ASYMPTOTIC GEOMETRIC ANALYSIS

Euler International Mathematical Institute

SAINT PETERSBURG
June 20 – June 24, 2013

CONFERENCE PROGRAM

Thursday, June 20

10:30–11:10	**Registration**
11:10–11:20	**Opening**
11:20–11:50	**V. Milman** *Geometric study of convex and quasi-concave functions in* $\mathbb{R}^n$
11:50–12:30	Coffee Break
12:20–13:00	**R. Adamczak** *The circular law under* log-*concavity*
13:00–14:50	Lunch
14:50–15:30	**O. Guédon** *Thin shell estimates for convex measures*
15:30–16:10	**O. Reynov** *Eigenvalues problems in spaces of nontrivial types and cotypes*
16:10–16:40	Coffee Break
16:40–17:20	**V. Yaskin** *Counterexamples to convexity of* k*-intersection bodies*
17:30–18:00	**B. Farrell** *Random unitary matrices with structure*

Friday, June 21

10:30–11:10	**R. Vershynin** *Smoothed analysis of random matrices*
11:20–11:50	**K. Tikhomirov** *Random vectors with i. i. d. coordinates: concentration and Dvoretzky's theorem*
11:50–12:20	Coffee Break
12:20–13:00	**A. Lytova** *The central limit theorem for linear statistics of the sum of rank one matrices with* log-*concave distribution*
13:00–14:50	Lunch
14:50–15:30	**D. Chafaï** *Aspects of Coulomb gases*
15:40–16:20	**M. Naszódi** *Push forward measures and concentration Phenomena*

Saturday, June 22

10:30–11:10	**M. Rudelson** *Permanent estimators via random matrices*
11:20–11:50	**D. Alonso-Gutiérrez** *Some estimates for random polytopes and their perturbations*
11:50–12:20	Coffee Break
12:20–13:00	**A. Zvavitch** *Uniqueness questions in convex geometry*
13:00–14:50	Lunch
14:50–15:30	**C. Schütt** *Affine invariant points*
15:40–16:10	**A. Segal** *Steiner symmetrization of p-convex sets*
16:10–16:40	Coffee Break
16:40–17:20	**E. Werner** L_p *affine surface areas for* log-*concave functions*
17:30–18:00	**U. Caglar** *Divergence for s-concave and* log-*concave functions*

Sunday, June 23

10:30–11:10	**M. Madiman** *Entropy and the additive combinatorics of probability densities on* $\mathbb{R}^n$
11:20–11:50	**B. Khabibullin** *Helly's Theorem and translation of convex sets*
11:50–12:20	Coffee Break
12:20–13:00	**M. Fradelizi** *Volume of polar of random sets and Blaschke–Santalo's type inequalities*
13:00–15:00	Lunch

Monday, June 24

EXCURSION

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ABSTRACTS

Adamczak Radosław, University of Warsaw, Warsaw, Poland

The circular law under log*-concavity*

I will discuss the circular law theorem for two models of random matrices in which independence of the entries is replaced by log-concavity:

1) matrices with independent isotropic log-concave columns,

2) matrices distributed according to a log-concave unconditional isotropic distribution (unconditionality and isotropy are considered with respect to the standard basis in the space of matrices). This part will be based on recent joint work with Djalil Chafaï.

Alonso-Gutiérrez David, Universidad de Murcia, Murcia, Spain

Some estimates for random polytopes and their perturbations

Let $X_1, \ldots, X_N$ be independent random vectors in $\mathbb{R}^n$ distributed according to an isotropic log-concave probability measure and let K_N be the random polytope $K_N = \mathrm{conv}\{\pm X_1, \ldots, \pm X_N\}$. Also, given a vector $y \in \mathbb{R}^N$ we denote by $K_{N,y} = \mathrm{conv}\{\pm y_1 X_1, \ldots, \pm y_N X_N\}$. We will give estimates for the expected value of the mean outer radii of K_N as well as some high probability results. We will also estimate the expected value of the mean width of $K_{N,y}$ when y is a random vector distributed with respect some probaility measures. This estimate will hold with high probability for y due to concentration of measure results.

Caglar Umut, Case Western Reserve University, Cleveland, OH, USA

Divergence for s-concave and log*-concave functions*

In information theory, probability theory and statistics, an f-divergence is a function that measures the difference between two (probability) distributions. It is a generalization of commonly used divergences such as relative entropy (Kullback–Leibler divergence), Renyi divergences, total variation distance, etc. In this paper we introduce f-divergence for s-concave and for log-concave functions. This is based on a joined work with C. Schütt and E. Werner.

Chafaï Djalil, Université Paris-Est, Marne-la-Vallée, France

On Calogero-Sutherland gases

We will present certain systems of interacting particles confined by an external field and experiencing pair repulsion. Such systems appear naturally in random matrix models. The first order global asymptotics of the empirical measure of the particles is captured by a large deviation principle. The convexity of the rate function is related to harmonic analysis. Its minimum is related to potential theory. We will also present various related problems, including the universality of the behavior at the edge of the gas.

Farrell Brendan, California Institute of Technology, Pasadena, CA, USA

Random unitary matrices with structure

Matrices with uniform distribution on the set of unitary matrices are the cannonical type of matrix to work with in many settings. For example, selecting a random subset of the columns of such a matrix gives a uniform distribution on subspaces of a certain dimension. Yet, there are distributions on the set of unitary matrices that allow for more structure and less randomness while still retaining important properties of uniformly distributed random unitary matrices. We present recent results for unitary matrices constructed using a Hadamard matrix and a signed permutation matrix or Kronecker products of a uniformly distributed unitary matrix. The structured approach also very naturally leads to formulations of discrete uncertainty principles. This is a joint work with G. Anderson and R. R. Nadakuditi.

Fradelizi Matthieu, Université Paris-Est, Marne-la-Vallée, France
Volume of polar of random sets and Blaschke–Santaló's type inequalities

We prove a dual version of Groemer's inequality on the volume of random convex sets: we establish that the volume of the polar of random sets is maximized when you are sampling from the Euclidean ball. The proof uses the rearrangement inequality of Brascamp–Lieb–Luttinger and an extension of the Campi–Gronchi inequality on the volume of the polar of shadow systems of symmetric convex sets. The result is applied to give a probabilistic proof of a generalized Blaschke–Santaló inequality and other affine isoperimetric inequalities. This is a joint work with Dario Cordero-Erausquin, Grigoris Paouris and Peter Pivovarov.

Guédon Olivier, Université Paris-Est, Marne-la-Vallée, France
Thin shell estimates for convex measures

We present some recent developments about high dimensional concentration phenomena in convex geometry. We discuss the extensions of thin shell estimates to the case of s-concave measures for $s < 0$, which corresponds to some heavy tailed measures.

Khabibullin Bulat, Bashkir State University, Ufa, Russia
Helly's Theorem and translation of convex sets

As usual, denote by $\mathbb{R}$ the set of real numbers, and $n \geq 1$ is integer. For $C, S \subset \mathbb{R}^n$,

- *the set-theoretic difference* $C \setminus S := \{c \in C \colon c \notin S\}$;
- *the vector difference* $C - S := \{c - s \colon c \in C, s \in S\}$
- *the geometrical difference* $C \overset{*}{-} S := \{x \in \mathbb{R}^n \colon S + x \subset C\}$

Let A and B are index sets. Suppose all sets C_α, $\alpha \in \mathrm{A}$, are convex in $\mathbb{R}^n$, and S_β, $\beta \in \mathrm{B}$, are arbitrary sets in $\mathbb{R}^n$. Let

$$C := \bigcap_{\alpha \in \mathrm{A}} C_\alpha, \quad S := \bigcup_{\beta \in \mathrm{B}} S_\beta.$$

We investigate the following problems. What relations will be between C and S, if for any sets of indexes $\{\alpha_0, \dots, \alpha_n\} \subset \mathrm{A}$, $\{\beta_0, \dots, \beta_n\} \subset \mathrm{B}$ *the difference*

- $\bigcap_{k=0}^{n} C_{\alpha_k} \setminus S_{\beta_k}$ *is non-empty set?*
- $\bigcap_{k=0}^{n} \bigl(C_{\alpha_k} - S_{\beta_k}\bigr)$ *is non-empty set?*
- $\bigcap_{k=0}^{n} \bigl(C_{\alpha_k} \overset{*}{-} S_{\beta_k}\bigr)$ *is non-empty set?*

Our research essentially uses the Helly's Theorem on the intersection of convex sets.

This work are supported by the grant RFBR, 13-01-00030a, and the Ministry of Education and Science (Russia), the agreement 14.B37.21.0358.

Lytova Anna, Institute for Low Temperature Physics, Kharkov, Ukraine

The central limit theorem for linear statistics of the sum of rank one matrices with log*-concave distribution*

We consider $n \times n$ real symmetric random matrices $M_n = \sum_{\alpha=1}^m \tau_\alpha P_{y_\alpha}$, where $\tau_\alpha \in \mathbb{R}$, $P_{y_\alpha} = y_\alpha \otimes y_\alpha$ are the rank one operators determined by i.i.d. isotropic random vectors $\{y_\alpha\}_{\alpha=1}^m$ with log-concave common probability law. In [2] it was shown that if $m, n \to \infty$, $m/n \to c \in [0, \infty)$, and the normalized counting measures of amplitudes $\{\tau_\alpha\}_{\alpha=1}^m$ converge weakly, then the distributions of eigenvalues of M_n converge weakly in probability to a non-random limit found in [1]. Here we show that if, in addition, the probability law of y_α is even with respect to the each component $y_{\alpha j}$, $j = 1, \ldots, n$, and

$$\begin{aligned}
&\mathbf{E}\{y_{\alpha j}^2 y_{\alpha k}^2\} = n^{-2} + O(n^{-3}),\ j \neq k, \quad \mathbf{E}\{y_{\alpha j}^4\} = O(n^{-2}),\\
&\mathbf{E}\{|(A_n y_\alpha, y_\alpha) - n^{-1} \operatorname{Tr} A_n|^4\} = o(n^{-1}), \quad n \to \infty,
\end{aligned}$$

for any matrix A_n independent of y_α and having the uniformly bounded in n norm, then a wide class of linear eigenvalue statistics of M_n satisfies the CLT provided that the limiting distribution of $\{\tau_\alpha\}_{\alpha=1}^m$ vanishes sufficiently at infinity. The above conditions on the components of y_α hold, for example, for vectors uniformly distributed over the unit ball of ℓ_p^n, $B_p^n = \{x \in \mathbb{R}^n : \sum_{i=1}^n |x_i|^p \leq 1\}$.

[1] Marchenko V., Pastur L. (1967). The eigenvalue distribution in some ensembles of random matrices. *Math. USSR Sbornik* **1** 457–483.

[2] Pajor A., Pastur L. (2009). On the limiting empirical measure of eigenvalues of the sum of rank one matrices with log-concave distribution, *Studia Math.* **195** 1, 11–29.

Madiman Mokshay, University of Delaware, Newark, DE, USA and Yale University, New Haven, CT, USA

Entropy and the additive combinatorics of probability densities on $\mathbb{R}^n$

Several functional or probabilistic analogues of interesting results in convex geometry have been obtained over the years, replacing subsets of $\mathbb{R}^n$ by functions or probability densities, Minkowski summation of sets by various kinds of operations involving the functions or densities, and the volume of a set by some functional (in our instance, the Boltzmann–Shannon entropy). We will discuss some further work along these lines, particularly motivated by analogies with sumset estimates in additive combinatorics, whose original setting was the integers or other discrete groups. Our results include the fact that for independent, identically distributed random vectors X and X', the entropies of $X + X'$ and $X - X'$ strongly constrain each other; new Plunnecke–Ruzsa-type inequalities for the volumes of Minkowski sums of convex sets; and a probabilistic analogue for log-concave densities of the Rogers–Shephard difference body inequality. Based on joint works with Sergey Bobkov (University of Minnesota) and Ioannis Kontoyiannis (AUEB).

Milman Vitali, Tel Aviv University, Tel Aviv, Israel

Geometric study of convex and quasi-concave functions in $\mathbb{R}^n$

We will discuss extension of Minkowski polarization result to log-concave and quasi-concave functions as well as mixed integrals.

Naszódi Márton, Lorand Eotvos University, Budapest, Hungary

Push forward measures and concentration phenomena

We discuss how a concentration phenomenon can be transferred from one measure μ to another measure ν. First, we push forward μ by $\pi : \mathrm{supp}(\mu) \to \mathbb{R}^n$, where $\pi(x) = \frac{x}{\|x\|_L}\|x\|_K$, and obtain a concentration inequality in terms of the medians of the given norms (with respect to μ) and the Banach–Mazur distance between them. This approach is finer than simply bounding the concentration of the push forward measure in terms of the Banach–Mazur distance between K and L. Then we show that any normed probability space with exponential type concentration is far (even in an average sense) from subspaces of ℓ_∞. The sharpness of this result is shown by considering ℓ_p spaces. This is a joint work with C. Hugo Jiménez and Rafael Villa.

Reynov Oleg, Saint Petersburg State University, Saint Petersburg, Russia

Eigenvalues problems in spaces of nontrivial types and cotypes

It is known that for some s-nuclear operators ($s \in (0, 1]$) acting in L_p-spaces (or subspaces of L_p-spaces), the nuclear trace is well defined and equals the sum of all eigenvalues of the corresponding operators. All subspaces (or quotients) of L_p-spaces, for $p \in (1, \infty)$, are of nontrivial "type-cotype" and, as consequence, have some good approximation properties. In this talk, we mainly consider a Johnson–König–Maurey–Retherford case of (1-)nuclear operators in L_p-spaces and its generalization to the cases of quotient of subspaces of L_p-spaces.

It is known that all $T \in N(L_p)$, for $p \geq 2$, are of spectral type r with $1/r = 1/p+1/2$ (such L_p's have type 2 and cotype p). We note that the same is true for all subspaces of quotient (equivalently: for all quotient of subspaces) of corresponding L_p-spaces. The natural question is arised: let X be a Banach space of cotype q (resp., 2) and of type 2 (resp., p); is it true that every nuclear operator in X is of spectral type r where $1/r = 1/p + 1/2$ (resp., $1/r = 1/2 + 1/p'$)?

We give some (difficult) examples which show that the answer is negative. E.g., we show that there exists a Banach space X with $\sup \mathrm{type}\, X = 2$, $\inf \mathrm{cotype}\, X = 2$ and with the property that there is an $\epsilon > 0$ so that $N(X)$ is not of spectral type $1+\epsilon$. Moreover, this space does not have the Grothendieck approximation property.

This is a joint work with Qaisar Latif. The research was supported by the Higher Education Commission of Pakistan.

Rudelson Mark, University of Michigan, Ann Arbor, MI, USA

Permanent estimators via random matrices

The permanent of a square matrix is defined similarly to the determinant. It is the sum of products of entries over all "generalized diagonals", only without signs in front of the products. The evaluation of the determinant is computationally efficient, while the evaluation of the permanent is an NP-hard problem. Since the deterministic methods are not available, permanents are estimated probabilistically. One of such estimators constructed by Barvinok evaluates the permanent of a deterministic matrix via the determinant of a random matrix associated to it. Barvinok proved that the multiplicative error of this estimator is at most exponential, and this result cannot be improved for general matrices. We provide conditions on the matrix, under which the Barvinok estimator yields a subexponential error. This is a joint work with Ofer Zeitouni.

Schütt Carsten, Christian Albrechts University, Kiel, Germany
Affine invariant points

We answer in the negative a question by Grünbaum who asked if there exists a finite basis of affine invariant points. We give a positive answer to another question by Grünbaum about the “size” of the set of all affine invariant points. Related, we show that the set of all convex bodies K, for which the set of affine invariant points is all of $\mathbb{R}^n$, is dense in the set of convex bodies. Crucial to establish these results, are new affine invariant points, not previously considered in the literature. This is joint work with Mathieu Meyer and Elisabeth M. Werner.

Segal Alexander, Tel Aviv University, Tel Aviv, Israel
Isomorphic Steiner symmetrization of p-convex sets

We show that given a p-convex set $K \subset \mathbb{R}^n$, there exist $5n$ Steiner symmetrizations that transform it into an isomorphic Euclidean ball. That is, if $|K| = |D_n| = \kappa_n$, we may symmetrize it, using $5n$ Steiner symmetrizations, into a set K' such that $c_p D_n \subset K' \subset C_p D_n$, where c_p and C_p are constants dependent on p only.

Tikhomirov Konstantin, University of Alberta, Edmonton, AB, Canada
Random vectors with i. i. d. coordinates: concentration and Dvoretzky's theorem

Several results are proved regarding concentration of random vectors with i. i. d. coordinates in normed spaces. We apply these results to the study of random subspaces.

Vershynin Roman, University of Michigan, Ann Arbor, MI, USA
Smoothed analysis of random matrices

Smoothed analysis is a paradigm in computer science, which postulates that objects become better (less singular) when they are randomly perturbed. This talk will focus on random perturbations of matrices and their invertibility properties. There was a significant recent progress on perturbations by matrices with independent entries, symmetric, unitary and orthogonal matrices. In spite of this, there are natural phenomena that are not yet understood.

Werner Elisabeth, Case Western Reserve University, Cleveland, OH, USA
L_p affine surface areas for log-*concave functions*

We give a new proof of a reverse log Sobolev inequality for log-concave functions due to Artstein, Klartag, Schütt and Werner. We introduce L_p affine surface areas for log-concave functions.

Yaskin Vladyslav, University of Alberta, Edmonton, AB, Canada

Counterexamples to convexity of k-intersection bodies

It is a well-known result due to Busemann that the intersection body of an origin-symmetric convex body is also convex. Koldobsky introduced the notion of k-intersection bodies. We show that the k-intersection body of an origin-symmetric convex body is not necessarily convex if $k > 1$.

Zvavitch Artem, Kent State University, Kent, OH, USA

Uniqueness questions in convex geometry

Classical theorems in Convex geometry (and Harmonic Analysis) tell us that a symmetric star-shaped body is uniquely determined by the volumes of its hyperplane sections, moreover, if in addition to symmetricity we would also require convexity, then volume of orthogonal projections can be used instead of sections. It is also well know that in both cases symmetricity is required. A very natural question is what information on section/projections we need to require to have uniqueness for non-symmetric case? Volume of projections and Sections? Volume of "maximal" hyperplane section in all fixed directions?

We will start this talk with the discussion on some open problems related to those questions. We will also present a couple, recently constructed, counterexamples: we show that in all dimensions higher then 2, there exists an asymmetric convex body of revolution all of whose maximal hyperplane sections have the same volume. In addition we will show that if we fix even dimension greater or equal then 4, then one can find two essentially different convex bodies such that the volumes of their maximal sections, central sections, and projections coincide for all directions. The talk is combination of joint works with R. Gardner, F. Nazarov, D. Ryabogin and V. Yaskin.