

Research Workshop of the Israel Science Foundation

Geometric Topology and Geometry of Banach Spaces

EILAT, May 14–19, 2017

Eilat Campus of Ben-Gurion University of the Negev, ISRAEL

Center for Advanced Studies in Mathematics,
Department of Mathematics

The workshop is sponsored by the **Israel Science Foundation** and
Center for Advanced Studies in Mathematics,
Ben-Gurion University of the Negev, Beer-Sheva, Israel

*Additional support by the Department of Mathematics of the University of Milano, Italy and BGU
President, Rector and Dean of the Faculty of Natural Sciences*

Contents

Registration	3
General Program	3
Parallel Sessions	5
Abstracts of Plenary Lectures	7
Spiros Argyros, <i>The space $\mathcal{L}(\mathfrak{X})$ for certain Banach spaces</i>	7
Alexander Dranishnikov, <i>On complements of compact sets in the Hilbert cube</i>	7
Jerzy Dydak, <i>Variants of decomposition complexity in coarse geometry</i>	7
Michael Farber, <i>Topology of large random spaces</i>	8
Steve Ferry, <i>An infinite-dimensional phenomenon in finite-dimensional topology</i>	8
Vladimir Fonf, <i>On operator ranges</i>	8
Vitali Milman, <i>"Irrational" Convexity</i>	9
Gideon Schechtman, <i>Obstructions to embeddability of metric spaces in L_p spaces</i>	9
Abstracts of Regular Talks	10
Kyle Austin, <i>Second Countable Approximation of Locally Compact Groupoids and an Application to Disintegration Theorems for Fell Bundles</i>	10
Taras Banach, <i>Topological spaces with an ω^ω-base</i>	10
Michael Brandenbursky, <i>Bi-invariant metrics on diffeomorphism groups</i>	11
Jesús Castillo, <i>Polyhedral excuses</i>	11
Matija Cencelj, <i>Gropes and their fundamental groups</i>	11
Udayan B. Darji, <i>Topological transitivity and mixing of the composition operator on L^p spaces</i>	12
Carlo Alberto De Bernardi, <i>Extreme points in polyhedral Banach spaces</i>	12
Robert Deville, <i>Self contracted curves on Riemannian manifolds</i>	12
Tadeusz Dobrowolski, <i>Making an F-space from an incomplete normed space</i>	13
Marian Fabian, <i>Non-separable Banach spaces studied via projectional skeletons and "rich" families of their separable subspaces</i>	13
Saak Gabrielyan, <i>The Ascoli property for locally convex spaces</i>	14
Boris Goldfarb, <i>Fibred finite asymptotic dimension and assembly maps</i>	14
Petr Hájek, <i>Coarse embeddings into $c_0(\Gamma)$</i>	14
Stavros Iliadis, <i>On homomorphisms of topological groups</i>	15
Jerzy Kąkol, <i>Separable quotient problem for spaces $C_p(K)$ over compact spaces K</i>	15
Tomasz Kania, <i>Separated subsets in the unit sphere of a Banach space</i>	16
Kazuhiro Kawamura, <i>Banach-Stone type theorem for C^1-function spaces over Riemannian manifolds</i>	16
James Keesling, <i>Generalized Covering Spaces</i>	16
Akira Koyama, <i>Homological properties of decomposition spaces</i>	17

Michael Levin, <i>A counterexample in Extension Theory</i>	17
Olga Maleva, <i>Where can real-valued Lipschitz functions on \mathbb{R}^n be non-differentiable?</i>	18
Vlasta Matijević, <i>On group structures on covering spaces over groups</i>	18
Sergey A. Melikhov, <i>Infinite-dimensional uniform polyhedra and classifying spaces of 0-dimensional groups</i>	19
Enrico Miglierina, <i>Separable Lindenstrauss spaces whose duals lack the weak* fixed point property for nonexpansive mappings</i>	19
Atish J. Mitra, <i>Extension Theory in Large Scale Geometry</i>	20
Pavlos Motakis, <i>Spaces of compact diagonal operators as Calkin algebras of Banach spaces</i>	20
Alexander Nabutovsky, <i>Balanced Presentations of the Trivial Group and Geometry of 4-Dimensional Manifolds</i>	21
Matěj Novotný, <i>On stability of Lipschitz functions on $c_0(\Gamma)$</i>	21
Eve Oja, <i>Principle of local reflexivity which respects nests of subspaces, and the nest approximation properties</i>	21
Tanmoy Paul, <i>Some recent development on proximality in Banach spaces</i>	22
Petar Pavešić, <i>Free topological groups and functorial fibrewise constructions</i>	22
Matias Raja, <i>Szlenk indices, variations, applications and problems</i>	22
Martin Rmoutil, <i>Recovering a Compact Hausdorff Space X from the Compatibility Ordering on $C(X)$</i>	23
Regina Rotman, <i>Width of the homotopy and the length of a shortest geodesic</i>	23
Leonard R. Rubin, <i>Simplicial Inverse Sequences in Extension Theory</i>	24
Pavel V. Semenov, <i>Splittings and selections</i>	24
Evgeny Shchepin, <i>On the convexity of Chebyshev sets</i>	25
Ol'ga V. Sipacheva, <i>Large and Discrete Sets in Countable Topological Groups</i>	26
Richard Smith, <i>Boundaries, polyhedrality and smoothness</i>	27
Jacopo Somaglia, <i>Retractional skeletons on trees</i>	27
Stanisław Spież, <i>Coincidence class for several maps</i>	27
Tulsi Srinivasan, <i>The Lusternik-Schnirelmann category of general spaces</i>	28
Pedro Tradacete, <i>Weakly compact subsets of $C[0, 1]$ and reflexive Banach lattices</i>	28
Stanimir Troyanski, <i>Strongly Extreme Points and Approximation Properties</i>	28
Jan van Mill, <i>Homogeneity of Erdős type space</i>	29
Žiga Virk, <i>Coarse dimension raising results</i>	29
Michael Zarichnyi, <i>Asymptotic dimensions related to some control functions</i>	29
Accommodation, transportation, meals, banking, electricity, internet	31
Excursion and Conference Dinner	32

Registration

Sunday, May 14

15:00 - 16:00 Hotel Adi

Monday, May 15

08:00 - 08:30 Hotel Adi

The conference will take place at Eilat Campus of Ben-Gurion University of the Negev. The opening session and Plenary Lectures will take place in Auditorium. All talks in section of Geometry of Banach Spaces take place in room N 122. All talks in section of Geometric Topology take place in room N 123.

General Program

Day One — Sunday, May 14

Opening (**Chair:** Michael Lin)

16:15 - 16:45 coffee break

16:45 - 16:50 Opening by Michael Lin

16:50 - 17:10 Clemente Zanco, *Vladimir Fonf's contributions*

17:15 - 17:55 **Plenary lecture:** Vladimir Fonf,
On operator ranges

18:00 - 18:50 **Plenary lecture:** Jerzy Dydak,
Variants of decomposition complexity in coarse geometry

19:00 bus to hotel

Day Two — Monday, May 15

Morning session (**Chair:** Vitali Milman)

09:00 - 09:50 **Plenary lecture:** Gideon Schechtman,
Obstructions to embeddability of metric spaces in L_p spaces

10:00 - 10:40 Session talk in 2 parallel sections

10:45 - 11:15 coffee break

11:15 - 11:55, 12:00 - 12:40 Session talks in 2 parallel sections

12:45 - 14:30 lunch break

Day Two — Monday, May 15

Afternoon session (**Chair:** Jerzy Dydak)

14:30 - 15:20 **Plenary lecture:** Alexander Dranishnikov,
On complements of compact sets in the Hilbert cube

15:30 - 16:10 Session talk in 2 parallel sections

16:15 - 16:45 coffee break

16:45 - 17:25, 17:30 - 18:10 Session talks in 2 parallel sections

18:20 bus to hotel

Day Three — Tuesday, May 16

09:00 - 12:45 Morning session

09:00 - 09:30, 09:35 - 10:05, 10:10 - 10:40 Session talks in 2 parallel sections

10:45 - 11:15 coffee break

11:15 - 11:45, 11:50 - 12:20 Session talks in 2 parallel sections

12:25 - 12:45 Session talk in the section of Geometric Topology

12:45 - 14:30 lunch break

14:30 - 19:00 Excursion (bus leaves hotel at 14:10, and the campus at 14:30)

Day Four — Wednesday, May 17

Morning session (**Chair:** Vladimir Fonf)

09:00 - 09:50 **Plenary lecture:** Vitali Milman,
"Irrational" Convexity

10:00 - 10:40 Session talk in 2 parallel sections

10:45 - 11:15 coffee break

11:15 - 11:55, 12:00 - 12:40 Session talks in 2 parallel sections

12:45 - 14:30 lunch break

Afternoon session (**Chair:** Alexander Dranishnikov)

14:30 - 15:20 **Plenary lecture:** Steve Ferry,
An infinite-dimensional phenomenon in finite-dimensional topology

15:30 - 16:10 Session talk in 2 parallel sections

16:15 - 16:45 coffee break

16:45 - 17:25, 17:30 - 18:10 Session talks in 2 parallel sections

18:20 bus to hotel

20:00 - 23:00 Conference Dinner

Day Five — Thursday, May 18

Morning session (**Chair:** William Johnson)

09:00 - 09:50 **Plenary lecture:** Spiros Argyros,
The space $\mathcal{L}(\mathfrak{X})$ for certain Banach spaces

10:00 - 10:40 Session talk in 2 parallel sections

10:45 - 11:15 coffee break

11:15 - 11:55, 12:00 - 12:40 Session talks in 2 parallel sections

12:45 - 14:30 lunch break

Afternoon session (**Chair:** Arkady Leiderman)

14:30 - 15:20 **Plenary lecture:** Michael Farber,
Topology of large random spaces

15:30 - 16:00, 16:05 - 16:35, 16:40 - 17:10 Session talks in 2 parallel sections

17:15 - 17:45 Closing and coffee break

17:50 Bus to hotel, then to Beer Sheva, Ben-Gurion airport and then to Tel Aviv.

Program of session talks

(titles on Contents page)

Day Two — Monday, May 15

Time	Geometry of Banach Spaces	Geometric Topology
morning	Chair: Libor Veselý	Chair: Steve Ferry
10:00 - 10:40	Petr Hájek	Boris Goldfarb
10:45 - 11:15	coffee break	coffee break
11:15 - 11:55	Jesús Castillo	James Keesling
12:00 - 12:40	Richard Smith	Vlasta Matijević
12:45 - 14:30	lunch break	lunch break
afternoon	Chair: Yoav Benyamini	Chair: Jerzy Dydak
15:30 - 16:10	Tanmoy Paul	Matija Cencelj
16:15 - 16:45	coffee break	coffee break
16:45 - 17:25	Jerzy Kąkol	Akira Koyama
17:30 - 18:10	Olga Maleva	Stanisław Spieź

Day Three — Tuesday, May 16

Time	Geometry of Banach Spaces	Geometric Topology
morning	Chair: Tadeusz Figiel	Chair: Michael Farber
09:00 - 09:30	Enrico Miglierina	Kyle Austin
09:35 - 10:05	Carlo De Bernardi	Michael Brandenbursky
10:10 - 10:40	Matěj Novotný	Sergey Melikhov
10:45 - 11:15	coffee break	coffee break
11:15 - 11:45	Dario Darji	Regina Rotman
11:50 - 12:20	Saak Gabrielyan	Žiga Virk
11:25 - 12:45		Michael Levin
12:45 - 14:30	lunch break	lunch break

Day Four — Wednesday, May 17

Time	Geometry of Banach Spaces	Geometric Topology
morning	Chair: Vladimir Fonf	Chair: James Keesling
10:00 - 10:40	Pedro Tradacete	Stavros Iliadis
10:45 - 11:15	coffee break	coffee break
11:15 - 11:55	Marian Fabian	Alexander Nabutovsky
12:00 - 12:40	Stanimir Troyanski	Michael Zarichnyi
12:45 - 14:30	lunch break	lunch break
afternoon	Chair: Richard Smith	Chair: Alexander Dranishnikov
15:30 - 16:10	Kazuhiro Kawamura	Evgeny Shchepin
16:15 - 16:45	coffee break	coffee break
16:45 - 17:25	Tadeusz Dobrowolski	Petar Pavesić
17:30 - 18:10	Robert Deville	Olga Sipacheva

Day Five — Thursday, May 18

Time	Geometry of Banach Spaces	Geometric Topology
morning	Chair: William Johnson	Chair: Michael Levin
10:00 - 10:40	Pavlos Motakis	Jan van Mill
10:45 - 11:15	coffee break	coffee break
11:15 - 11:55	Eve Oja	Taras Banakh
12:00 - 12:40	Matias Raja	Leonard Rubin
12:45 - 14:30	lunch break	lunch break
afternoon	Chair: Clemente Zanco	Chair: Arkady Leiderman
15:30 - 16:00	Tomasz Kania	Atish Mitra
16:05 - 16:35	Martin Rmoutil	Tulsi Srinivasan
16:40 - 17:10	Jacopo Somaglia	Pavel Semenov
17:15 - 17:45	closing and coffee break	closing and coffee break

Abstracts of Plenary Lectures

The space $\mathcal{L}(\mathfrak{X})$ for certain Banach spaces

Spiros Argyros

National Technical University of Athens, Greece

A Banach space \mathfrak{X} satisfies the “scalar-plus-compact” property if every bounded linear operator $T \in \mathcal{L}(\mathfrak{X})$ is of the form $\lambda I + K$ with K a compact operator in $\mathcal{L}(\mathfrak{X})$. The space \mathfrak{X} satisfies the “invariant subspace property” if every $T \in \mathcal{L}(\mathfrak{X})$ has a non trivial closed invariant subspace. In this talk we will present a variety of \mathcal{L}_∞ spaces with the “scalar-plus-compact” property and we will explain the significant role of the \mathcal{L}_∞ structure to achieve such a property. In the second part we will discuss some new spaces with non separable $\mathcal{L}(\mathfrak{X})$ satisfying the “invariant subspace property”. At the end we will introduce the “forward bounded transfer” and “backward bounded transfer” and we will present some research related to those concepts.

On complements of compact sets in the Hilbert cube

Alexander Dranishnikov

University of Florida, USA

We define a cohomological version of weakly infinite dimensional compacta (cWID) for coefficients in a ring. The main result is that for any coefficient ring R the complement of cWID compactum in the Hilbert cube is R -acyclic. We show for any ring R that the class of cWID compacta contains all weakly infinite dimensional compacta (WID) and all compacta with finite cohomological dimension with respect to R .

Variants of decomposition complexity in coarse geometry

Jerzy Dydak

University of Tennessee, USA

By decomposition complexity I mean any coarse invariant defined in terms of splitting, for any positive number $r > 0$, a metric space X into subsets that can be expressed as a union of a uniformly bounded family that consists of r -disjoint sets. The strongest such invariant is asymptotic dimension of Gromov, the weakest such invariant is an analog of weak paracompactness. Up to now there were a few intermediate invariants: finite decomposition complexity (Yu and collaborators), straight finite decomposition complexity (Dranishnikov and Zarichnyi), and Asymptotic Property C (Dranishnikov). Recently, Yamauchi gave a very ingenious proof that infinite direct sum of integers has Asymptotic Property C and T. Davila generalized it by showing that any infinite direct product of groups of finite asymptotic dimension has Asymptotic Property C. I will outline how to define Asymptotic Property D, a coarse invariant stronger than Asymptotic Property C. By using ideas from Matrix Algebra, I will show that any infinite

product of spaces of finite asymptotic dimension has Asymptotic Property D, thus generalizing theorems of Yamauchi and Davila.

Topology of large random spaces

Michael Farber

Queen Mary's College of London, Great Britain

I will discuss probabilistic models generating random simplicial complexes. One is able to predict their topological properties with probability tending to one when the spaces are large, i.e. depend on a growing number of independent random variables.

An infinite-dimensional phenomenon in finite-dimensional topology

Steve Ferry

Rutgers University, USA

Given a monotone continuous function $r : [0, R) \rightarrow [0, \infty)$ with $r(0) = 0, r(t) \geq t$, we study the class of closed n -dimensional topological manifolds M such that each ball of radius $t < R$ in M contracts to a point in the concentric ball of radius $r(t)$. We think of r as a continuous analog of feature size. A collection C of such manifolds has a covering function p if for each $\epsilon > 0$ and M in C , M has a $p(\epsilon)$ -element open cover by sets of diameter $< \epsilon$.

If the elements of C have a uniform diameter bound D and $n > 6$, C contains only finitely many diffeomorphism types. However, it is not the case that any two manifolds from C which are sufficiently close in the Gromov-Hausdorff sense must be homeomorphic. This has applications to the problem of reconstructing a manifold from a finite sample.

Coauthors: A. Dranishnikov, S. Weinberger.

On operator ranges

Vladimir Fonf

Ben-Gurion University of the Negev, Israel

This is a joint work with S. Lajara, S. Troyanski, and C. Zanco.

Given bounded linear operators $A : X \rightarrow E$ and $T : E \rightarrow Y$ between Banach spaces, with E separable, and a subspace $L \subset E$ such that $L \cap AX = \{0\}$, we provide sufficient conditions to ensure the existence of an infinite-codimensional subspace $L_1 \subset E$ such that $L \subset L_1$, $L_1 \cap AX = \{0\}$ and $\text{cl}TL_1 = \text{cl}TE$. Some applications to the study of quasi-complemented subspaces of a Banach space are also given.

”Irrational” Convexity

Vitali Milman

Tel Aviv University, Israel

Do we have enough examples of Convex Bodies? Is diversity of our standard examples enough to understand Convexity? In the talk we demonstrate many different constructions which are analogous to constructions of irrational numbers from rationals. We show, following Il.Molchanov, that the solutions of ”quadratic” equations like $Z^o = Z + K$ always exists (where Z^o is the polar body of Z ; Z and K are convex compact bodies containing 0 in the interior). Then we show how the geometric mean may be defined for any convex compact bodies K and T (containing 0 into their interior). We also construct K^a for any centrally symmetric K and $0 < a < 1$, and also $\text{Log}K$ for K containing the euclidean ball D (and $K = -K$). Note, the power a cannot be above 1 in the definition of power! All these constructions may be considered also for the infinite dimensional setting, but this is outside the subject of the talk.

These results are joint with Liran Rotem.

Obstructions to embeddability of metric spaces in L_p spaces

Gideon Schechtman

Weizmann Institute of Science, Israel

I shall present a few inequalities on metric spaces which serve as obstructions to good Lipschitz (and uniform) embeddings of certain metric spaces into L_p spaces. Most of the recent results are due to Assaf Naor and myself. One such inequality, The metric X_p inequaity, completes the search for bi-Lipschitz invariants that serve as an obstruction to the embeddability of L_p spaces into each other. Another, more recent one, The metric property α inequality, serves as an obstruction to the embeddability of Schatten classes (and natural discrete subsets of them) into L_p spaces.

Abstracts of Regular Talks

Second Countable Approximation of Locally Compact Groupoids and an Application to Disintegration Theorems for Fell Bundles

Kyle Austin

Ben-Gurion University of the Negev, Israel

The representation theory for locally compact groupoids has been extensively developed for second countable groupoids. In this talk, I will explain how my collaborators and I have devised a method of approximating sigma compact (equivalently Lindelof) locally compact groupoids by second countable ones. I will explain how our approximations are compatible with twists and with Haar systems. As an application, I will show how we have extended the Muhly-Williams disintegration theorem for representations of the algebra of sections of Fell Bundles from second countable groupoids to sigma compact groupoids. The reader may ask why all this matters. The reason all of this matters is that there are natural locally compact groupoids that are not second countable that are of extreme importance in geometric group theory; namely, the coarse groupoid of a coarse space.

Topological spaces with an ω^ω -base

Taras Banach

University in Kielce, Poland and University of Lviv, Ukraine

Given a partially ordered set P , we say that a topological space X has a *local P -base* if each point $x \in X$ has a neighborhood base $(U_\alpha[x])_{\alpha \in P}$ such that $U_\beta[x] \subset U_\alpha[x]$ for all $\alpha \leq \beta$ in P . For every $\alpha \in P$ the neighborhoods $U_\alpha[x]$, $x \in X$, compose an entourage $U_\alpha = \{(x, y) \in X \times X : y \in U_\alpha[x]\}$ on X . The indexed family $\{U_\alpha\}_{\alpha \in P}$ is called a *P -base* for the topological space X . A P -base $\{U_\alpha\}_{\alpha \in P}$ is called *locally uniform* if for any point $x \in X$ and neighborhood $O_x \subset X$ of x there is $\alpha \in P$ such that the ball $U_\alpha U_\alpha^{-1} U_\alpha[x] = \{y \in X : (x, y) \in U_\alpha U_\alpha^{-1} U_\alpha\}$ is contained in O_x . It is clear that a topological space is first-countable if and only if it has an ω -base. By Moore Metrization Theorem, a topological space X is metrizable if and only if X is a T_0 -space with a locally uniform ω -base. In the talk we shall discuss some properties of topological spaces possessing a (locally uniform) ω^ω -base. We show that topological spaces with an ω^ω -base share some common properties with first-countable spaces. In particular, many known upper bound on the cardinality of first-countable spaces remain true for countably tight spaces with an ω^ω -base. On the other hand, topological spaces with a locally uniform ω^ω -base have many properties, typical for generalized metric spaces.

References:

[1] T.Banach, *Topological spaces with an ω^ω -base*, preprint (<http://arxiv.org/abs/1607.07978>).

Bi-invariant metrics on diffeomorphism groups

Michael Brandenbursky

Ben-Gurion University of the Negev, Israel

Let Σ_g be a compact orientable surface of genus g and let $Ham(\Sigma_g)$ be the group of Hamiltonian diffeomorphisms of Σ_g . The most natural word metric on this group is the autonomous metric. It has many interesting properties, most important of which is the bi-invariance of this metric. In this talk I will show that for each g the group $Ham(\Sigma_g)$ is unbounded with respect to this metric. This is a joint work with Kedra and Shelukhin.

Polyhedral excuses

Jesús Castillo

University of Extremadura, Badajoz, Spain

A Banach space is said to be polyhedral if the unit ball of every finite dimensional subspace is the convex hull of a finite number of points. A Banach space is said to be *isomorphically polyhedral* if it admits a polyhedral renorming. Polyhedrality is a geometrical notion: c_0 is polyhedral while c is just isomorphically polyhedral.

Isomorphically polyhedral Banach spaces are elusive creatures, often making unexpected apparitions in remote areas. Vladimir Fonf has long since been the greatest polyhedral hunter, collector and scholar.

In this talk I though first about presenting a few open problems and examples in Banach space, such as the possibility of twisting $C(K)$ -spaces or the existence of spaces of universal disposition, in which one way or another polyhedral creatures appear involved. So in the end I give up and openly consider the 3-space problem for isomorphic polyhedrality.

Gropes and their fundamental groups

Matija Cencelj

University of Ljubljana, Slovenia

Gropes are an important construction in geometric and algebraic topology, introduced by Stan'ko and Cannon. Open infinite gropes are nice 2-dimensional CW complexes and Eilenberg-MacLane spaces of their fundamental groups. We present some results on gropes and an application to comparing wildness of certain crumpled cubes.

Topological transitivity and mixing of the composition operator on L^p spaces

Udayan B. Darji

University of Louisville, USA and Ashoka University, India

Let $X = (X, \Sigma, \mu)$ be a σ -finite measure space and $f : X \rightarrow X$ be an one-to-one bimeasurable transformation satisfying $\mu(f(B)) \geq c_1\mu(B)$ for some constant $c_1 > 0$ and every measurable set B . Then, $T_f : \varphi \mapsto \varphi \circ f$ is a bounded linear operator acting on $L^p(X, \Sigma, \mu)$, $1 \leq p < \infty$, called the *composition operator* induced by f . We provide necessary and sufficient conditions on f for T_f to be topologically transitive or topologically mixing. We also give two examples of one-to-one bimeasurable transformations whose composition operators are topologically transitive but not topologically mixing. Finally, we show that the composition operator induced by a bi-Lipschitz μ -contraction (or more generally, by a μ -dissipative transformation) defined on a finite measure space is always topologically mixing.

Extreme points in polyhedral Banach spaces

Carlo Alberto De Bernardi

University of Milano, Italy

A Banach space is called *polyhedral* if the unit ball of each of its finite-dimensional subspaces is a polytope. In 1966, Joram Lindenstrauss [2] proved that no infinite-dimensional dual (and in particular reflexive) Banach space is polyhedral. In view of this fact, the following problem, posed by Joram Lindenstrauss in [2], arises naturally.

Problem. Does there exist a polyhedral infinite-dimensional Banach space whose unit ball is the closed convex hull of its extreme points?

In [1] we solved in the affirmative the problem above. During the talk, we present the details of our construction.

References:

- [1] C.A. De Bernardi, *Extreme points in polyhedral Banach spaces*, Israel J. Math., to appear.
- [2] J. Lindenstrauss, *Notes on Klee's paper: "Polyhedral sections of convex bodies"*, Israel J. Math. **4** (1966), 235–242.

Self contracted curves on Riemannian manifolds

Robert Deville

University of Bordeaux, France

It is proved that a self contracted curve on a Riemannian manifold has finite length provided its range is relatively compact.

This is a joint work with A. Daniilidis, E. Durand-Cartagena and L. Rifford.

Making an F -space from an incomplete normed space

Tadeusz Dobrowolski

Pittsburg State University, USA

This is a joint work with W. Marciszewski.

For a normed linear space Y , we are interested in finding a stronger complete topology on Y such that Y becomes a complete metric linear space X (an F -space). Such an X , if it exists, must be unique. Moreover, if Y is separable, it must be Borel. In the realm of separable metric groups, Solecki showed that, for a separable Borel Abelian group Y , a stronger Polish group topology on Y *doesn't* exist iff there is a *topological* embedding $i : C^\omega \rightarrow \hat{Y}$ such that, for all $c, c' \in C^\omega$,

$$c - c' \in C_f^\omega \Leftrightarrow i(c) - i(c') \in Y,$$

that is, i sends the cosets of C^ω/C_f^ω into the cosets of \hat{Y}/Y in a one-to-one manner. Above, C^ω stands for the countable product of the Cantor group C , C_f^ω for eventually zero sequences, and \hat{Y} for the completion of Y . We show that if Y is additionally a separable normed linear space, then the resulting Polish group X must be an F -space.

Several more observations on the subject will be discussed (this is a work in progress).

Non-separable Banach spaces studied via projectional skeletons and “rich” families of their separable subspaces

Marian Fabian

Institute of Mathematics, Academy of Science, Prague, Czech Republic

We present a structural statement characterizing Asplund space X via a certain “rich” family of separable “rectangles” $V \times Y \subset X \times X^*$. This enables to construct easily a “projectional skeleton” (a modern substitute of PRI) in X^* . Further we find some rich “rectangle” families in $X \times X^*$ where X is WCG, WLD, or even Plička space. Thus we get a “commutative” projectional skeleton in X . The class of Plička spaces is quite large. It contains $L_1(\mu)$, where μ is a σ -additive measure, duals of C^* algebras, order continuous lattices, $C(G)$, with G a compact abelian group, and preduals of semifinite von Neumann algebras. Finally, putting the results above together, we immediately yield that X is simultaneously Asplund and WCG, if and only if it admits a commutative projectional skeleton such that the adjoint projections form a projectional skeleton in X^* .

The lecture is based on three recent joint papers written together with Marek Cúth.

The Ascoli property for locally convex spaces

Saak Gabrielyan

Ben-Gurion University of the Negev, Israel

Being motivated by the classic Ascoli theorem we introduced in [1] a new class of topological spaces, namely, the class of Ascoli spaces. In the talk we discuss the Ascoli property for various classes of locally convex spaces, Banach spaces and their unit balls endowed with the weak topology and function spaces.

References:

[1] T. Banach, S. Gabrielyan, *On the C_k -stable closure of the class of (separable) metrizable spaces*, Monatshefte Math. 180 (2016), 39-64.

Fibred finite asymptotic dimension and assembly maps

Boris Goldfarb

State University at Albany, USA

I will define a new weakening of Gromov's finite asymptotic dimension (FAD) for finitely generated groups which is called "fibred finite asymptotic dimension" and illustrate it with infinite-dimensional examples. There are now several different proofs of Novikov and related conjectures for groups with FAD. I will show that one of those methods can be extended to "fibred finite asymptotic dimension".

Coarse embeddings into $c_0(\Gamma)$

Petr Hájek

Institute of Mathematics, Academy of Science, Prague, Czech Republic

This is a joint work with Th. Schlumprecht.
We investigate the coarse embeddings into $c_0(\Gamma)$. We show e.g. that if X has density character at least \aleph_ω and X coarsely embeds into $c_0(\Gamma)$ then X cannot have nontrivial cotype.

On homomorphisms of topological groups

Stavros Iliadis

Lomonosov Moscow State University, Russia

We prove the following result:

Let \mathbf{F} be an indexed collection of (open) topological homomorphisms of Raikov complete topological groups of weight less than or equal to a fixed infinite cardinal τ . Then, there exist a *continuously containing space* T_d of weight $\leq \tau$ for the indexed collection \mathbf{S}_d of the domains of elements of \mathbf{F} (see [1]) and a continuously containing space T_r of weight $\leq \tau$ for the indexed collection \mathbf{S}_r of the ranges of the elements of \mathbf{F} such that the mapping $F : X_d \rightarrow Y_r$, which is defined by relations $F|_X = f$, $X \in \mathbf{S}_d$, where f is the element of \mathbf{F} whose domain is X , is correctly defined, (open), and continuous.

Also, we indicate some pairs $(\mathbb{S}_d, \mathbb{S}_r)$ of classes of topological groups, defined by topological properties of **spaces**, such that for each indexed collection \mathbf{F} of topological homomorphisms $F : X \rightarrow Y$, where $X \in \mathbb{S}_d$ and $Y \in \mathbb{S}_r$, the corresponding continuously containing spaces T_d and T_r have also these properties.

References:

[1] S. Iliadis, *On embeddings of topological groups*, Fundamental and Applied Mathematics, Vol 20, No.2, 2015, pp. 105-112 (Russian)

Separable quotient problem for spaces $C_p(K)$ over compact spaces K

Jerzy Kąkol

University of Poznań, Poland

The classic Rosenthal-Lacey theorem asserts that an infinite dimensional Banach space $C(K)$ of continuous real-valued maps on a compact Hausdorff space K has a Hausdorff quotient either isomorphic to ℓ_2 or c_0 . Very recently we proved that the space $C_p(K)$ endowed with the pointwise topology has a separable quotient algebra iff K has a denumerable closed subset. Hence $C_p(\beta\mathbb{N})$ lacks separable quotient algebras. This motivates the following natural question: (*) *Does $C_p(K)$ admit an infinite dimensional separable Hausdorff quotient over any compact Hausdorff space K ?*

Our main theorem reduces problem (*) to the case when K is a compact *Efimov space* (i.e. K neither contains infinite converging sequences nor a copy of $\beta\mathbb{N}$). Some applications are provided.

Separated subsets in the unit sphere of a Banach space

Tomasz Kania

University of Warwick, Great Britain

Let X be a Banach space. We study the circumstances under which there exists an uncountable set $\mathcal{A} \subset X$ of unit vectors such that $\|x - y\| > 1$ for distinct $x, y \in \mathcal{A}$. We prove that such a set exists if X is quasi-reflexive and non-separable; if X is additionally super-reflexive then one can have $\|x - y\| \geq 1 + \varepsilon$ for some $\varepsilon > 0$ that depends only on X . If K is a non-metrizable compact, Hausdorff space, then the unit sphere of $X = C(K)$ also contains such a subset; if moreover K is perfectly normal, then one can find such a set with cardinality equal to the density of X ; this solves a problem left open by S. K. Mercourakis and G. Vassiliadis. These are joint results with Tomasz Kochanek (Warsaw).

Banach-Stone type theorem for C^1 -function spaces over Riemannian manifolds

Kazuhiro Kawamura

University of Tsukuba, Japan

For a compact connected Riemannian manifold M , let $C^1(M)$ be the space of all real-valued C^1 -functions on M with the C^1 -topology. For a submanifold K of M , we define a norm $\|\cdot\|_{\langle M, K \rangle}$ on $C^1(M)$ by $\|f\|_{\langle M, K \rangle} = \max(\|f|_K\|_\infty, \|df\|_\infty)$ for $f \in C^1(M)$, where df denotes the derivative of f and $\|df\|_\infty$ is the supremum of the operator norm $\|d_x f\|$ of the derivative $d_x f : T_x M \rightarrow \mathbb{R}$.

For two submanifolds K and L of M with $\dim K = \dim L > 0$, we prove that every surjective isometry $T : (C^1(M), \|\cdot\|_{\langle M, K \rangle}) \rightarrow (C^1(M), \|\cdot\|_{\langle M, L \rangle})$ such that $T(0) = 0$, $T(\text{Const}) = \text{Const}$ and $T(C^3(M)) = C^3(M)$ must be of the form: $Tf = \varepsilon \cdot (f \circ \varphi)$, $f \in C^1(M)$, where $\varepsilon = \pm 1$ and $\varphi : M \rightarrow M$ is a Riemannian isometry with $\varphi(L) = K$.

Thus such isometries determine the embedding type of the submanifolds up to isometry. Some extensions and applications of the above will also be discussed.

Generalized Covering Spaces

James Keesling

University of Florida, USA

This is a joint work with Jerzy Dydak, Joanna Furno. We report on three results.

(1) Let G be an Abelian pro-finite group with underlying space homeomorphic to the Cantor. Then there is a separable metric space X with $\pi_1(X) \cong G$ as a group such that there is a surjective map of separable infinite-dimensional Hilbert space, $g : \ell_2 \rightarrow X$ which serves as a generalized universal covering map for X . Furthermore, the group of transformations $\mathcal{T}_g(\ell_2) \subset \mathcal{H}(\ell_2)$, defined by $h \in (T_g)(\ell_2)$ if and only if $g \circ h = g$ is isomorphic to G and the natural topology on this set of homeomorphisms yields the given pro-finite topology on G .

We say that *all loops are small* in a pointed space (X, x_0) if the space has the property that for every loop $\gamma : [0, 1] \rightarrow (X, x_0)$ and every open set $x_0 \in U \subset X$, there is a loop $\gamma' : [0, 1] \rightarrow (U, x_0)$ which is homotopic to γ in (X, x_0) . It is known that for such a space, there are no generalized covering spaces. This leads to

(2) Let G be an Abelian pro-finite group as in (1). Then there is a pointed separable metric space (X, x_0) having all loops small such that $\pi_1(X, x_0) \cong G$. Key to these first two results is the result of Bessaga and Pełczyński that the space of Borel measurable functions $\mathcal{M}([0, 1], X)$ has the property that $\mathcal{M}([0, 1], X) \cong \ell_2$ for all complete separable metric spaces X having at least two points.

(3) Let G be any group and let (X, x_0) be a pointed topological space such that $\pi_1(X, x_0) \cong G$. Then there is a pointed space (Y, y_0) and an embedding $e : (X, x_0) \subset (Y, y_0)$ such that (Y, y_0) has all loops small and such that $e_* : \pi_1(X, x_0) \cong \pi_1(Y, y_0)$. The construction of (Y, y_0) can be used to show additional results. For instance, if G has non-measurable cardinality, then the spaces (X, x_0) and (Y, y_0) can both be taken to be compact Hausdorff. It is also the case that $e : (X, x_0) \rightarrow (Y, y_0)$ is a weak homotopy equivalence. The space (Y, y_0) in (3) is not metrizable. There is no such (Y, y_0) metrizable with $\pi_1(Y, y_0) \cong \mathbb{Z}$.

Homological properties of decomposition spaces

Akira Koyama

Waseda University, Japan

Since 1960 the decomposition space X of the Euclidean 3-space \mathbb{R}^3 by the Case-Chamberlin continuum C has been investigated and Shrikhande showed that X is not simply connected and not locally simply connected. Bogopolski and Zastrow showed that the first dimensional singular homology group of X is not trivial. We are discussing (local) Čech homological properties of X .

A counterexample in Extension Theory

Michael Levin

Ben-Gurion University of the Negev, Israel

Let G be the p -adic circle. We construct a 3-dimensional compact metric space X such that the cohomological dimension of X with the coefficients in G is 1 and the standard Moore space $M(G, 1)$ for G is not an absolute extensor of X . Related results are discussed.

Where can real-valued Lipschitz functions on \mathbb{R}^n be non-differentiable?

Olga Maleva

University of Birmingham, Great Britain

There are subsets N of \mathbb{R}^n for which one can find a real-valued Lipschitz function f defined on the whole of \mathbb{R}^n and not differentiable at every point of N . Of course, by the Rademacher theorem any such set N is Lebesgue null, however, due to a celebrated result of D. Preiss from 1990 not every Lebesgue null subset of \mathbb{R}^n gives rise to such a Lipschitz function f .

In this talk, I discuss sufficient conditions on a set N for such f to exist. As a corollary of the main result we show that every purely unrectifiable set U possesses a Lipschitz function non-differentiable on U in the strongest possible sense.

This is a joint work with D. Preiss.

On group structures on covering spaces over groups

Vlasta Matijević

University of Split, Croatia

In the theory of covering maps over topological groups the following question naturally arises: If $f: X \rightarrow Y$ is a covering map from a connected space X onto a topological group Y , is it possible to define a group operation on X in such a way that X becomes a topological group and f a homomorphism of groups. Recently, the question was answered in the negative by constructing infinite-sheeted covering maps over solenoids which do not admit such group operation on total spaces. However, the answer is positive in two particular cases: if Y is a locally path connected group or if f is an overlay map over compact group Y . Note that overlay maps are a certain proper subclass of covering maps. We extend positive answers to covering maps over locally compactly connected groups Y and to overlay maps over locally compact groups Y generalizing previously obtained results. In both cases the group operation on X is unique and is defined by lifting of chains of open sets.

This is a joint work with Katsuya Eda.

References:

- [1] K. Eda and V. Matijević, *Covering maps over solenoids which are not covering homomorphisms*, Fund. Math. 221 (2013), 69-82.
- [2] K. Eda and V. Matijević, *Existence and uniqueness of group structures on covering spaces over groups*, Fund. Math. (to appear).

Infinite-dimensional uniform polyhedra and classifying spaces of 0-dimensional groups

Sergey A. Melikhov

Steklov Mathematical Institute, Moscow, Russia

Classifying spaces of groups are usually considered to be well-defined up to homotopy equivalence. But just like topological groups are naturally uniform spaces, their classifying spaces may well be thought of as uniform spaces, well-defined up to uniform homotopy equivalence (i.e. a homotopy equivalence given by uniformly continuous maps and homotopies).

But is this additional structure of any use? Not that I'm aware of, as long as discrete groups or Lie groups are concerned. However, for 0-dimensional groups it does make some difference. The classifying space $B\mathbb{Q}_p$ of the additive group of p -adic numbers is cohomologically 3-dimensional, but in the uniform setting, it becomes cohomologically infinite-dimensional. The classifying space $B\mathbb{Z}_p$ of the additive group of p -adic integers is at most 2-dimensional with respect to any cohomology theory, but in the uniform setting, it becomes infinite-dimensional with respect to complex K-theory. A characteristic application of this phenomenon is a p -adic Borsuk–Ulam theorem, which says that there exists no uniformly continuous equivariant map from $E\mathbb{Z}_p$ to any compact metric space with a free action of \mathbb{Z}_p . The key word here is “uniformly”, for without it this would have been a much, much more interesting result. It must be mentioned that there has been no progress in this subject in recent years because I was working on unrelated projects. There are some new hopes, however, of obtaining the desired applications, rather than just their uniform analogues.

The “uniform setting” mentioned above is based on infinite-dimensional uniform polyhedra. These can be used, in particular, to approximate (in the sense of inverse limits) uniform classifying spaces — as well as any other separable metrizable complete uniform spaces. The main feature of such approximation is that infinite-dimensionality is retained in the individual approximants, including on an algebraic level. This property is absolutely lacking in usual approximations of metrizable topological spaces by polyhedra. The theory of infinite-dimensional uniform polyhedra (arXiv:1109.0346) settles Isbell’s 1964 “Research Problem B_2 ” and is in turn based on reworking much of basic PL topology in strictly combinatorial terms (arXiv:1208.6309) and on putting in order the subjects of quotients and ANRs in the setting of metrizable uniform spaces (arXiv:1106.3249).

In the talk, I intend to give a review of infinite-dimensional uniform polyhedra, and then, armed with it, discuss constructions of uniform classifying spaces. The latter topic is still on its way from ad hoc methods to a satisfactory understanding (which may or may not improve by May).

Separable Lindenstrauss spaces whose duals lack the weak* fixed point property for nonexpansive mappings

Enrico Miglierina

Università Cattolica del Sacro Cuore, Milano, Italy

In this talk we study the w^* -fixed point property for nonexpansive mappings. First we show that the dual space X^* lacks the w^* -fixed point property whenever X contains an isometric

copy of the space c of the convergent sequences. Then, the main result of our paper provides some characterizations of weak-star topologies that fail the fixed point property for nonexpansive mappings in ℓ_1 space. This result allows us to obtain a characterization of all separable Lindenstrauss spaces X inducing the failure of w^* -fixed point property in X^* . The key tool of our result is a detailed study of the hyperplanes of the space c .

The talk is essentially based on a joint paper with Emanuele Casini and Łukasz Piasecki, appeared in *Studia Mathematica* 238 (1) (2017), 1-16.

Extension Theory in Large Scale Geometry

Atish J. Mitra

Montana Tech of the University of Montana, USA

Classical extension theory deals with extensions of maps between topological spaces. In this talk we will discuss progress made in the extension theory of functions in various large scale categories, and will compare the results and techniques with that of classical extension theory.

Spaces of compact diagonal operators as Calkin algebras of Banach spaces

Pavlos Motakis

Texas A&M University, USA

The Calkin algebra of a Banach space Z is the unital Banach algebra $\mathcal{C}al(Z)$ defined as the quotient $\mathcal{L}(Z)/\mathcal{K}(Z)$ of the algebra of all bounded linear operators on Z over the ideal of all compact ones. We investigate the question of what types of unital algebras can occur as Calkin algebras. Given a Banach space X with a Schauder basis we denote by $\mathcal{K}_{\text{diag}}(X)$ the space of all compact and diagonal operators on X . We prove that there exists a Banach space \mathfrak{X}_X so that the Calkin algebra of \mathfrak{X}_X is isomorphic, as a Banach algebra, to $\mathcal{K}_{\text{diag}}(X) \oplus \mathbb{R}I$. This yields Banach spaces with interesting Calkin algebras, e.g., James' quasi reflexive Banach space and even a hereditarily indecomposable Banach algebra constructed by S. A. Argyros, I. Deliyanni, and A. Tolias. The space \mathfrak{X}_X is of the form $(\sum \oplus X_k)$ where each X_k is a version of the Argyros-Haydon space and the outside norm is a modified Argyros-Haydon sum incorporating the norm of the space X .

Balanced Presentations of the Trivial Group and Geometry of 4-Dimensional Manifolds

Alexander Nabutovsky

University of Toronto, Canada

We will describe triangulations of S^4 that are enormously far from each other in the metric defined as the minimal number of bistellar transformations required to transform one of them into the other. The number of constructed triangulations grows exponentially with the number of simplices; the required number of bistellar transformations grows faster than the tower of exponentials of any fixed height. The proof involves a construction of “many” balanced presentations of the trivial group so that these presentations are “very different” from each other (and from the trivial presentation). “Balanced” means that the number of generators is equal to the number of relations. We also demonstrate that there exist trivial 2-knots in R^4 that can be untied only if one allows an enormous increase of complexity during an isotopy.

Joint work with Boris Lishak.

On stability of Lipschitz functions on $c_0(\Gamma)$

Matěj Novotný

Institute of Mathematics, Academy of Science, Prague, Czech Republic

It is a famous result by Gowers that every real Lipschitz function on the sphere of c_0 stabilizes on some infinite-dimensional subspace. We prove for every uncountable Γ , there is a real symmetric 1-Lipschitz function defined on the sphere of $c_0(\Gamma)$ which doesn't stabilize on any of its subspaces with density $densc_0(\Gamma)$. However, we prove that in the case of equivalent norms on $c_0(\Gamma)$, the stability on some subspace with density $densc_0(\Gamma)$ is obtained.

Principle of local reflexivity which respects nests of subspaces, and the nest approximation properties

Eve Oja

University of Tartu, Estonia

We discuss new forms of the principle of local reflexivity (PLR): their strength is that the local reflexivity operators respect given nests of subspaces. These PLR results are then systematically applied to obtain duality and lifting theorems for the nest approximation properties in Banach spaces.

Nest approximation properties were launched by Figiel and Johnson in *J. Funct. Anal.* 271 (2016), 566–576. This concept involves finite-rank approximating operators which leave invariant all subspaces in a given nest of closed subspaces of a Banach space.

This is a joint work with Silja Veidenberg. The work was motivated by the question of Bill Johnson (at “Aleksander Pełczyński Memorial Conference”, 2014): do there exist versions of the PLR which respect nests of subspaces?

Some recent development on proximality in Banach spaces

Tanmoy Paul

Indian Institute of Technology Hyderabad, India

Aim of this talk is to discuss the behavior of the notion proximality (existence of best approximation) for few cases; viz. the transitivity of this notion or its variant through the subspaces, duality between *the intersection properties of balls* and proximality, stability of various strengthenings of proximality in function spaces and generalization of this property to *Chebyshev centre* for a closed convex set. This talk is based on the following articles.

References:

- [1] T. Paul, *Various notions of proximality in spaces of Bochner integrable functions* Adv. Operator Theory, **2**, no 1, (2017) 59–77.
- [2] S. Lalithambigai et al, *Chebyshev centres and some geometry of Banach spaces*, J. Math. Anal. Appl., **499**, no 1, (2017) 926–938.
- [3] C. R. Jayanarayanan et al, *Strong proximality and intersection properties of balls in Banach spaces*, J. Math. Anal. Appl., **426**, no 2, (2015), 1217–1231.

Free topological groups and functorial fibrewise constructions

Petar Pavešić

University of Ljubljana, Slovenia

In fibrewise homotopy theory one often needs fibrewise versions of various functorial constructions on pointed topological spaces (e.g. loop-spaces, Pontryagin-Thom construction, etc.). We will present a general approach to this problem that is based on the construction of free topological groups.

Szlenk indices, variations, applications and problems

Matias Raja

University of Murcia , Spain

The Szlenk index is a powerful tool in isomorphic theory of Banach spaces. We review the relationships between the ordinary Szlenk index, the convex Szlenk index and the dentability index, including the recent results on optimal bounds. It is well known that the existence of asymptotically uniformly convex dual norms is related to the Szlenk index, however the use of alternative measures of noncompactness gives new alike results. We will show that a variation of the Szlenk index provides asymptotically uniformly smooth renormings without appealing to the duality. A few applications to c_0 are given since it is “the most” asymptotically uniformly smooth space. Finally, we will show some applications to the nonlinear classification of Banach spaces.

Recovering a Compact Hausdorff Space X from the Compatibility Ordering on $C(X)$

Martin Rmoutil

University of Warwick, Great Britain

Let X and Y be compact Hausdorff spaces. Let $f, g \in C(X)$ where $C(X)$ denotes the space of continuous functions on X . We say that g dominates f in the *compatibility ordering* if g coincides with f on the support of f . Our main result states that X and Y are homeomorphic if and only if there exists a compatibility isomorphism $T : C(X) \rightarrow C(Y)$. We derive several classical theorems of functional analysis as easy corollaries to our result:

If X and Y are compact Hausdorff spaces, we obtain that they are homeomorphic whenever there exists a bijection $T : C(X) \rightarrow C(Y)$ satisfying one of the following conditions:

- T is a ring isomorphism (Gelfand–Kolmogorov);
- T is multiplicative (Milgram);
- T the ordinary pointwise ordering (Kaplansky);
- T is linear and $Tf \cdot Tg = 0$ whenever $f \cdot g = 0$ (Jarosz).

We also study the question of continuity of compatibility isomorphisms: Depending on the properties of X we either prove or disprove that all compatibility isomorphisms are continuous (in different senses).

Coauthor: Tomasz Kania.

Width of the homotopy and the length of a shortest geodesic

Regina Rotman

University of Toronto, Canada

Recall that the width of a homotopy is defined as the maximal length of a trajectory of a point during this homotopy.

We will discuss various estimates of the width of "optimal" homotopies contracting arbitrary closed curves on a Riemannian manifold M in terms of the diameter of M , its volume, and various bounds for curvatures of M . Note that if M is closed, then the upper bounds for the width of such "optimal" homotopies can be used to obtain upper bounds for the length of the shortest periodic geodesic on M .

Results about optimal homotopies contracting closed curves can be non-trivial already in dimension 2. For example, we will discuss the following theorem (joint with E. Chambers, G. Chambers, A. De Mesmay, T. Ophelders):

Let D be the Riemannian 2-disk of diameter d . Suppose that the boundary curve ∂D can be contracted to a point via closed curves of length less than L . Then for any point q on the boundary of D , there exists a homotopy of ∂D to q over loops based at q of length less than $2d + L$.

Simplicial Inverse Sequences in Extension Theory

Leonard R. Rubin

University of Oklahoma, USA

In extension theory, in particular in dimension theory, it is frequently useful to represent a given compact metrizable space X as the limit of an inverse sequence of compact polyhedra. We are going to show that, for the purposes of extension theory, it is possible to replace such an X by a better metrizable compactum Z . This Z will come as the limit of an inverse sequence of triangulated polyhedra with bonding maps that are simplicial with respect to these fixed triangulations, and that factor in a certain way. As has been proved by S. Mardešić, not every metrizable compactum can be represented by such a “simplicial” inverse sequence. There will be a cell-like map $\pi : Z \rightarrow X$, and we shall show that if K is a CW -complex with $X\tau K$, then $Z\tau K$.

The simplicial inverse sequence determining Z is subject to “adjustments.” Any such adjustment determines an inverse sequence whose limit maps onto X , and the fibers of such a map have explicit and useful descriptions as the limits of certain subsequences. We plan to exploit this technique as part of a unified approach involving proofs of the resolution theorems of Edwards-Walsh (cell-like), Dranishnikov (\mathbb{Z}/p -acyclic), and Levin (\mathbb{Q} -acyclic), and perhaps to obtain a new and different one more general than the latter.

Coauthor: Vera Tonic.

Splittings and selections

Pavel V. Semenov

Higher School of Economics, Moscow, Russia

For an n multivalued mappings $F_k : X \rightarrow Y_k, k = 1, 2, \dots, n$, for a singlevalued mapping $L : \oplus Y_k \rightarrow Y$ and for a continuous selection $f : X \rightarrow Y$ of the composite mapping $L \circ (\oplus F_k)$ an n -tuple (f_1, \dots, f_n) is said to be a *splitting* of f if $f_k : Y_k \rightarrow Y$ is a selection of $F_k, k = 1, 2, \dots, n$, and $f(x) = L(f_1(x); \dots; f_n(x)), x \in X$. A very special case give the following mappings: $F_k(\cdot) \equiv A_k$, where A_k are convex subsets of a Banach space Y , $L : Y^n \rightarrow Y$ linear continuous operator and $f = id|_X, X = L(A_1, \dots, A_n)$. Under these assumptions a splitting of $f = id|_X$ gives a singlevalued solution (y_1, \dots, y_n) of the classical linear equation $L(y_1, \dots, y_n) = y, y_1 \in A_1, \dots, y_n \in A_n$ which continuously depends on the data y .

A series of results on splittings for the case $n = 2$ was considered in [1], [2]. Here we present the generalization for the case of an arbitrary $n \in \mathbb{N}$. Theorem.

Splittings always exist for a lower semicontinuous convex- and closed valued mappings $F_k : X \rightarrow \mathbb{R}, k = 1, 2, \dots, n$ on a paracompact domain and for linear mapping $L : \mathbb{R}^n \rightarrow \mathbb{R}$

Remark, that the induction with the base $n = 2$ in general doesn't work even for the reduction of $n = 3$ to $n = 2$. So the proof is based on a good tomography of convex *rectangular* subsets, i.e. sets which coincide with the Cartesian product of their projections onto the coordinate lines. As it pointed out in [3] the restriction $dim Y = 1$ is necessary for a positive answer on existence of splittings with an arbitrary paracompact domains.

By returning to the case $n = 2$ we have that for every linear $L : Y_1 \oplus Y_2 \rightarrow \mathbb{R}^3$ with surjective restriction $L|_{Y_1}$ and with non-zero restriction $L|_{Y_2}$ there are convex compacta $C_i \subset Y_i$, $i = 1, 2$ such that the linear equation

$$L(y_1, y_2) = y, \quad y_i \in C_i, \quad y \in C = L(C_1, C_2)$$

has no singlevalued solutions $y_1 = y_1(y)$, $y_2 = y_2(y)$ which are continuous with respect to data $y \in C$.

The proof exploits the Minkowski sum of the convex compacta $K = \overline{\text{conv}}\{(\cos t, \sin t, t) : 0 \leq t \leq 2\pi\}$, see [3] and the segment $S = \{(0, 0, t) : 0 \leq t \leq 2\pi\}$. It appears that for any splitting $c = k + s$, $c \in K + S$, $k \in K$, $s \in S$ the second item is discontinuous with respect to c at the point $c_0 = (1, 0, 2\pi)$. For the first example of such effect, see [1].

References:

- [1] M. V. Balashov and D. Repovš, *J. Math. Anal. Appl.*, **355** (2009), 277–278
- [2] D. Repovš, P.V. Semenov, *J. Math. Anal. Appl.*, **334** (2007), 646 – 655
- [3] D. Repovš, P.V. Semenov, *Topology and Its Appl.*, **156:7** (2009), 1192–1198.

On the convexity of Chebyshev sets

Evgeny Shchepin

Steklov Mathematical Institute, Moscow, Russia

A subset of a metric space is called a *Chebyshev set* if every point from its complement has a unique nearest point from the set. In finite-dimensional Banach spaces with smooth unique sphere, the classes of Chebyshev sets and closed convex sets are known to coincide. (T. S. Mozkin, L. N.H. Bunt). To deal with the non-smooth setting, which is more challenging, we shall need the concepts of convexity and smoothness in a given direction. The main result is as follows: a Chebyshev set in a finite-dimensional Banach space is convex in any direction tangent to the unit sphere of the space.

Here, under a direction tangent to the unit sphere one means a direction such that any line of the direction meeting the boundary of the ball but missing the interior is tangent (i.e. contains a tangent ray).

For the two-dimensional case, the opposite result holds: a connected closed subset of a 2-dimensional Banach space which is convex relative to all tangent directions of its unit sphere is a Chebyshev set iff its boundary and the unit sphere do not contain a rectilinear segments of the same direction.

References:

- [1] A. R. Alimov, *On the structure of the complements of Chebyshev sets*, *Funct. Anal. Appl.* 35:3 (2001), 176–182.
- [2] V. S. Balaganskii and L.P. Vlasov, *The problem of convexity of Chebyshev sets*, *Russian Math. Surveys* 51:6 (1996), 1127–1190.
- [3] J. Fletcher and W. B. Moors, *Chebyshev sets*, *J. Aust. Math. Soc.* 98:2 (2015), 161–231.
- [4] A. L. Brown, *Chebyshev sets and facial systems of convex sets in finite-dimensional spaces*, *Proc. London Math. Soc.* (3) 41:2 (1980), 297–339.

Large and Discrete Sets in Countable Topological Groups

Ol'ga V. Sipacheva

Lomonosov Moscow State University, Russia

The most important result of the report is the following recent theorem proved jointly with Evgenii Reznichenko.

Throughout, all topological groups are assumed to be Hausdorff.

Theorem. (Reznichenko, Sipacheva)

- (i) *Any countable nondiscrete topological group whose identity element has nonrapid filter of neighborhoods contains a discrete subset with precisely one limit point.*
- (ii) *If there are no rapid filters, then any countable nondiscrete Boolean topological group contains two disjoint discrete subsets for each of which the zero of the group is a unique limit point.*

(A filter \mathbb{F} on ω is rapid if every function $\omega \rightarrow \omega$ is majorized by the increasing enumeration of some element of \mathbb{F} . The nonexistence of rapid filters is consistent with ZFC.)

This theorem and its consequences concerning countable topological groups with extremal properties answer, partially or completely, several old questions. In particular, they imply that the nonexistence of a nondiscrete separable extremally disconnected group, as well as that of a nondiscrete countable topological group in which all discrete subspaces are closed, is consistent with ZFC.

A key role in the proof is played by fat subsets of a group. Fatness is a new notion of largeness organically related to that of syndeticity, which originated in Ramsey theory and topological dynamics in the context of the additive semigroup of positive integers, in which syndetic sets are precisely those with bounded gaps.

In the study of countable topological groups with extremal properties, of most interest are Boolean groups (any extremally disconnected group and any Abelian or countable irresolvable group contains an open Boolean subgroup), and every Boolean group is free, being a linear space over the field \mathbb{Z}_2 .

Theorem.

- (i) *Any countable Boolean topological group has a closed discrete basis.*
- (ii) *Any countable closed linearly independent set in an extremally disconnected Boolean group has at most one limit point.*
- (iii) *It is consistent with ZFC that any countable closed linearly independent set in an extremally disconnected Boolean group is discrete.*

Finally, we present a curious consequence of the equivalence between the existence of an extremally disconnected free (Boolean) topological group and that of selective ultrafilters, which concerns selectivity-type properties of filters.

Boundaries, polyhedrality and smoothness

Richard Smith

University College Dublin, Ireland

We give a survey of the progress made in the fields of polyhedrality and smoothness in Banach spaces over the last few years, in collaboration with Prof. Fonf and other authors, and present some open problems.

Retractional skeletons on trees

Jacopo Somaglia

University of Milano, Italy

A non-commutative Valdivia compact space is a compact space with retractional skeleton. A compact space is Valdivia if and only if it has a commutative retractional skeleton. The two classes do not agree: the ordinal space $[0, \omega_2]$, endowed with the interval topology, is an easy and well-known example of a non-commutative Valdivia compact space that is not Valdivia. In this talk, I will recall the definition and some properties of the Coarse wedge topology on trees. A characterization of non-commutative Valdivia trees will be presented. This characterization will be used to give a negative answer to the following question:

Problem. Let X be a non-commutative Valdivia compact space that does not contain any copy of the ordinal space $[0, \omega_2]$. Is X necessarily Valdivia?

Coincidence class for several maps

Stanisław Spież

IMPAN, Polish Academy of Sciences, Poland

Given two maps $f, g : M \rightarrow N$ between connected closed orientable manifolds of the same dimension, the Lefschetz coincidence number of f and g is defined as

$$\Lambda_{f,g} = \sum (-1)^k \text{Tr}(D_M \circ g^* \circ D_N^{-1} \circ f_*),$$

where f_* and g^* are the induced homomorphisms of the homology groups and the cohomology groups, respectively, with rational coefficients, and D_M and D_N are the Poincaré duality isomorphisms. Lefschetz proved that if the coincidence number is nonzero, then f and g have a coincidence point.

For maps $f_1, \dots, f_k : X \rightarrow N$ from a topological space X into a connected closed n -manifold (even non-orientable) N , we define a cohomological class

$$L(f_1, \dots, f_k) \in H^{n(k-1)}(X; (f_1, \dots, f_k)^*(R \times \Gamma_N^* \times \dots \times \Gamma_N^*))$$

in such a way that $L(f_1, \dots, f_k) \neq 0$ implies that the set of coincidences

$$\text{Coin}(f_1, \dots, f_k) = \{x \in X \mid f_1(x) = \dots = f_k(x)\}$$

is non-empty. (Here, R is a principal ideal domain and $\Gamma(N)$ is the orientation system of N .)

We prove some properties and give some applications of the defined Lefschetz type coincidence class.

This a joint research with Thais Monis.

The Lusternik-Schnirelmann category of general spaces

Tulsi Srinivasan

Ashoka University, India

The Lusternik-Schnirelmann category (LS-category) is a topological invariant that has historically been studied for absolute neighbourhood retracts. I will talk about how the theory of the LS-category can be extended to Peano continua like the Menger and Pontryagin spaces. I will then discuss current work applying these results to the boundaries of hyperbolic groups with an aim to finding an analogue to the Bestvina-Mess formula. I will also talk about how these techniques can be applied to topological complexity.

Weakly compact subsets of $C[0, 1]$ and reflexive Banach lattices

Pedro Tradacete

University of Madrid, Spain

We show that for every weakly compact subset K of $C[0, 1]$ with finite Cantor-Bendixson rank, there is a reflexive Banach lattice E and an operator $T : E \rightarrow C[0, 1]$ such that $K \subseteq T(B_E)$. On the other hand, we exhibit an example of a weakly compact set of $C[0, 1]$ homeomorphic to $\omega^\omega + 1$ for which such T and E cannot exist. This answers a question of M. Talagrand in [Proc. Amer. Math. Soc. 96 (1986), no. 1, 95–102].

Joint work with J. Lopez-Abad.

Strongly Extreme Points and Approximation Properties

Stanimir Troyanski

University of Murcia, Spain

We establish, in terms of approximation properties, sufficient conditions for a strongly extreme point of a closed convex bounded subset of a Banach space to be a denting point. The results are from a joint work with T. Abrahamsen, P. Hajek and O. Nygaard.

Homogeneity of Erdős type space

Jan van Mill

University of Amsterdam, Holland

For subsets X of the real line we investigate homogeneity properties of the Erdős type space $E(X) = \{p \in \ell^2 : (\forall n)(p_n \in X)\}$. This space has much in common with the countable infinite product of copies of X , which is homogeneous by the result of Lawrence. Continuous families of coordinate permutations form an important ingredient in his proof. The Erdős space $E(X)$ is 1-dimensional in many cases which is an obstacle in homogeneity issues. On the other hand, $E(X)$ is invariant under coordinate permutations of ℓ^2 which suggests to investigate whether the Lawrence ideas are applicable. Our main result is the construction of a subset X of the real line such that every homeomorphism f of $E(X)$ is norm-preserving. That is, $\|f(p)\| = \|p\|$ for every $p \in E(X)$. Hence $E(X)$ need not be homogeneous. Since for every $\varepsilon > 0$, the sphere $\{p \in E(X) : \|p\| = \varepsilon\}$ is zero-dimensional, a natural question is whether spheres are always homogenous in Erdős type spaces. We prove that they are not.

Joint work with K. P. Hart.

Coarse dimension raising results

Žiga Virk

Institute of Science and Technology, Austria

The Hurewicz Dimension Raising Theorem states that a closed n -to-1 map between metric spaces may raise the covering dimension by at most $n - 1$, i.e., $\dim Y \leq \dim X + n - 1$. We will survey the development of a coarse (asymptotic) version of this theorem by presenting the following results:

- (1) *The first version of a Coarse Dimension Raising Theorem and a Finite-to-One Mapping Theorem* (joint with T. Miyata).
- (2) *Improved bound via Gromov boundary and coarse permanence via coarsely n -to-1 maps* (joint with J. Dydak).
- (3) *The optimal bound via Higson compactification and a generalization using coarse metric approximation* (joint with K. Austin).

Asymptotic dimensions related to some control functions

Michael Zarichnyi

University of Lviv, Ukraine and University of Rzeszów, Poland

The Gromov asymptotic dimension of a metric space X does not exceed n if, for any $D > 0$, there exists a uniformly bounded cover \mathcal{U} of X which is the sum of $n + 1$ D -disjoint families. If we impose restrictions onto the mesh of the cover \mathcal{U} (as a function of D), we obtain versions of the asymptotic dimension, e.g., asymptotic Assouad - Nagata dimension [1] and asymptotic subpower dimension [2].

We consider some examples of spaces and groups with non-coinciding dimensions. We also consider the connections to the dimensions of the coronas (remainders of the compactifications) related to these asymptotic dimensions.

Some results are obtained in collaboration with Jacek Kucab.

References:

- [1] A.N. Dranishnikov, J. Smith, *On asymptotic Assouad–Nagata dimension*, *Topol. Appl.* **154** (2007), 934–952.
- [2] J. Kucab, M. Zarichnyi, *On asymptotic power dimension*, *Topol. Appl.* **201** (2016), 124–130.

Additional information

Accommodation

Rooms for all conference participants are reserved at the Hotel Adi (3*). All rooms are air-conditioned. If you want to make a tea or coffee in the room then bringing your own small electric kettle (220 volt) could be a good idea.

Transportation

Bus will leave hotel Adi to the university campus on Sunday, May 14 at 16:00; Monday, May 15 –Thursday, May 18 at 08:30.

Return bus to hotel Adi: Sunday at 19:00, Monday at 18:20, Wednesday at 18:20, Thursday at 17:50, continuing to Beer-Sheva, Ben-Gurion airport and Tel Aviv.

Expected arrivals: Beer Sheva 22:00, Airport 23:30; Tel Aviv 00:00.

On Tuesday, May 16 the excursion will leave BGU campus at 14:30 and will return to hotel Adi around 19:00. The cost of short or medium size journey in Eilat by taxi range from 30-35 shekels.

Meals

Breakfasts will be served in the hotel. During the working days of the conference (May 15, 16, 17, 18) free lunches will be organized for all participants in the restaurant at the university campus. The restaurant is located in the main building N 5, where all lectures will take place. The name of the restaurant literally means "Pots and Books".

For dinner, there are a lot of restaurants in Eilat, which can be found via Internet.

We have a Conference Dinner on Wednesday, May 17.

Banking

The New Israeli Shekel - abbreviated as NIS, is Israel's currency. There are coins of 10, 50 agorot and 1, 2, 5, 10 shekels, as well as 20, 50, 100 and 200 shekels notes. Money can be exchanged at any of the street exchange bureau, ATMs or any of Israel's major banks (i.e.- Hapoalim, Leumi, Discount bank, and Hamizrahi).

Banks - When exchanging money at a bank, you will be charged a fixed exchange fee, and if you choose to use an exchange place on the street, you will not be charged for the transaction, but will receive a lower rate than the banks supply.

Exchange rates: 1 US\$ ~ 3.6, 1 Euro ~ 3.9 (May 1, 2017)

All major credit cards (Visa and Master Card/Eurocard, American Express and Diners Club) are widely accepted throughout Israel.

Electricity

The electrical current in Israel is 220 volt AC, single phase, 50 Hertz. 110 volt appliances can be used only with a step-up transformer or appropriate adapter.

Internet access

Computer and internet access facilities are available in the building N 5, where all lectures will take place. Computers room is N 121. For the duration of the conference, a wireless access to the Internet will be arranged.

Excursion and Conference Dinner

Tuesday, May 16:

Excursion to Timna Park, the place of the world's first ever copper mine

All participants and accompanying persons are invited to take part in the Excursion to Timna Park.

<http://www.parktimna.co.il/EN/>

Excursion details: Bus departs first from hotel Adi to the campus at 14:10. Leaving BGU campus at 14:30. Travel to Timna Park takes about 30 minutes. The walking track is about 2 km length and we arrive back to the hotel around 19:00.

IMPORTANT!

You are advised to have the following items with you:

- Good broad-rim hats
- sun-glasses
- sun blocking lotion (blocking factor > 30 is recommended)
- light walking clothes
- walking shoes (not sandals)

Water and some fruits will be supplied by us.

Weather in May: Sunny, no rains at all. Maximal daytime temperature: around +35 Celsius daily. Minimal night-time temperature around 22 Celsius. Humidity around 25%.

Water temperature in Red Sea is stable: 22 - 24 Celsius.

Wednesday, May 17: Conference Dinner in the Restaurant Ashkara

<http://eilat.city/en/ashkara-grill-bar>

The restaurant is located in the industrial area of Eilat.

Address: Hamelaha 18, Eilat, Phone: 08-6587444

Restaurant Ashkara is kosher.

Menu includes numerous kinds of vegetable salads, grilled meat and fish, tea, coffee, dessert, and more. Light beverages, wine and beer are unlimited.

Time: 20:00 – 23:00. Leaving the hotel Adi by bus at 19:45.

Tuesday, May 16:

A special additional activity. (For "early birds" only).

<http://eilat.city/en/underwater-observatory-park>

We will wake up early in the morning and go to the Underwater Observatory before sunrise. There, we will go beneath the sea level into the observatory and watch the coral reef wake up. Which fish is sleepy and who is hungry to find food, day and night transition and changes in activity as the sun goes up. The excursion will be guided by BGU marine biologists who are studying the coral reef for many years.

Leaving the hotel Adi by minibus at 05:15. Arriving back to the hotel around 07:00.

The number of seats in the minibus is limited. Please reserve a seat only in the case that you 100% wake up earlier than 05:00.

Participants:

Spiros Argyros (National Technical University of Athens, Greece),
Kyle Austin (Ben-Gurion University, Israel),
Taras Banakh (University in Kielce, Poland and University of Lviv, Ukraine),
Yoav Benyamini (Technion, Israel),
Michael Brandenbursky (Ben-Gurion University, Israel),
Jesús Castillo (University of Extremadura, Spain),
Matija Cencelj (University of Ljubljana, Slovenia),
Dario Darji (University of Louisville, USA and Ashoka University, India),
Carlo De Bernardi (University of Milano, Italy),
Robert Deville (University of Bordeaux, France),
Tadeusz Dobrowolski (Pittsburg State University, USA)
Alexander Dranishnikov (University of Florida, USA),

Sudipta Dutta (Indian Institute of Technology Kanpur, India)*

Jerzy Dydak (University of Tennessee, USA),
Marian Fabian (Institute of Mathematics, Academy of Science, Prague, Czech Republic),
Michael Farber (Queen Mary's College of London, Great Britain),
Steve Ferry (Rutgers University, USA),
Tadeusz Figiel (IMPAN, Polish Academy of Sciences, Poland),
Vladimir Fonf (Ben-Gurion University, Israel),
Saak Gabrielyan (Ben-Gurion University, Israel),
Boris Goldfarb (State University at Albany, USA),
Petr Hájek (Institute of Mathematics, Academy of Science, Prague, Czech Republic),
Stavros Iliadis (Moscow University, Russia),
William Johnson (Texas A&M University, USA),
Jerzy Kąkol (University of Poznan, Poland),
Tomasz Kania (University of Warwick, Great Britain),
Kazuhiro Kawamura (University of Tsukuba, Japan),
James Keesling (University of Florida, USA),
Akira Koyama (Waseda University, Japan),
Sebastián Lajara (Escuela de Ingenieros Industriales, Albacete, Spain),
Arkady Leiderman (Ben-Gurion University, Israel),
Michael Levin (Ben-Gurion University, Israel),
Michael Lin (Ben-Gurion University, Israel),
Olga Maleva (University of Birmingham, Great Britain),
Elisabetta Maluta (Politecnico of Milano, Italy),
Vlasta Matijević (University of Split, Croatia),
Sergey Melikhov (Steklov Mathematical Institute, Moscow, Russia),
Enrico Migliarina (Universita Cattolica del Sacro Cuove, Milano, Italy),
Jan van Mill (University of Amsterdam, Holland),
Vitali Milman (Tel Aviv University, Israel),
Atish Mitra (Montana Tech of the University of Montana, USA),
Pavlos Motakis (Texas A&M University, USA),
Alexander Nabutovsky (University of Toronto, Canada),
Matěj Novotný (Institute of Mathematics, Academy of Science, Prague, Czech Republic),

Eve Oja (University of Tartu, Estonia),
Petar Pavesić (University of Ljubljana, Slovenia),
Tanmoy Paul (Indian Institute of Technology Hyderabad, India),
Matias Raja (University of Murcia, Spain),
Martin Rmoutil (University of Warwick, Great Britain),
Regina Rotman (University of Toronto, Canada),
Leonard Rubin (University of Oklahoma, USA),
Tomasso Russo (University of Milano, Italy),
Gideon Schechtman (Weizmann Institute of Science, Israel),
Pavel Semenov (Higher School of Economics, Moscow, Russia),
Evgeny Shchepin (Steklov Mathematical Institute, Moscow, Russia),
Olga Sipacheva (Moscow University, Russia),
Jacopo Somaglia (University of Milano, Italy),
Richard Smith (University College Dublin, Ireland),
Stanisław Spież (IMPAN, Polish Academy of Sciences, Poland),
Tulsi Srinivasan (Ashoka University, India),
Pedro Tradacete (University of Madrid, Spain),
Stanimir Troyanski (University of Murcia, Spain),
Silja Veidenberg (University of Tartu, Estonia),
Libor Veselý (University of Milano, Italy),
Žiga Virk (Institute of Science and Technology, Austria),
Clemente Zanco (University of Milano, Italy),
Michael Zarichnyi (University of Lviv, Ukraine and University of Rzeszów, Poland),
Nicoló Zava (University of Udine, Italy)

*Prof. Sudipta Dutta accepted our invitation to participate in the conference.
With great sorrow we report that Prof. Sudipta Dutta has passed away on 20.04.2017.

Scientific Committee:

Alexander Dranishnikov (University of Florida, USA),
William Johnson (Texas A&M University, USA),
Michael Levin (BGU, Israel),
Clemente Zanco (University of Milano, Italy)

Organizing Committee:

Arkady Leiderman (BGU, Israel) arkady@math.bgu.ac.il
Michael Lin (BGU, Israel), lin@math.bgu.ac.il

Conference Web page:

http://www.math.bgu.ac.il/~arkady/Eilat_2017_conference/main_page.html