Workshop in High-dimensional Phenomena and Convexity

Nahsholim, June 9th-13th, 2025

Timetable

Monday, June 9th

8:50–9:00	**Welcome remarks**	
9:00–9:40	**Emanuel Milman**	Spectral geometry and stability of soap-bubbles
9:50–10:30	**Arnon Chor**	A classification of isometries of the class of ball bodies
10:30–11:00	**Coffee Break**	
11:00–11:40	**Shiri Artstein-Avidan**	New results on Ball Bodies
11:50–12:30	**Manuel Fernandez V**	Distance theorems and the smallest singular of inhomogeneous random rectangular matrices
12:30–14:30	**Lunch**	
14:30–15:10	**Arianna Piana**	Stochastic Localization with Non-Gaussian Tilts and Applications to Tensor Ising Models
15:20–16:00	**Zsolt Lángi**	Uniform approximation of convex bodies by monostable polyhedra
16:00–16:30	**Coffee Break**	
16:30–17:10	**Ronen Eldan**	TBA
17:10–19:00	**Informal Discussions**	
19:00	**Dinner**	

Tuesday, June 10th

9:00–9:40	**Márton Naszódi**	John ellipsoids of revolution
9:50–10:30	**Gergely Ambrus**	Cube sections and the Laplace-Pólya integral
10:30–11:00	**Coffee Break**	
11:00–11:40	**Pazit Haim-Kislev**	A counterexample to Viterbo's conjecture
11:50–12:30	**Boaz Slomka**	The complex illumination problem
12:30–14:30	**Lunch**	
14:30–15:10	**Maud Szusterman**	Gaussian variant of the Banaszczyk transform
15:20–16:00	**Omer Friedland**	L^∞ Bounds for Eigenfunctions on Rough Domains via Diophantine Problems
16:00–16:30	**Coffee Break**	
16:30–17:10	**Problem session**	
17:10–19:00	**Informal Discussions**	
19:00	**Dinner**	

Wednesday, June 11th

9:00–9:40	**Bo'az Klartag**	Lattice packings of spheres in high dimensions
9:50–10:30	**Károly J. Böröczky**	Sphere packings in dimensions 8 and 24 – at the crossroad of geometry, number theory and Fourier analysis
10:30–11:00	**Coffee Break**	
11:00–11:40	**Matan Eilat**	Euclidean nets under isometric embeddings
11:50–12:30	**Victor-Emmanuel Brunel**	Deep points in curved spaces
12:30	**Lunch & Free Afternoon**	

Thursday, June 12th

9:00–9:40	**Gautam Aishwarya**	Entropy and functional forms of the dimensional Brunn–Minkowski inequality for the Gaussian measure
9:50–10:30	**Sudan Xing**	On Multiple L^p-curvilinear-Brunn-Minkowski inequality
10:30–11:00	**Coffee Break**	
11:00–11:40	**Dima Faifman**	Valuations on Lie groups, convolution and tubes
11:50–12:30	**Mokshay Madiman**	A characterization of Lebesgue measure via convex bodies
12:30–14:30	**Lunch**	
14:30–15:10	**Alexander Kolesnikov**	On p-Brunn-Minkowski and Brascamp-Lieb inequalities
15:20–16:00	**Sergey Bobkov**	Quantified Cramer-Wold continuity theorem for Kantorovich and Zolotarev distances
16:00–16:30	**Coffee Break**	
16:30–17:10	**Rotem Assouline**	Curvature-Dimension for Autonomous Lagrangians
17:10–19:00	**Informal Discussions**	
19:00	**Dinner**	

Friday, June 13th

9:00–9:40	**Dmitry Ryabogin**	On the homothety conjecture for convex bodies of flotation, a counterexample
9:50–10:30	**Alexander Litvak**	TBA
10:30–11:00	**Coffee Break**	
11:00–11:40	**Eli Putterman**	On unbalanced difference bodies and Godbersen's conjecture
11:50–12:30	**Gil Kur**	On the works of Paouris and Valettas and their connection to benign overfitting
12:30	**Lunch**	

List of Abstracts

Gautam Aishwarya (Michigan State University)

Title: Entropy and functional forms of the dimensional Brunn– Minkowski inequality for the Gaussian measure

The Gaussian measure in n-dimensional Euclidean space satisfies $1/n$-concavity under Minkowski averages when restricted to origin-symmetric convex bodies—a result first established by Eskenazis and Moschidis, resolving a conjecture of Gardner and Zvavitch. In this talk, we present a more general entropy formulation of this result, derived via mass transport techniques. This entropy perspective not only provides an alternative proof of the original geometric inequality but also naturally yields its functional analogues.

Gergely Ambrus (University of Szeged and Rényi Institute)

Title: Cube sections and the Laplace-Pólya integral

Calculating and estimating the volume of hyperplane sections of the cube has been in the center of attention for over a century. Most results rely on an integral formula for the volume that dates back to Pólya, and has its origins in Laplace's work in probability. We consider central hyperplane sections and provide estimates for them. In particular, we prove the existence of non-diagonal critical sections, and establish inequalities whose combinatorial counterparts were proved earlier by Lesieur and Nicolas. Our approach is purely combinatorial, and it is based on recursive properties of the Laplace-Pólya integral, which stands in stark contrast with previous results which apply involved analytical estimates.

This is a joint work with Barnabás Gárgyán (Warwick & Szeged)

Shiri Artstein-Avidan (Tel-Aviv University)

Title: New results on Ball Bodies

TBA

Rotem Assouline (Weizmann Institute of Science)

Title: Curvature-Dimension for Autonomous Lagrangians

The talk will introduce a new curvature-dimension condition for autonomous Lagrangians on weighted manifolds. We will see that, like its Riemannian counterpart, this condition is equivalent to displacement convexity of entropy along cost- minimizing interpolations in an L^1 sense, and that it implies various familiar consequences of lower Ricci curvature bounds. As examples, we will consider classical and isotropic Lagrangians on Riemannian manifolds. In particular, we will state a generalization of the horocyclic Brunn-Minkowski inequality to complex hyperbolic space of arbitrary dimension, and a new Brunn-Minkowski inequality for contact magnetic geodesics on odd-dimensional spheres.

Sergey Bobkov (University of Minnesota)

Title: Quantified Cramer-Wold continuity theorem for Kantorovich and Zolotarev distances

Upper bounds for the Kantorovich and Zolotarev distances for probability measures on multidimensional Euclidean spaces are given in terms of similar distances between one dimensional projections of the measures. This quantifies the Cramer-Wold continuity theorem about the weak convergence of probability measures.

Károly J. Böröczky (University of Budapest)

Title: Sphere packings in dimensions 8 and 24 – at the crossroad of geometry, number theory and Fourier analysis

The problem of dense packings of equal spheres in $\mathbb{R}^n$ – a problem arising in number theory and geometry – goes back to Kepler, Lagrange and Gauss, still the optimal density is only known in dimensions $n = 2, 3, 8, 24$. Our main focus is the cases $n = 8, 24$ where the $E8$ lattice and the Leech lattice are optimal. We sketch history, and how a little lemma in Fourier analysis set up the scene to Maryna Viazovska's groundbreaking results using modular forms. At the end, the structure of the close to be optimal packings is described in dimensions 8 and 24, a joint result with Joao Ramos and Danylo Radchenko.

Victor-Emmanuel Brunel (ENSAE)

Title: Deep points in curved spaces

In this talk, based on a joint work with Shin-ichi Ohta (Osaka University) and Jordan Serres (Institut National des Sciences Appliquées, Toulouse), I will present a generalization of Grunbaum's inequality to curved spaces. This inequality states that in Euclidean spaces, uniform distributions on convex bodies and, more generally, log-concave distributions, have deep points in Tukey's sense: There always exists a point such that any half-space containing that point has mass bounded from below by some universal positive constant. This fact is important in high dimensional statistics because it allows to discriminate deep points from shallow points even in high dimensions. It also has applications in convex optimization, e.g., to prove the algorithmic performance of cutting plane methods in high dimensions.

We extend this inequality to non-Euclidean spaces that satisfy a curvature-dimension condition, where splitting theorems allow to extend the definition of half-spaces and reduce the analysis to one-dimensional computations.

Arnon Chor (Tel-Aviv University)

Title: A classification of isometries of the class of ball bodies

We classify all isometries of the class of ball- bodies, i.e. convex bodies which are intersections of unit Euclidean balls, w.r.t. the Hausdorff metric. More precisely, we show that any such isometry is, up to rigid motions, either the identity or the so- called "c-duality" isometry. Based on joint work with Shiri Artstein-Avidan and Dan Florentin.

Matan Eilat (Tel-Aviv University)

Title: Euclidean nets under isometric embeddings

Suppose that there exists a discrete subset X of a complete, connected, n-dimensional Riemannian manifold M such that the Riemannian distances between points of X correspond to the Euclidean distances of a net in $\mathbb{R}^n$. What can then be derived about the geometry of M?

In previous joint work with Bo'az Klartag we showed that if $n = 2$ then M is isometric to $\mathbb{R}^2$. In this talk we show two consequential geometric properties that the manifold M shares with the Euclidean space in any dimension. The first property is that X is a net with respect to the Riemannian distance in M. The second property is that all geodesics in M are distance minimizing, and there are no conjugate points in M. This demonstrates the possibility of inferring infinitesimal qualities from discrete data, even in higher dimensions. As a corollary we obtain that the large-scale geometry of M is asymptotically Euclidean.

Ronen Eldan (OpenAI)

Title: TBA

Dima Faifman (University of Montreal)

Title: Valuations on Lie groups, convolution and tubes

The convolution of translation-invariant valuations is closely tied to Minkowski sum and additive kinematic formulas. It was extended by Alesker and Bernig to smooth valuations on compact Lie groups. We find an explicit formula for this convolution in terms of differential forms. We then apply it to study the volume of tubes for a bi-invariant metric on a Lie group. We also use it to generalize convolution to smooth bi-invariant valuations on arbitrary unimodular Lie groups, and find all groups with nontrivial algebras of bi-invariant valuations. Joint work with A. Bernig and J. Kotrbatý.

Manuel Fernandez V (Georgia Institute of Technology)

Title: Distance theorems and the smallest singular of inhomogeneous random rectangular matrices

In recent years, significant progress has been made in our understanding of the quantitative behavior of random matrices. Such results include delocalization properties of eigenvectors and tail estimates for the smallest singular value. A key ingredient in their proofs is a 'distance theorem', which is a small ball estimate for the distance between a random vector and subspace. Building on work of Livshyts and Livshyts, Tikhomirov and Vershynin, we introduce a new distance theorem for inhomogeneous vectors and subspaces spanned by the columns of an inhomogeneous matrix. Such a result has a number of applications for generalizing results about the quantitative behavior of i.i.d. matrices to matrices without any identical distribution assumptions. To highlight this, we show that the smallest singular value estimate of Rudelson and Vershynin, proven for i.i.d. subgaussian rectangular matrices, holds true for inhomogeneous and heavy-tailed matrices.

This talk is partially based on joint work with Max Dabagia.

Omer Friedland (Sorbonne University)

Title: L^∞ Bounds for Eigenfunctions on Rough Domains via Diophantine Problems

We introduce a new method to obtain sharp L^∞ bounds for eigenfunctions of partial differential operators on arbitrary domains, without any assumptions on boundary regularity, boundary conditions, or spectral theory.

Our approach resolves longstanding open problems originating in the 1960s concerning eigenfunctions on rough and unbounded domains, extending the classical results of Hörmander, Agmon, and Seeley to settings previously considered inaccessible. The core of the method reduces the analytic problem to a novel Diophantine counting argument involving the principal symbol of the operator. Applications include Schrödinger operators on domains with fractal boundaries, unbounded domains, and non-self-adjoint operators, where traditional spectral techniques fail.

Pazit Haim-Kislev (Princeton University)

Title: A counterexample to Viterbo's conjecture

Symplectic capacities are invariants arising from various themes in Hamiltonian dynamics and symplectic topology which, roughly speaking, measure the "symplectic size" of sets. Although convexity itself is not preserved under symplectomorphisms, symplectic capacities exhibit distinctive properties when restricted to the class of convex domains. A related natural question is Viterbo's volume-capacity conjecture from 2000, an isoperimetric-type problem positing that among all convex domains of a given volume, the ball possesses the largest capacity. This simply formulated question has managed to capture the nontrivial interplay between convex and symplectic geometries, becoming highly influential in the study of symplectic capacities.

In this talk, I will present a recent counterexample to Viterbo's conjecture based on joint work with Yaron Ostrover. This result opens new avenues of investigation, including the possibility of modified versions of the conjecture and a deeper exploration of the role of convexity within symplectic geometry.

Bo'az Klartag (Weizmann Institute of Science)

Title: Lattice packings of spheres in high dimensions

We prove that in any dimension n there exists an origin-symmetric ellipsoid of volume cn^2 that contains no points of $\mathbb{Z}^n$ other than the origin, where $c > 0$ is a universal constant. Equivalently, there exists a lattice sphere packing in $\mathbb{R}^n$ whose density is at least $cn^2/2^n$. Previously known constructions of sphere packings in $\mathbb{R}^n$ had densities of the order of magnitude of $n/2^n$, up to logarithmic factors. Our proof utilizes a stochastically evolving ellipsoid that accumulates at least cn^2 lattice points on its boundary, while containing no lattice points in its interior except for the origin.

Alexander Kolesnikov (Higher school of economics)

Title: On p-Brunn-Minkowski and Brascamp-Lieb inequalities

We show that a strong version of the Brascamp- Lieb inequality for symmetric log-concave measure with α-homogeneous potential V is equivalent to a p-Brunn-Minkowski inequality for level sets of V with some $p(\alpha, n) < 0$. We establish links between several inequalities of this type on the sphere and the Euclidean space. Exploiting these observations we prove new sufficient conditions for symmetric p-Brunn- Minkowski inequality with $p < 1$. Joint work with Galyna Livshyts and Liran Rotem.

Gil Kur (ETH Zurich)

Title: On the works of Paouris and Valettas and their connection to benign overfitting

In this talk, we will explore the close connections between the phenomenon of benign overfitting — such as minimum norm interpolation — and several works by Paouris and Valettas. These include their proposed minimal variance position, the convex small deviation inequality for Gaussians, and random versions of Dvoretzky's theorem in ℓ_p^n. No prior background will be assumed.

Zsolt Lángi (Budapest University of Technology)

Title: Uniform approximation of convex bodies by monostable polyhedra

A convex polyhedron in $\mathbb{R}^3$ is called *monostable* if it can be balanced on a horizontal plane only on one of its faces. These objects were introduced by Conway at the end of the 1960s, and were described by Shephard in a 1968 paper as 'a remarkable class of convex polyhedra whose properties it would probably be very rewarding and interesting to make a study of'. In 1969 three problems were proposed by Conway regarding monostable polyhedra, which since then have been re-stated in some open problem books on geometry. Two of these problems were solved by the presenter in a recent paper. In this talk we sketch the solution of the third problem, asking the following: Which convex bodies can be approximated arbitrarily well, measured in Hausdorff distance, by monostable polyhedra? This is a joint work with Csaba D. Tóth.

Alexander Litvak (University of Alberta)

Title: TBA

Mokshay Madiman (University of Delaware)

Title: A characterization of Lebesgue measure via convex bodies

We show that any Radon measure that is supermodular on the class of convex bodies in a finite-dimensional real vector space must be a multiple of the Lebesgue measure. Equivalently, weighted versions of certain mixed volumes (sometimes called "mixed measures") are nonnegative on the class of convex bodies if and only if the weighting measure is a multiple of the Lebesgue measure. These new characterizations of Lebesgue measure are somewhat surprisingly delicate; slight relaxations of the assumptions break the characterization. The talk is based on joint work with Matthieu Fradelizi, Dylan Langharst, and Artem Zvavitch.

Emanuel Milman (Technion – Israel Institute of Technology)

Title: Spectral geometry and stability of soap-bubbles

We develop the spectral analysis of the Jacobi operator on the interfaces of soap-bubble clusters. By Plateau's laws, these always meet in threes at 120°-angles, and thus naturally interact via 3 linearly independent "conformal" boundary conditions (a mixture of Dirichlet and Robin). This gives rise to a self-adjoint operator, whose spectral properties determine the *stability* of the soap-bubbles – whether an infinitesimal regular perturbation preserving volume to first order yields a non-negative second variation of area modulo the volume constraint. In essence, stability amounts to verifying a Poincaré-type inequality on soap-bubble clusters.

We verify that for all $n \geq 3$ and $2 \leq k \leq n+1$, the standard k-bubble clusters, conjectured to be minimizing total perimeter in $\mathbb{R}^n$, $\mathbb{S}^n$ and $\mathbb{H}^n$, are indeed stable. In fact, stability holds for all Möbius-flat *partitions*, in which several cells are allowed to have infinite volume. In the Gaussian setting, any partition in $\mathbb{G}^n$ ($n \geq 2$) obeying Plateau's laws and whose interfaces are all *flat*, is stable. Our proof relies on a new conjugated Brascamp-Lieb inequality on partitions with conformally flat umbilical boundary, and the construction of a good conformally flattening boundary potential.

Joint work with Botong Xu.

Márton Naszódi (Rényi Institute)

Title: John ellipsoids of revolution

The largest volume ellipsoid E contained in a convex body K in d-dimensional space is a central object in convexity. Fritz John gave conditions in terms of the contact points of K and E guaranteeing that E is of largest volume. In this joint work with Grigory Ivanov, Zsolt Lángi and Ádám Sagmeister, we study the problem of finding the largest volume ellipsoid of revolution in K.

Arianna Piana (Weizmann Institute of Science)

Title: Stochastic Localization with Non-Gaussian Tilts and Applications to Tensor Ising Models

We present generalizations and modifications of Eldan's Stochastic Localization process, extending it to incorporate non-Gaussian tilts, making it useful for a broader class of measures. As an application, we introduce new processes that enable the decomposition and analysis of non-quadratic potentials on the Boolean hypercube, with a specific focus on quartic polynomials. Using this framework, we derive new spectral gap estimates for tensor Ising models under Glauber dynamics, resulting in rapid mixing. Joint work with Dan Mikulincer.

Eli Putterman (Tel-Aviv University)

Title: On unbalanced difference bodies and Godbersen's conjecture

The longstanding Godbersen's conjecture states that for any convex body $K \subset \mathbb{R}^n$ of volume 1 and any $j \in \{0, \dots, n\}$, the mixed volume $V_j = V(K[j], -K[n-j])$ is bounded by $\binom{n}{j}$, with equality if and only if K is a simplex. We demonstrate that several consequences of this conjecture are true: certain families of linear combinations of the V_j-s, arising from different geometric constructions, are bounded above by their values when one substitutes $\binom{n}{j}$ for V_j, with equality if and only if K is a simplex. To prove these results we introduce new twists on some classical geometric constructions of Rogers and Shephard. Our tools include the ubiquitous Rogers-Shephard inequality for sections and projections on the one hand, and a local Steiner formula of Hug, Last and Weil which deserves to be better known on the other.

Dmitry Ryabogin (Kent State University)

Title: On the homothety conjecture for convex bodies of flotation, a counterexample

This is a joint work with Maria Alfonseca, Fedor Nazarov, Alina Stancu and Vlad Yaskin.

Let K be a convex body in $\mathbb{R}^2$. For every $\theta \in \mathbb{R}$ and the corresponding unit vector $e(\theta) = (\cos\theta, \sin\theta)$ and for every $t \in \mathbb{R}$, define the half-planes

$$W^+(\theta, t) = \{x : \langle x, e(\theta)\rangle \geq t\} \quad \text{and} \quad W^-(\theta, t) = \{x : \langle x, e(\theta)\rangle \leq t\}.$$

If $0 < \mathcal{D} < 1$, then for every $\theta \in \mathbb{R}$, there is a unique $t(\theta)$ such that

$$\mathrm{vol}_2(W^+(\theta, t(\theta)) \cap K) = \mathcal{D}\,\mathrm{vol}_2(K).$$

The corresponding convex body of flotation $K^{\mathcal{D}}$ is defined as

$$K^{\mathcal{D}} = \bigcap_{\theta \in \mathbb{R}} W^-(\theta, t(\theta)).$$

We investigate the homothety conjecture for convex bodies of flotation of planar domains. We show that there is a density close to $\frac{1}{2}$ for which there is a body K different from an ellipse with the property that $K^{\mathcal{D}}$ is homothetic to K.

Boaz Slomka (Open University of Israel)

Title: The complex illumination problem

We formulate a new analog of Hadwiger's illumination conjecture for complex convex bodies, along with its fractional version. We compute the illumination number of the polydisc, which plays a central role in this setting, and verify the conjectures for the classes of complex zonotopes and zonoids.

Joint work with Liran Rotem and Alon Schejter.

Maud Szusterman (University of Warsaw)

Title: Gaussian variant of the Banaszczyk transform

To derive his 5K-theorem, Banaszczyk introduced (in 1998) a transform of convex bodies which tends to stretch them in one direction. The monotonicity of this transform for the gaussian measure, is crucial to derive the combinatorial application. By studying a more simple variant of the transform he introduced, we obtain an alternative proof of this monotonicity, as well as new inequalities. However, one cannot use the latter transform to derive certain strengthenings of the 5K-theorem, as obtained by Dadush et al. (2020) : if time permits, we will explain why.

Sudan Xing (University of Arkansas at Little Rock)

Title: On Multiple L^p-curvilinear-Brunn-Minkowski inequality

In this talk, the extension of the curvilinear summation for bounded Borel measurable sets to the L_p space for multiple power parameters is introduced. Based on the multiple L_p-curvilinear summation, we establish the multiple Lp curvilinear- Brunn-Minkowski inequality for bounded Borel measurable sets. We also present the proof of multiple L_p Borell-Brascamp-Lieb inequality as well as its normalized version for functions. This talk is based on the joint work with Dr. Michael Roysdon.

List of Participants

Gautam Aishwarya	Michigan State University
Gergely Ambrus	University of Szeged and Rényi Institute
Shiri Arstein Avidan	Tel-Aviv University
Rotem Assouline	Weizmann Institute of Science
Avi Berman	Technion - Israel Institute of Technology
Sergey Bobkov	University of Minnesota
Károly Böröczky	University of Budapest
Victor-Emmanuel Brunel	ENSAE
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Tomer Falah	Technion - Israel Institute of Technology
Manuel Fernandez	Georgia Institute of Technology
Omer Friedland	Sorbonne University
Ho Fu-Hsuan	Weizmann Institute of Science
Boaz Guberman	Tel-Aviv University
Pazit Haim-Kislev	Princeton University
Ben Jaye	Georgia Institute of Technology
Chrisitian Kipp	TU Berlin
Bo'az Klartag	Weizmann Institute of Science
Sasha Kolesnikov	Higher School of Economics
Gil Kur	ETH Zurich
Zsolt Lángi	Budapest University of Technology
Sasha Litvak	University of Alberta
Galyna Livshyts	Georgia Institute of Technology
Mokshay Madiman	University of Delaware
Davide Manini	Technion - Israel Institute of Technology
Dan Mikulincer	University of Washington
Emanuel Milman	Technion - Israel Institute of Technology
Vitali Milman	Tel-Aviv University
Ilya Molchanov	University of Bern
Márton Naszódi	Rényi Institute
Shahaf Nitzan	Georgia Institute of Technology
Arianna Pianna	Weizmann Institute of Science
Achintya Raya Polavarapu	Georgia Institute of Technology
Eli Putterman	Tel-Aviv University
Martin Rappaport	Carnegie Mellon University
Liran Rotem	Technion - Israel Institute of Technology
Dima Ryabogin	Kent State University
Shay Sadovsky	Courant Institute

Gideon Schechtman	Weizmann Institute of Science
Alon Schejter	Technion - Israel Institute of Technology
Vadim Semenov	Brown University
Boaz Slomka	Open University of Israel
Sasha Sodin	The Hebrew University of Jerusalem
Maud Szusterman	University of Warsaw
Sudan Xing	University of Arkansas at Little Rock
Botong Xu	Technion - Israel Institute of Technology