ALGEBRA, TOPOLOGY AND DYNAMICAL SYSTEMS

In honor of Dikran Dikranjan on the occasion of his 75th birthday
and in honor of Ivan Prodanov on the 90th anniversary of his birth

UDINE
JULY 28-30, 2025

Plenary speakers

Ivan Gotchev
Central Connecticut State University, USA

Michael Megrelishvili
Bar-Ilan University, Israel

Dekui Peng
Nanjing Normal University, China

Luigi Salce
University of Padova, Italy

Manuel Sanchis
University Jaume I, Castelló, Spain

Dmitri Shakhmatov
Ehime University, Matsuyama, Japan

Luchezar Stoyanov
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DIPARTIMENTO DI MATEMATICA E INFORMATICA

Algebra, Topology, and Dynamical Systems

A conference in honor of Dikran Dikranjan on the occasion of his 75th birthday and of Ivan Prodanov on the occasion of the 90th anniversary of his birth.

Book of Abstracts

July 2025

July 28			
Italy Time		Room T4: Auditorium	Room T5
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	11:10-11:45	Ivan Gotchev Cardinal inequalities for $S(n)$-spaces	
	11:50-12:25	Dekui Peng Cardinal Spectra	
	12:30-14:30	Lunch Break	
PM	14:30-14:50	F. Javier Trigos-Arrieta Sequentially barrelled groups	Ilaria Svampa Representations of the p-adic rotation group, towards p-adic quantum computing
	14:55-15:15	Lydia Außenhofer Reflexive group topologies on $\mathbb{Z}$	Serhii Bardyla Intrinsic topologies on groups
	15:20-15:40	Víctor Hugo Yañez No small subgroups vs no small normal subgroups	Evgenii Aleksandrovich Reznichenko Weight of convex compact sets and their boundaries
	15:45-16:15	Coffee Break	
	16:15-16:35	Pratulananda Das Statistically Characterized Subgroups: A Comparison Between Arithmetic and Non-Arithmetic Sequences	Carmelo Antonio Finocchiaro Topology and Prüfer domains
	16:40-17:00	Ayan Ghosh On topologically torsion elements and their subgroups corresponding to arithmetic-type sequences	Simone Virili A study of Sylvester rank functions via functor categories
	17:05-17:25	Tamim Aziz Topologically torsion elements of the circle group for arithmetic-type sequences (online)	Olga V Sipacheva Universal algebras with topology

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	12:40-14:30	Lunch Break	
	14:30-14:50	Thomas S Weigel The Euler Characteristic of a totally disconnected, locally compact group	Manoranjan Singha Compactness and Compactification from the statistical point of view
	14:55-15:15	Angel Calderón Hattori topologies on almost topological groups	Sima Roy Exploring topological properties using ideal structure
	15:20-15:40	Dimitrios N. Georgiou The existence of universal elements in new classes of mappings	Ujjal Kumar Hom Ideal Towards Exploring Piecewise Syndetic Sets
	15:45:16:05	Sergey Antonyan Free and based-free involutions	Raffaele di Santo Element-wise description of the $\mathcal{I}$-characterized subgroups of the circle
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	10:10-10:45	Michael Megrelishvili Key subgroups in the Polish group of all automorphisms of the rational circle (online)	
	10:50-11:20	Coffee Break	
	11:20-11:55	Luigi Salce Polyclones over valuation domains	
PM	12:00-12:35	Alberto Tonolo Periodic sequences	
	12:40-14:30	Lunch Break	
	14:30-14:50	Jerzy Kąkol On Asplund spaces $C_k(X)$ with the compact-open topology	Athanasios C. Megaritis A new poset of topologies
	14:55-15:15	Arkady Leiderman On the product of Weak Asplund locally convex spaces	Bryant Rosado Silva Generalized Ważewski dendrites, generic subcontinua, and generic chains
	15:20-15:40	Tadeusz Dobrowolski Schauder Fixed-Point Theorem – 95 years later	Albert Kubzdela Remarks on non-archimedean normed spaces
	15:45-16:15	Coffee Break	
	16:15-16:35	Vesko Valov Linear and uniformly continuous surjections between function spaces	Kyriakos Papadopoulos Natural vs. Artificial Topologies for a Relativistic Spacetime
	16:40-17:00	Nicolò Zava Dimension theory in the toolbox of a computational topologist: the case study of the Gromov-Hausdorff distance	Aura Lucina Kantún-Montiel Extensorial and Homotopic Properties for Almost Connected Groups (online)
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Main speakers

A short talk on Ivan Prodanov's work

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Cardinal inequalities for $S(n)$-spaces

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The $S(n)$-spaces, where n is a positive integer, were introduced in 1969 by Viglino who showed that for every n there is an $S(n)$-space which is not $S(n+1)$, and that there are spaces which are $S(n)$ for every n, but are not regular. We recall that the $S(1)$-spaces are exactly the Hausdorff spaces and $S(2)$-spaces are the Urysohn spaces.

In 1973, Porter and Votaw, extended Viglino's definition to every infinite ordinal number α and characterized the minimal $S(\alpha)$ and $S(\alpha)$-closed spaces, and in 1988, Dikranjan and Giuli characterized the $S(n)$-θ-closed spaces and Dikranjan, Giuli and Tholen proved that the category of $S(n)$-spaces is not cowellpowered for every $n > 1$.

In this talk we will show how by using new cardinal invariants defined specifically for $S(n)$-spaces, some well-known cardinal inequalities of Pospišil ($|X| \leq 2^{2^{d(X)}}$ and $|X| \leq d(X)^{\chi(X)}$), Hajnal and Juhász ($|X| \leq 2^{c(X)\chi(X)}$ and $|X| \leq 2^{2^{s(X)}}$), Arhangel'skiĭ ($|X| \leq d(X)^{bt(X)}$), and others, proved for Hausdorff spaces, could be sharpened for $S(n)$-spaces.

Key subgroups in the Polish group of all automorphisms of the rational circle

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Extending some results of a joint work with E. Glasner (2021), we continue to study the Polish group $G := \mathrm{Aut}(\mathbb{Q}_0)$ of all circular order preserving permutations of $\mathbb{Q}_0$ with the pointwise topology, where $\mathbb{Q}_0 = \mathbb{Q}/\mathbb{Z}$ is the rational discrete circle. We show that certain subgroups H of $G := \mathrm{Aut}(\mathbb{Q}_0)$ are *inj-key* (i.e., H distinguishes weaker Hausdorff group topologies on G) but not co-minimal in G. This counterexample answers a question from a recent joint work with M. Shlossberg (2025) and is inspired by a question proposed (during the conference: *Algebra, Topology and Their Interactions 2024*) by V. Pestov about Polish groups G with metrizable universal minimal G-flow $M(G)$. It is an open problem to study Pestov's question in its full generality. We are also going to discuss some additional open questions.

The following (algebraic, topological and dynamical) concepts are important in this project:

1. Key subgroups (as a new minimality condition in topological groups).
2. Circularly ordered dynamical G-systems.
3. Universal minimal dynamical G-systems $M(G)$.
4. Maximal G-compactifications of G-spaces.

References

[1] E. Glasner and M. Megrelishvili, *Circular orders, ultrahomogeneity and topological groups*, AMS Contemporary Math. book series **772** "Topology, Geometry, and Dynamics: Rokhlin-100" (ed.: A.M. Vershik, V.M. Buchstaber, A.V. Malyutin) 2021, pp. 133–154. ArXiv:1803.06583.

[2] M. Megrelishvili and M. Shlossberg, *Key subgroups in topological groups,* Forum Math. 2025, doi.org/10.1515/forum-2023-0418. ArXiv:2309.06785

[3] M. Megrelishvili, *Key subgroups in the Polish group of all automorphisms of the rational circle.* ArXiv:2410.17905

Cardinal Spectra

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Let P be a cardinal invariant of topological groups. We call the set

$$\{P(H) : H \text{ is a dense subgroup of } G\}$$

the *P-spectrum of dense subgroups* of G. We can also define the *P-spectrum of quotient groups* (subgroups, closed subgroups, etc.) in the obvious way.

This notion is inspired by the *double density spectrum* of a topological space defined by Juhász, van Mill, Soukup, and Szentmiklóssy.

We mainly discuss the density spectrum of dense subgroups and the weight spectrum of quotient groups in this talk. The main results are:

- For every compact group G, the density spectrum of dense subgroups is the interval $[d(G), w(G)]$.
- For every subset $E \subseteq [\omega, \mathfrak{c}]$ with $\sup E \in E$, there exists a precompact abelian group whose weight spectrum of quotient groups is E. Moreover, if $\omega \in E$, then the group can be chosen to be pseudocompact.

References

[1] I. Juhász, J. van Mill, L. Soukup, and Z. Szentmiklóssy, The double density spectrum of a topological space, *Israel J. Math.*, **255** (2023), 383–400.

[2] D. Peng, Densities and weights of quotients of precompact abelian groups, to appear in *Israel J. Math.*, available at arXiv:2211.06831v4.

Polyclones over valuation domains

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A clone over a valuation domain R is a divisible torsion uniserial module whose non-zero elements have principal annihilator. A clone is standard if it is isomorphic to Q/R, where Q is the field of fractions of R, otherwise it is non-standard.

A polyclone is an R-module M which is the union of a pure composition series $0 < M_1 < M_2 < \cdots < M_n = M$ whose composition factors M_{i+1}/M_i are clones. A crucial result for the study of polyclones is that $Ext^1_R(Q/R, U)$ is not zero for all clones U. We present a recent proof of this fact

obtained just using homological algebra and the structure of the semiring of polyclones equipped with the direct sum and the product induced by the functor Tor.

Fuzzy neural network interpolation operators

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We extend Cardaliaguet-Euvrard neural network operators to the context of fuzzy number valued continuous functions and study their behaviour. We focus on level continuous, sendograph continuous and endograph continuous functions and obtain Jackson-type results in all these cases.

Joint paper with J.J. Font and S. Macario

Algebraic structure of pseudocompact Abelian groups

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We give a complete description of the algebraic structure of Abelian groups which admit a pseudocompact Hausdorff group topology. This solves a major problem left open in [1].

This is a joint work with Dikran Dikranjan and Alejandro Dorantes-Aldama.

References

[1] D. N. Dikranjan, D. B. Shakhmatov, *Algebraic structure of pseudocompact groups*, Mem. Amer. Math. Soc. 133/633 (1998), 83 pages.

Some dynamical problems in inverse scattering by obstacles

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An obstacle in $\mathbb{R}^n$ is a compact subset of $\mathbb{R}^n$ with smooth boundary ∂K and connected complement $\Omega_K = \overline{\mathbb{R}^n \setminus K}$. By a scattering trajectory in Ω_K we mean the trajectory of a point moving with unit speed in the interior of Ω and reflecting at ∂K following the usual law of geometrical optics. These are just trajectories of the billiard flow in the co-sphere bundle $S^*(\Omega_K)$ of the exterior domain Ω_K. In scattering theory physicists consider as "observables" the singularities of the so called scattering matrix which are related to sojourn times of scattering trajectories in the exterior of the obstacle. A natural problem is then to recover information about the obstacle K from sojourn times. An equivalent and easier to state problem concerns travelling times of scattering trajectories. Let S_0 be a large sphere in $\mathbb{R}^n$ containing K in its interior. For any $x = (p, \xi)$, where $p \in S_0$ and ξ is a unit vector pointing "inside" the sphere, let $\gamma^+(x)$ be the scattering trajectory in Ω_K issued from p in direction ξ. Let $t(x)$ be the *travelling time* of x, i.e. the time it spends in S_0 "before going to infinity". It may happen that $t(x) = \infty$, this defines a "trapped trajectory". This talk is concerned with the following *General Inverse Problem:* Obtain information about the obstacle K from measurements of travelling times $t(x)$ of scattering trajectories $\gamma^+(x)$.

It turns out that some obstacles are completely recoverable from scattering data, however there are examples of obstacles that cannot be recovered. As one would expect, the dynamical system generated by the billiard flow in Ω_K plays an important role in this study. We will also discuss an analogue of the well-known Santalo's formula in geometry for billiard flows that turns out to be useful in dealing with the inverse scattering problem.

From infinite series in a normed vector space to infinite composites in a normed category

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We use elementary examples of sequential convergence from Calculus, Linear Algebra and Functional Analysis to motivate our notion of Cauchy sequence and its convergence in a category whose morphisms come with a norm in the sense of Lawvere [1, 1973]. This notion, as well as the naturally ensuing notion of Cauchy cocompleteness of a normed category, provide a common framework for the given examples, and beyond. For instance, the additive group of a normed vector space, viewed as a one-object (small) category, is Cauchy cocomplete precisely when the space is Banach. Much harder to show is the result that also the (large) category of all normed vector spaces (with norms allowed to be infinite) and their linear operators as morphisms, normed by the logarithm of its usual operator norm, is Cauchy cocomplete. Furthermore, as first indicated by Kubis [2, 2017], for a contractive endofunctor of a Cauchy cocomplete normed category, we prove a Banach Fixed Point Theorem that directly generalizes the classical metric result.

Our norms are allowed to take values in a (commutative and unital) quantale, rather than just in Lawvere's extended real half-line. This generalization not only increases the range of examples and applications, but also makes it easier to see the theory of normed categories as part of enriched category theory. In this way we can apply some powerful results from that theory in order to characterize Cauchy cocompleteness and establish Cauchy cocompletions of normed categories.

This talk is based on joint work with Maria Manuel Clementino and Dirk Hofmann [3, 2025].

References

[1] F.W. Lawvere. *Metric spaces, generalized logic, and closed categories.* Rendiconti del Seminario Matematico e Fisico di Milano **43**:135–166. **Republished in: Reprints in Theory and Applications of Categories 1**.

[2] W. Kubis. *Categories with norms.* arXiv:1705.10189v1 [math.CT]

[3] M.M. Clementino, D. Hofmann, W. Tholen. *Cauchy convergence in V-normed categories.* Advances in Mathematics **470**, 110247.

Periodic sequences

Alberto Tonolo

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Based on a joint paper with Luisa Fiorot and Riccardo Gilblas.

No prerequisites are required to attend this talk.

Through new recurrence relations for certain binomial coefficients modulo a power of a prime, we study the evolution of the iterated anti-differences of periodic sequences modulo an integer m. Thanks to our music applications, you can not only see but also hear our results.

Contributed speakers

Free and based-free involutions

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By a *space* we mean a separable metric space X. An involution is a continuous map $f : X \to X$ such that $f \circ f = Id_X$. An involution is called *free* if it has no fixed points, i.e., $f(x) \neq x$, $\forall x \in X$. An involution is called *based-free* if it has a unique fixed-point.

The main goal of this talk is to provide a brief summary of recent results on free and based free involutions, published in the papers [1] and [2].

For Hilbert space ℓ_2 we denote by σ the standard based-free involution $\sigma : \ell_2 \to \ell_2$ given by the formula $\sigma(x) = -x$. Let B denote the unit ball in ℓ_2, that is, $B := \{x \in \ell_2 \mid \|x\| \leq 1\}$.

We prove that for every space (X, τ) with a based-free involution, the equivariant maps $(X, \tau) \to (B, \sigma)$ separate points and closed sets in X. That is, given a closet set $A \subset X$ and a point $x \in X \setminus A$, there exists an equivariant map $f : (X, \tau) \to (B, \sigma)$ such that $f(x) \notin \overline{f(A)}$. Here, the equivariantness of f means that it commutes with the given involutions, i.e., $f(\tau(x)) = \sigma(f(x))$ for all $x \in X$.

This is applied to show that (ℓ_2, σ) is universal in the sense that for each space with a based-free involution τ, there exists an equivariant topological embedding $(X, \tau) \hookrightarrow (\ell_2, \sigma)$. Similarly, we prove that the unit sphere $\mathbb{S} = \{x \in \ell_2 \mid \|x\| = 1\}$, endowed with the standard free involution $x \mapsto -x$, is universal for all spaces X with a free involution $\tau : X \to X$. Another universal space with a free involution is the punctured Hilbert cube $[-1, 1]^\infty \setminus \{0\}$ endowed with the natural free involution $x \mapsto -x$.

We also investigate equivariant free and based-free compactifications and will present two new characterizations of based-free compactifications. It turns out that $\mathbb{S}$ has no free compactification, while ℓ_2 has no based-free compactification. We will explain why the countable product of real lines $\mathbb{R}^\infty$, endowed with the standard involution $x \mapsto -x$, is not universal for all based-free involutions. At the same time we will show that $\mathbb{R}^\infty$ is universal for those based-free involutions which admit a based-free compactification.

This is a joint work with Jan van Mill (University of Amsterdam, The Netherlands) and James E. West (Cornell University, USA).

References

[1] S. Antonyan, J. van Mill and J. West, *Based-free Involutions*, Topology Appl. (2025), to appear.

[2] J. van Mill and J. West, *Involutions of ℓ_2 and s with unique fixed points*, Trans. Amer. Math. Soc. 373, no. 10 (2020), 7327-7346.

Reflexive group topologies on $\mathbb{Z}$

Lydia Außenhofer

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A strictly increasing sequence $\mathbf{b} = (b_n)_{n\in\mathbb{N}_0}$ of natural numbers is called a D-sequence, if $b_0 = 1$ and if b_n divides b_{n+1} for every $n \in \mathbb{N}$. There exists a finest group topology $T_{\mathbf{b}}$ on $\mathbb{Z}$ in which (b_n) converges to 0. We characterize those D-sequences $\mathbf{b}$ in $\mathbb{Z}$ for which $(\mathbb{Z}, T_{\mathbf{b}})$ is reflexive and show that for every D-sequence $\mathbf{b}$ the character group of $(\mathbb{Z}, T_{\mathbf{b}})$ is reflexive.

Topologically torsion elements of the circle group for arithmetic-type sequences

Tamim Aziz

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A subgroup H of the circle group $\mathbb{T}$ is called characterized by a sequence of integers (u_n) if $H = \{x \in \mathbb{T} : \lim_{n\to\infty} u_n x = 0\}$, denoted by $t_{(u_n)}(\mathbb{T})$ whereas the elements of $t_{(u_n)}(\mathbb{T})$ are called topologically torsion elements (corresponding to the sequence (u_n)). In this article, we primarily consider a class of sequences which can be extracted from a given arithmetic sequence (we call these extracted sequences "arithmetic-type" sequences) and investigate the corresponding characterized subgroups thoroughly. The primary result of this article is the characterization of topologically torsion elements corresponding to an "arithmetic-type" sequence and thus generalizing the main result of [Dikranjan et al., Comm. Alg. 42 : 600-614, 2014; namely Theorem 2.3] where the characterization of topologically torsion elements for a given arithmetic sequence was established. It is important to note that in the literature there has not been any characterization result for non-arithmetic sequences. This consequently helps us to understand certain cardinality aspects of the characterized subgroups characterized by arithmetic-type sequences all of which happen to be contained in the characterized subgroup characterized by the generating arithmetic sequence.

Intrinsic topologies on groups

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In this talk, we shall discuss intrinsic topologies on groups. In particular, various Zariski topologies generated by certain families of (semi)group polynomials as well as the Markov topology and its

semigroup counterparts. We shall answer several questions by Dikranjan, Elliott, Mitchell, Peresse, Toller et al., and complement results of Banakh, Goffer, Greenfeld, Guran and Protasov.

Hattori topologies on almost topological groups

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In 2010, Hattori defined a family of topologies on $\mathbb{R}$, between the usual topology on $\mathbb{R}$ and the Sorgenfrey line topology. In this talk, we define Hattori spaces $H(A)$ on almost topological groups and study the behavior of some topological properties on Hattori spaces.

Statistically Characterized Subgroups: A Comparison Between Arithmetic and Non-Arithmetic Sequences

Pratulananda Das

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Very recently, characterized subgroups associated with certain non-arithmetic sequences were studied in [Das et al., Mediterr. J. Math. 21:164, 2024]. On the other hand, statistically characterized subgroups introduced as a non-trivial generalization of characterized subgroups have been primarily explored in the context of arithmetic sequences [Dikranjan et al., Fund. Math. 249:185 - 209, 2020]. This naturally leads to the question of how such subgroups behave when defined via non-arithmetic sequences, which is the focus of the present work.

Our investigation reveals that statistically characterized subgroups corresponding to these non-arithmetic sequences are mostly larger in size, typically of cardinality c, and exhibit properties markedly distinct from those of classical characterized subgroups. In particular, it was shown in [Das et al., Bull. Sci. Math., 103157, 2022] that for arithmetic sequences, statistically characterized subgroups are never characterizable. However, by employing certain non-arithmetic sequences, we construct for the first time, a countable (and hence characterizable) statistically characterized subgroup.

Some of the results presented in this talk have been published in Expositiones Mathematicae (2025)

Element-wise description of the $\mathcal{I}$-characterized subgroups of the circle

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According to Cartan, given an ideal $\mathcal{I}$ of $\mathbb{N}$, a sequence $(x_n)_{n\in\mathbb{N}}$ in the circle group $\mathbb{T}$ is said to *$\mathcal{I}$-converge* to a point $x \in \mathbb{T}$ if $\{n \in \mathbb{N} : x_n \notin U\} \in \mathcal{I}$ for every neighborhood U of x in $\mathbb{T}$. For a sequence $\mathbf{u} = (u_n)_{n\in\mathbb{N}}$ in $\mathbb{Z}$, let

$$t_{\mathbf{u}}^{\mathcal{I}}(\mathbb{T}) := \{x \in \mathbb{T} : u_n x \ \mathcal{I}\text{-converges to } 0\}.$$

This set is a subgroup of $\mathbb{T}$ with many nice properties, largely studied in the case when $\mathcal{I} = \mathcal{F}in$ is the ideal of all finite subsets of $\mathbb{N}$ (so $\mathcal{F}in$-convergence coincides with the usual one). We give a complete element-wise description of $t_{\mathbf{u}}^{\mathcal{I}}(\mathbb{T})$ when $u_n \mid u_{n+1}$ for every $n \in \mathbb{N}$ and under suitable hypotheses on $\mathcal{I}$. In the special case when $\mathcal{I} = \mathcal{F}in$, we obtain an alternative proof of a simplified version of a known result from [4].

References

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Schauder Fixed-Point Theorem – 95 years later

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In 1930, J. Schauder claimed the fixed-point property of convex compacta in metric linear spaces. Surprisingly, in 1935, he posted a question of whether that claim held. Contemporary, Schauder's claim is referred to as Schauder Conjecture. I will provide a list of false calls on settling the conjecture that I am aware of. Fixed-point vs absolute retract property of convex compacta will be emphasized.

I will concentrate on numerous recent attempts to prove the conjecture via p-convexity, $0 < p < 1$. Also, I will sketch major steps in Cauty's approach published in Serdica Math. J. that are relevant to the case of convex compacta.

Regretfully, I can't say that the conjecture has been settled.

Topology and Prüfer domains

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Prime spectra and abstract Riemann surfaces of valuation domains play a central role in commutative algebra: they are often helpful in describing classes of integral domains and their ideals in topological terms. The aim of this talk is provide some recent developments regarding the use of such spaces in studying Prüfer domains. **Joint work with Alan Loper**.

The existence of universal elements in new classes of mappings.

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In [1, 2] S.D. Iliadis introduced the notion of a universal mapping for a given class of continuous mappings and proved the existence of universal elements for many classes of mappings. In this paper, we give a special interest to this investigation of universal elements. Especially, we study the existence of universal elements in several new classes of continuous mappings which are determined by types of open mappings.

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On topologically torsion elements and their subgroups corresponding to arithmetic-type sequences

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An element x of the circle group $\mathbb{T}$ is said to be topologically torsion with respect to a sequence of integers (u_n) if $\lim_{n\to\infty} u_n x = 0_{\mathbb{T}}$. The most well-established results concerning such elements are primarily associated with arithmetic sequences.

In this study, we extend the investigation to arithmetic-type sequences, conducting a comprehensive analysis of these elements and their corresponding characterized subgroups, with particular attention to their cardinality aspects. Since arithmetic sequences constitute a special subclass of arithmetic-type sequences, our findings provide a more generalized framework, unveiling broader structural properties that encompass and refine several intriguing results known for arithmetic sequences.

Ideal Towards Exploring Piecewise Syndetic Sets

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The Stone-Čech compactification is the largest/maximal compactification of a Tychonoff space. For a discrete space, the Stone-Čech compactification may be revealed as the set of ultrafilters on that space identifying elements of the discrete space with principal ultrafilters. Further, any semigroup operation on a discrete space can be elegantly extended to the space of ultrafilters which makes it a compact right topological semigroup possessing the discrete semigroup in its topological center. This phenomenon provides an excellent synthesis of algebra and topology that has many fascinating applications in Ramsey theory as well as in topological dynamics involving various notions of sets such as IP sets, piecewise syndetic sets, central sets etc. of a discrete semigroup.

This talk will cover an array of visualizations of ultrafilters belonging to the smallest two-sided ideal of the Stone-Čech compactification of a discrete semigroup in terms of variants of central sets. Indeed, each arrangement of the array will bloom a representation of piecewise syndetic sets. Moreover, a characterization of piecewise syndetic sets is exhibited in the framework of topological dynamical system, highlighting the utility of ultrafilter attributes. As there is a one-to-one corresponding between non-empty closed subsets of Stone-Čech compactification of a discrete semigroup and filters on that semigroup, the discussion is concluded by exploring the aforesaid results in the ambiance of filters.

On Asplund spaces $C_k(X)$ with the compact-open topology

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A famous theorem of Namioka and Phelps says that for a compact space X, the Banach space $C(X)$ is Asplund iff X is scattered. We extend this result to the space $C_k(X)$ of continuous real-valued functions endowed with the compact-open topology for several natural classes of non-compact Tychonoff spaces X. The concept of Δ_1-spaces recently introduced will be used for this research.

Extensorial and Homotopic Properties for Almost Connected Groups

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In this talk we will focus on the equivariant homotopy theory, dealing with the homotopic properties of G-spaces, which are topological spaces equipped with a continuous action of a topological group G. A G-fibrant space is the equivariant version of a fibrant space in the sense of F. Cathey [4], that is to say, a G-fibrant space is a G-space with the extension property with respect to G-$SSDR$-maps.

As well as in the non-equivariant case, G-fibrant spaces constitute a generalization of equivariant Absolute Neighborhood Extensors (G-ANE). That equivariant version was introduced in [2] by A. Bykov and M. Texis in order to construct the equivariant strong shape category (G-$sSh\mathcal{CM}$) [3], where G is a compact group, and proved that all compact metrizable groups are G-fibrant spaces.

Due to the extensorial properties for almost connected group actions presented in [1], we can extend the G-$sSh\mathcal{CM}$ category to the non-compact case and show that the natural projections of almost connected groups are strong G-fibrations and, as a consequence, locally compact almost connected groups are G-fibrant spaces as well.

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Remarks on non-archimedean normed spaces

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The field of p-adic numbers, the non-Archimedean completion of $\mathbb{Q}_p$ appears in a natural way, as the Archimedean completion $\mathbb{R}$ of $\mathbb{Q}$. This fact motivates the study of normed spaces defined over non-Archimedean fields. Some properties of non-Archimedean Banach spaces will be presented and discussed.

On the product of Weak Asplund locally convex spaces

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The classical Mazur's theorem in modern terms states that every separable Banach space is Weakly Asplund.

For locally convex spaces, we systematize several known equivalent definitions of Fréchet (Gâteaux) Differentiability Spaces and Asplund (Weak Asplund) Spaces. As an application, we extend the Mazur's theorem as follows:

Theorem 1. Let E be a separable Baire locally convex space and let Y be the product $\prod_{\alpha\in A} E_\alpha$ of any family of separable Fréchet spaces; then the product $E \times Y$ is Weak Asplund.

Also, we prove

Theorem 2. The product Y of any family of Banach spaces (E_α) is an Asplund locally convex space if and only if each E_α is Asplund.

Analogues of both results are valid under the same assumptions, if Y is the Σ-product of any family (E_α).

This is joint work with Jerzy Kakol.

A new poset of topologies

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The family $\mathcal{T}(X)$ of all topologies on a given set X, partially ordered by set inclusion, is a complete lattice in which the meet of a collection of topologies is their intersection and the join is the topology with their union as a subbase. In this talk, we first introduce a new partial order on $\mathcal{T}(X)$ and then we investigate some natural questions about the structure of this poset of topologies.

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Natural vs. Artificial Topologies for a Relativistic Spacetime

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Consider a set M equipped with a structure $*$. We call a natural topology T_*, on $(M, *)$, the topology induced by $*$. For example, a natural topology for a metric space (X, d) is a topology T_d induced by the metric d and for a linearly ordered set $(X, <)$ a natural topology should be the topology $T_<$ that is induced by the order $<$. This fundamental property, for a topology to be called "natural", has been largely ignored while studying topological properties of spacetime manifolds (M, g) where g is the Lorentz "metric", and the manifold topology T_M has been used as a natural topology, ignoring the spacetime "metric" g.

In this survey we review critically candidate topologies for a relativistic spacetime manifold, we pose open questions and conjectures with the aim to establish a complete guide on the latest results in the field, and give the foundations for future discussions.

We discuss the criticism against the manifold topology, a criticism that was initiated by people like Zeeman, Goebel, Hawking-King-McCarthy and others, and we examine what should be meant by the term "natural topology" for a spacetime. Since the common criticism against spacetime topologies, other than the manifold topology, claims that there has not been established yet a physical theory to justify such topologies, we give examples of seemingly physical phenomena, under the manifold topology, which are actually purely effects depending on the choice of the topology; the Limit Curve Theorem, which is linked to singularity theorems in general relativity, and the Theorem of Gao-Wald type of "time dilation" are such examples.

Weight of convex compact sets and their boundaries

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The boundary of a convex compact set K is a set $B \subset K$ such that any continuous affine function on K attains a maximum on B. The set of extreme points is the boundary. It has been proved that if some boundary B of a convex compact subset K of a locally convex linear space has a countable network, then the convex compact set K is metrizable.

R. Haydon proved this statement in 1976 for the case when B is a set of extreme points. J. Spurnỳ proved this statement in 2010 for the case when B is a separable metrizable space.

If the boundary B is a Lindelof Σ-space, then the network weight $nw(B)$ of the boundary K coincides with the weight $w(K)$ of the convex compact set K.

Generalized Ważewski dendrites, generic subcontinua, and generic chains

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We say that a continuum X is a hereditarily equivalent continuum if every non-degenerate subcontinuum of it is homeomorphic to X. This concept is one of the main motivations behind the construction of the pseudo-arc. If considered in the hyperspace of continua of X, denoted by $\mathrm{Cont}(X)$, it means that

$$\mathrm{Cont}(X) \setminus \mathrm{Fin}(X) = \{K \in \mathrm{Cont}(X) \mid K \simeq X\}.$$

This is an open and dense set, hence comeager. Therefore, it is natural to ask if there exist other spaces that satisfy this weaker property of having such a collection of homeomorphic sets being comeager. We call these spaces generically hereditarily equivalent continua and have shown that the generalized Ważewski dendrites W_M for $M \subseteq \{3, 4, \ldots, \infty\}$ are such spaces. Moreover, in the hyperspace of maximal order arcs of W_M - $\mathrm{MOA}(W_M)$, the chains having every non-degenerate element homeomorphic to W_M make a comeager subset of the maximal order arcs.

Additionally, we consider the action of the homeomorphism group $\mathrm{Homeo}(W_M)$ on $\mathrm{Cont}(X)$ and on $\mathrm{MOA}(W_M)$ and describe a comeager orbit for each of them.

Exploring topological properties using ideal structure

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In the realm of general topology, ideal has opened a new horizon. The year 2000 saw the raise of ideal convergence which was a generalization of usual convergence. Ideal convergence sheds light on limit points of functions, closure operator, continuity, compactness etc. The notions of $\mathcal{I}$-Fréchet compactness and $\mathcal{I}^{\mathcal{K}}$-Fréchet compactness are introduced via ideals $\mathcal{I}$, $\mathcal{K}$ of subsets of a non-empty set and $\mathcal{I}$-nonthin function. It has been seen that, in first countable T_1 spaces Fréchet compactness and $\mathcal{I}$-Fréchet compactness are equivalent. A family of ideals has been established for which $\mathcal{I}$-Fréchet compactness coincides with $\mathcal{I}^{\mathcal{K}}$-Fréchet compactness. The concepts of $\mathcal{I}$-functionally compactness and $\mathcal{I}^{\mathcal{K}}$-functionally compactness are introduced in the context of ideals $\mathcal{I}$, $\mathcal{K}$ of subsets of a non-empty set and $\mathcal{I}$-nonthin function and showed that these are different from compactness even in metric spaces. The relation between the aforementioned compactness with usual compactness are explored by using the class of ideals.

Compactness and Compactification from the statistical point of view

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The concept of statistical convergence was conceived in the mind of H. Fast, which is a generalization of usual convergence of sequence from statistical point of view based on natural density of subsets of natural numbers. Then a number of mathematicians like A. Caserta, L.D.R. Kočinac, J. Connor, J. Kline, G. Di Maio, J.A. Fridy, H.I. Miller, M.K. Khan, C. Orhan, P. Das etc. extended this research area by passing one of the important properties namely smallness or compactness properties of topological spaces; actually the way for looking into subsequence could not provide anything new in this regard. A way of thinking about convergence of subsequence is found and seen that it is consistent with the usual one that enable to establish a notion of compactness which is not even equivalent to the usual compactness of metric spaces. Blended change have been seen while developing the theory of statistical compactness. A realization of statistical compactness as an application of Cantor-Bendixson derivative is presented in Euclidean spaces $\mathbb{R}^n$ and subsequently extended to the product space $\mathbb{R}^\omega$.

The notions of I-compactness and I*-compactness are introduced via ideal I on N and I-nonthin subsequences, and their continuous image, hereditary property, productive property are discussed. Corelations between the said compactness and their relation with usual compactness are exhibited under some conditions namely shrinking conditions on I. The discussion is continued towards I-US spaces and I-sequential spaces. Various properties I-continuous functions and I-proper maps are displayed. One point I-compactification of a topological space is revealed via the radiant of an ideal

on N. A class of ideals has been identified for which one point I-compactification of a metrizable space coincides with usual one point compactification of that space.

Universal algebras with topology

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A universal algebra, or simply an algebra, is a nonempty set together with arbitrarily many operations (of finite arity). A topological (quasi-topological) algebra is an algebra endowed with a topology with respect to which all operations are continuous (respectively, separately continuous). Classes of (topological, quasi-topological) algebras closed with respect to the formation of subalgebras, products, and quotients are called varieties. A variety of all topological (quasi-topological) algebras whose underlying abstract algebras (that is, the same algebras without topology) belong to a given variety of abstract algebras is said to be full. In any variety of topological or quasi-topological algebras, the free topological algebra of any nonempty topological space is uniquely defined.

By a topological quotient of an algebra A with a topology we mean a homomorphic image of A endowed with the quotient topology. It is proved that any topological quotient of a quasi-topological algebra is a quasi-topological algebra, i.e., all operations are separately continuous with respect to the quotient topology. An example showing that this is not so in the case of topological algebras is given. Sufficient conditions on a variety of topological algebras under which any topological quotient of any algebra in this variety is a topological algebra are presented.

It is shown that properties of free quasi-topological algebras are nicer than those of free topological algebras in many respects. In particular, the free quasi-topological algebras $F(X)$ of spaces X in full varieties of quasi-topological have the following features distinguishing them from free topological algebras:

(i) the quasi-topological algebra $F(X)$ of any space X is the inductive limit of its subspaces $F_n(X)$ of words of length at most n (defined in a standard natural way);

(ii) if the number of operations is finite and X is Tychonoff, then the subalgebra of $F(X)$ generated by any closed subspace Y of X is topologically isomorphic to $F(Y)$;

(iii) the quasi-topological algebra $F(X)$ of any space X is a topological quotient of the absolutely free quasi-topological algebra (that is, the algebra of words) $W(X)$ over the signature of the variety under consideration.

Embeddings of topological spaces in their free topological and quasi-topological algebras, as well as separation axioms in such algebras, are also considered.

Representations of the p-adic rotation group, towards p-adic quantum computing

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We investigate the structure of the p-adic rotation group $\mathrm{SO}(3)_p$, and initiate a program aimed at classifying its finite-dimensional irreducible projective unitary representations. Our approach relies on the profinite nature of $\mathrm{SO}(3)_p$, together with its Haar measure. These representations can be interpreted as a theory of p-adic angular momentum and spin, where the p-adic qubit arises as a two-dimensional representation. Indeed, p-adic numbers find fruitful applications in p-adic formulations of quantum mechanics, and in dynamical systems, where their ultrametric topology naturally models hierarchical and fractal-like structures.

We describe the foundations of our program, starting from the main features of $\mathrm{SO}(3)_p$ (in parallel to its real counterpart), such as a p-adic analogue of the Cardano (aka nautical) angles decomposition. We characterise the profinite group $\mathrm{SO}(3)_p$ as an inverse limit of the inverse family of groups $\mathrm{SO}(3)_p$ modulo p^n, and we exploit the inverse-limit machinery to express the Haar measure on $\mathrm{SO}(3)_p$ and to induce its representations. In fact, as a key result, we show that all finite-dimensional projective unitary representations of $\mathrm{SO}(3)_p$ factorise on some $\mathrm{SO}(3)_p$ modulo p^n, and we find explicit p-adic qubit representations for every prime p.

As an application, in the realm of quantum computing, we outline how these representations can be used to define algebraic operations on qubits. In particular, we propose to construct p-adically controlled quantum logic gates on the single-, two- and n-qubit levels, using elements from the same 2^n-dimensional unitary representations of $\mathrm{SO}(3)_p$. The main focus is placed on the four-dimensional representations, with the ultimate aim to provide a universal set of gates.

(Based on arXiv:2104.06228, arXiv:2306.07110, arXiv:2401.14298, and arXiv:2112.03362)

Sequentially barrelled groups

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A topological group G with character group $G^\wedge$ is said to be *sequentially barrelled* if every sequence in $G^\wedge$ converging pointwise is equicontinuous on G. In this talk we present some new results, comparing this concept with related ones.

Joint work with Lydia Außenhofer and Elena Martín-Peinador.

Linear and uniformly continuous surjections between function spaces

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We show that some topological properties are preserved by linear continuous or uniformly continuous surjections between function spaces with the pointwise topology. For example, zero-dimensionality is such a property which provides a positive answer raised by Kawamura and Leiderman.

A study of Sylvester rank functions via functor categories

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Given a ring R, a Sylvester rank function on the category of finitely presented right R-modules is an isomorphism-invariant function which is additive on coproducts, subadditive on right-exact sequences, monotone on quotients, and taking the value 1 on R.

In this talk I will start by observing that any Sylvester rank function can be uniquely extended to a so-called length function on the category of functors from finitely presented left R-modules to Abelian groups. This enlargement of the setting comes with many advantages and, to illustrate this, I will provide examples of results about rank functions whose initial proofs are technically demanding, yet can be derived almost effortlessly within the expanded framework.

The Euler Characteristic of a totally disconnected, locally compact group

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(joint work with Ilaria Castellano and Gianmarco Chinello)

For a unimodular totally-disconnected, locally compact (=t.d.l.c.) group G it is possible to define a Hattori-Stallings rank for every finitely generated, rational discrete, projective left G-module. Thus using the standard techniques in homological algebra, one may define an Euler characteristic χ_G for every unimodular t.d.l.c. group G which is of type FP, i.e., the trivial left G-module $\mathbb{Q}$ admits a finite and finitely generated projective resolution in the category of rational discrete left G-modules.

The intention is to present some recent results and open problems concerning the Euler characteristic of t.d.l.c. groups.

No small subgroups vs no small normal subgroups

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A topological group G is said to have *no small subgroup* (resp. *no small normal subgroup*) if it admits an open neighbourhood of the identity containing no non-trivial subgroup (resp. *normal subgroup*) of G. These properties are usually denoted by NSS (and respectively NSnS). The NSS property plays an important historical role in the solution to the fifth problem of Hilbert due to Gleason, Montgomery-Zippin and Yamabe for the characterization of Lie groups.

In this talk we present an example of a free group (with countably infinitely many generators) which is NSnS (through *topological simplicity*), but which admits no non-trivial continuous homomorphism to NSS groups; showing a very strong contrast between both properties.

Dimension theory in the toolbox of a computational topologist: the case study of the Gromov-Hausdorff distance

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In topological data analysis (TDA), datasets are often summarised through topological signatures—compact descriptors capturing features such as connected components or holes. These signatures are typically embedded into Hilbert spaces for statistical analysis or low-dimensional visualisation. However, such embeddings may inherently distort the geometry of the space of signatures. Over the past decade, tools from dimension theory have been developed to study the complexity of these signature spaces and to quantify the intrinsic limitations of such representations.

In this talk, we explore the role of dimension theory—specifically, topological, Assouad, and asymptotic dimensions—in studying the space of compact metric spaces equipped with the Gromov–Hausdorff distance. This distance, which quantifies how far two metric spaces are from being isometric, serves as a foundational notion in shape comparison and the theoretical underpinnings of computational topology. We present recent results on the dimension of this space and discuss their implications in computational topology.