Comunicări Științifice ale Studenților
Matematică, UBB

Secțiunea: Doctorat

Sala ‘e’

Clădirea Mathematica, str. Ploiești 23-25, Cluj-Napoca

sau

online prin Zoom
https://zoom.us/j/95818345616?pwd=uXA9Z8rSIbKybwQYB8gE2SXghUBgWb.1

Universitatea Babeș-Bolyai
Facultatea de Matematică și Informatică
Departamentul de Matematică

PROGRAM

10:45-11:00 Deschidere		
11:00	Valerian-Alin Fodor	An Algorithm for Approximating the Metric Projection onto a Superellipse
11:20	Georgiana Fasolă	Grupuri complet realizabile. Un pas în teoria inversă a grupurilor
11:40	Cristian Rafiliu	Kaplansky-Walker Lemma in Idempotent Complete Additive Categories
12:00	Iulia-Cătălina Pleșca	Harmonic Mean of Element Orders in a Finite Group
12:20	Mihai Aron	Invariant Geometric Properties in Bubble Contraction During Fluid Infiltration Between Parallel Plates
12:40-13:00 Pauză		
13:00	Andrei Stoenică	Unirationality of Bielliptic Loci
13:20	George-Bogdan-Alexandru Lung	Obiecte Rickart în Categorii Exacte
13:40	Lehel Csillag	The Inverse Problem of Calculus of Variations of Autoparallels
14:00	Alexandru Pîrvuceanu	Rigidity Results for RCD$(0, N)$ Spaces via Sharp Hypercontractivity Estimates
14:20-14:40 Pauză		
14:40	Călin-Daniel Spiridon	Linear Sections of Grassmannians and Resonance of Vector Bundles
15:00	Robert Pop	Approximation Domains in Exact Categories
15:20	Andra-Maria Stoica	Wold-Type Decompositions and Quasi-Isometries on Hilbert Spaces
15:40	Miklós-József Laping	Computing Ringel–Hall Polynomials Using Parallel Algorithms
16:00 Mini-Ceremonie de Închidere în Sala de Lectură		

ABSTRACTE

10:45-11:00 Deschidere

11:00 **Valerian-Alin Fodor** (Universitatea Babeș-Bolyai, Facultatea de Matematică și Informatică)

Titlu: **An Algorithm for Approximating the Metric Projection onto a Superellipse**

Îndrumător: Prof. Cornel-Sebastian Pintea

Abstract: We propose a new method for computing an approximation of the metric projection onto a superelliptic disk of order $n > 1$, i.e., the convex hull of a superellipse (Lamé curve). We analyse the approximation error and the computational complexity of the algorithm, which we prove to be logarithmic.
This is joint work with Virgilius-Aurelian Minuță.

11:20 **Georgiana Fasolă** (Universitatea Alexandru Ioan Cuza din Iași, Facultatea de Matematică)

Titlu: **Grupuri complet realizabile. Un pas în teoria inversă a grupurilor**

Îndrumător: Prof. Marius Tărnăuceanu

Abstract: În teoria grupurilor, sunt multe construcții f care, pornind de la un grup H, produc un alt grup, $f(H)$. Câteva exemple de astfel de construcții din teoria grupurilor sunt: centrul, subgrupul central, subgrupul comutator, subgrupul Frattini, subgrupul Fitting, subgrupul Chermak-Delgado, grupul automorfismelor, multiplicatorul Schur, alte grupuri de coomologie și diferite aplicații pornind de la grupuri de permutări. Pentru fiecare astfel de construcție, se pune problema inversă:

Dat un grup G, există un grup H astfel încât $G \cong f(H)$?

11:40 **Cristian Rafiliu** (Universitatea Babeș-Bolyai, Facultatea de Matematică și Informatică)

Titlu: **Kaplansky-Walker Lemma in Idempotent Complete Additive Categories**

Îndrumător: Prof. Simion-Sorin Breaz

Abstract: Kaplansky established in 1958 that, for an arbitrary ring R, the class of all R-modules that are direct sums of $\aleph_0$-generated modules is closed under taking direct summands. This result was improved by Walker, who extended it to classes of λ-generated modules for certain infinite cardinals λ, and further, by Warfield, to classes of λ-small modules. In this presentation, we will give similar results for classes of objects in idempotent complete additive categories.

12:00 **Iulia-Cătălina Plești** (Universitatea Alexandru Ioan Cuza din Iași, Facultatea de Matematică)

Titlu: **Harmonic Mean of Element Orders in a Finite Group**

Îndrumător: Prof. Marius Tărnăuceanu

Abstract: In this talk, we begin by surveying different properties of functions of a finite group G ($\psi(G), \psi'(G), m(G)$, etc.). Afterwards, we list some properties of the newly introduced harmonic mean of element orders ($h_m(G) = \frac{|G|}{m(G)}$), study the preimage of $\mathbb{N}$ under h_m and give criteria for solvability, and super-solvability using h_m.

12:20 **Mihai Aron** (Universitatea Babeș-Bolyai, Facultatea de Matematică și Informatică)

Titlu: **Invariant Geometric Properties in Bubble Contraction During Fluid Infiltration Between Parallel Plates**

Îndrumător: Prof. Mirela Kohr

Abstract: The property of σ-superstarlikeness is invariant in the interior version of the Hele-Shaw flow problem for

$$\sigma \in \left[\frac{1}{2}, +\infty\right) \cup \bigcup_{n=1}^{\infty} \left[\frac{1}{4n+2}, \frac{1}{4n}\right].$$

This result was recently established by Aron in J. Math. Fluid Mech. In contrast, the invariance of starlikeness and strongly starlikeness (that is, σ-superstarlikeness for $\sigma \geq 1$) in the exterior Hele-Shaw problem was incorrectly claimed. We present a general geometric property, more general than the notion of starlikeness, which remains invariant in the exterior version of the Hele-Shaw flow problem. Specifically, the property of σ-superstarlikeness for

$$\sigma \in \bigcup_{n=1}^{\infty} \left[\frac{1}{4n}, \frac{1}{4n-2}\right]$$

is shown to be invariant in the exterior version of the Hele-Shaw problem.

12:40-13:00 Pauză

13:00 **Andrei Stoenică** (Universitatea București, Facultatea de Matematică și Informatică)

Titlu: **Unirationality of Bielliptic Loci**

Îndrumător: Prof. Marian Aprodu

Abstract: Bielliptic curves of genus g are double covers of genus 1 curves. Since they admit automorphisms, their isomorphism classes represent points in the singular locus of M_g, the moduli space of genus g curves. The bielliptic locus of M_g has been investigated before by Bardelli, Casnati and Del Centina and they have shown that it is rational for $g \leq 5$ and unirational for $g \geq 6$. In this talk, we present a stronger result in the case when $g \geq 11$, namely that the bielliptic locus of the Hilbert scheme of canonical curves in $\mathbb{P}^{g-1}$ is unirational. Then the unirationality of the bielliptic locus of M_g comes as an immediate consequence. This result is based on the description of canonical bielliptic curves as intersections between cones over elliptic normal curves and quadric hypersurfaces and the construction of a parameter space which reflects this structure. Afterwards, we present some future research directions.

13:20 **George-Bogdan-Alexandru Lung** (Universitatea Babeș-Bolyai, Facultatea de Matematică și Informatică)

Titlu: **Obiecte Rickart în Categorii Exacte**

Îndrumător: Prof. Septimiu Crivei

Abstract: Lucrarea urmărește studiul noțiunii de obiect Rickart în categorii exacte în sensul lui Quillen. Aceasta permite unificarea și generalizarea rezultatelor anterioare existente în literatura de specialitate asupra obiectelor Rickart din categorii abeliene și a obiectelor pur-Rickart din categorii Grothendieck. Rezultatele obținute se referă la proprietăți legate de sumanzi direcți și sume directe de obiecte Rickart în categorii exacte, respectiv la transferul proprietății Rickart prin anumite clase de functori.

13:40 **Lehel Csillag** (Universitatea Babeș-Bolyai, Facultatea de Fizică)

Titlu: **The Inverse Problem of Calculus of Variations of Autoparallels**

Îndrumător: Prof. Ladislau Nagy

Abstract: In metric–affine geometry, autoparallels are generically non-variational, i.e., they are not the extremals of any action integral. The existence of a parameter-invariant action principle for autoparallels is a long standing open problem, which is equivalent to the so-called Finsler metrizability of the connection – that is, to the fact that these autoparallels can be interpreted as Finsler geodesics.

In this article, we address this problem for the class of torsion-free affine connections with vectorial nonmetricity, which includes as notable subcases, Weyl and Schrödinger connections. For this class, we determine the necessary and sufficient conditions for the existence of a Finsler Lagrangian that metrizes the connection (and depends only algebraically on the metric and on the nonmetricity defining vector field). In the cases where such a Finsler Lagrangian exists, we construct it explicitly. In particular, we show that a broad class of such connections is in fact Finsler metrizable, i.e., the autoparallels of these connections are Finsler geodesics.

14:00 **Alexandru Pîrvuceanu** (Universitatea Babeș-Bolyai, Facultatea de Matematică și Informatică)

Titlu: **Rigidity Results for** $\mathsf{RCD}(0,N)$ **Spaces via Sharp Hypercontractivity Estimates**

Îndrumător: Prof. Alexandru Kristály

Abstract: In this talk, we present sharp hypercontractivity bounds for the heat flow on $\mathsf{RCD}(0,N)$ spaces and we completely characterise the equality case in these estimates. As applications of these results, we obtain an extension of Li's rigidity result, as well as almost rigidities of $\mathsf{RCD}(0,N)$ spaces. In the non-collapsed case, topological rigidities are also established. This is joint work with Shouhei Honda and Alexandru Kristály.

14:20-14:40 Pauză

14:40 **Călin-Daniel Spiridon** (Universitatea București, Facultatea de Matematică și Informatică)

Titlu: **Linear Sections of Grassmannians and Resonance of Vector Bundles**

Îndrumător: Prof. Marian Aprodu

Abstract: The varieties swept out by the projective lines corresponding to the points of linear sections of Grassmannians $\mathrm{Gr}(2,n)$ are called resonance varieties. Any vector bundle gives rise to a resonance in a natural way. We highlight some of the distinctive features of resonance loci associated with vector bundles, study the resonance of restricted universal quotient bundles and explore the role of transversality. We will also describe the resonance of rank-two bundles over the projective line and over an elliptic curve.

Joint work with Marian Aprodu.

15:00 **Robert Pop** (Universitatea Babeș-Bolyai, Facultatea de Matematică și Informatică)

Titlu: **Approximation Domains in Exact Categories**

Îndrumător: Prof. Septimiu Crivei

Abstract: Precover completing domains generalize subprojectivity domains in additive (exact) categories. This is the setting in which study objects having a minimal precover completing domain. We also give some closure properties for precover completing domains and derive applications to finitely accessible categories (in particular, to module categories).

15:20 **Andra-Maria Stoica** (Universitatea Lucian Blaga din Sibiu, Facultatea de Științe)

Titlu: **Wold-Type Decompositions and Quasi-Isometries on Hilbert Spaces**

Îndrumător: Prof. Laurian Suciu

Abstract: The classical Wold decomposition establishes that any isometry on a Hilbert space can be expressed as the orthogonal sum of a unitary operator and a unilateral shift, revealing a deep connection between probabilistic structures and the theory of linear operators. This framework has inspired the development of Wold-type decompositions, which extend the original idea to broader classes of left-invertible operators that are not necessarily isometries but exhibit similar structural behaviour. Such generalizations play a key role in understanding operators that are "close" to isometries, including quasi-isometries. In particular, quasi-isometries play an important role in the dilation theory of operators similar to contractions, providing a natural framework for extending classical results.

Moreover, analytic operators and those admitting Wold-type decompositions can often be transferred from an abstract Hilbert space setting to concrete functional models, commonly known as model spaces. This transition allows for a more explicit representation and facilitates deeper analysis.

In this talk, we focus on identifying necessary and sufficient conditions under which a quasi-isometry admits a Wold-type decomposition. In addition, we provide illustrative examples that highlight the applicability of the theoretical results and clarify the underlying structure.

15:40 **Miklós-József Laping** (Universitatea Babeș-Bolyai, Facultatea de Matematică și Informatică)

Titlu: **Computing Ringel–Hall Polynomials Using Parallel Algorithms**

Îndrumător: Conf. István Szöllősi

Abstract: Ringel–Hall polynomials play a central role at the intersection of representation theory, algebraic geometry, and combinatorics, forming a bridge between quiver representations and quantum groups. In the case of finite quivers, these polynomials encode the number of extensions between given representations, and their remarkable property is that they behave as polynomials (not merely integer-valued functions) in the size of the finite field, reflecting a deep underlying geometric structure. This polynomiality is exploited in the construction of the Ringel–Hall algebra, where the structure constants of the algebra are precisely given by the values of these polynomials evaluated over finite fields.

In the case of tame (Euclidean) quivers, this structure becomes particularly rich. Here, Ringel–Hall polynomials not only describe the composition series of indecomposable representations, but also encapsulate the essential combinatorics of the underlying Euclidean root system, linking them to other branches of mathematics such as quantum affine algebras, and the categorification of cluster algebras.

Despite their fundamental importance, relatively few explicit Ringel–Hall polynomials are known (in the Euclidean case). We are developing a computational tool (in the programming languages GAP, Rust, and C++, using OpenCL technology) that computes these polynomials via optimized parallel algorithms. Thanks to OpenCL, the computations can be executed in a scalable way on heterogeneous platforms (such as traditional CPUs, GPUs, etc.).

The tool can be used by researchers in representation theory to verify theoretical results or computations, and to formulate conjectures. The correctness of the system is validated by recomputing known Ringel–Hall polynomials (in some cases previously determined by theoretical methods), benchmarking performance, and we also compute some new polynomials.

16:00 Mini-Ceremonie de Închidere în Sala de Lectură