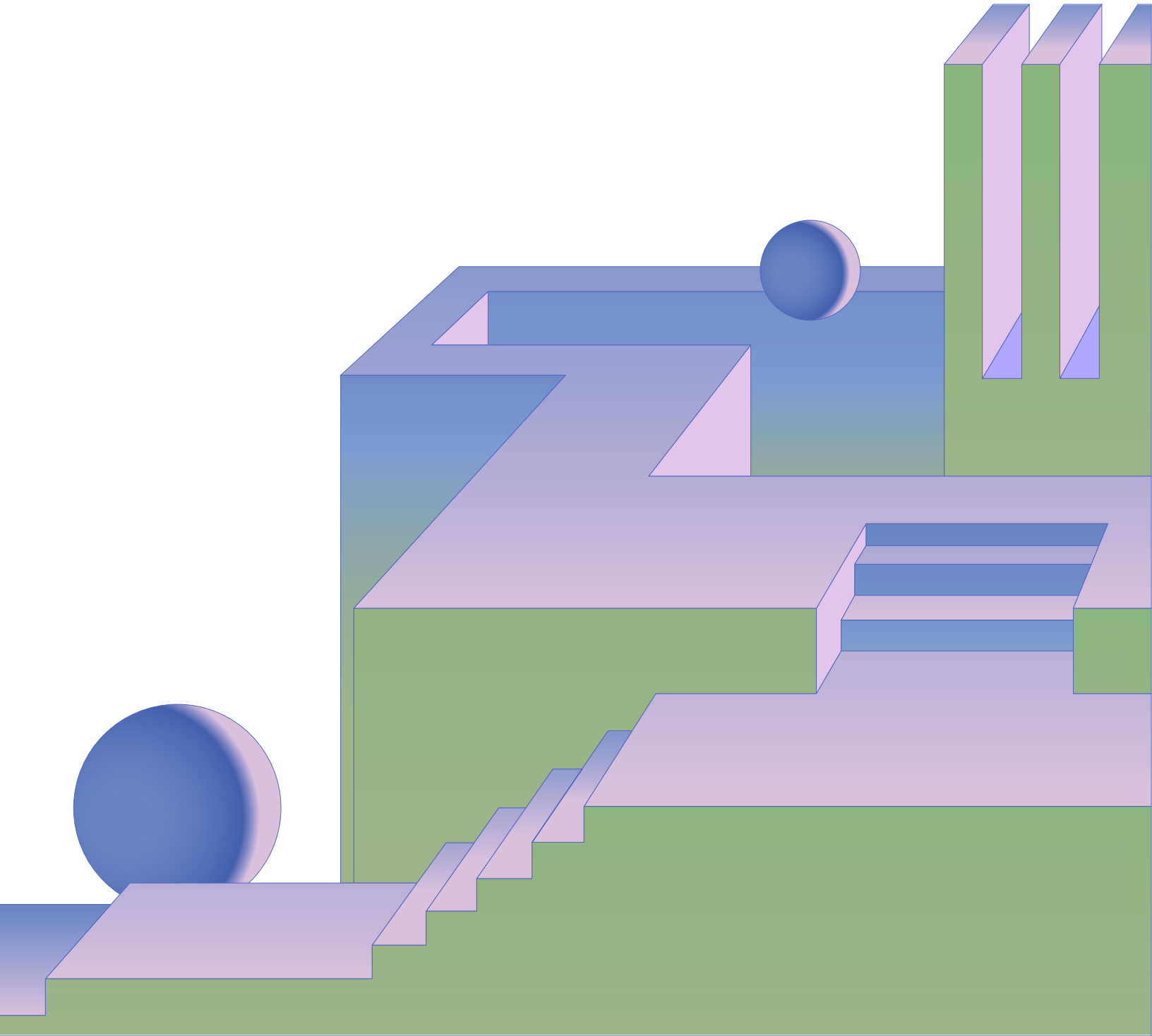
Our results demonstrate that discretization significantly enriches the system dynamics compared to its continuous counterpart. Depending on the functional forms and parameter regimes, the

model exhibits stable equilibria, periodic oscillations, quasi-periodic solutions, and transitions to instability. Notably, each of the nine cases produces qualitatively distinct dynamical patterns, highlighting the critical role of toxin mechanisms and grazing responses in shaping plankton population dynamics.

These findings provide deeper insight into the complexity of ecological interactions in plankton systems and emphasize the importance of discrete-time modeling in understanding nonlinear phenomena such as bifurcations and dynamic transitions in aquatic ecosystems.

POSTERS

SECTION 10– PARTIAL DIFFERENTIAL EQUATIONS



Pitchfork bifurcation and traveling waves for a planar ensemble of rigid filaments with repulsive interaction

Name: Gervy Marie Angeles

Institution: Institute of Mathematics, University of the Philippines Diliman

Abstract: The so-called Filament Based Lamellipodium Model is a complex modeling framework for a very heterogeneous chemo-mechanical system of cell biology. It contains a model for Coulomb repulsion between filaments, whose effect on the stability of the system has been unclear. In this work, a strongly simplified version of the model is considered, showing a destabilizing effect of the repulsion, leading to a pitchfork bifurcation from a trivial steady state to traveling wave solutions. The simplified model is derived, its linearization around the trivial steady state is analyzed, and a formal bifurcation analysis is carried out. It is shown that the pitchfork bifurcation maybe super- or sub-critical. Time dependent numerical simulations illustrate these results and provide additional, more global information.

The negative order modified Korteweg-de Vries equation with a self-consistent source

Name: Shoira Atanazarova

Institution: V.I.Romanovskiy Institute of Mathematics, Uzbekistan Academy of Sciences.

Abstract: The negative order modified Korteweg – de Vries (mKdV) equation arise as member of the extended mKdV hierarchy. This equation is often nonlocal and exibits features that are qualitatively different from its positive order analogues, such as nonlinear dispersion and the possibility of wave breaking. Nevertheless, it retains its integrability. In this study, we discuss the negative order mKdV equation with a special source by linking it to a linear eigenvalue problem. Based on scattering theory for linear operators, we explain how the temporal dependence of the scattering data for the linear Zakharov-Shabat system of equations with moving eigenvalues can be obtained, through which the solution of the considered problem can be constructed. We also present the one-soliton solution of the considered problem based on obtained results.

Determining wavenumbers for Hall and electron magnetohydrodynamics

Name: Hassan Babaei

Institution: University of Illinois Chicago

Abstract: Kolmogorov's theory of turbulence predicts that, in three-dimensional flows, energy is primarily contained in Fourier modes below a critical wavenumber—the Kolmogorov dissipation wavenumber—beyond which viscous effects dominate. Analogous dissipation wavenumbers have been observed in numerical and experimental studies of Hall and electron magnetohydrodynamics (MHD) which model key aspects of astrophysical plasma turbulence. In this work,

we employ Littlewood – Paley decomposition techniques to establish a rigorous mathematical analog of these physical scales by proving the existence of time-dependent determining wavenumbers for both the Hall-MHD and electron MHD equations. We further show that the time averages of these determining wavenumbers are bounded by the Kolmogorov-type dissipation wavenumbers predicted by plasma turbulence phenomenology.

Existence and uniqueness of solutions for loaded mixed-type equation with fractional integral operators

Name: Yulduz Babajanova

Institution: Khorezm Mamun Academy

Abstract: The theory of mixed-type partial differential equations plays a significant role in modern analysis and has numerous applications in applied sciences. In this paper, we study a boundary value problem for a second-order mixed-type integro-differential equation with variable coefficients. Special attention is given to discontinuous gluing (transmission) conditions imposed along the line where the type of the equation changes. We establish sufficient conditions for the existence and uniqueness of a regular solution to the problem. The analysis is carried out using the method of integral equations, which allows the original boundary value problem to be reduced to an equivalent system of integral equations. The unique solvability of this system is then rigorously proven.

Integration of the negative order Nonlinear Schrödinger Equation with self-consistent source

Name: Iroda Baltaeva

Institution: Urgench State University

Abstract: This paper focuses on the integrability properties of the negative-order nonlinear Schrödinger equation with a source The source consists of the combination of the eigenfunctions of the corresponding spectral problem for the Dirac system which has not spectral singularities. The connection between the negative-order nonlinear Schrödinger equation with a self-consistent source and the Dirac system of equations is crucial, as it allows the complex dynamics of the original nonlinear model to be interpreted through the spectral theory of the Dirac operator. Building on this relationship it was derived the evolution equations of scattering data of the Dirac operator, which is the central part in the IST framework. Due to the IST procedure, the rapidly decaying potential of the Dirac operator can be reconstructed through the derived differential equations for scattering data, and this potential is precisely the solution to the considered problem. To illustrate the practical value of the theoretical results, the paper presents a detailed example demonstrating each stage of the method, from the formulation of scattering data to the final recovery of the potential. This example enables the clarifying the overall procedure and highlights the effectiveness of the approach in concrete applications.

Uniform inviscid damping and vorticity depletion near non-monotonic shear flows

Name: Shan Chen

Institution: University of Minnesota, Twin Cities

Abstract: In this poster, I will present recent results on the long-time dynamics of the two-dimensional linearized Navier – Stokes equations near spectrally stable shear flows. There are three main mechanisms: inviscid damping of velocity fields over time, depletion of vorticity from critical points of the shear flow, and enhanced dissipation due to mixing effects. Most real-world fluids have very small viscosity, which mathematically, corresponds to the Navier – Stokes equations formally reducing to the Euler equations. In this singular limit, our results provide quantitative decay estimates that are both uniform and optimal. These estimates capture all three stability phenomena and are consistent with experimental observations. This is joint work with Rajendra Beekie and Hao Jia.

On the existence of source-solutions to the multidimensional Burgers equation

Name: João Fernando Da Cunha Nariyoshi

Institution: Instituto de Matemática, Estatística e Ciência da Computação da Universidade de São Paulo (IME-USP)

Abstract: We establish that, in general, there are no entropy solutions to the Cauchy problem for the multidimensional Burgers equation when the initial data is a measure. This answers in the negative a conjecture of Serre and Silvestre concerning the asymptotic behavior of entropy solutions with integrable initial data. Despite this negative result, we still obtain information on the asymptotic behavior of such solutions. Our approach relies on new Laplace transform estimates for the propagation of information.

On local well-posedness of the stochastic incompressible density-dependent Euler equations

Name: Claudia Lorena Duarte Espitia

Institution: State University of Campinas

Abstract: We study the stochastic inhomogeneous incompressible Euler equations in the whole space $\mathbb{R}^3$. We show the existence and pathwise uniqueness of local solutions with a multiplicative stochastic noise. Our approach is based on reducing our problem to a random problem and some estimations for type transport equations. Joint work with Christian Olivera and David A.C Mollinedo.

A coupled PDE – ODE system with boundary interaction arising in heat transfer

Name: Le Duc Nhien

Institution: Department of Mathematics, Chonnam National University

Abstract: This work proposes a coupled PDE – ODE system, arising in heat transfer, with nonhomogeneous boundary conditions, where the coupling is imposed on a portion of the boundary. The PDE component is a reaction – diffusion equation with boundary convective heating governed by a first-order ODE. Under suitable assumptions, we establish the well-posedness of the system in the multidimensional setting. In the scalar autonomous case, we further investigate the effect of large diffusion in the PDE component on the coupled PDE – ODE system and analyze the resulting singular limit problem via the Invariant Manifold Theorem.

This is joint work with Jihoon Lee (Chonnam National University) and Leonardo Pires (State University of Ponta Grossa)

Cauchy problem for generalized Euler–Poisson–Darboux equation with loaded term

Name: Zebo Egamberganova

Institution: Khorezm Mamun Academy, Academy of Sciences of the Republic of Uzbekistan

Abstract: In this work, we study the Cauchy problem for the singular inhomogeneous hyperbolic equation

$$u_{tt} + \frac{2\beta}{t}u_t - \left(u_{xx} + \frac{2\alpha}{x}u_x\right) + \lambda^2 u - \mu^2 u(x_0, t) = f(x, t)$$

in the domain $D = \{(x, t) : 0 < t < x < +\infty\}$, subject to the initial conditions

$$u(x, t)|_{t=0} = \varphi(x), \qquad x \geq 0,$$

$$\lim_{t\to 0} t^{2\beta} u_t(x, t) = \psi(x), \qquad x > 0.$$

The equation arises from a transformation of an Euler–Poisson–Darboux-type equation with singular coefficients in characteristic variables. By applying Erdélyi–Kober operators, the problem is reduced to auxiliary hyperbolic equations of the form

$$Z_{\xi\xi} - Z_{\eta\eta} = -\mu^2 Z(\xi_0, \eta).$$

This reduced equation is analyzed using d'Alembert-type representations and Volterra integral equations. The resolvent kernels of the corresponding Volterra integral equations are derived explicitly. This leads to closed integral representations of the solution involving Bessel functions and special functions.

The nonlinear Schrödinger equation on metric graphs

Name: Damien Galant

Institution: Brown University

Abstract: In this poster, we introduce metric graphs and the (elliptic) nonlinear Schrödinger equation (NLS) defined on them. We define the notion of a "ground state" within the framework of the calculus of variations and show that, for noncompact metric graphs, the terminology "ground state" requires precision. Specifically, we demonstrate that one must distinguish between the notions of a ground state and a minimal action solution. We present several examples of graphs illustrating the possible relationships between these two concepts. Finally, we introduce the notion of a "nodal ground state" on metric graphs and show that nodal solutions may vanish identically on some edges - a distinctive behavior that does not occur for solutions on open sets of the Euclidean space.

A constructible conductivity cloak via homogenisation

Name: Eleanor Gemida

Institution: Universite Paris Cite, University of the Philippines

Abstract: We present a methodology to construct near-cloaks in the setting of electrical impedance tomography. Theoretical near-cloaks computed by cloaking-by-mapping technique require that the material parameters of the constituting medium are very anisotropic. We propose a near-cloak design realised by laminating three or more distinct isotropic, homogeneous materials in a finite number of layers. The structure is a radial laminate and can be built by additive manufacturing. The approach is based on homogenisation theory, which we apply backwards compared to the purpose for which it was developed. Our approach is to view anisotropic matrix-valued materials obtained by the cloaking-by-mapping method as the effective limit of a multiple materials rank-one laminate, and to quantify precisely the approximation error. The key elements in the construction are the explicit formulas that give (1) the range of isotropic homogeneous materials that can realise the near-cloak, and (2) the scale of heterogeneity, which can be interpreted as the number of layers needed to achieve a specified level of invisibility.

Traveling Band Solutions in Degenerate Chemotactic Systems: Existence, Stability, and Pattern Selection

Name: Isanka Hevage

Institution: Central State University, OH

Abstract: This project develops a rigorous analytical framework for a class of chemotactic transport models derived from an Einstein – Brownian – type paradigm of material transport in active media, rooted in a thought experiment. Particle motion is governed by a nonlinear interaction between chemoattractant-driven drift and a concentration-dependent jump time. Unlike classical Keller – Segel systems, degeneracy of the free-jump time at low particle densities

induces an intrinsic anti-diffusive mechanism, producing sharp moving interfaces and compactly supported solutions. The resulting system forms a nonlinear prey – predator-type coupling between particle density and chemoattractant concentration, generating a bidirectional feedback loop in which density modulates chemoattractant consumption while chemoattractant drives directed motion. This structure fundamentally alters qualitative dynamics: classical monotone traveling waves are precluded, and instead the system supports traveling band solutions, spatially localized, hump-shaped profiles with sharply defined edges arising from degeneracy at low densities. The governing system takes the form of degenerate nonlinear partial differential inequalities,

$$\tau(v)\,\partial_t u - D(x,t)\,\partial_{xx} u + \partial_x\big(\mathsf{k}(x,t)\,u\,\partial_x v/v\big) \le 0, \tag{7}$$

$$\partial_t v + \psi_0(u)\,\psi_1(v) \le 0, \text{ with } \psi_0(0) = \psi_1(0) = 0, \tag{8}$$

where $\tau(v) \ge 0$ is the jump time (degenerate as $v \to 0$), $D(x,t)$ the jump variance, $\mathsf{k}(x,t)$ the chemoattractant transport scale, and $\psi_0, \psi_1 \ge 0$ the consumption rates. Degeneracy in $\tau(v)$ drives the formation of compactly supported, band-like profiles. The research aims to: (i) prove the existence of localized traveling bands; (ii) establish their asymptotic stability under perturbations; and (iii) determine robustness with respect to system parameters and initial data. The analysis leverages finite-speed propagation, degenerate diffusion, and moving-interface theory, extending prior results on degenerate transport equations. A central goal is to characterize the basin of attraction of traveling bands and identify mechanisms governing pattern selection and long-time dynamics. Anticipated outcomes will clarify how localized structures emerge, persist, and self-organize in degenerate chemotactic media, with implications for transport, diffusion, and self-organization in active materials.

Minkowski-curvature equation under a Schwarzian constraint

Name: Kuo-Chih Hung

Institution: National Chin-Yi University of Technology

Abstract: We study the exact multiplicity of positive solutions and the global bifurcation structure for the one-dimensional Minkowski-curvature equation. While previous works have classified bifurcation diagrams for specific nonlinearities, a unified structural framework for general superlinear nonlinearities remains unavailable. In this research, we introduce a class of nonlinearities characterized by five explicit conditions, combining a structural curvature-growth constraint with a strictly negative Schwarzian derivative S(f) < 0. These geometric restrictions provide a structural mechanism for controlling the convex regime, where classical approaches fail to yield sufficient information. As a consequence, we prove that the bifurcation curve is strictly C-shaped, yielding the exact multiplicity of positive solutions. Our framework applies to several representative nonlinearities, including logarithmic, exponential-type, and inverse-trigonometric nonlinearities.

On an algorithm for finding solutions of initial – boundary value problem for functional – hyperbolic equation with distributed parameters

Name: Narkesh Iskakova

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: Functional – hyperbolic equations with distributed parameters constitute a class of complex mathematical models describing dynamical systems with spatially distributed characteristics. Such equations arise in various applications, including physics, engineering, and biology, where the coupled evolution of processes in time and space plays a crucial role. Their investigation requires advanced analytical techniques combined with numerical methods.

In this work, we consider the delay hyperbolic equation of the second order with distributed parameters on the domain $\Omega_\tau = [-\tau, T] \times [0, \omega]$

$$\frac{\partial^2 u(t,x)}{\partial t \partial x} = A(t,x)\frac{\partial u(t,x)}{\partial x} + B(t,x)\frac{\partial u(t,x)}{\partial t} + C(t,x)\frac{\partial u(t-\tau,x)}{\partial x} +$$
$$+D(t,x)u(t,x) + A_0(t,x)\frac{\partial u(\gamma(t),x)}{\partial x} + B_0(t,x)\frac{\partial u(\gamma(t),x)}{\partial t} + \tag{9}$$
$$+D_0(x,t)u(\gamma(t),x) + K_1(t,x)\lambda(x) + K_2(t,x)\mu(t) + f(t,x),$$
$$(t,x) \in \Omega = [0,T] \times [0,\omega],$$

for which the unknown function satisfies the initial and boundary conditions

$$\frac{\partial u(t,x)}{\partial x} = diag\left[\frac{\partial u(0,x)}{\partial x}\right]\varphi(t), \quad (t,x) \in [-\tau, 0] \times [0,\omega], \tag{10}$$

$$u(0,x) = \phi(x), \quad u(T,x) = \phi_0(x), \quad x \in [0,\omega], \tag{11}$$

$$u(t,0) = \psi(t), \quad u(t,\omega) = \psi_0(t), \quad t \in [-\tau, T], \tag{12}$$

and additional constraints in the form of integral relations are added to the unknown parameters $\lambda(x), \mu(t)$. The analysis is carried out using the method of functional parameterization. The domain is partitioned by lines parallel to one of the independent variables, and functional parameters are introduced as the values of the solution along these lines. By defining auxiliary unknown functions as deviations from these parameters within the subdomains, the original problem is transformed into an equivalent system of functional – hyperbolic equations with parameters and associated functional relations. A constructive solution method is developed and an algorithm is proposed to calculate approximate solutions to the initial – boundary value problem.

Existence and Uniqueness of the Navier-Stokes Initial Value Problem in Infinite Space

Name: Kulyash Kaliyeva

Institution: al-Farabi University

Abstract: We investigate the existence and uniqueness of solutions to the compressible Navier–Stokes initial value problem in a weighted three-dimensional critical space. The study is based on the separation of gradient components associated with the energy flux using the rotator operator. To define the velocity vector, the Navier–Stokes equations are transformed into a nonlinear Volterra–Fredholm integral equation in convolution form involving the Green's function of the heat equation. The resulting nonlinear vector equation is solved using the method of successive approximations. The convergence of the iterative scheme is justified by the contraction mapping principle adapted to weighted spaces. An analogue of the Reynolds number is introduced, which characterizes the existence of particle velocity and pressure under certain conditions. Furthermore, three regimes are identified: a subcritical regime, characterized by two solutions, one of which is stable and globally defined via successive approximations;a critical regime corresponding to a bifurcation point, which is also stable and determined by the same iterative method; and a supercritical regime, in which the solution cannot be controlled, convergence is lost, and instability arises.By substituting the obtained velocity field into the Navier–Stokes equations, an energy conservation law is derived, from which the scalar pressure distribution is determined. This approach provides an explicit analytical representation that can be applied to both theoretical investigations and numerical simulations. Its novelty lies in combining the integral formulation of the velocity field in weighted functional spaces with convergence of Picard iterations under general initial conditions and external forces, governed by a critical parameter interpreted as an analogue of the Reynolds number.

A topological derivative-based method to image inhomogeneities in an acoustic waveguide

Name: Umid Karimov

Institution: Urgench State University

Abstract: This work aims to image an inhomogeneity inside a tubular acoustic waveguide given multistatic time harmonic data at several frequencies with point sources and receivers positioned on surfaces away from the inhomogeneity (but not in the far field, so we call these near field data). We consider an unbounded straight cylindrical waveguide whose cross-section is bounded and smooth. We also consider a lossless obstacle supported inside the tubular acoustic waveguide, which we suppose is Lipschitz and bounded and not touching the boundary of the waveguide. The forward problem is stated in a bounded section of the waveguide by making use of the Dirichlet-to-Neumann map. For the imaging problem, we prove uniqueness results provided we have full exact data, and then derive a closed-form expression of the topological derivative that can be evaluated in practice. We also investigate the performance of the topological derivative method on synthetic data in 2D, focusing on multifrequency data in the ultrasound range. To find the support of the unknown scatterer, we derive a closed-form expression for the topological derivative in our application. The results confirm that topological derivative-based imaging constitutes an effective and flexible tool for inverse acoustic waveguide problems.

A boundary value problem for a degenerate elliptic equation with singular coefficients

Name: Kalligul Kazakbaeva

Institution: V.I. Romanovskiy Institute of Mathematics, Uzbekistan Academy of Sciences

Abstract: In this talk, we study a boundary value problem for the Holmgren equation with singular coefficients in an unbounded domain. The uniqueness of the solution to the problem is proved using the energy integral method, while the existence of a solution is proved by the method of integral equations. To establish the existence of a solution, we employ the solution of a generalized Neumann problem for the Holmgren equation with singular coefficients in the upper half-plane. The problem under consideration involves a boundary condition containing a fractional-order Riemann-Liouville operator. Depending on the values of the fractional derivative's order in this operator, the problem reduces to solving a Fredholm's integral equation of the second kind and a singular integral equation with a Cauchy-type kernel. The resulting integral equations are solved using the Carleman-Vekua method.

Initial-boundary value problems for Navier-Stokes-Voigt equations with power-law nonlinearity

Name: Khonatbek Khompysh

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: In this work, we consider the following initial-boundary value problems for the system of Navier-Stokes-Voigt equations with power-law nonlinearity

$$\mathbf{u}_t + (\mathbf{u}\cdot\nabla)\,\mathbf{u} - \varkappa\Delta\mathbf{u}_t - \operatorname{div}\left(\left(\mu+\nu\,|\mathbf{Du}|^{p[\theta]-2}\right)\mathbf{Du}\right) + \nabla\pi = \gamma g(\mathbf{x},t)\theta + \mathbf{f}(\mathbf{x},t),\ (x,t)\in Q_T,$$

$$\operatorname{div}\mathbf{u}(\mathbf{x},t) = 0,\ \ (x,t)\in Q_T,$$

$$\theta_t + (\mathbf{u}\cdot\nabla)\,\theta - \lambda\Delta\theta = j(\mathbf{x},t),\ \ (x,t)\in Q_T,$$

supplemented with an initial and boundary conditions. Here $\mathbf{u}$ is the velocity, θ is the temperature, π is the pressure-are unknowns while the functions $\mathbf{f}$, j, and the constants $\varkappa$, μ,ν, and λ are given. Exponent p is also given functional such that

$$p[\theta] = p(l(\theta)) = \int\limits_{\Omega} |\theta(\mathbf{x},t)|^{\alpha}\,d\mathbf{x} : L^{\infty}(0,T;L^{\alpha}(\Omega)) \to \mathbb{R}.$$

Under suitable assumptions on the data, we establish the existence and uniqueness of weak solutions of such possed initial-boundary value problem.

Geometric Rigidity and Unstable Set Decomposition of Normally Hyperbolic Frozen Waves

Name: Jihoon Lee

Institution: Chonnam National University

Abstract: We establish a geometric rigidity principle for unstable dynamics near translation-generated continua of equilibria (frozen waves) in scalar semilinear parabolic equations on the circle. Because of translation invariance, every nonconstant equilibrium generates a one-dimensional orbit of equilibria, and the associated neutral translation mode prevents the direct application of classical hyperbolicity theory.

Our main theorem shows that, under the assumption of normal hyperbolicity, the unstable set of such an equilibrium orbit admits an exact decomposition: the unstable set of the entire continuum coincides precisely with the union of the unstable sets of its individual elements. Moreover, every trajectory in this unstable set converges exponentially, as time tends to negative infinity, to a uniquely determined phase along the orbit. In particular, continuous symmetry does not produce additional unstable complexity beyond that of each single equilibrium.

As a structural consequence, we prove that the equilibrium orbit is dynamically isolated: any nearby equilibrium necessarily belongs to the same translation-generated family. This allows the continuum of equilibria to be regarded as a normally hyperbolic invariant manifold in the infinite-dimensional phase space.

We further establish a local unstable manifold theorem adapted to the presence of the neutral direction. After appropriate phase modulation, the local unstable set admits a Lipschitz graph representation over the unstable eigenspace. The proof relies on spectral splitting, modulation analysis along the symmetry direction, and weighted fixed-point arguments, and is carried out entirely within a functional-analytic framework, without using Sturm theory or zero-number techniques.

These results provide a precise geometric description of unstable dynamics near non-isolated equilibrium families generated by symmetry. They clarify how continuous symmetry organizes unstable behavior within the global attractor and complement the Sturm attractor theory for one-dimensional scalar parabolic equations. The approach suggests further extensions to reaction – diffusion systems with symmetry, higher-dimensional domains with compact group actions, and symmetry-breaking perturbations.

This work is based on joint research with H. Jang and N. Nguyen.

Global boundedness and pattern formation in a flux-limited Keller – Segel system with logistic growth

Name: Ruiliang Li

Institution: Tsinghua University

Abstract: Chemotaxis models describe how cells move along chemical gradients and are a classical source of challenging nonlinear partial differential equations. In the standard Keller –

Segel system, strong chemotactic attraction can drive solutions to blow up in finite time, whereas experiments suggest that the chemotactic flux saturates when the signal gradient becomes large. Flux-limited chemotaxis replaces the linear drift by a gradient-dependent, bounded flux and thus provides a more realistic macroscopic description, but its interaction with logistic growth in fully parabolic systems is still not well understood.

This work presents new analytical results for a fully parabolic flux-limited Keller – Segel system with a superlinear logistic source in a two-dimensional bounded domain. Under natural assumptions on the flux-limiting function and for every logistic exponent strictly larger than one, we prove global existence and uniform-in-time boundedness of classical solutions for arbitrary nonnegative initial data. This reveals a robust mechanism through which flux limitation and logistic damping cooperate to prevent chemotactic collapse in the fully parabolic setting. For sufficiently small chemotactic sensitivity we then obtain exponential convergence of all solutions toward the unique positive homogeneous equilibrium, by combining a spectral analysis of the linearised operator with nonlinear energy estimates. Finally, a Turing-type linear stability analysis identifies a mode-dependent threshold at which this equilibrium becomes unstable to spatially inhomogeneous perturbations, and numerical simulations in one space dimension illustrate the resulting diffusion-driven patterns. The results clarify how realistic flux saturation modifies both the global dynamics and the pattern formation scenarios of classical chemotaxis models, and connect tools from nonlinear parabolic PDE, dynamical systems, and numerical analysis.

Partially holomorphic solutions of higher order totally characteristic equations

Name: Jose Ernie Lope

Institution: University of the Philippines Diliman

Abstract: Consider singular nonlinear equations of the form $t\partial_t u = F(t, x, u, \partial_x u)$ where $(t, x) \in \mathbb{R} \times \mathbb{C}$ and $F(t, x, u, v)$ is continuous in t and holomorphic in the other variables. We seek solutions that are continuous in t and holomorphic in x, hence the term partially holomorphic. Assuming that $F(0, x, 0, 0) = \partial_u F(0, x, 0, 0) = 0$ and $\partial_v F(0, x, 0, 0) = x\gamma(x)$ with $\operatorname{Re}\gamma(0) < 0$, Bacani and Tahara showed in 2012 the unique existence of a solution $u(t, x)$ that is continuous in t and holomorphic in x. Moreover, they showed that the solution has the same growth as $F(t, x, 0, 0)$ as $t \to 0$. In 2020, Ona and Lope presented an improved result by weakening the growth condition on $F(t, x, 0, 0)$. In this paper, we extend the previous results to higher order equations. This is a joint work with Michael Sta. Brigida of UP Diliman.

Regime dependent infection propagation fronts in an SIS model.

Name: Vahagn Manukian

Institution: Miami University

Abstract: We show the existence of traveling front solutions in a di□usive classical SIS epidemic model and the SIS model with a saturating incidence in the size of the susceptible population.

We investigate the situation where both susceptible and infected populations move around at a comparable rate, but small compared to the spatial scale. In this case, we show that traveling front solutions exist for each fixed positive speed. In the regime where the infected population di□uses slower than the susceptible population, we show the existence of traveling wave solutions for each fixed positive speed and describe their structure and dependence on the wave speed as it is varied from 0 to infinity. In the regime where the infected population di□uses faster than the susceptible population, we derive a bound for the speeds of the fronts in this regime in which the infection propagates as a front. Moreover, for the classical SIS model we show that there is a case when the spread of the disease is governed by the Burgers-FKPP equation.

Effects of Stage-structure and Dispersal Mechanism on Species' Persistence

Name: Maria Amarakristi Onyido

Institution: Northern Illinois University

Abstract: The existence of the principal eigenvalue of the linear local dispersal operator modeled by the Laplacian is a well known consequence of the Krein-Rutman's theorem. In contrast, for nonlocal dispersal described by integral operators, in spatially heterogeneous environments there are counterexamples showing that the principal spectrum point may not an eigenvalue, thus a principal eigenvalue may fail to exist. In this case, it becomes crucial to find criteria for the existence of principal eigenvalue.

Considering a stage-structured model in which juveniles disperse locally by random diffusion while adults disperse nonlocally, we provide necessary and sufficient conditions for the existence of principal eigenvalue, providing a counterexample to show possible nonexistence. As an application, we derive criteria for the existence and global stability of a unique positive equilibrium for the nonlinear model in environments that are spatially and temporally heterogeneous.

Global dynamics of solitons coupled to radiation for critical wave maps and nonlinear wave equations

Name: Mohandas Pillai

Institution: University of Tennessee, Chattanooga

Abstract: This work constructs infinite time blow-up, relaxation, and intermediate types of solutions to the critical, quintic, focusing semilinear wave equation, and the critical wave maps problem with two-sphere target. More precisely, we first define an admissible class of time-dependent length scales, which includes a symbol class of functions. Then, we construct solutions which can be decomposed, for all sufficiently large time, into a soliton, re-scaled by an admissible length scale, plus radiation (which solves a linear wave equation), plus corrections which decay as time approaches infinity. The solutions include infinite time blow-up and relaxation with rates including, but not limited to, positive and negative powers of time, with exponents sufficiently small in absolute value. We also obtain solutions whose soliton component has oscillatory length

scales, including ones which converge to zero along one sequence of times approaching infinity, but which diverge to infinity along another such sequence of times. The method of proof is inspired by matched asymptotic expansions.

New Analytical Soliton Solutions and Dynamical Analysis of a Double-Stranded DNA Model

Name: Md Nurul Raihen

Institution: University of Toledo

Abstract: In this work, we investigate nonlinear wave dynamics in a double-stranded DNA model consisting of two coupled polynucleotide chains interacting through an elastic membrane that represents hydrogen bonding. By applying the Sine-Gordon Expansion Method and the Improved Bernoulli Sub-Equation Function Method, we derive new traveling-wave solutions, including hyperbolic, exponential, rational, and complex periodic structures. These solutions describe localized excitations such as strand-opening and breathing modes along the DNA double helix. To illustrate their physical behavior, we present two- and three-dimensional visualizations of the longitudinal and transverse displacements, highlighting localization, amplitude variation, and spatial coherence. We also analyze the dynamics of the reduced system through phase portraits and bifurcation analysis, showing how parameter changes influence equilibrium structure and stability. Under periodic external forcing, the model exhibits chaotic responses, and a sensitivity analysis reveals that small perturbations in initial conditions can produce significantly different trajectories. These results provide new analytical wave patterns together with a qualitative dynamical description of the model, offering insight into how nonlinear interactions and parameter variation affect wave propagation, stability, and localized deformation in double-stranded DNA.

On Hardy Inequalities with Homogeneous Weights

Name: Subhajit Roy

Institution: Indian Institute of Science Education and Research, Pune

Abstract: his talk is devoted to the study of a weighted Hardy-type inequality in the L^p framework involving angular weights. Depending on the dimension and the exponent p, we determine appropriate function spaces that ensure the validity of the inequality. We prove that the associated constant is sharp, in the sense that it coincides with the optimal constant in the classical case when the angular weight is constant. Furthermore, we establish the corresponding sharp fractional Hardy inequality with homogeneous weights.

A Nash stratification inequality and global regularity for a chemotaxis-fluid system on general 2D domains

Name: Naji Sarsam

Institution: Duke University, Department of Mathematics

Abstract: Incompressible fluid advection has been shown to facilitate singularity suppression in various differential equations, often by mixing-enhanced diffusion or by dimension-reduction effects. To aid with the study of such scenarios, we prove a refinement of the classical Nash inequality,

$$\|f - f_M\|_{L^2}^2 \lesssim \|f - f_M\|_{L^1}^{8/7} \|\nabla f\|_{L^2}^{6/7} + \|\partial_1 f\|_{\dot{H}_0^{-1}}^{2\vartheta} \|f - f_M\|_{L^1}^{1-\vartheta} \|\nabla f\|_{L^2}^{1-\vartheta},$$

for $f \in H^1$ with mean f_M over a smooth bounded planar domain under the main constraint of having connected horizontal cross-sections. The first term on the right-hand side follows the classical Nash scaling for a formal dimension of $3/2$. The second term introduces a mixing norm that measures how far f is from being stratified. The proof provides an explicit exponent $0 < \vartheta \ll 1$, although the sharpness of this inequality and its generalization to higher dimensions remain open questions.

As an application, we study the 2D parabolic-elliptic Patlak – Keller – Segel (PKS) chemotaxis model over the aforementioned large class of bounded domains. This aggregation-diffusion equation is well-known to admit an exact mass threshold for finite-time singularity formation. Using the above Nash stratification inequality, we prove that the 2D PKS equation becomes globally regular when actively coupled via buoyancy to a fluid obeying Darcy's law for incompressible porous media flows. This result holds for arbitrarily large C^∞ initial data, far from perturbative regimes, and for arbitrarily weak coupling strength. Moreover, the spatial domain can have "bottle neck" regions of small area and boundary segments of large curvature. The argument simplifies and generalizes recent work by Hu, Yao, and the first author on the analogous result for the periodic channel.

On the asymptotics of attractors of the Ginzburg-Landau complex equation in a perforated domain with an oscillating boundary: Supercritical case

Name: Altyn Toleubay

Institution: NJSC "Shakarim University"

Abstract: We study the asymptotic behavior of trajectory attractors for the Ginzburg-Landau complex equation in a perforated domain with a rapidly oscillating outer boundary when the parameter characterizing the pore sizes and the distance between them, as well as the amplitude and frequency of the boundary oscillation, tends to zero. In the supercritical case (the Fourier (Robin) boundary condition is changed to the homogeneous Dirichlet boundary condition in the limit) we proved that the trajectory attractors of this system converge in a weak sense to the trajectory attractors of the limit (homogenized) Ginzburg-Landau complex systems of equations in domain independent of the small parameter, characterizing the oscillation rate. The

asymptotic behaviour of attractors to an initial boundary value problem for complex Ginzburg–Landau equations in perforated domains for the supercritical case is studied by Bekmaganbetov K.A., Chechkin G.A., Chepyzhov V.V., and Tolemis, A.A. "On Attractors of the Ginzburg–Landau Equations in Domain with Locally Periodic Microstructure. Subcritical, Critical and Supercritical Cases" (Doklady Mathematics.-2023.-v.2 (108).-p. 346–351). Theorem and prove it with the help of auxiliary lemmas.

Fractional Sturm – Liouville Problem on Metric Graphs

Name: Ariukhan Turemuratova

Institution: National University of Uzbekistan

Abstract: In the work, we investigate the fractional analog of the Sturm-Liouville problem on a metric graph using a combination of left Riemann-Liouville and right Caputo fractional derivatives. This combination creates a symmetric and positive analog of the Sturm-Liouville operator. We demonstrated that the operator has a countable number of eigenvalues converging to infinity and analyzed the convergence of the series of the reciprocal eigenvalues, providing estimates for the eigenfunctions.

Using Differential-Equation-Based Methods to Automate Microscopy Segmentation in Developmental Biology

Name: Markjoe Uba

Institution: Northern Illinois University

Abstract: Automatic and semi-automatic segmentation methods are important in developmental biology, where microscopy images are used to study animal embryo development. Manual segmentation is often inefficient, time-consuming, and difficult to scale to large datasets. In this poster, we present and discuss computational results from differential-equation-based approaches applied to real-world biological images.

Inverse problems for nonlinear parabolic equations in degenerate domains

Name: Madi Yergaliyev

Institution: Institute of mathematics and mathematical modeling

Abstract: We investigate inverse problems for a class of nonlinear parabolic equations posed in degenerate domains with time-dependent geometry. Such models arise in heat conduction and diffusion processes in media whose spatial structure evolves in time, leading to degeneration of the underlying domain.

The main focus is on the identification of unknown time-dependent coefficients in nonlinear parabolic equations, including Burgers-type models, from additional integral or boundary measurements. Degeneracy is caused by moving boundaries or vanishing cross-sections, which substantially complicates the analysis and prevents the direct application of classical parabolic theory.

We establish existence and uniqueness of solutions to the corresponding direct problems for loaded nonlinear parabolic equations in appropriate functional spaces and derive a priori estimates adapted to the degenerating geometry of the domain. For the inverse problems, uniqueness and conditional stability of the recovered coefficients are proved by combining energy methods with specially constructed overdetermination conditions. Moreover, we consider nonlinear models for which either global-in-time solvability or only local-in-time solvability of solutions is established, depending on the structure of the nonlinearity and the initial data.

The obtained results extend existing theories of inverse parabolic problems to nonlinear models in noncylindrical and degenerate domains and provide a rigorous mathematical framework for parameter identification in diffusion-type models with evolving spatial structure.

Non-Local Problems for the Fractional Order Diffusion Equation and the Degenerate Hyperbolic Equation

Name: Nargiza Yuldasheva

Institution: University of Exact and Social Sciences

Abstract: This research explores nonlocal problems associated with fractional diffusion equations and degenerate hyperbolic equations featuring singular coefficients in their lower-order terms. The uniqueness of the solution is established using the energy integral method, while the existence of the solution is equivalently reduced to solving Volterra integral equations of the second kind and a fractional differential equation. The study focuses on a mixed domain where the parabolic section aligns with the upper half-plane, and the hyperbolic section is bounded by two characteristics of the equation under consideration and a segment of the x-axis. By utilizing the solution representation of the fractional-order diffusion equation, a primary functional relationship is derived between the traces of the sought function on the x-axis segment from the parabolic part of the mixed domain. An explicit solution form for the modified Cauchy problem in the hyperbolic section of the mixed domain is presented. This solution, combined with the problem's boundary condition, yields a fundamental functional relationship between the traces of the unknown function, mapped to the interval of the equation's degeneration line. Through the conjugation condition of the problem, an equation with fractional derivatives is obtained by eliminating one unknown function from two functional relationships. The solution to this equation is explicitly formulated. For a specific solution of the proposed problem, visualizations are provided for various orders of the fractional derivative. The analysis demonstrates that the derivative order influences both the intensity of the diffusion (or subdiffusion) process and the shape of the wave front.

Discrete wave turbulence of a coupled system of quintic Schrödinger equations

Name: Shayan Zahedi

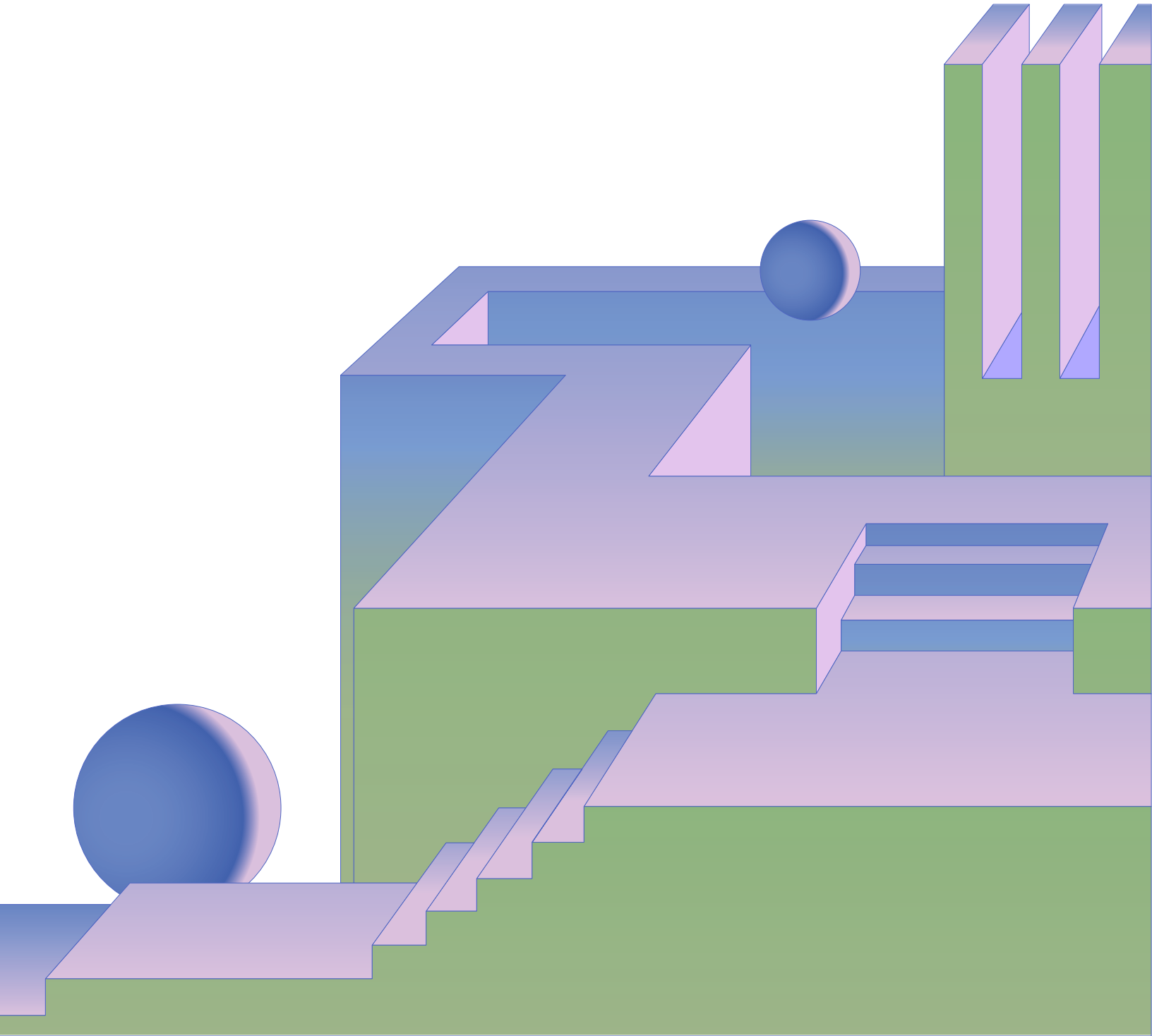
Institution: École Polytechnique

Abstract: We derive rigorously the macroscopic system associated to a microscopic system of coupled quintic Schrödinger equations in the framework of discrete wave turbulence under a particular scaling law that describes the limiting process. Our system evolves from a pair of well-prepared random initial data. More precisely, in dimensions $d \geq 2$, we set up our microscopic system on a large box of size L with weak non-linearity of strength ϵ. In the limit $L \to \infty$ and $\epsilon \to 0$, under the scaling law $\epsilon L^{\frac{1}{\beta}} = 1$ with $\beta \in (1, \infty)$, we prove that the long-time behaviour of our microscopic system is statistically described by a resonant system whose dynamics are driven by exact resonances.

The difference between systems that are approximated by wave kinetic equations and our microscopic system is that our system does not display standard symmetries such as mass conservation. In such systems with fewer invariances, exact resonances contribute significantly compared to quasi-resonances and are essentially responsible for the effective dynamics in the large-box limit. We justify the emergence of discrete wave turbulence for our microscopic system.

POSTERS

SECTION 11– MATHEMATICAL PHYSICS



AI-Driven Data Augmentation and Sensitivity Analysis of Radiative Bödewadt Ternary Nanofluid Flow over a Porous Rotating Disk with Multiple Slips

Name: Shahirah Abu Bakar

Institution: Universiti Teknologi Malaysia

Abstract: Bödewadt flow is a 3D rotating flow that occurs over a stationary disk subjected to a constant angular velocity of the surrounding fluid. Near the disk surface, viscous effects induce a secondary motion characterized by radially inward flow and axially upward movement due to friction and the associated radial pressure gradient. While Bödewadt flow has been widely studied in classical rotating disk problems, limited attention has been given to its optimization and sensitivity analysis, particularly for ternary nanofluid configurations. In this study, an AI-based framework is proposed for data augmentation, optimization, and sensitivity analysis of a radiative Bödewadt ternary nanofluid (Al2O3-TiO2-Cu/H2O) flow over a porous rotating disk with heat generation, velocity and thermal slips. The governing partial differential equations (PDEs) are transformed into a system of ordinary differential equations (ODEs) using similarity transformation techniques and solved numerically via the MATLAB bvp4c solver, where the numerical analysis shows that increasing the rotational strength and porosity parameters reduces temperature distribution. These numerical solutions form the baseline dataset for training an artificial neural network surrogate model. Further, AI-based data augmentation is employed via Google Colaboratory to expand the solution space efficiently and to predict thermal performance indicators particularly the heat transfer rate. Optimization is then carried out using a genetic algorithm operating on the trained surrogate model. In addition, sensitivity analysis is performed to quantify the relative influence of key parameters. Graphical tools such as AI-based response surfaces, convergence plots, optimization summary plots, and heatmaps are presented to support the analysis of the optimization and sensitivity results. The proposed framework demonstrates the feasibility of integrating physics-based modelling with AI-assisted techniques for efficient analysis of complex rotating nanofluid flow systems relevant to thermal engineering applications.

Electrogravimagnetic Field of a Toroidal Resonator with Biquaternion Representation of Currents

Name: Bakhyt Alipova

Institution: Institute of Mechanics and Mechanical Engineering named after Academician Dzholdasbekov

Abstract: This research investigates the structure of the electrogravitomagnetic field generated by a toroidal radiator, in which the charge and current distributions are described using biquaternion algebra. The dynamics of charge and current configurations are examined within a hybrid model that integrates elements of electromagnetic and gravitational interactions in a complex extended metric space.The current density is decomposed into two orthogonal components: along the major radius of the torus (longitudinal component) and along the minor radius (transverse component). Each component is described in terms of a biquaternion field, which makes it possible to account for both phase properties and the internal geometry of the cur-

rent.Calculations are performed for angular velocities, wave numbers, eigenmode frequencies, energy densities, field amplitudes, and other parameters associated with stable oscillations of the system. The conditions for the excitation of standing and traveling waves in a ring configuration are investigated analytically and numerically.Possible conditions for the generation of toroidal electrogravitomagnetic waves and the features of their propagation in the near and far zones are also discussed, including the structural anisotropy of the radiated field. The obtained results may be applied to the modeling of toroidal sources of complex fields and to the development of related devices, particularly for applications in electromagnetic gravitation, nonlocal control, and resonant absorption.

On the matrix negative order Korteweg-de Vries equation - the commutative case

Name: Aygul Babadjanova

Institution: V.I.Romanovskiy Institute of Mathematics, Uzbekistan Academy of Sciences.

Abstract: Authors: T. Kriecherbauer, G. U. Urazboev, A. K. Babadjanova, The negative-order KdV (NKdV) hierarchy was introduced by Verosky through the study of symmetries and negative powers of the KdV recursion operator

$$R = (-D^3 + 2(uD + Du))D^{-1}$$

where D denotes the operator $\frac{\partial}{\partial x}$. The classic KdV equation can then be written as

$$u_t = Ru_x\,.$$

Replacing R formally by R^{-1} but avoiding the use of R^{-1} by introducing a new variable v Verosky derived the NKdV equation in the form

$$\begin{aligned} u_t &= v_x\,, \\ v_{xxx} - 4v_x u - 2vu_x + u_x &= 0\,. \end{aligned} \tag{13}$$

We consider the matrix NKdV (mNKdV) equation in the class of self-adjoint matrices. Observe that it is not obvious how to generalize system (1) to the matrix case as matrix products may not commute. Using the letters Q and W to replace u and v in system (1), a natural choice for generalizing equation (1) is

$$\begin{aligned} Q_t &= W_x\,, \\ W_{xxx} - 2W_xQ - 2QW_x - WQ_x - Q_xW + Q_x &= 0\,. \end{aligned} \tag{14}$$

We investigate the integrable structure of the matrix negative KdV equation using the inverse scattering transform in the commutative case, where the matrix-valued functions W and Q satisfy $WQ = QW$. This assumption does not require commutativity of their derivatives. After reviewing the scattering theory for matrix Sturm – Liouville operators with self-adjoint potentials, we present a Lax-pair formulation of the equation and derive the time evolution of the associated scattering data for a suitable class of solutions. The main result characterizes the evolution of the scattering data for the matrix Sturm – Liouville operator $-D^2 + Q(x,t)$ under the commutativity condition

and leads to a constructive algorithm for generating solutions. Using the Gelfand – Levitan – Marchenko approach, we verify by explicit computation that this algorithm indeed produces solutions of the system. Explicit calculations and numerical illustrations for multi-soliton solutions in the reflectionless case are also presented via the (A, B, C) triplet matrix method.

Transport Boundary Value Problems for the Klein-Gordon Equation and Their Solution

Name: Aigulim Bayegizova

Institution: Institute of Mechanics and Mechanical Engineering named after Academician U.A. Dzholdasbeko

Abstract: The study of wave processes in physical fields and media by mathematical modeling methods leads to the solution of differential equations and boundary value problems for them. A special class of problems is made up of transport problems, in which the acting loads move at certain speeds. At the same time, their shape does not change over time. Such loads are called transport. Here, the Klein-Gordon equation is considered. As is known, these equations describe the wave functions of elementary particles.

This work is devoted to the development of the boundary integral equation method (BIEM) for solving transport boundary value problems for the Klein-Gordon equations in cylindrical domains at sublight speed. Fundamental solutions are the basis for constructing the kernels of integral equations and integral representations of solutions to boundary value problems. These solutions of the Klein-Gordon equation are constructed for sublight speed of the disturbance source. A statement of boundary value problems for the Klein-Gordon transport equation is given. A dynamic analogue of the Green's formula in the space of generalized functions for the Green's function and an analogue of the Gauss formula for the Green's function of the Klein-Gordon transport equation are constructed. The analogue of the Gauss formula allows one to construct resolving boundary value integral equations for boundary value problems for the Klein-Gordon transport equation at sublight speed.

Singular boundary integral equation of boundary value problems for the Klein-Gordon transport equation are received. This equation is resolving for the stated transport boundary value problems. To solve them, one must use analytical or numerical methods, which are well developed for elliptic equations. (Grant Number AP23488145)

Fröhlich-Spencer contours in Multidimensional Long-Range Ising Models

Name: Rodrigo Bissacot

Institution: University of São Paulo (USP)

Abstract: Disconnected contours in Ising models were introduced by J. Fröhlich and T. Spencer to establish the phase transition in the one-dimensional ferromagnetic long-range Ising model

with interaction exponent $\alpha = 2$. We present a multidimensional generalization of the contour concept, building on the ideas of Fröhlich and Spencer. The approach produces sharp results regarding exponents and allows the treatment of ferromagnetic long-range Ising models with both random and decaying external fields. This poster is based on papers and theses, most of whose authors are (former) members of the Mathematical Physics group at the University of São Paulo (USP).

Cohomological vertex algebras

Name: Colton Griffin

Institution: University of Pennsylvania

Abstract: Vertex algebras (and their modules) can be described as vector spaces together with a linear operator-valued series in one parameter z. With the interpretation of z as a coordinate at a point on a curve, one can construct algebraic structures on the moduli space of curves from V-modules. Here we propose a generalization of vertex algebras involving linear operators in parameters $z_1, \ldots, z_n$. One may interpret these as being the components of a set of coordinates on an n-dimensional algebraic variety. These are referred to as cohomological vertex algebras (CVAs): the formal punctured 1-disk underlying a vertex algebra is replaced by a ring modeling the cohomology of certain modifications of the formal n-disk. We prove several structural theorems for CVAs and give a definition of cohomological vertex operator algebras (CVOAs). Using a reconstruction theorem for CVAs, we provide basic examples such as the $\beta\gamma$-system, the Heisenberg CVA, and the affine Kac-Moody CVAs. We use these constructions to describe BRST reduction, leading to an analog of W-algebras.

Topological Stability of Beltrami Fields as a Framework for Flavor Symmetry Alignment

Name: Charles Grimm

Institution: University of Hawaii at Manoa

Abstract: This paper investigates the stability of stationary solutions to the incompressible Euler equations on Euclidean 3-space, specifically focusing on the role of Beltrami fields ($\nabla \times u = \alpha u$) in modeling flavor-mixing matrices. We propose that the CKM (Cabibbo-Kobayashi-Maskawa) matrix emerges as a Renormalization Group (RG) fixed point where the velocity-vorticity commutator tracks the alignment of Yukawa couplings.

Utilizing the foundational work of Enciso and Peralta-Salas regarding the existence of knotted vortex lines, we demonstrate that the "flavor angles" of the Standard Model can be mapped to the helicity invariants of these fluid knots. We introduce a Gravitoelectromagnetic (GEM) coupling, where the Lense-Thirring frequency acts as a perturbative background flow. This allows for a rigorous calculation of the nondimensionalization constants (reference u, α) required to maintain topological "locking" across disparate energy scales.

We further derive an effective kinematic viscosity for the vacuum ($v \approx 10^{-10} m^2/s$) by treating the weak-scale transition as a dissipative boundary layer in a relativistic superfluid. This framework predicts a small but mathematically precise spatial dependence of flavor mixing in the presence of extreme angular momentum gradients. By bridging topological fluid dynamics with effective field theory, this model provides a novel geometric mechanism for the stability of fundamental constants, offering testable predictions for directional anisotropy in weak-decay observables.

Mixed physical informed neural networks in bio-fluid mechanics: Ureter Applications

Name: Kh Mekheimer

Institution: Al-Azhar University

Abstract: A better understanding of various biological phenomena can be gained by studying the transport of fluid related to those phenomena. The motion involved in such phenomena is described by the so-called governing equations, regardless of the approximation, which may lead to an exact solution for these models. Usually, a numerical technique must be used to obtain an approximate solution. This study aims to investigate the advantage of using mixed physics-informed neural networks (MPINN) to simulate these phenomena. A hypothetical scenario was considered where an obstacle appeared in the ureter channel during its peristaltic motion, known as kidney stone disease. The momentum conservation governing equations are used for an incompressible Newtonian fluid, and their dimensionless form is introduced. Contour plots for pressure and velocity fields are shown for different stone shapes. Additionally, shear stress at the lumen surface is calculated. Our findings demonstrate the effectiveness of MPINN in providing reliable results for such critical situations.

Enhancing Heat Transfer Using GO–MoS_2/Glycerine Hybrid Nanofluid under Slip Conditions on a Riga Plate

Name: Nor Ain Azeany Mohd Nasir

Institution: National Defence University of Malaysia

Abstract: This study investigates the flow and heat transfer behaviour of a non-Newtonian hybrid nanofluid consisting of graphene oxide (GO) and molybdenum disulfide (MoS_2) suspended in glycerine, flowing over a moving shrinking Riga plate under velocity and thermal slip conditions. The governing partial differential equations are reduced to ordinary differential equations using similarity transformations and solved numerically via MATLAB's bvp4c. The effects of key physical parameters on skin friction, local Nusselt number, entropy generation, velocity, and temperature profiles are examined. Results show that increasing velocity and thermal slip parameters significantly reduces the fluid temperature by approximately 7–11%, indicating improved thermal regulation. Moreover, the inclusion of graphene oxide enhances heat transfer performance, increasing the temperature by 4–10%, confirming its superior thermal conductivity. These findings

demonstrate the effectiveness of hybrid nanofluids combined with slip mechanisms for advanced heat transfer control in electromagnetic and microfluidic applications.

Magnetohydrodynamics Ternary Hybrid Nanofluid Flow over a Permeable Moving Surface

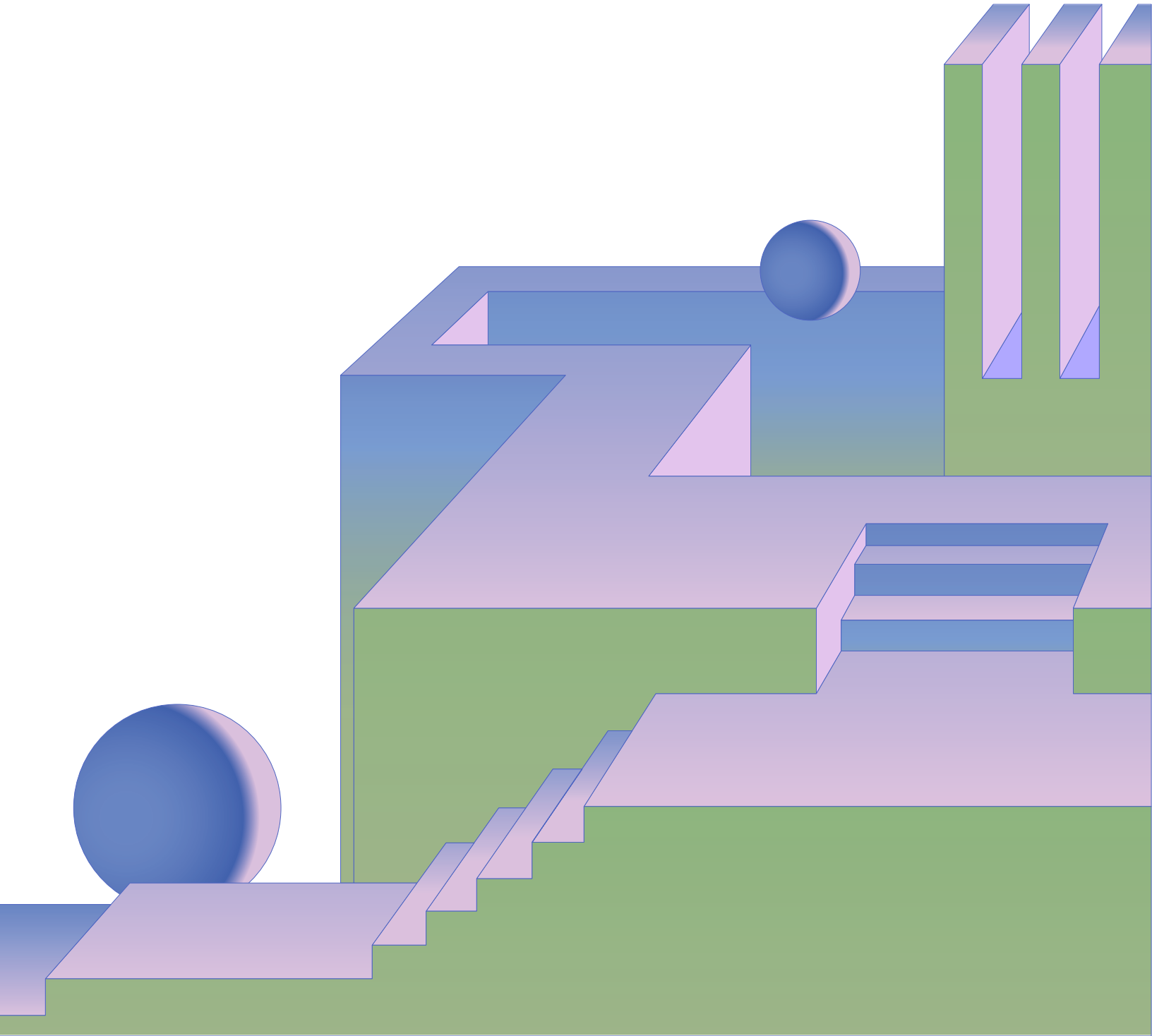
Name: Nur Syahirah Wahid

Institution: Universiti Putra Malaysia

Abstract: Ternary hybrid nanofluids represent an advanced class of heat transfer fluids that offer superior thermal performance compared to conventional and hybrid nanofluids due to the synergistic interaction among multiple nanoparticles, which enables an effective trade-off between enhanced thermal conductivity and acceptable flow characteristics. This study investigates the flow and heat transfer behavior of a magnetohydrodynamic (MHD) ternary hybrid nanofluid over a permeable moving surface in the presence of thermal radiation, with particular emphasis on the case where the surface motion opposes the free-stream flow direction. By employing similarity transformations, the governing partial differential equations are reduced to a system of ordinary differential equations, which are then solved numerically using the MATLAB boundary value problem solver, bvp4c. The effects of key parameters, including the magnetic parameter, suction parameter, nanoparticle volume fraction, and thermal radiation parameter, on the velocity and temperature distributions, skin friction coefficient, and local Nusselt number are analyzed. The results demonstrate that, when the surface moves against the flow direction, increasing the TiO_2 nanoparticle volume fraction, wall suction, and magnetic field strength significantly enhances the heat transfer rate, as indicated by the local Nusselt number, while simultaneously improving momentum transport and promoting boundary layer stability by delaying separation.

POSTERS

SECTION 12–PROBABILITY



Regularisation by noise of quasilinear partial differential equations

Name: Antoine Marie Bogso

Institution: University of Yaounde 1

Abstract: In this presentation, we deal with strong existence and uniqueness for a quasilinear stochastic partial differential equation driven by a two-parameter Brownian white noise. We restrict ourselves to the case where the diffusion is identity matrix and the drift is a bounded Borel measurable vector field. We show the existence of a Malliavin differentiable strong solution which is pathwise unique. The result is based on tools from Malliavin calculus and Davie variational techniques. This result extends to the Brownian sheet case those obtained by Zvonkin (1974) and Veretennikov (1979) for one-parameter SDEs.

This presentation is based a recent joint work with Moustapha Dieye, Olivier Menoukeu Pamen and Frank Proske.

Coordinate-wise Elephant Random Walk

Name: Denisse Escobar Parra

Institution: University of California, Santa Barbara

Abstract: We introduce the Coordinate-wise Elephant random walk (CERW) on the hypercube $Q_K := \{-1, 1\}^K$, a model where reinforcement is localized to individual coordinate processes. At each discrete time step, a coordinate is selected uniformly at random and updated by sampling from its own history; the sampled value is replicated with probability $p \in [0, 1]$ or reflected with probability $1 - p$. This dynamics is non-Markovian on the hypercube but admits a finite-dimensional Markovian augmentation. Geometrically, this defines a walk on the edges of Q_K where long-range memory interacts with the combinatorial structure of the graph.

We identify two principal aspects of its asymptotic behavior. First, we show that for all $p < 1$ reinforcement is diluted by the random update schedule: the empirical bias of each coordinate history converges almost surely to zero. Second, we study the global height observable $H_n = \sum_{i=1}^{K} X_n^{(i)}$, which encodes the layered geometry of the hypercube. By deriving its Doob decomposition, we isolate a martingale component with bounded increments and establish a self-normalized central limit theorem for this martingale for all $p \in (0, 1)$.

Statistical Geometrization: A Unified Measure-Theoretic and Probabilistic Resolution to the Riemann Hypothesis

Name: Kemal Gursoy

Institution: Rutgers University

Abstract: This research article presents a unified statistical framework for the Riemann Hypothesis (RH), synthesizing Geometric Measure Theory (GMT), Probability Theory, and the Information-

Theoretical methods. We argue that the critical line is not merely a symmetry axis but a statistical attractor where the "arithmetic entropy" of the primes is minimized.

Uniqueness of Invariant Measures for Stochastic Damped Anisotropic Navier – Stokes Equations on the Full Plane

Name: Siyu Liang

Institution: Nanjing University of Science and Technology

Abstract: We study a two-dimensional stochastic Navier – Stokes system with anisotropic viscosity, linear damping, and additive noise on the full plane. Due to the anisotropic dissipation and the whole-space setting, the problem differs from the classical isotropic case on bounded domains. In particular, no Poincaré inequality is available, so the damping term plays an essential role even in the existence of invariant measures. We prove that the associated Markov semigroup admits at most one invariant measure when the damping coefficient is sufficiently large with respect to the noise intensity. The proof is based on an asymptotic coupling argument and relies on anisotropic energy estimates together with exponential-type estimates for the H^1-energy. Our result applies to general additive noise without any non-degeneracy assumption and remains valid even in the deterministic case.

LDP for Tensor Forms

Name: Reihaneh Malekian

Institution: Columbia University

Abstract: We develop a large deviation principle for tensor-valued functionals of i.i.d. random variables, under a natural notion of convergence for tensors inspired by variants of the cut norm. This framework allows us to analyze Gibbs measures with tensor-valued Hamiltonians and to characterize the associated limiting variational problem through a functional fixed point equation. As applications, we study a range of models including monochromatic subgraph counts in inhomogeneous random graphs, Erdős – Rényi hypergraphs, and higher-order Potts models. We further investigate the structure of the variational problem, providing sufficient conditions for uniqueness of the optimizer and for the emergence of constant (replica symmetric) solutions. Our results establish universal weak laws for a broad class of tensor Gibbs models with approximately regular interaction structures.

The Resolvent Method in Complex Dynamics with applications to building a bridge between Schramm – Loewner Evolutions and Random Matrix Theory, and beyond

Name: Vlad Margarint

Institution: University of North Carolina at Charlotte

Abstract: Loewner dynamics is a powerful tool used in many areas of research, including the study of growth processes in the complex plane, Schramm – Loewner Evolutions (SLE) and more. In this work, I describe a newly introduced toolbox that studies Loewner dynamics via the resolvents of matrices. This method applies to both deterministic and random matrices. In the random setting, one of the first applications of this approach establishes a connection between two major areas of Probability Theory: Schramm – Loewner Evolutions (SLE) and Random Matrix Theory (RMT). This framework opens new avenues of research by enabling techniques from one field to be applied to the other. Moreover, the regular dynamics in the matrix space provides an alternative to the singular driver dynamics of SLE theory. I will cover the first applications of this method, based on a joint work with A. Campbell, and K. Luh, along with recent developments from a series of related projects exploring its interactions with other active areas of research. These include the analysis of growth processes, the study of geometric features of random matrix spaces, investigations of symmetric polynomials techniques, and connections to Machine Learning. These projects are joint work with collaborators from Europe, North America, and Asia, including V. Silvestri, F. Higgs; T. Alberts, V. Healey; S. Andraus, N. Hufnagel, J. Małecki; and N. Shrotri. More information is available at: https://margarintvlad.com/

Stability criteria for rough systems

Name: Thanh Hong Phan

Institution: Thang Long University

Abstract: We propose a quantitative direct method to prove the local stability of a stationary solution for a rough differential equation and its regular discretization scheme. Using Doss-Sussmann technique and stopping time analysis, we provide stability criteria for a stationary solution of the continuous system to be exponentially stable, provided the diffusion term is bounded and its derivatives exhibit small growth. The same conclusions hold for the regular discretization scheme with a sufficiently small step size, but one needs to apply the sewing lemma and stopping times for the discrete time set. Our stability criteria are based on the linearization of the drift and require only information about the bound and growth rates of the diffusion, making them data-driven criteria.

Multi-component matching queues with abandonment and buffers : Fluid, diffusion limit and large deviations

Name: Souvik Ray

Institution: Iowa State University

Abstract: We consider a regulated matching queue system in an assembly-to-order (ATO) production line. Here each product is assembled from several distinct perishable components which arrive randomly over time at the ATO station and wait in their respective class-specific queues until they are either matched or their patience expires. A match occurs instantaneously whenever one component from each category is available, and the matched set of ingredients exits the system immediately. Due to resource constraints, each queue is subject to a buffer capacity constraint. In this model, a component may leave the system for one of three reasons: successful matching, abandonment due to impatience, or rejection upon arrival due to a full buffer. For a practical example, one can consider a large hospital where surgeries require the simultaneous availability of multiple perishable medical supplies and specialist staff. We develop a properly scaled system for the heavy-traffic regime where the arrival rates grow increasingly large without bounds. We derive the fluid limit, large deviation properties under such a heavy-traffic regime and perform variational analysis of the rate function for this scaled system to derive exact asymptotic rate of decay for some interesting rare event probabilities (e.g., how likely is that some queue will run at full capacity sometime over a time period?). Under a slightly different scaling, we also derive the diffusion limit for the system.

The novelty of our work lies in three particular aspects which differentiate it from the previous works : (i) More than two queues are considered, (ii) The abandonment and buffer constraints are both present in the model, (iii) Large deviation properties for the scaled system has been derived with extensive variational analysis of the rate function. This model poses some the peculiar analytic challenges : A muti-dimensional Skorokhod problem and its well-posedness, uniqueness and continuity properties, which make the analysis considerably harder compared to existing works.

Lower deviations for critical branching processes with immigration

Name: Sadillo Sharipov

Institution: V.I.Romanovskiy Institute of Mathematics, Uzbekistan Academy of Sciences

Abstract: Let $\{Y_n, n \geq 1\}$ be a critical branching process with immigration having finite variance for the offspring number of particles and finite mean for the immigrating number of particles. We study lower deviation probabilities for Y_n. More precisely, assuming that $k, n \to \infty$ such that $k = o(n)$, we investigate the asymptotics of $\Pr(Y_n \leq k)$ and $\Pr(Y_n = k)$. Our results clarify the role of the moment conditions in the local limit theorem for Y_n proven in B.Mellein.

A Dynamical Approach to Nodal Lines of Critical Random Fields

Name: Menglin Wang

Institution: ENS Paris

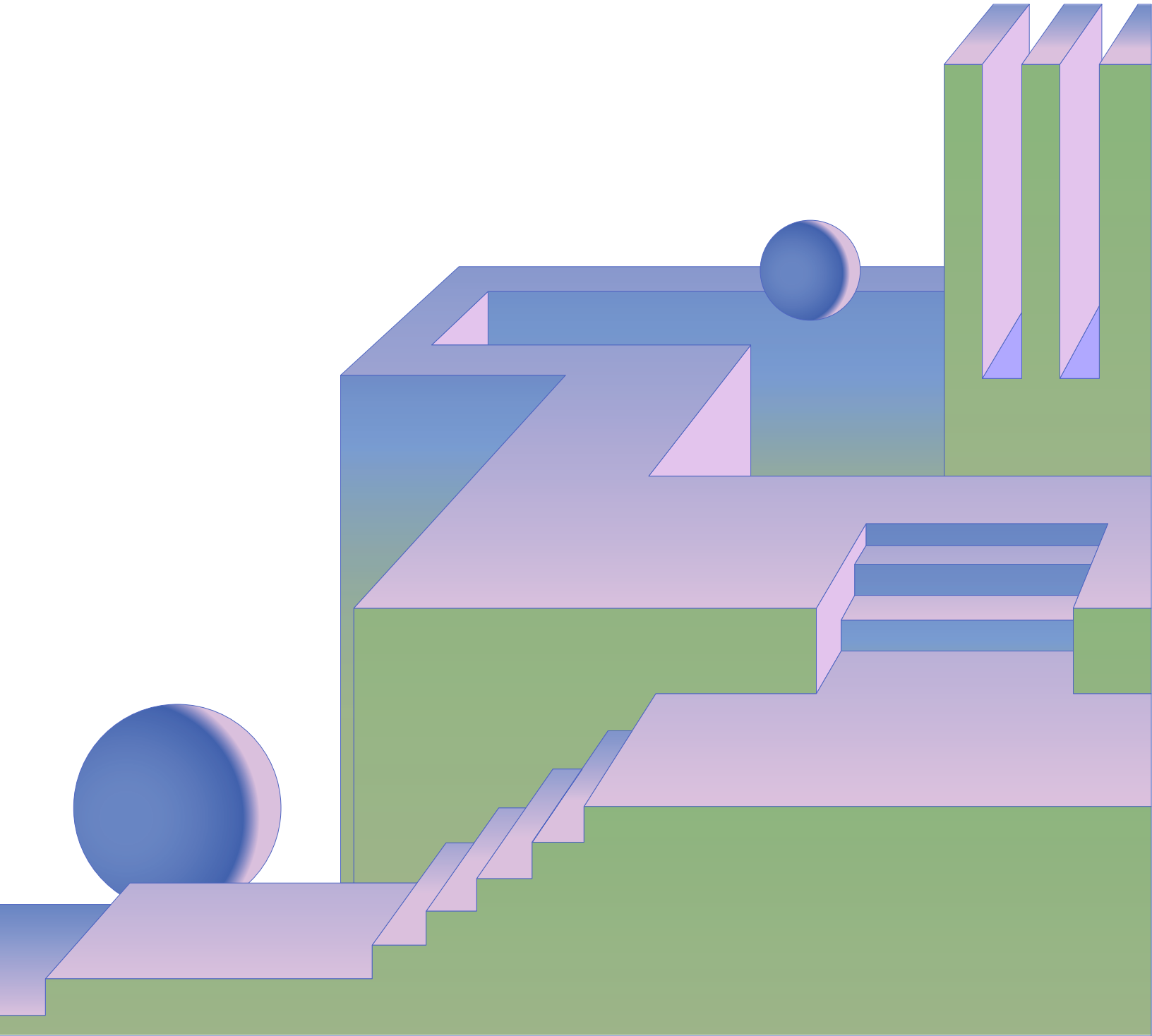
Abstract: In this work, we propose a dynamical framework to generate Schramm-Loewner Evolution (SLE) traces by confining a particle to move along the nodal lines of critical random fields: the 2D Gaussian Free Field (GFF) and Berry's Random Wave Model (BRWM).

To bridge these non-equilibrium physical trajectories with the conformal parameter space, we implement a discrete Zipper algorithm coupled with continuous loop-erasure and macroscopic coarse-graining. The loop-erasure dynamically removes microscopic topological dead-ends, while coarse-graining filters out high-frequency thermodynamic waste, leaving a pure macroscopic skeleton.

Through extensive ensemble simulations, we demonstrate a universality: the macroscopic Loewner driving function W_τ extracted from these kinetic trajectories robustly exhibits a linear variance growth $\langle W_\tau^2 \rangle = \kappa\tau$. Specifically, we recover $\kappa \approx 4$ for the GFF and $\kappa \approx 6$ for BRWM. This provides strong phenomenological evidence that microscopic thermodynamic fluctuations self-organize into rigorous conformal measures in the scaling limit. Furthermore, our framework naturally extends to $\kappa \in (0, 4)$ via the flow lines of imaginary geometry, demonstrating its broad applicability.

POSTERS

SECTION 13–COMBINATORICS



Transition matrices between permutation characters of the symmetric group and classical bases

Name: Beth Anne Castellano

Institution: Dartmouth College

Abstract: Orellana and Zabrocki introduced inhomogeneous bases of symmetric functions which evaluate to characters of the symmetric group. These new bases are related to important open problems in representation theory such as the Kronecker problem and the restriction problem. Restriction coefficients arise when decomposing an irreducible GL_n-module into irreducible S_n-modules. The problem of finding a combinatorial description for restriction coefficients is called the restriction problem. The Kronecker problem is the problem of finding a combinatorial interpretation for the Kronecker coefficients which occur when we tensor S_n-modules.

In our work, we describe combinatorial interpretations for the transition matrices between the basis that evaluates to permutation characters and other classical bases of symmetric functions. In particular, we use Lyndon words and tableau combinatorics to write the permutation character basis in terms of the homogeneous, monomial, and Schur bases.

Algorithms and criteria for constructing ternary totally parastrophic-orthogonal quasigroups

Name: Iryna Fryz

Institution: Vasyl' Stus Donetsk National University

Abstract: We consider ternary operations, i.e., functions of three variables, defined on a finite set. A function is called invertible or a quasigroup operation if it is invertible in each of its variables. A parastrophe of an invertible ternary function f is a function defined by a permutation of variables in the equality $f(x, y, z) = u$.

A triplet of ternary quasigroups defined on the same set is called orthogonal if each possible triplet of the elements of the carrier set occurs exactly once when the corresponding hypercubes are superimposed. A set of ternary quasigroups is orthogonal if each triplet of operations in this set is orthogonal. An invertible function is called a totally parastrophic-orthogonal quasigroup if the set of its distinct parastrophes is orthogonal. The number of distinct parastrophes of a quasigroup is a divisor of 4!.

We study linear group isotopes which are defined by the equality

$$f(x, y, z) = \varphi_1 x + \varphi_2 y + \varphi_3 z + a,$$

where $(Q; +)$ is an abelian group, φ_1, φ_2, φ_3 are its pairwise commuting automorphisms and $a \in Q$. The quasigroup (Q, f) is called medial.

The necessary and sufficient conditions for a medial ternary quasigroup to be totally parastrophic-orthogonal in cases when the quasigroup has 6, 12 and 24 distinct parastrophes have been established. These results complete a description of all possible cases for medial ternary quasigroups. A series of criteria which describe the conditions for the existence of ternary medial totally

parastrophic-orthogonal quasigroups is proposed. The problem of spectra of their existence remains open, however some answers are given for quasigroups with 24 distinct parastrophes.

Bent partitions, LP-packings, and amorphic association schemes

Name: Tekgül Kalayci

Institution: Sabanci University

Abstract: Recently, Anbar and Meidl (2022) introduced the concept of bent partitions, which are partitions of elementary abelian groups with properties similar to spreads. In particular, they enable the construction of p-ary bent functions, vectorial bent functions, and bent functions into finite abelian groups. Examples of bent partitions are generalized semifield spreads arising from (pre)semifields with a certain additional property.

We show that generalized semifield spreads do not arise from any spread and that any union of the sets in generalized semifield spreads forms a partial difference set. Moreover, such a partition induces an edge decomposition of the complete graph with vertex set $\mathbb{F}_{p^m} \times \mathbb{F}_{p^m}$ into strongly regular graphs, where any union of the graphs remains strongly regular. This enables us to construct $(p^k + 1)$-class amorphic association schemes on $\mathbb{F}_{p^m} \times \mathbb{F}_{p^m}$ from (pre)semifields, where k is a divisor of m with special properties.

Also recently, Jedwab and Li (2022) introduced the concept of Latin square partial difference set packings (LP-packings) of finite abelian groups. We point out that LP-packings induce bent partitions of finite abelian groups, and that generalized semifield spreads form LP-packings of elementary abelian groups. We also present examples of bent partitions which do not form LP-packings.

Wang, Fu, and Wei (2023) proved that vectorial dual-bent functions, under certain conditions, correspond to bent partitions with specific properties. They also presented a secondary construction of vectorial dual-bent functions, and thus of bent partitions and LP-packings. We generalize this construction and analyse other secondary constructions of vectorial bent functions, such as the direct sum and the generalized Maiorana–McFarland construction, which also give rise to new vectorial dual-bent functions, bent partitions, LP-packings, and amorphic association schemes.

This is joint work with Sezel Alkan, Nurdagül Anbar, and Wilfried Meidl.

Chromatic Numbers of Abelian Cayley Graphs

Name: Mike Krebs

Institution: California State University, Los Angeles

Abstract: We take a modest first step towards a systematic study of chromatic numbers of Cayley graphs on abelian groups. We lose little when we consider these graphs only when they are connected and of finite degree. As in the work of Heuberger and others, in such cases the graph can be represented by an $m \times r$ integer matrix, where we call m the dimension and r the rank. Replacing two rows with their sum or difference produces a graph homomorphism to a graph

with a matrix of smaller dimension, thereby giving an upper bound on the chromatic number of the original graph. In this way we completely determine the chromatic number when the rank is 1 or 2. Applications include improved upper bounds for periods of colorings of six-valent integer distance graphs; an alternate proof of Payan's theorem (that cube-like graphs cannot have chromatic number 3); and the 3-colorability of graphs in the plane generated by four unit vectors.

Generalized chip firing and critical groups of arithmetical structures on trees

Name: Joel Louwsma

Institution: Niagara University

Abstract: Chip firing provides a way to study the sandpile group (also known as the Jacobian) of a graph. We use a generalized version of chip firing to bound the number of invariant factors of the critical group of an arithmetical structure on a graph. We also show that, under suitable hypotheses, critical groups are additive under wedge sums of graphs with arithmetical structures. These results allow us to relate the number of invariant factors of critical groups associated to any given tree to decompositions of the tree into simpler trees. We use this to classify those trees for which every arithmetical structure has cyclic critical group. Finally, we show how to construct arithmetical structures on trees with prescribed critical groups. In particular, every finite abelian group is realized as the critical group of some arithmetical structure on a tree. This is joint work with Kassie Archer, Alexander Diaz-Lopez, and Darren Glass.

Expansions Among Non-Tensor Bases of Polysymmetric Functions

Name: David Martinez

Institution: CUNY Graduate Center

Abstract: Polysymmetric functions, introduced by Asvin G. and Andrew O'Desky, provide a new framework linking combinatorics and algebraic geometry through motivic measures in the Grothendieck ring of varieties. Their construction revealed structural parallels between plethystic operations, λ-rings, and geometric invariants, opening a new direction in algebraic combinatorics. Building on this foundation and the combinatorial results of Khanna and Loehr, we study the non-tensor bases of the polysymmetric algebra, introducing a new basis $\{H_\tau^+\}$ and deriving explicit expansions among the families $\{H_\tau\}$, $\{E_\tau\}$, $\{E_\tau^+\}$, $\{P_\tau\}$, and $\{H_\tau^+\}$, where each basis is indexed by stack partitions (types) that generalize integer partitions by recording both degrees and multiplicities. Using the Pieri-type rule established by Khanna for related families, we extend it to the H^+ basis, give a combinatorial description of the product of monomial polysymmetric functions, and identify an involution for the P basis. Together, these results expose new structural symmetries and open the algebra of polysymmetric functions to further exploration.

A method for constructing D-distance (anti)magic graphs

Name: Anak Agung Gede Ngurah

Institution: Universitas Merdeka Malang

Abstract: Let G be a graph without isolated vertices of order n and diameter t. Let D be a set of distance subset of $\{1, 2, 3, \ldots, t\}$ and f be a bijection from $V(G)$ to $\{1, 2, \ldots, n\}$. The D-weight of a vertex v, $w_D(v)$, is defined to be the sum of labels of all vertices whose its distance from v are in D. If $w_D(v)$ is a constant for all v in $V(G)$, then f is called a D-distance magic labeling. If $w_D(v) \neq w_D(u)$ for every vertex u and v in $V(G)$, then f is called a D-distance antimagic labeling. In particular, if $w_D(v)$ form an arithmetic progression with the first term a and common difference d, then f is called an (a, d)-D-diatance antimagic labeling of G. The notion of D-distance magic and D-distance antimagic labelings were introduced by O'Neal and Slater in 2011 and Simanjuntak and Wijaya in 2013, respectively. If D is $\{1\}$, $\{1\}$-distance (anti)magic labelings is called distance (anti)magic labelings.

In this poster, we present a method how to construct D-distance (anti)magic graphs. An immediate consequence of this method is that some 2-regular graphs are D-distance (anti)magic. We also introduce a method to expand classes of 2-regular (a, d)-distance antimagic graphs from previously known 2-regular (a, d)-distance antimagic graphs.

Constructible twin-sets in distance-hereditary graphs

Name: Martín Safe

Institution: Universidad Nacional del Sur

Abstract: This work explores the structural properties of distance-hereditary graphs, a class of graphs where the distance between any two vertices is preserved in every connected induced subgraph. There are several structural characterizations of this class, such as the one by minimal induced forbidden subgraphs (house, gem, domino, and cycles C_n for $n \geq 5$) and a recursive definition proposed by Chang, Hsieh, and Chen (1997), in which graphs G are constructed together with a distinguished vertex set called a twin-set, denoted $TS(G)$. They proved that a graph is distance-hereditary if and only if it can be constructed from K_1, with $TS(K_1) = \{\bullet\}$, using a sequence of the following three operations: false-twin ($G = G_1 \cup G_2$), true-twin (joining $TS(G_1)$ to $TS(G_2)$), both with $TS(G) = TS(G_1) \cup TS(G_2)$, and attachment (joining $TS(G_1)$ to $TS(G_2)$) where $TS(G) = TS(G_1)$.

We noticed that, depending on the construction, the same graph could be obtained with different twin-sets. We define a pair (G, X) as constructible if G is distance-hereditary and there exists a sequence of the previously mentioned operations such that $X = TS(G)$. Consequently, we investigate which subsets of vertices in a distance-hereditary graph can function as a twin-set for some recursive construction.

We provide a complete characterization of constructible pairs (G, X) by means of minimal forbidden bicolored patterns. By identifying vertices in X as "black" and those in $V(G) \setminus X$ as "white", we show that (G, X) is constructible if and only if X intersects all the components of G and it avoids specific configurations, such as certain colored paths P_n, specific colorings of the

paw, diamond, and C_4, and all colorings of the forbidden induced subgraphs for the distance-hereditary class. As a consequence, (G, X) is constructible if and only if the graph that arises from G by adding a vertex adjacent precisely to the vertices in X is connected and distance-hereditary. Interestingly, this leads to a linear-time recognition algorithm for constructible pairs.

On regular Ramsey $mK_2, H)$-minimal graphs and their extensions

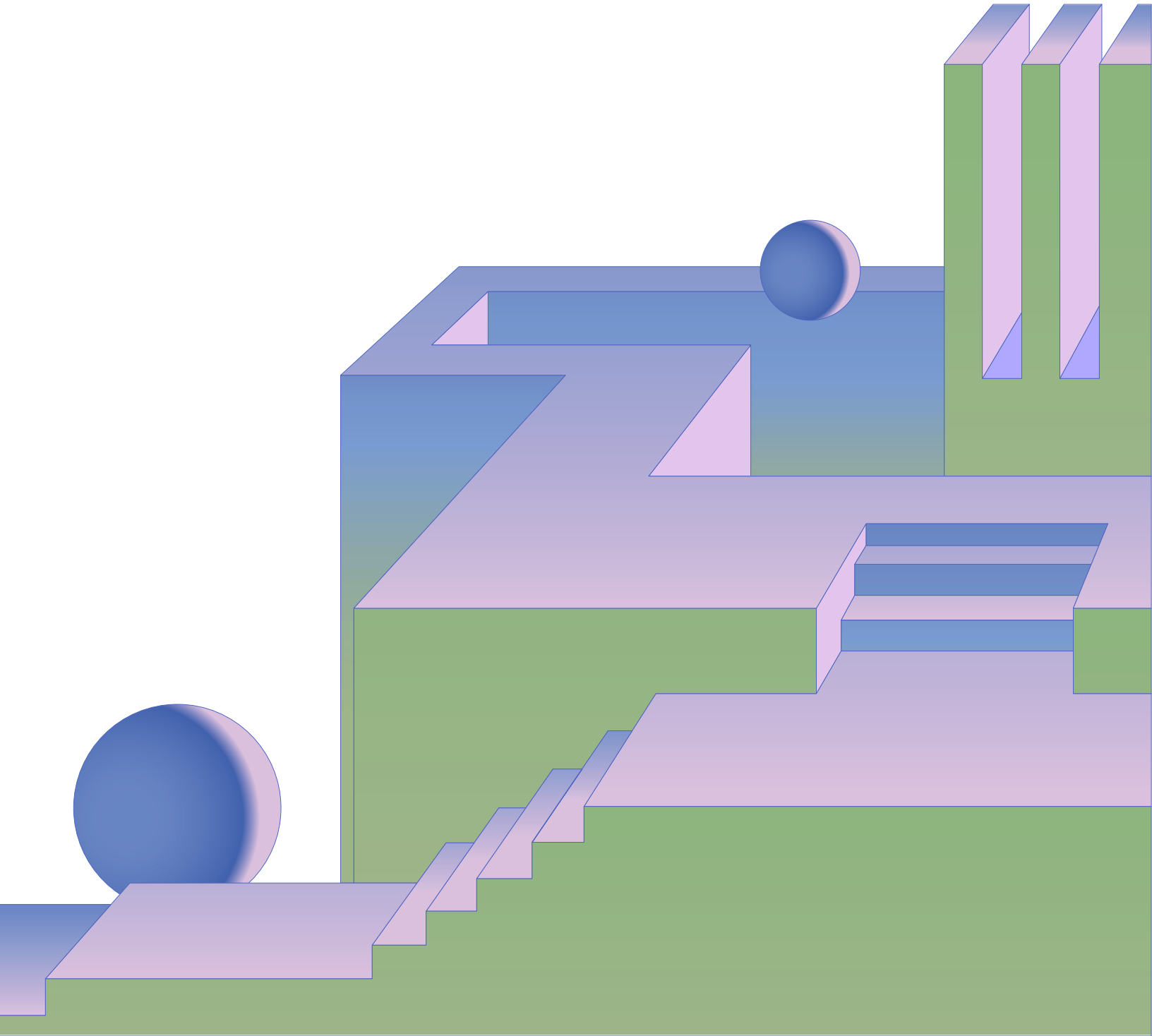
Name: Kristiana Wijaya

Institution: Universitas Jember

Abstract: For simple graphs F, G, and H, we write $F \to (G, H)$ if every red-blue coloring of the edges of F yields a red copy of G or a blue copy of H. A graph F (without isolated vertices) is called Ramsey (G, H)-minimal if $F \to (G, H)$ but $F - e \nrightarrow (G, H)$ for every edge $e \in E(F)$. The set of all Ramsey (G, H)-minimal graphs is denoted by $\mathscr{R}(G, H)$. In this paper, we present new regular graphs in $\mathscr{R}(mK_2, H)$. Furthermore, using these regular graphs as building blocks, we construct graphs that belong to $\mathscr{R}(mK_2, H')$, where H' is a supergraph of H and H is a path P_n, a triangle K_3, or a matching nK_2.

POSTERS

SECTION 14– MATHEMATICS OF COMPUTER SCIENCE



Boundary Value Problem with Parameter for Impulsive Integro-Differential Equation under Integral Constraints

Name: Elmira Bakirova

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: We consider on the interval $(0,T)$ the integro-differential equation with a parameter

$$\frac{dx}{dt} = A(t)x + \varphi(t)\int_0^T \psi(s)x(s)ds + K_0(t)\mu + f(t), \quad x \in \mathbb{R}^n, \quad \mu \in \mathbb{R}^m, \tag{15}$$

subject to a two-point boundary conditions involving integral constraints

$$B_1x(0) + C_1x(T) + K_1\mu + \int_0^T M(t)x(t)dt = d_1, \quad d_1 \in \mathbb{R}^{n+m}, \tag{16}$$

and impulse action

$$B_2 \lim_{t\to\theta_1-0} x(t) - C_2 \lim_{t\to\theta_1+0} x(t) = d_2, \quad \theta_1 \in (0,T), \quad d_2 \in \mathbb{R}^n. \tag{17}$$

Here, the $(n\times n)$ matrices $A(t), \varphi(t), \psi(t)$, the $(n\times m)$ matrix $K_0(t)$, and the $(m\times n)$ matrix $M(t)$ are continuous on $[0,T]$, and the vector function $f(t)$ is piecewise continuous on $[0,T]$, with possible discontinuity at $t = \theta_1 \in (0,T)$. B_1, C_1, K_1, B_2 and C_2 are constant matrices of dimensions $\big((n+m)\times n\big)$, $\big((n+m)\times n\big)$, $\big((n+m)\times m\big)$, $\big(n\times n\big)$ and $\big(n\times n\big)$ respectively; $\big(n+m\big)-$ vector d_1 and $n-$ vector d_2 are constant.

In the present study, the authors employ Dzhumabaev's parameterization method to establish the conditions for the unique solvability of the problem (15)-(17) and to develop an algorithm for computing its numerical solution.

Bit Complexity of Polynomial GCD on Sparse Representation

Name: Xiaoshan Gao

Institution: Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Abstract: Multivariate polynomial greatest common divisor (GCD) computation is one of the central problems in algebraic and symbolic computation. Despite the vast literature, explicit bit complexities for sparse multivariate polynomial GCD algorithms were not given. In this poster, an input- and output-sensitive GCD algorithm for multi-variate polynomials over finite fields is proposed by combining the modular method with the Ben-Or/Tiwari sparse interpolation. The bit complexity of the algorithm is given and is sensitive to the sparse representation, while for previous sparse GCD algorithms, the complexities were given only in some special cases. It is shown that the new algorithm is superior both in theory and in practice compared with existing GCD algorithms: the complexity in the degree is decreased from quadratic to linear and the running times are decreased by 1-3 orders of magnitude in various benchmarks. This is a joint

work with Qiao-Long Huang of Shandong University and has been accepted by Mathematics of Computation for publication.

Evolutionary game theory (EGT) provides a rigorous mathematical paradigm for automating optimal large language model (LLM) selection

Name: Prasad Kothari

Institution: Ind

Abstract: Evolutionary game theory (EGT) provides a rigorous mathematical paradigm for automating an optimal large language model (LLM) selection, balancing computational cost, accuracy, and hallucination Risk as a function of query complexity. The explained process in the attached document - converges to an evolutionarily stable strategy (ESS), maximizing accuracy and minimizing cost and hallucination relative to query complexity. The Nash equilibrium of this game yields an optimal, adaptive model selection policy $\pi \quad (q)$ that maps each query to the LLM maximizing expected utility. This mathematically principled EGT approach ensures scalable, cost-efficient, and hallucination-averse LLM deployment across diverse tasks.

Detection of Malicious Images Generated by Large Language Models Using Graph Neural Networks and Feature-Based Representations

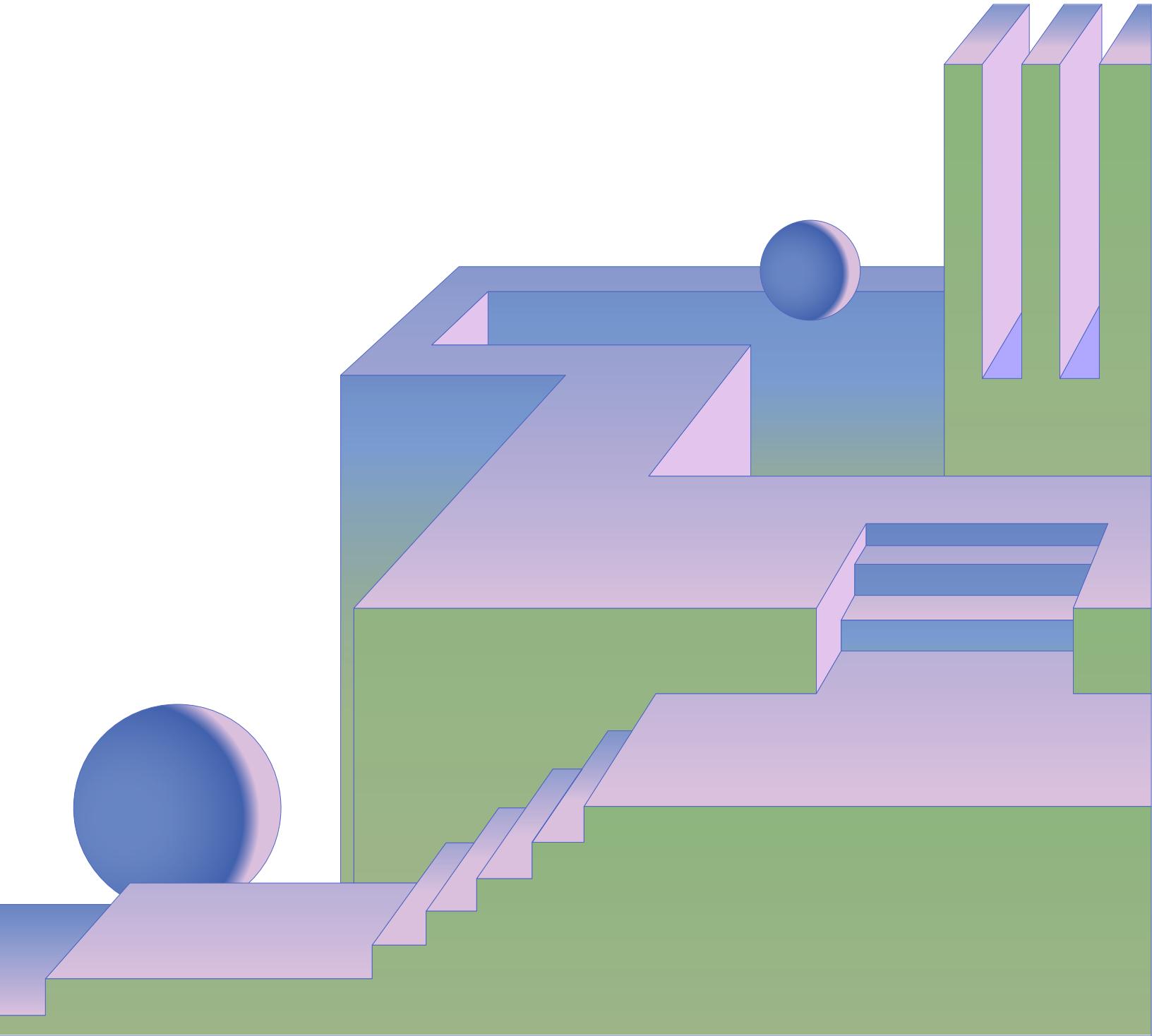
Name: Mohammed Serrhini

Institution: University Mohamed Premier Oujda

Abstract: Malicious scripts hidden in images are a growing cybersecurity threat, especially when obfuscated to bypass traditional detection methods. This research presents a complete pipeline for generating, embedding, and detecting such malicious content. Large Language Models (LLMs) are used to create obfuscated JavaScript payloads that are difficult for conventional detection systems to recognize. These payloads are embedded into images using the Least Significant Bit (LSB) technique, producing a controlled dataset of clean and malicious images. Detection focuses on identifying images containing malicious scripts by analyzing pixel-level modifications without extracting the embedded code. We evaluate several machine learning models, including Graph Neural Networks (GNNs), Convolutional Neural Networks (CNNs), Random Forest, and Support Vector Machines (SVM). Experimental results show that the GNN model achieves the best performance with an accuracy of 95.3%, precision of 95.3%, recall of 100%, and F1-score of 97.1%, outperforming the other models. These results demonstrate that graph-based learning effectively captures subtle pixel-level changes caused by hidden obfuscated scripts. This study provides a reproducible dataset and a robust detection framework, offering a solid foundation for future research in image-based cybersecurity, steganography detection, and mitigation of hidden attacks.

POSTERS

SECTION 15– NUMERICAL ANALYSIS AND SCIENTIFIC COMPUTING



Heat Regulation Model in the Human Body During Cycling due to the Met-abolic Effect

Name: Saraswati Acharya

Institution: Department of Mathematics, School of Science, Kathmandu University

Abstract: The physical properties of convective and evaporative heat loss and thermo-physical properties such as blood perfusion, specific heat capacity, thermal conductivity, and metabolic heat generation rate play a significant role in thermoregulation in the human body during cycling. While cycling, skeletal muscles generate a large amount of metabolic energy. Metabolic energy distributes over the different parts of the body by the perfusion process. The surplus heat releases from the body through tears and keeps the body in thermoregulation. The temperature profiles of the epidermis, dermis, and subcutaneous tissue have been analyzed at various ambient temperatures and sweat evaporation rates during cycling. The solution of the model is performed by using the finite element method (FEM), and the obtained results have been simulated graphically.

Preconditioned Iterative Methods and Sensitivity Analysis for a Class of Saddle Point Problems

Name: Sk Safique Ahmad

Institution: Indian Institute of Technology Indore

Abstract: We present preconditioned iterative methods for efficiently solving two classes of saddle point problems (SPPs): the generalized SPP (GSPP) and the double SPP (DSPP). To evaluate the sensitivity and stability of the computed solutions, we employ perturbation analysis, providing deeper insights into the quality of a computed solution.

This presentation focuses on the development of novel iterative methods and preconditioners for DSPPs characterized by three-by-three block structures. Specifically, we propose two classes of shift-splitting (SS)-type iterative methods along with corresponding preconditioners tailored for DSPPs. A comprehensive convergence analysis is provided to establish the theoretical foundations of these methods. Additionally, we conduct a spectral analysis of the preconditioned matrices to understand their efficiency and effectiveness better. To evaluate the efficiency of the proposed preconditioners, we apply them to DSPPs arising from PDE-constrained optimization problems and the Stokes equations. Next, we address several fundamental questions: How sensitive is the solution when structure-preserving perturbations are applied to the coefficient matrix of GSPP or DSPP? Does a backward stable algorithm for solving the GSPP or DSPP also exhibit strong backward stability? What is the nearest GSPP or DSPP for which the approximate solution becomes the exact one?

Λ-admissible subspaces of self-adjoint matrices

Name: Francisco Arrieta Zuccalli

Institution: UNLP - Universidad Nacional de La Plata

Abstract: Given a self-adjoint matrix $A \in \mathbb{K}^{n\times n}$ and an index $h \ll n$ such that $\lambda_h(A)$ lies in a cluster of eigenvalues of A, we introduce the novel class of h-dimensional Λ-admissible subspaces of A, denoted as Λ-adm$_h(A)$. First, we point out some basic facts about this class. Among those facts, we show that a low-rank approximation of the form $P_{\mathcal{T}}AP_{\mathcal{T}}$, for a subspace $\mathcal{T}$ that is close to any element of Λ-adm$_h(A)$, has nice properties. Then, we prove that some well-known iterative algorithms (such as the Subspace Iteration Method or the Krylov subspace method) produce subspaces that become arbitrarily close to h-dimensional Λ-admissible subspaces. We also obtain upper bounds for the distance between subspaces obtained by the Rayleigh-Ritz method applied to A and the class Λ-adm$_h(A)$. These results are to be compared to those in the literature that require the eigen-gap $\lambda_h - \lambda_{h+1}$ to be significant, which in the clustered eigenvalue setting may be small (or even zero). We also find upper bounds for the condition number of the (set-valued) map computing the class of Λ-admissible subspaces of A. Finally, we include numerical examples that show the advantage of considering this new class in the clustered eigenvalue setting.

Efficient Numerical Implementation of a Stochastic Time-Fractional Coupled Flow Model

Name: Abdumauvlen Berdyshev

Institution: Institute of Information and Computational Technologies

Abstract: We consider a stochastic time-fractional coupled incompressible model describing the interaction between free-fluid flow and flow in a porous medium. The problem may be regarded as a fractional-order extension of the stochastic Stokes-Darcy system, in which the classical time derivative is replaced by the Caputo fractional derivative. Such a formulation reflects hereditary effects in the evolution process, while randomness in the medium parameters allows uncertainty in the hydraulic conductivity to be incorporated into the model. To represent the random hydraulic conductivity tensor, we employ a truncated Karhunen-Loeve expansion, which reduces the stochastic problem to a finite-dimensional parametric family of deterministic time-fractional coupled systems. For the approximation of the random space, a sparse-grid stochastic collocation method is used. The deterministic subproblems are discretized by a finite element/finite difference scheme, together with a fast approximation of the Caputo fractional derivative. In order to reduce the cost of repeated solves for different collocation nodes, an ensemble strategy is introduced. The main attention is devoted to the analysis of the deterministic fully discrete scheme. Under suitable assumptions, stability and convergence are established rigorously. The obtained estimates show that the proposed discretization is well posed and provides accurate approximation of the underlying coupled problem. The theoretical results are supported by numerical experiments, which confirm the predicted convergence behavior. From the computational viewpoint, the combination of sparse collocation, fast treatment of the history term, and the ensemble procedure yields a substantial reduction in memory requirements and execution time compared with a direct realization-by-realization approach. The experiments

further indicate that the fractional-order operator has a pronounced influence on the dynamics of the coupled flow, showing the importance of memory effects in uncertain porous-media systems. The study provides a mathematically justified and computationally efficient framework for the numerical treatment of stochastic time-fractional coupled incompressible models. This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP26101983).

A Poisson-Nernst-Planck single ion channel model and its effective finite element solver

Name: Zhen Chao

Institution: Western Washington University

Abstract: A single ion channel is a membrane protein with an ion selectivity filter that allows only a single species of ions (such as potassium ions) to pass through in the “open” state. Its selectivity filter also naturally separates a solvent domain into an intracellular domain and an extracellular domain. Such biological and geometrical characteristics of a single ion channel are novelly adopted in the construction of a new kind of dielectric continuum ion channel model, called the Poisson-Nernst-Planck single ion channel (PNPSIC) model, in this paper. An effective PNPSIC finite element solver is then developed and implemented as a software package workable for a single ion channel with a three-dimensional X-ray crystallographic molecular structure and a mixture of multiple ionic species. Numerical results for a potassium channel confirm the convergence and efficiency of the PNPSIC finite element solver and demonstrate the high performance of the software package. Moreover, the PNPSIC model is applied to the calculation of electric current and validated by biophysical experimental data.

Numerics-Informed Neural Networks for Parabolic Partial Differential Equations

Name: George Chumbipuma

Institution: Rice University

Abstract: We present Numerics-Informed Neural Networks (NINNs) for solving time-dependent parabolic partial differential equations. The method combines finite difference discretization with neural network learning by fixing the spatial discretization (a 5-point Laplacian stencil) and training U-Net networks to learn step-to-step updates through residual minimization on fixed grids. Dirichlet boundary conditions are enforced via boundary lifting.

We establish discrete error bounds connecting residual minimization to solution accuracy. We benchmark NINNs against Backward Euler finite difference schemes across nineteen test problems for the 2D heat equation. Comparison of NINN and FD errors relative to the exact solution shows that NINN can outperform the FD baseline it was trained against, with improvements ranging from $2\times$ to over $260\times$ on smooth problems at fine mesh resolutions.

We analyze training schedule design across eight deterministic schedule types and multiple training fractions. Partial training achieves comparable or better accuracy than full training with reduced computational cost. Low training fractions reduce runtime by $3.5\times$-$4.2\times$ while maintaining accuracy within 5% of best values for most schedules.

This work demonstrates that neural networks trained to approximate finite difference operators can achieve lower error than the underlying finite difference discretization while maintaining stability guarantees through explicit discrete structure.

Numerical Analysis of Transient Instability: A Pseudospectra Approach in Convection-Diffusion Matrices

Name: Adan Diaz

Institution: Universidad Nacional Autónoma de México

Abstract: Classical spectral analysis fails to predict transient instabilities in non-normal systems. In this work, we numerically study the behavior of non-normal matrices arising from discretized convection-diffusion operators. Using modern computational algorithms, we compute and visualize the ϵ-pseudospectra of these matrices, demonstrating how perturbations of order 10^{-5} generate exponential transient growth that eigenvalues fail to detect. We present numerical simulations comparing theoretical resolvent bounds with the actual temporal evolution of the system, illustrating the gap between asymptotic theory and finite-time dynamics.

Numerical-Analytical Evidence for Convergence of the Semi-Discrete Lagrangian – Eulerian Method Applied to the Korteweg – de Vries Equation

Name: Erivaldo Diniz de Lima

Institution: Federal University of Roraima

Abstract: In this work, we introduce an extended formulation of the semi-discrete Lagrangian – Eulerian numerical method tailored to the **Korteweg-de Vries** (KdV) equation

$$\begin{cases} \partial_t u + \partial_x(H(u)) = \mu\partial_x^3 u, & (x,t) \in \mathbb{R} \times (0,T], \\ u(x,0) = u_0(x), & x \in \mathbb{R}, \end{cases}$$

where u_0 is the initial condition, $\mu \neq 0$ is the dispersive constant, and the flux function is $H(u) = \varepsilon u^2$ with ε non-zero. The proposed scheme is designed for one-dimensional scalar problems featuring a linear dispersive term with a constant dispersion coefficient. We provide numerical experiments that offer compelling evidence of the convergence of the method. When available, numerical results are compared with exact solutions or high-fidelity approximations. The KdV equation, first introduced in 1895 by Korteweg and de Vries, has been extensively used to model wave phenomena such as shallow-water waves and bubble-liquid mixtures, among other applications. Although analytical solutions exist for certain idealized problems, numerical methods remain

essential for addressing a wider range of scenarios. Indeed, since closed-form solutions are typically available only under restrictive initial conditions, numerical approaches are indispensable for exploring the rich dynamics governed by the KdV equation. Recent contributions have developed and extended Lagrangian-Eulerian numerical frameworks, both in fully discrete (FDLE) and semi-discrete (SDLE) formulations, for solving hyperbolic conservation laws and balance laws. Building on these advances, the present work proposes a semi-discrete Lagrangian – Eulerian method tailored to the dispersive equation, where the flux function H defines the KdV-type dynamics. The primary goal of this study is to provide numerical evidence supporting the convergence of the proposed SDLE method for the KdV equation. Our analysis focuses on benchmark problems that have been thoroughly investigated in the literature. In addition, we assess the convergence order of the method through a series of numerical experiments, employing the spaces L^2 and L^∞.

Inverse Design of Magnetic Cloaks via Adjoint-Based PDE-Constrained Optimization

Name: Yusen Guo

Institution: University of Leicester

Abstract: The design of magnetic cloaks—metastructures that render objects undetectable to external magnetic fields—presents a challenging inverse problem, particularly when extended to arbitrary, non-trivial geometries beyond idealized canonical shapes. We formulate this design challenge as a rigorous PDE-constrained optimization problem governed by the nonlinear, time-dependent Maxwell's equations in the H-formulation (curl-curl structure). The objective is to minimize a cost functional quantifying the magnetic field distortion in the exterior domain, subject to the physics-governing PDE constraints. Solving this inverse problem robustly and efficiently requires advanced numerical tools. We present two distinct optimization strategies:

1. Material Optimization (Coefficient Control): we seek an optimal spatially varying permeability function $\mu_r \in L^2(\Omega)$ while fixing the geometry of the metastructure. To address the ill-posedness and manufacturing challenges associated with material anisotropy, we introduce a regularization technique employing a smoothed Total Variation (TV) functional. This effectively penalizes excessive spatial variation, ensuring smooth, physically realizable optimal permeability profiles.

2. Shape Optimization (Domain Control): we treat the geometry of the ferromagnetic shell itself as the control variable. Because the set of admissible shapes is not a vector space, we represent shapes via geometric transformations(diffeomorphisms). This enables the rigorous application of infinite-dimensional optimization algorithms to achieve rapid convergence toward optimal geometries.

Both methods are compatible with the Finite Element Method (FEM), which is required for handling the PDE constraints. Moreover, this enables the automated evaluation of gradients and shape derivatives via the adjoint method, allowing for the evaluation for thousands of design variables at the computational cost of just one forward and one adjoint computation. We implemented these approaches using the open-source finite element software Firedrake and its automated shape optimization toolbox Fireshape. Our results, published in Science Advances (2025), demonstrate that the proposed numerical framework successfully extends magnetic

cloaking to real-world geometries, establishing a route to customizable magnetic shields for applications in fusion energy and medical technology. Joint with Alberto Paganini, Harold S. Ruiz.

Topological gradient-based methods for solving geometric inverse problems: theory and applications

Name: Maatoug Hassine

Institution: Faculty of Sciences - Monastir University

Abstract: The standard geometrical shape optimization method proceed by the application of successive diffeomorphisms close to the identity starting from an initial guessed shape. Consequently, it does not allow for the optimization of the topology which is kept unchanged during the optimization process. The topological sensitivity analysis consists in studying the behavior of a given shape functional when the topology of the domain is perturbed, typically by the nucleation of a small hole. This notion forms the basic ingredient of different topology optimization methods. This contribution will be focused on some recent advances in the theoretical and numerical aspects of the topological derivative notion. We will derive a topological sensitivity analysis for the full nonlinear Navier-Stokes operator. The mathematical concepts of the performed analysis can be found in [1,2,3]. As a practical application, we will develop an efficient topological gradient-based approach for the detection of submerged objects in the mediterranean sea [1].

[1] Hassine M., M. Hrizi, and Ouni M. (2025); Inverse problem for the Navier-Stokes equations and identification of immersed obstacles in the Mediterranean Sea. Inverse Problems, https://arxiv.org/html/2509.05287v1

[2] Hassine M., and Ouni M. (2023); Topological sensitivity analysis for the 3D nonlinear Navier – Stokes equations. Asymptotic Analysis. 2023;135(1-2):277-304. doi:10.3233/ASY-231855

[3] Hassine M., and Chaouch S. (2022); Topological asymptotic expansion for the full Navier – Stokes equations. Asymptotic Analysis. 2022;133(1-2):91-121. doi:10.3233/ASY-221807

Multi-Resolution Wavelet-Augmented Physics-Informed Neural Networks for Efficient and Accurate Solutions of Complex Financial Differential Equations

Name: Kavita Kavita

Institution: Thapar Institute of Engineering and Technology, Patiala, India

Abstract: The present research work developed and implemented the Wavelet-Augmented Physics-Informed Neural Network (WAPINN) model for finding the numerical solutions of financial differential equations. The model combines wavelet-based multi-scale resolutions with Physics-Informed Neural Network (PINN) to address the challenges in standard PINN, particularly the high relative L^2 error in complex differential equations. The WAPINN model, with five different wavelet functions, such as Mexican hat, Morlet, Gaussian, Paul, and Shannon as mother wavelets, were built and trained to approximate the Black-Scholes PDE, Heston PDE, Cox-Ingersoll-Ros

(CIR) PDE, and Hull-White PDE, with initial and boundary conditions. During training, different parameters such as the number of layers, neurons, and epochs were tuned, and the relative L^2 error was minimized. A detailed performance comparison of WAPINNs with PINNs using absolute error, training time, and loss values has also been analyzed with respect to the least relative L^2 error. It has been found from the results that WAPINNs performed better than PINN for each of the problems addressed in this research work. The relative L^2 error observed with PINNs lies in the range of 10^{-1}, whereas with WAPINNs, it ranges between $10^{-1} - 10^{-3}$. The loss values observed with PINNs ranges between $10 - 10^2$, whereas with WAPINNs, it ranges between $10^{-1} - 10^{-4}$. Unlike PINN, WAPINN does not rely on automatic differentiation. Instead, it computes derivatives using a wavelet matrix derived from the mother wavelet, enabling more accurate and efficient performance.

Local optimization of weak distance between compact surfaces on special Euclidean group

Name: Kazuki Koga

Institution: Institute of Science Tokyo

Abstract: We consider local optimization of a weak distance between two compact surfaces embedded in the three-dimensional Euclidean space on its special Euclidean group. Identifying those objects with the associated surface measures, their discrepancy is quantified in terms of the inhomogeneous Sobolev norm of negative order via the Plancherel theorem. Then, applying an isometry to one surface corresponds to pushforwarding its surface measure and the distance can be regarded as a function on the Euclidean group. With appropriate exponents of the Sobolev norm, the second power of the function acquires sufficient differentiability that allows to find its local minima in the derivative-based framework. In numerical experiments, we observe superlinear convergence in the optimization problem with the Broyden – Fletcher – Goldfarb – Shanno method and discuss its implications from a more geometric perspective.

Lyapunov Stability Analysis of a Uncertain Linear System

Name: Vanel Lazcano

Institution: Universidad Mayor

Abstract: This work analyzes the stability problem in a discrete-time linear system with uncertain parameters. We take into account an invariant linear system as in the equation:

$$\mathbf{x}_{k+1} = (A + \Delta A)\mathbf{x}_k + B\mathbf{u}_k \tag{18}$$

where $\mathbf{x_k} \in \mathbb{R}^n$, $\mathbf{u} \in \mathbb{R}^m$, A the evolution matrix $\in \mathbb{R}^{n\times n}$, ΔA is the uncertainty $\in \mathbf{R}^{n\times n}$ $B \in \mathbb{R}^{n\times m}$, and $\mathbf{x}_0$ is known.

For this linear system with uncertain parameters, it is often desirable to determine a domain for the uncertainty variations in order to ensure that the system remains asymptotically stable around an equilibrium point.

First, we determined the Lyapunov function associated with the linear system's evolution matrix.

Taking the uncertainty into account and based on the variation of the Lyapunov function, we found a criterion to ensure asymptotic stability, which has to be satisfied by the system's uncertainties.

Second, we applied the proposed criteria to a model of an organic composting process available in the literature. The model's parameters were empirically estimated. It was formulated as a set of discrete-time recursive state equations involving CO2 concentration, temperature, and organic mass. We considered the CO2 concentration and the temperature of the organic matter as state variables.

We set the uncertainties of the composting process model as:

$\Delta A(s_1, s_2) = \begin{pmatrix} s_1 & 0 \\ 0 & s_2 \end{pmatrix}$, and our criteria imposes:

$$-1 + 2\max\{0.1084|s_1|, 0.0491|s_2|\} + \max\left\{1.0110s_1^2, 1.0024s_2^2\right\} < 0,$$

defining a domain for the uncertainty variations to keep the model asymptotically stable. This result was verified in our simulations.

Inverse problem for a parabolic equation

Name: Fagueye Ndiaye

Institution: Université Cheikh Anta Diop de Dakar (UCAD)

Abstract: In this paper, we are motived by the inverse problem which consists in determining the time and space varying scattering coefficients in a parabolic equation in $\Omega \subset \mathbb{R}^N$ a bounded measurable domain, interior non-empty and not containing a source, $N \geq 3$, for some fixed time $T > 0$. We define the Dirichlet-to-Neumann Map associating any measurement of the solution of an unstable advection-diffusion-reaction on $\partial\Omega$ the sufficiently regular boundary with the flow off the boundary, i.e. from the Cauchy data, for some fixed time $T > 0$. We are interested in the stability of the map which associates any scattering coefficient to the Dirichlet-to-Neumann Map. We are also interested in the existence and uniqueness of the solution of the inverse problem. We use abstract parabolic problem tools, and the Dirichlet-to-Neumann operator to identify the time and space varying scattering coefficients.

Bridging Scales in Choanoflagellate Hydrodynamics: Hybrid Model of Small-Colony Behavior

Name: Hoa Nguyen

Institution: Trinity University

Abstract: Choanoflagellates, the closest living relatives of animals, display complex hydrodynamic behaviors driven by their flagellum and microvilli collar, which are critical for swimming and feeding. This study introduces a hybrid computational model that combines the Method of Regularized Stokeslets (MRS) for the cell body and flagellum with the Method of Regularized Stokeslet Segments (MRSS) for the microvilli to simulate fluid-structure interactions in small Salpingoeca rosetta colonies (2-4 cells). By integrating detailed collar dynamics with computational efficiency, the model captures near-field fluid flows and swimming performance, addressing limitations of previous simplified models.

Simulations show that swimming speed strongly depends on colony configuration, flagellar phase, frequency, and plane rotation. Rosette colonies generally outperform chain configurations in three- and four-cell setups due to non-coplanar thrust. However, no consistent trend in swimming speed emerges with increasing colony size, highlighting the dominant influence of cell arrangement and stochastic flagellar dynamics. Validated against experimental data, this model provides a versatile framework for studying multicellular hydrodynamics and offers insights into the evolutionary advantages of early colonial organisms.

Numerical integrators for disordered multidimensional Hamiltonian systems

Name: Bob Senyange

Institution: Muni University

Abstract: We create and implement several integration schemes for studying the chaotic behavior of one- and two-dimensional generalized disordered Hamiltonian models with many degrees of freedom and investigate their numerical performance. We consider many different initial energy excitations and follow the evolution of the created wave packets in the various dynamical regimes exhibited by these models. We compare the computational efficiency of the considered integrators by checking their ability to correctly reproduce several features of the wave packets' propagation, namely, features depicting the symplectic and chaotic nature of the systems. We discuss the performance when a moderate and a high accuracy in conserving the systems' total energy value is considered.

Numerical Investigation of Two-Dimensional Two-Phase Kelvin-Helmholtz Instability Problem

Name: Abdullah Shah

Institution: KFUPM

Abstract: This study presents a numerical investigation of two-phase Kelvin-Helmholtz instability using the artificial compressibility method. The governing model consists of the mass-conserving Allen-Cahn equation coupled with the incompressible Navier-Stokes equations. To apply the artificial compressibility approach, the coupled system is first reformulated in conservative form. A fifth-order weighted essentially non-oscillatory scheme is employed for the convective terms,

while standard central finite differences are used for the viscous and surface tension terms. The resulting system is solved by the Beam-Warming approximate factorization technique.

The effects of single-mode and double-mode sinusoidal perturbations on the evolution of the instability are examined. For single-mode perturbations, the interface exhibits a pronounced roll-up near the center of the domain. The influence of the surface tension parameter is also investigated, and the results show that the instability dynamics are highly sensitive to its value. In addition, a grid convergence study is carried out to assess the resolution required for accurately capturing interface deformation.

The numerical results show good qualitative agreement with published studies. Overall, the proposed method effectively captures the complex and chaotically distorted interfacial structures that arise during the development of Kelvin-Helmholtz instability in two-phase flows.

Numerical Study of Waves Generated by Landslides in U-Shaped Bays

Name: Rani Sulvianuri

Institution: Bandung Institute of Technology

Abstract: Research related to modeling waves generated by landslides is still intensively carried out until now, those studies include landslides on flat bottom or sloping beaches, using analytical, numerical or experimental approaches. This research focuses on discussing the study of waves generated by landslide in long and narrow bays, on which the Saint-Venant type of equations hold. Here, we revisit and modify a numerical scheme we previously developed to accommodate landslide movements. The ability of the scheme to simulate the wave generated by landslide in U-bays is validated using analytical solutions. Further, we investigate the shoaling processes experienced by waves in the U-bay, as well as resonance phenomena, obtaining results that align perfectly with analytical predictions. In addition, we analyze the non-linear effects revealed by numerical simulations. Finally, we apply our model to a more realistic scenario, providing estimates of wave runup in Palu Bay.

Novel iterative algorithm for solving equilibrium problem with applications to optimal control and 3D image processing

Name: Victor Uzor

Institution: University of KwaZulu-Natal, South Africa

Abstract: In handling complex optimization problems, iterative algorithms are the go-to, since employing analytical methods would be a Herculean task. However, designing efficient iterative schemes is crucial, to avoid computational drain, large memory consumption and time wastage. In this paper, we introduce a novel two-step inertial algorithm that incorporates a self-adaptive step size and relaxation parameter, for solving equilibrium problems in the framework of real Hilbert spaces. While most two-step inertial results in the literature only converge weakly, we propose a new scheme that converges strongly under certain newly imposed relaxed conditions,

which avoids the on-line rule or any line-search protocol. This, to the best of our knowledge, is a new idea and has not been explored in the literature. To validate the computational advantage of our proposed algorithm, we provide numerical experiments in comparison with state-of-the-art methods. Furthermore, we present practical applications of our proposed numerical scheme in solving optimal control problem of a harmonic oscillator and restoration of distorted 3D images.

A Semi-Discrete Lagrangian-Eulerian Scheme for Systems of 3D Hyperbolic Conservation Laws in Cubic Grids

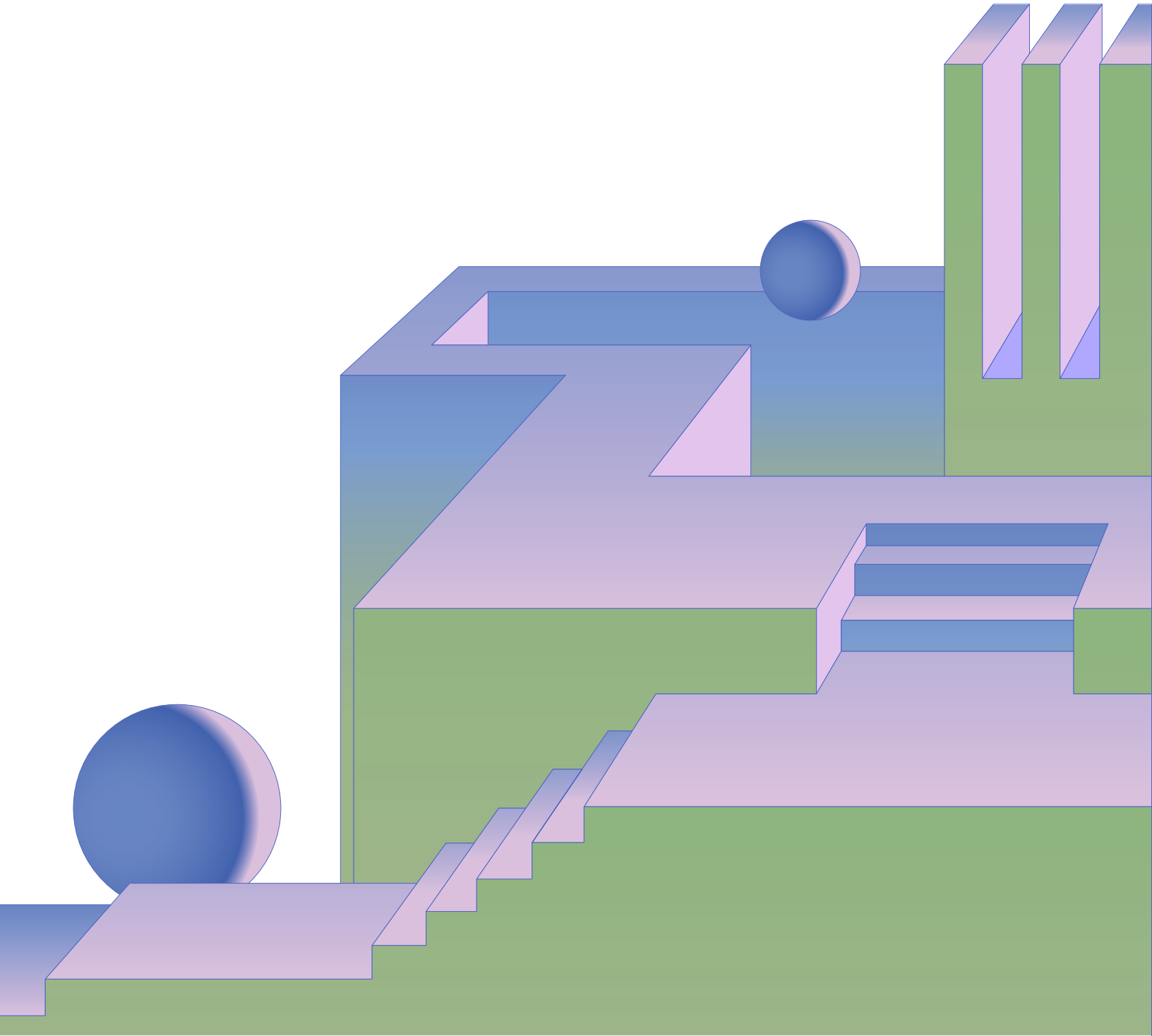
Name: Pedro Henrique Valerio de Godoi

Institution: Universidade Estadual de Campinas

Abstract: In this work we present a semi-discrete Lagrangian-Eulerian scheme for three-dimensional systems of hyperbolic conservation laws, in the form $(u_i)_t + \nabla \cdot H_i(u) = 0$, with $u = (u_1, u_2, \cdots, u_m)$, $u_i \in \mathbb{R}^3$, $H_i : \mathbb{R}^m \to \mathbb{R}$ and $m \geq 1$, using the novel concept of the no-flow curves. A higher-resolution variant using a linear reconstruction technique is also presented. The Lagrangian-Eulerian approach consists in the use of the no-flow curves to derive a special control volume in the space-time domain, allowing the construction of a finite volume method that follows the conserved quantities mass in time (the Lagrangian approach) but is able to recover the mass in a fixed spatial grid (the Eulerian approach) at any given time. This Lagrangian-Eulerian approach allows us to obtain accurate numerical solutions to the system using only the information from the flux function, without the need to calculate or approximate the Jacobian, eigenvalues or eigenvectors to compute the numerical flux or the stability condition. Also, it does not use Riemann solvers. The presented scheme converges to the Kruzhkov entropy solution in the scalar case and satisfies the positivity principle, proposed by Xu-Dong Liu and Peter Lax, for systems of hyperbolic conservation laws when solved with widely known integrators, like Forward Euler or the total variation diminishing Runge-Kutta schemes proposed by Chi-Wang Shu and Stanley Osher. We present results showing evidence that the scheme converges to the physically relevant solution for well-known hyperbolic systems describing physical models.

POSTERS

SECTION 16- CONTROL THEORY AND OPTIMIZATION



Total controllability for fractional differential systems with impulsive effects

Name: Rajesh Dhayal

Institution: Thapar Institute of Engineering & Technology, Patiala, Punjab, India

Abstract: The main objective of this work is to investigate a new class of fractional differential systems with impulsive effects. The existence of piecewise continuous mild solutions is established using the Mittag-Leffler function and fixed-point techniques. Furthermore, total controllability results are derived by constructing an appropriate control function and the associated controllability Gramian matrix. Finally, the theoretical results are validated through numerical examples.

Stabilization of Unstable Periodic Orbits via Delayed Feedback Controls

Name: Dohan Kim

Institution: Seoul National University

Abstract: The delayed feedback control of Pyragas type (DFC, for short) is a widely recognized method for stabilizing unstable periodic orbits of differential equations. In this work, we determine the stability region within which an originally unstable periodic solution can be stabilized using DFC. This region is characterized by the geometric properties of the closed sets derived from the C-map theorems under the commuting condition. Furthermore, we identify the optimal range of feedback gain values that ensure stabilization via DFC, based on the maximality of stability regions.

First-Order Algorithms for Stochastic Multi-Objective Optimization Problems

Name: Yiyang Li

Institution: The Hong Kong Polytechnic University

Abstract: Stochastic multi-objective optimization (SMOO) problems arise in many applications where random conflicting performance are valued by expectations, such as return and risk. In this paper, we develop a projected gradient algorithm with the sample-average approximation and scalarization-free approach for the SMOO. We introduce a Tikhonov-regularized simplex quadratic program to define a single-valued multi-gradient direction and a regularized Pareto-stationarity measure. We establish Lipschitz continuity of the induced multiplier and direction mappings on the convex feasible set. We also show that the regularized stationarity measure converges to the Pareto-stationarity measure as the regularization parameter tends to zero. We establish stationarity-complexity results for the proposed algorithm and quantify the sample size required to guarantee the approximation accuracy. Numerical results demonstrate the effectiveness of the proposed algorithm.

Modified Gradient Descent Methods for Coupled-Constrained Minimization and Quasi-Variational Inequalities

Name: Nevena Mijajlovic

Institution: University of Montenegro

Abstract: In this poster we investigate several methods that can be interpreted as modifications of the standard gradient descent algorithm, aimed at solving minimization problems with coupled constraints and the associated variational and quasi-variational inequalities. Quasi-variational inequalities extend the classical variational inequality framework by allowing the constraint set to depend on the decision variable, a formulation that is particularly useful in modeling a broad range of equilibrium and constrained optimization problems.

In particular, we study the extragradient and forward – backward – forward methods, considering both their dynamic and iterative variants. We also analyze proximal-type methods and discuss extensions to higher-order schemes. The proposed approaches exhibit complementary advantages: some significantly accelerate convergence, while others guarantee convergence for a broader class of problems than the classical gradient descent method.

Under standard assumptions such as Lipschitz continuity and strong monotonicity of the underlying operator, convergence of all considered methods is rigorously established, and convergence-rate estimates are derived. We highlight the main theoretical properties, emphasizing applicability to variational and quasi-variational inequalities. Numerical experiments are included to illustrate the theoretical findings and to demonstrate the effectiveness of the proposed approaches.

Negative Stepsizes Make Gradient-Descent-Ascent Converge

Name: Henry Shugart

Institution: University of Pennsylvania

Abstract: Solving min-max problems is a central question in optimization, games, learning, and controls. Arguably the most natural algorithm is Gradient-Descent-Ascent (GDA), however since the 1970s, conventional wisdom has argued that it fails to converge even on simple problems. This failure spurred the extensive literature on modifying GDA with extragradients, optimism, momentum, anchoring, etc. In contrast, we show that GDA converges in its original form by simply using a judicious choice of stepsizes. The key innovation is the proposal of unconventional stepsize schedules that are time-varying, asymmetric, and (most surprisingly) periodically negative. We show that all three properties are necessary for convergence, and that altogether this enables GDA to converge on the classical counterexamples (e.g., unconstrained convex-concave problems). The core intuition is that although negative stepsizes make backward progress, they de-synchronize the min/max variables (overcoming the cycling issue of GDA) and lead to a slingshot phenomenon in which the forward progress in the other iterations is overwhelmingly larger. This results in fast overall convergence. Geometrically, the slingshot dynamics leverage the non-reversibility of gradient flow: positive/negative steps cancel to first order, yielding a second-order net movement in a new direction that leads to convergence and is otherwise impossible for GDA to move in. Joint work with Jason Altschuler.

Solution Theory for Singular Linear Switched Systems in Discrete Time

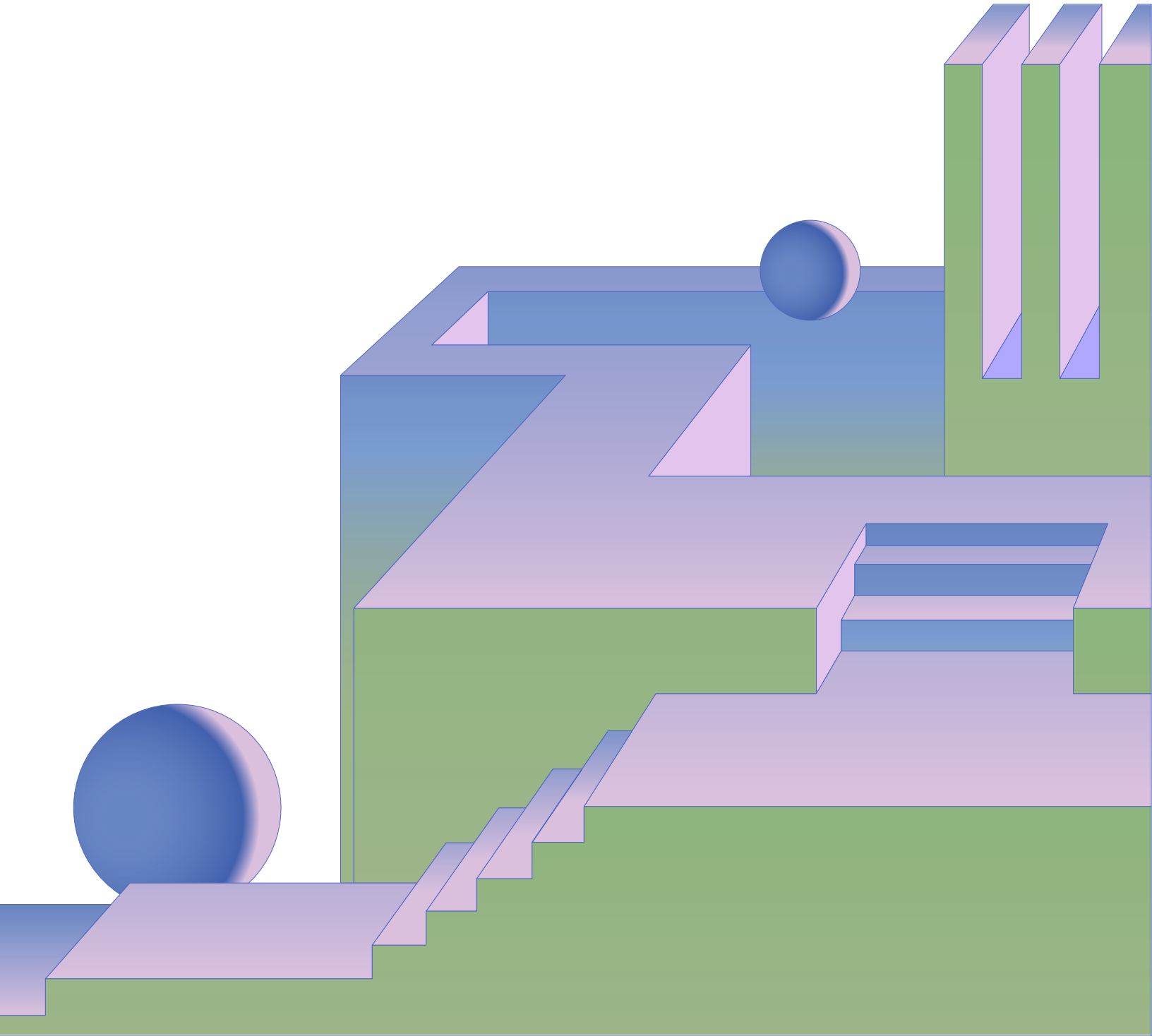
Name: Sutrisno Sutrisno

Institution: Universitas Diponegoro

Abstract: This work develops a rigorous solution theory for singular linear switched systems in discrete time. The solvability of such systems under general and restricted switching regimes is characterized. The conditions for the existence and uniqueness of solutions are established. The analysis accounts for algebraic constraints induced by singularity and their interaction with mode transitions. The resulting framework provides a unified theoretical basis for understanding well-posedness and trajectory evolution in singular linear switched dynamics.

POSTERS

SECTION 17–STATISTICS, MACHINE LEARNING, IMAGE AND SIGNAL PROCESSING



Multivariate Information Measures: A Copula-based Approach

Name: Mohd Arshad

Institution: Indian Institute of Technology Indore

Abstract: Multivariate datasets are common in various real-world applications. Recently, copulas have received significant attention for modeling dependencies among random variables. A copula-based information measure is required to quantify the uncertainty inherent in these dependencies. This paper introduces a multivariate variant of the cumulative copula entropy and explores its various properties, including bounds, stochastic orders, and convergence-related results. Additionally, we define a cumulative copula information generating function and derive it for several well-known families of multivariate copulas. A fractional generalization of the multivariate cumulative copula entropy is also introduced and examined. We present a non-parametric estimator of the cumulative copula entropy using empirical beta copula. Furthermore, we propose a new distance measure between two copulas based on the Kullback-Leibler divergence and discuss a goodness-of-fit test based on this measure.

Image Encryption Based On Newly Designed Chaotic Map

Name: Kritika Gupta

Institution: Lovely Professional University

Abstract: This paper presents a secure and efficient image encryption scheme that combines chaotic maps, perturbation techniques, and Linear Feedback Shift Registers (LFSR) to achieve high levels of security and performance. The proposed chaotic maps, known for their extreme sensitivity to initial conditions, are utilized to generate pseudorandom sequences for both pixel position scrambling and value diffusion. By introducing perturbations into the logistic map, the scheme increases sequence complexity and unpredictability. The integration of LFSR adds another layer of cryptographic randomness, helping to mitigate potential predictability and reinforcing encryption strength. The encryption process involves pixel shuffling, nonlinear diffusion of pixel values, and multiple iterative rounds, significantly enhancing security robustness. A comprehensive security evaluation including key space analysis, histogram analysis, and resistance to statistical and differential attacks demonstrates the effectiveness of the proposed approach. Experimental validation confirms its efficiency and real time applicability for secure image transmission. Rigorous testing, including entropy analysis, correlation metrics, NPCR (Number of Pixels Change Rate), UACI (Unified Average Changing Intensity), and NIST randomness tests, indicates that the encrypted images possess high entropy, low correlation, and strong resistance to differential attacks. These results affirm the scheme's suitability for robust and secure image encryption in practical applications.

Predictive Models for Breast Cancer Brain Metastasis: An Integration of Neuroimaging and Genomics Data for Better Clinical Practice

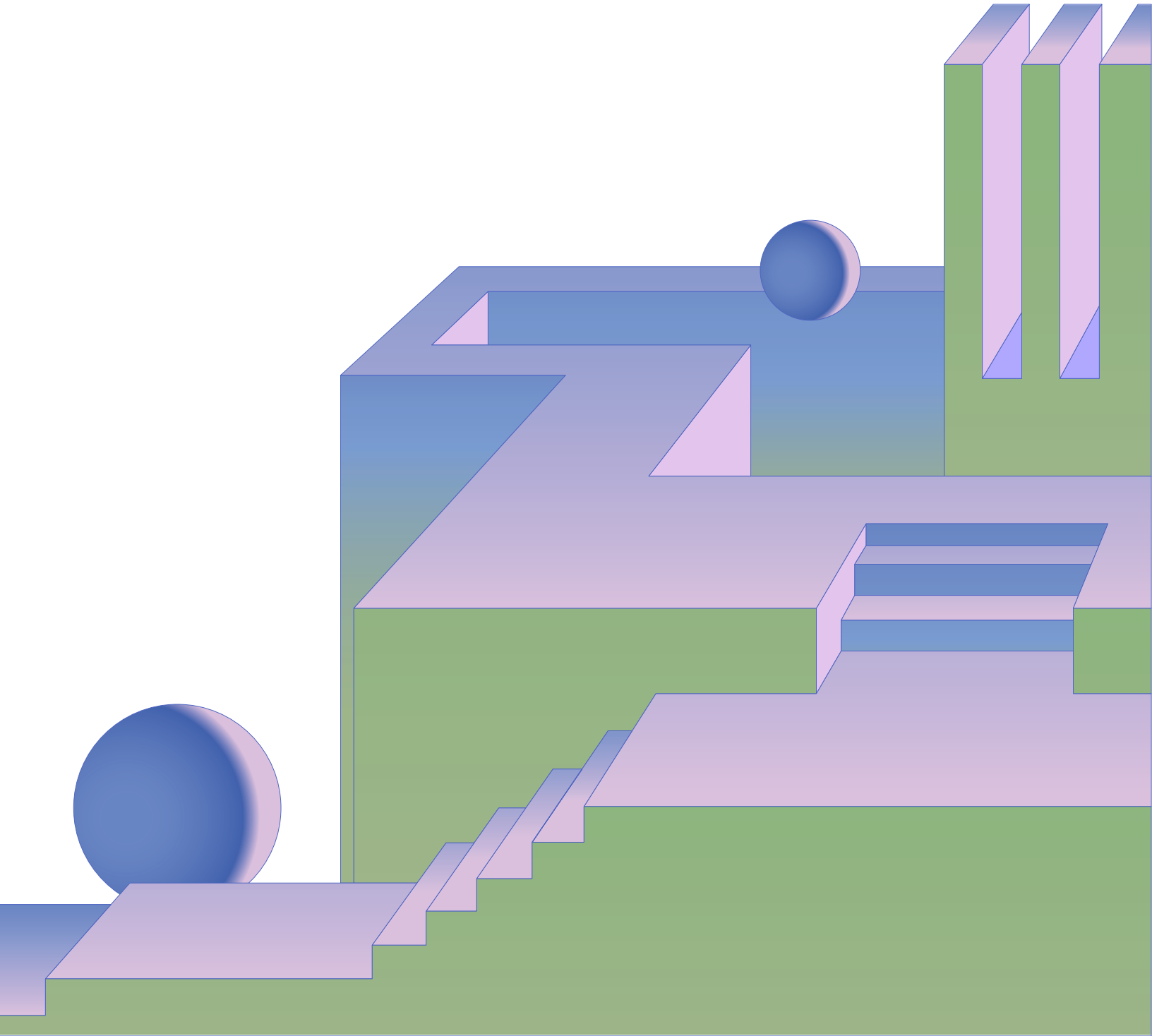
Name: Chipo Zidana

Institution: Botswana International University of Science and Technology

Abstract: Breast cancer brain metastasis (BCBM) is among the most aggressive forms of advanced breast cancer and is associated with poor prognosis. Conventional diagnostic approaches, such as invasive biopsies and standard imaging techniques, often fail to capture the biological and structural complexity of metastatic tumors. While magnetic resonance imaging (MRI) has been widely used to study BCBM, the neurological implications of brain structure and function in metastasis remain poorly understood. In this study, we developed and evaluated predictive models that integrate neuroimaging features with gene expression data to identify (i) the most predictive features of BCBM, (ii) the brain regions most affected, and (iii) the genes associated with those regions. Neuroimaging features were obtained from a publicly available MRI dataset of BCBM, while gene expression profiles were retrieved from a paired microarray dataset comprising 32 samples (16 primary breast tumors and 16 BCBM) from the Gene Expression Omnibus (GEO). Four machine learning models namely LASSO logistic regression, support vector machine (SVM), random forest, and XGBoost were trained using (i) neuroimaging features alone and (ii) genomically guided features derived from differentially expressed genes (DEG)s and their corresponding regions of interest (ROI)s. Differential expression analysis using the Linear models for microarray data (LIMMA) method identified 105 significant probesets corresponding to 79 unique genes and only 17 of these as available in the UK Biobank were used for correlations analysis with and neuroimaging using the neuroimaGene package in R. These correlations showed strong associations for CTSK and VCAN with neuroimage features predominantly in the cerebellum and thalamus, cingulate and frontal regions. Important predictive features included first-order intensity, texture and shape metrics such as elongation and sphericity. Random forest achieved the highest accuracy (79%) and recall (77%), while XGBoost showed the best area under the curve (AUC) and specificity (81%). This study further showed that integrating gene expression with MRI-derived features can maintain strong performance while improving biological interpretability. These findings provide knowledge into the genomic and neurological processes of BCBM and may support the development of more targeted and clinically relevant treatment strategies.

POSTERS

SECTION 18– STOCHASTIC AND DIFFERENTIAL MODELLING



Optimal Stopping Problems for Real Options Driven by Short-Noise Processes

Name: Ini Adinya

Institution: University of Ibadan

Abstract: Classical real options models assume that project values evolve as diffusions driven by white noise, leading to simple optimal stopping rules. This framework neglects shortrange dependence caused by noise with finite correlation. We study a real options model in which the project value is driven by a short-noise stochastic process and formulate the investment decision as a multidimensional optimal stopping problem. The value function is characterised through a variational inequality associated with a degenerate elliptic operator. We show that short-noise effects influence the structure of the optimal stopping boundary and and recover the classical geometric Brownian motion model as a limiting case.

Stochastic Analysis of Epidemic Dynamics Under a Two-Threshold Control Policy

Name: Hassane Bouzahir

Institution: Ibn Zohr University

Abstract: We introduce a non-smooth epidemic model incorporating a two-threshold control strategy, where social distancing and isolation measures intensify as infection levels increase. The model is examined within a stochastic dynamics framework, with carefully chosen thresholds shown to control infection levels effectively, de-laying and reducing peak infections. However, overly high thresholds diminish the impact of control measures on the epidemic's long-term behavior and cumulative cases. We establish the well-posedness of the model, perform a thorough stochastic analysis, and support our theoretical findings with extensive numerical simulations.

Mathematical Modeling and Sensitivity Analysis of SynNotch-CAR-T Cells Identify Engineering Targets for Dynamic Tunability

Name: Alexander Diefes

Institution: Duke University

Abstract: Cancer therapeutics are increasingly incorporating engineered receptors due to their ability to detect extracellular ligands and initiate intracellular responses that regulate gene expression. By redesigning these natural signaling systems, synthetic receptors hold great potential for use in novel cell-based therapies. One particularly promising direction is modifying the Notch receptor, a transmembrane protein that naturally mediates ligand-dependent signaling at the cell surface to regulate cell proliferation and differentiation in neurogenesis. Both the intracellular and extracellular domains of Notch can be replaced with alternative domains, creating

the family of modified Notch receptors known as synthetic Notch (synNotch). In existing synNotch-activated chimeric antigen receptor (CAR) T-cells, the extracellular domain can be engineered to adjust binding affinity for a specific cancer antigen, enabling precise tuning of therapeutic activity while minimizing off-target effects. To quantify and inform such tuning, we develop differential equations models of synNotch receptor signaling and subsequent gene expression. The mathematical model couples activation dynamics on fast timescales (characteristic of receptor-ligand interactions) and on slow timescales (characteristic of downstream gene expression dynamics). Global Sobol sensitivity analysis of the proposed models highlights parameters that yield the greatest variability in synNotch signal transduction and gene expression, indicating their potential to be engineered for different functions in future cancer therapeutics. For the receptor-ligand interactions in the synNotch model, we find that ligand association and ligand-independent activation are the most sensitive parameters. In the downstream gene expression model, promoter strength and degradation rates of mRNA and gene product are found to be most amenable to engineering.

A Bayesian Approach in Pricing Insurance under Stochastic Gompertz Model with Health Risk Factors

Name: Anjali Lomugdang

Institution: Institute of Mathematics, University of the Philippines Diliman

Abstract: This study aims to enhance the Gompertz mortality model by incorporating stochastic parameters and providing a Bayesian framework for pricing term life insurance based on policyholders' survival and familial health history. The Vasicek model is used to describe the temporal evolution of these stochastic parameters, capturing their mean-reverting behavior, with its distribution at a fixed time point serving as the prior in the Bayesian framework. Bayes' rule is used to update these priors using observed survival and death outcomes along with familial health factors. Using illustrative data for 30-year-old policyholders, prior and posterior prices are computed across different health profiles, showing that posterior prices can increase or decrease relative to prior-based prices depending on the observed risk patterns. These results illustrate how incorporating observed survival and health information refines pricing and aligns prices with actual risk across policyholder profiles.

On Large Deviations in Nonlinear Filtering Theory in the Besov-Orlicz Space

Name: Dina Miora

Institution: Mathematics Department of Antananarivo University

Abstract: Let X^ε be the solution of the following stochastic differential equation:

$$X_t^\varepsilon = x + \sum_{i=1}^{r} \int_0^t \sigma_i(X_s^\varepsilon)\, dW_s^i + \varepsilon \sum_{j=1}^{l} \int_0^t \tilde{\sigma}_j(X_s^\varepsilon)\, d\tilde{W}_s^j + \int_0^t b(X_s^\varepsilon)\, ds,$$

and consider

$$\varphi_{\phi}^{\varepsilon} = \mathbb{E}_{\phi}(X^{\varepsilon}).$$

We establish a large deviation principle for the family of laws induced by $\{X^{\varepsilon} : \varepsilon > 0\}$ in the Besov-Orlicz space. Consequently, we obtain the same result for the family of laws induced by $\{\varphi_{\phi}^{\varepsilon} : \varepsilon > 0\}$. Finally, we provide an application of these results to nonlinear filtering.

Hybridization of stochastic hydrological models and machine learning methods for improving rainfall-runoff modeling

Name: Stephen Moore

Institution: University of Cape Coast

Abstract: Rainfall-runoff modeling is a crucial tool for water resource management and assessing risks related to extreme hydrological events. It enables the simulation and prediction of river discharge responses to precipitation under various geographical and climatic conditions. The Hydrological Model based on the Least Action Principle (HyMoLAP) demonstrates that rainfall-runoff transformation can be described as dynamic systems. As a physically-based model formulated as an Ordinary Differential Equation (ODE), it offers simplicity in simulation. The aim of this paper is to enhance the accessibility of this model by investigating the composite forcing function that characterizes it, showcasing its capacity to simulate basin discharge. This work employs the two main composite forcing functions from the literature and introduces a new one, which can significantly enhance model predictions. Using the conceptual GR6J model as a benchmark for comparison, and applying both models to two different basins including the Ouémé at Savé (Benin) and Yala (Kenya) river basins, it is clear that the HyMoLAP model can provide insightful predictions for any study basin, depending on how the composite forcing function is defined. When employing the proposed function, which includes an additional parameter, the HyMoLAP model demonstrates improved performance, achieving NSE values of 0.831 for calibration and 0.893 for validation in the Ouémé at Savé basin. Furthermore, for day-ahead prediction that incorporates the previous day's observed discharge, the HyMoLAP model achieves NSE values of 0.963 for Savé and 0.924 for Yala. This study illustrates that the model has the potential to attract interest from hydrological researchers and can still be improved to provide even more robust performance.

Equity Premium in a Semimartingale Market When Jump Amplitudes Follow an Arbitrary, Normal, Binomial and Gamma Distributions While Assuming Some Selected Utility Functions

Name: George Mukupa

Institution: Mulungushi University

Abstract: Introduction We study the equity premium in a market when a stock price process is being driven by a semimartingale. We model equity premium for a risk averse, risk neutral and

risk seeking investor when jump amplitudes follow the normal, binomial and gamma distributions. Method This research employs a mathematical finance framework to model equity premium within a filtered probability space. The market includes a non-risky asset (money market account) and a risky asset (stock). The risky asset's dynamics incorporate both Brownian motion for continuous price fluctuations and a Poisson process to account for sudden, discontinuous jumps. The methodology involves applying Itô's Lemma to derive the logarithmic dynamics of the risky asset, confirming its classification as a semimartingale. The study then formulates an investor's optimal control problem to maximize utility, subject to wealth dynamics that incorporate the non-risky and risky assets, along with consumption. Results A risk-averse investor yields a greater equilibrium equity premium due to continuous hedging. When trading time is n and upward jump probability is p, the process Xt follows a binomial distribution, ensuring long-term compensation for excess risk. A risk-neutral investor's equilibrium equity premium is constant, unaffected by linear utility function parameters. If jumps follow a normal distribution, both mean and variance impact the premium. However, frequent jumps (indicated by gamma amplitudes) significantly decrease the equity premium. A risk-seeking investor with arbitrary or normal jumps has no optimal consumption. The wealth process Vt solely influences the rare-event premia.

Conclusion Risk-averse investors in a semimartingale market benefit from higher equity premiums influenced by wealth and volatility, unlike risk-neutral or risk-seeking investors.

On the concept of digital pathogens and their impact on 'Technopandemics'

Name: Farai Nyabadza

Institution: University of Johannesburg

Abstract: This paper develops a novel epidemiological framework for understanding compulsive digital behaviours as manifestations of behavioural contagion transmitted through social media platforms. We introduce the concept of "digital pathogens" to describe algorithmic mechanisms that induce and propagate compulsive engagement patterns, including excessive scrolling, reflexive content forwarding, and obsessive engagement monitoring. These behaviours are modelled using compartmental epidemic approaches, treating susceptible users as vulnerable populations exposed to algorithmically mediated infection vectors. Our mathematical model partitions users into distinct behavioural states: susceptible individuals, exposed users experiencing initial engagement escalation, infected individuals exhibiting compulsive behaviours, and recovered users who have regained autonomous digital agency. Transmission dynamics are governed by platform design features, including infinite scroll architecture, notification systems, recommendation algorithms, and social validation mechanisms that function as pathogenic agents. We derive the basic reproduction number (R_0) for behavioural contagion, identifying critical thresholds beyond which compulsive behaviours achieve epidemic prevalence within digital communities. The framework reveals how platform affordances create feedback loops that amplify addictive engagement, producing techno-pandemic conditions characterized by widespread behavioural dysregulation. Sensitivity analysis identifies intervention leverage points, including algorithm transparency, friction-inducing design modifications, and digital literacy programs that enhance population immunity. Numerical simulations demonstrate how varying platform parameters influence outbreak severity and persistence. This epidemiological approach

provides quantitative tools for assessing public health implications of attention economy business models. We propose evidence-based interventions analogous to vaccination campaigns and quarantine protocols, adapted for digital environments. The findings suggest an urgent need for regulatory frameworks treating algorithmic compulsion as a transmissible behavioural pathology requiring population-level intervention strategies to prevent and mitigate technopandemics.

Stochastic Epidemic Models with Partial Information on Undetected Infections in the Transmission of Zika Virus

Name: Lillian Oluoch

Institution: The Technical University of Kenya

Abstract: Zika fever, a mosquito-borne viral disease with potential severe neurological complications and birth defects, remains a significant public health concern. The epidemiological models often oversimplify the dynamics of Zika transmission by assuming immediate detection of all infected cases. This study provides an enhanced SEIR (Susceptible-Exposed-Infectious-Recovered) model to incorporate partial information by distinguishing between detected and undetected Zika infections (also known as "dark figures"). By distinguishing the compartments, the model captures the complexities of disease spread by accounting for uncertainties about transmission and the number of undetected infections. This model implements the Kalman filter technique to estimate the hidden states from the observed states. Numerical simulations were performed to understand the dynamics of Zika transmission, and real-world data were utilized for parameterization and validation of the model. The study aims to provide information on the impact of undetected Zika infections on disease spread within the population, thereby contributing to evidence-based decision-making in public health policy and practice.

A study of overcompensatory prey growth on discrete-time predator-prey model with continuous and seasonal breeding

Name: Narendra Pant

Institution: University of Louisiana at Lafayette

Abstract: We study the effects of seasonality on predator – prey interactions in discrete-time models with overcom- pensatory (Ricker-type) nonlinear population growth. Building on a model introduced by Ackleh et al. (2024), we analyze two settings: continuous reproduction and seasonal reproduction. In the continuous reproduction case, we show that both species persist and that the system can exhibit stable coexistence together with rich dynamical behavior. In the seasonal reproduction case, we establish persistence and demonstrate the emergence of stable population cycles and more rich dynamics. Numerical simulations illustrate and complement the analytical results, with some seasonal effects remaining preliminary

Mathematical modelling for CTCE-9908 (a CXCR4 inhibitor) on B16 F10 melanoma cell proliferation

Name: Avulundiah Edwin Phiri

Institution: Copperbelt University

Abstract: The percentage of living cells that are present at any given time when the population is under treatment is known as cell viability. The cell vitality of tumour cells undergoing treatment is a crucial quantitative measure of drug efficacy. Hence, determining cell viability as a function of time is a crucial stage in the development of new cancer drugs. Such a function is frequently developed by interpolating the existing data using statistical techniques like regression. We use mechanistic modelling techniques rather than statistical tools to ensure that information on the dynamics of activation and inhibition is also included in the cell-viability function. We therefore derive a cell viability function in this presentation that is appropriate for experimental data collected from the inhibitory drug, CTCE-9980. Then, we use the experimental data to approximate the parameters at a 95% confidence interval. To validate the model, we use the bootstrapping technique to determine the stability of the estimated parameters at a 95% bootstrap confidence level.

The accuracy of predictions produced via interpolation, linear or nonlinear regression at any given value of an independent variable depends on the density of data points around this value. Predictions outside the domain adequately covered by data points can seldom be relied upon. Such predictions, often referred to as extrapolation, significantly depend on the type of functions used in the fitting process and, to a lesser extent, on the accuracy of the approximations of the data. To avoid the stated problem, the protocol proposed here is focused on appropriately deriving a type of function to be used in the app

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Can we save the Tasmanian devil and restore ecosystem balance in Tasmania?

Name: Megan Powell

Institution: University of North Carolina Asheville

Abstract: Co-authors: Brian Drawert, Sean Matthew, Elliott Phipps, Bryan Rumsey, Rose Sciaudone, Myra Szobody

Devil facial tumor disease (DFTD) is a cancer that affects Tasmanian devils and that has caused the devil population to grossly decline since 1996. Multiple intervention strategies have been employed to save the Tasmanian devil from extinction. This presentation will focus on differential equation models of these intervention strategies, considering the efficacy of each with the intention of informing field researchers on important components on which to focus. Specifically, distribution of a vaccine is modeled considering how vaccine efficacy and bait ingestion rates can minimize the frequency and duration of a campaign. Additionally, decline in devil populations as the apex predator in Tasmania has led to an increase in invasive species activity such as feral cats and decrease in small mammal native prey species. Feral cats are estimated to kill well over a million native species daily in Australia and threaten the biodiversity of the country. This presentation will show models of how recovery of the Tasmanian devil populations and/or

introduction of captive-bred devils may reduce the impact of invasive species and help native species populations recover.

Boundary-value problems for dynamic and integro-dynamic equations on time scales

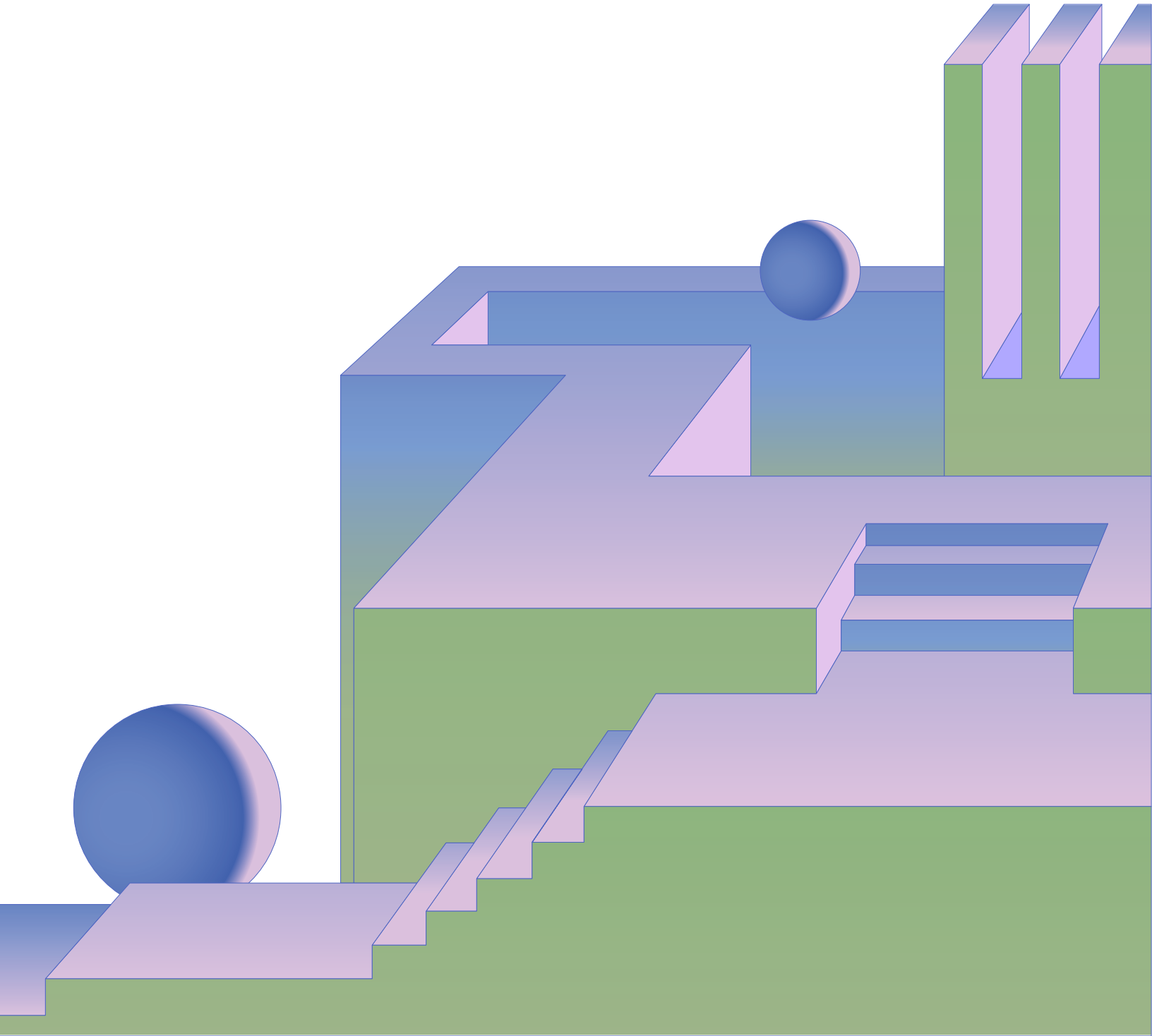
Name: Roza Uteshova

Institution: Institute of Mathematics and Mathematical Modeling

Abstract: We investigate boundary-value problems for linear and nonlinear dynamic and integro-dynamic equations on time scales. A generalized parameterization method is developed for the analysis of solvability and the construction of numerical solution algorithms for boundary-value problems on time scales of fixed and variable structure. For dynamic and integro-dynamic equations on fixed time scales, constructive solvability conditions are obtained. For families of boundary-value problems on time scales of variable structure, sufficient conditions are established for the convergence of their solutions to solutions of the corresponding differential and integro-differential boundary-value problems on real intervals. The results provide a rigorous framework for the study of boundary-value problems for hybrid discrete – continuous systems within the theory of dynamic equations on time scales. This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (grant no. AP23485618).

POSTERS

SECTION 19– MATHEMATICAL EDUCATION AND POPULARIZATION OF MATHEMATICS



Educational games for teaching threshold concepts in mathematics

Name: Vedrana Mikulić Crnković

Institution: University of Rijeka, Faculty of Mathematics

Abstract: Some concepts are essential for mastering mathematics. In every discipline, certain concepts have proven particularly difficult for students to understand. These concepts share specific characteristics and are known as threshold concepts. Such concepts are challenging yet fundamental to knowledge and understanding within particular disciplines. They are not merely difficult to grasp; their complexity is compounded by incorrect mental models, misconceptions, and difficulties in transferring understanding from one context to another. In this presentation, we will provide a list of threshold concepts in mathematics identified using the Nominal Group Technique. The research and analysis were conducted by a group of mathematicians from the Faculty of Mathematics, University of Rijeka. A total of 59 mathematics teachers (from primary and secondary schools), 16 classroom teachers, and 10 mathematics students participated in the study. For some threshold concepts, we developed educational scenarios based on a game-based learning approach. In these scenarios, we used educational games that, in addition to reinforcing individual concepts, foster computational thinking. We implemented these scenarios in schools and evaluated their effectiveness. In this presentation, we will showcase the designed games and scenarios, as well as the evaluation results.

Teacher Educators' Learning and Development in Blended Learning Contexts

Name: Chanroath Monita

Institution: Cambodian Mathematical Society

Abstract: The COVID-19 pandemic forced education systems worldwide to rapidly shift from conventional classroom teaching to online and blended learning environments. This sudden transition challenged teachers' pedagogical practices and highlighted the need for instructional models that support flexible, student-centered learning. In Thailand, the Blended Learning Classroom (BLC) Model proposed by Inprasitha offers a framework that extends learning beyond physical classrooms by integrating live interaction with on-demand self-learning environments. This study explores teacher educators' learning and beliefs regarding the implementation of the BLC Model during the pandemic within Lesson Study integrated Open Approach (TLSOA). This qualitative study involved 54 teacher educators with at least two years of TLSOA experience, including 14 participants actively engaged in blended lesson study teams. Data were collected through lesson planning documents, classroom observations, reflection meetings, and semi-structured interviews, and were analyzed using thematic analysis. Findings indicate that the On-Demand Classroom (ODC) promoted student autonomy by enabling self-paced learning and independent conceptual development, while the Live Classroom (VLC) supported collaborative learning through active interaction among students and teachers. Teacher educators reported enhanced professional learning, improved instructional design skills, and deeper understanding of student thinking. Despite challenges related to technological access and classroom management, the BLC Model effectively supported continuous learning, collaboration, and pedagogical innovation. The study concludes that the BLC Model provides a sustainable approach to blended

mathematics instruction and teacher professional development, particularly in contexts requiring flexible learning arrangements. The findings contribute to understanding how blended learning can be meaningfully integrated into lesson study frameworks to support long-term educational improvement.