Abstracts

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Noga Alon
Princeton University, USA
Tel Aviv University, Israel

Sign Patterns and Ordering

Motivated by a possible application in Social Choice, I will discuss a recent work with Defant, Kravitz and Zhu that studies the number of ways to order points in the plane or in higher dimension according to the sum of their Euclidean distances from chosen vantage points.

A crucial mathematical tool here is an extension of results of Milnor and Warren about sign patterns of real polynomials, that have been used in the study of several problems in Discrete Mathematics and theoretical Computer Science, to a version that deals with sign patterns of more general functions.

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Anurag Bishnoi
TU Delft, Netherlands

The Chromatic Number of Finite Projective Spaces

The chromatic number of a finite projective space is the minimum number of colors needed to color its points so that there are no monochromatic lines. I will present my recent joint work with Wouter Cames van Batenburg and Ananthakrishnan Ravi (arXiv:2512.01760), where we prove new upper bounds on this chromatic number. We also establish relations between the chromatic number and some problems from Ramsey theory. In particular, our upper bounds on the chromatic number and its generalization to higher dimensional subspaces imply new lower bounds on multicolor vector space Ramsey numbers. For the binary case, we also prove lower bounds on the chromatic number using a connection with the classical multicolor Ramsey numbers of triangles.

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Yijia Fang
National University of Singapore, Singapore

Canonical Ramsey Property for All Triangles

Euclidean Ramsey theory asks if we can find specific geometric structures in coloured space. A refined version of this, known as the canonical Ramsey property, asks: Does every finite colouring of Euclidean space contain a congruent copy of a shape that is either monochromatic or rainbow (all in different colours)?

While this was known for specific shapes, such as acute and right triangles, the question of whether all triangles satisfy this property remained open. In this talk, I will present a solution to this problem posed by Gehér, Sagdeev, and Tóth. We prove that 4-dimensional space is sufficient to guarantee the canonical property for all triangles including obtuse ones.

Joint work with Gennian Ge, Yang Shu, Qian Xu, Zixiang Xu, and Dilong Yang

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Boon Suan Ho
National University of Singapore, Singapore

How many Spanning Trees in a Bipartite Graph?

Given a bipartite graph G with parts of size m and n, Ehrenborg conjectured in 2006 that the number of spanning trees in G is at most the product of all vertex degrees, divided by mn. We will discuss a linear-algebraic proof of this bound, including a characterization of when equality holds.

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Zilin Jiang
Arizona State University, USA

Classification of Equiangular Lines with a Fixed Angle

Equiangular lines are a classical object at the intersection of discrete geometry and algebraic graph theory. A central question asks how many such lines can exist in a given dimension when the common angle is fixed.

In this talk, I will discuss joint work with Theodore Gossett, Adam Teets, and Zoe Wellner in which we completely classify equiangular line systems for one fixed angle. Beyond the classification itself, the work highlights a broader phenomenon: for some angles, the exceptional constructions are not merely worse than the standard constructions in high dimensions; they are bounded in size altogether.

I will explain the main ideas behind the classification, including how the problem is translated into graph-theoretic language, how the non-exceptional examples arise, and how the remaining exceptional cases are ruled out.

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Matthew Kwan
Institute of Science and Technology Austria, Austria

The No-4-in-line Problem

What is the maximum number of points one can place in an $n \times n$ grid such that every Euclidean line contains at most k points? For $k = 2$, this is the notorious no-three-in-line problem of Dudeney. We resolve this problem for all other k (and sufficiently large n). Namely, for $k \geq 3$ and sufficiently large n, we show that this maximum is exactly kn.

Joint work with Anubhab Ghosal, Ritesh Goenka, Alex Grebennikov, Peter Keevash and Huy Pham

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Joonkyung Lee
Yonsei University, Korea

Improved Bounds for Loose Odd Cycle Densities

While Sidorenko's conjecture remains open, its hypergraph generalisation is known to be false since Sidorenko's own work in the 1990s. Specifically, the homomorphism density $t\left(C_{2\ell+1}^{(r)}, G\right)$ of an r-uniform loose cycle in a hypergraph G of density p can be strictly less than $p^{2\ell+1}$. Recently, Nie and Spiro have focused on estimating the optimal exponent $s = s(r, \ell)$ such that $t\left(C_{2\ell+1}^{(r)}, G\right) \geq p^{2\ell+1+s}$, extending an earlier work of Fox, Sah, Sawhney, Stoner, and Zhao that settled the case $(r, \ell) = (3,1)$.

We significantly improve the recent upper bound of $s(r, \ell) \leq \frac{4\ell-1}{(r-1)(2\ell+1)-3}$ due to Deng, Han, Nie, and Spiro by proving that $s(r, \ell) \leq \frac{1}{r-2}$. Furthermore, for the r-expansion $E^r(H)$ of any k-graph H, we prove $t(E^r(H), G) \geq p^{e(H)+C_H/r}$ for a constant C_H, providing an approximate positive answer to a conjecture of Nie and Spiro.

We also address an interesting case of a general question raised by Blekherman, Raymond, Razborov, and Wei, asking whether the tightness of an inequality of the form $t(H, G) \geq p^s$ is evidenced by a (hyper)graph G with fixed density $p \in (0,1)$. We answer this in the negative for $H = C_3^{(3)}$ by obtaining nontrivial lower-order terms for $t\left(C_3^{(3)}, G\right)$ beyond p^4 for any fixed $p \in (0,1)$.

Our proofs utilise information-theoretic tools, including Pinsker's inequality and a novel hypergraph generalisation of Szegedy's edge-vertex transitivity reduction on Sidorenko's conjecture, which may be of independent interest.

Joint work with Ingyu Baek

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Anita Liebenau
UNSW Sydney, Australia

Asymptotic Enumeration of Latin Rectangles

We obtain an asymptotic formula for the number of $k \times n$ Latin rectangles for $k = o(n/\log^3 n)$, extending a classical result of Godsil and McKay (1990) from the regime $k = o\left(n^{6/7}\right)$. The proof builds on a probabilistic framework that we originally developed for the asymptotic enumeration of regular graphs of medium density. I will discuss the main ideas of the framework, its adaptation to Latin rectangles, and the additional challenges that arise in this setting.

Joint work with Kevin Leckey and Nick Wormald

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Jeck Lim
University of Oxford, UK

Dominoes Tiling a Common Figure

Call a two-element subset of $\mathbb{Z}^2$ a domino. Given finitely many dominoes $D_1, \dots, D_k$, we show that there exists a finite non-empty $B \subset \mathbb{Z}^2$ such that B can be partitioned into disjoint translates of D_i for all i.

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Hong Liu
Institute for Basic Science, Korea

Structural Reductions for Monochromatic Matchings and Ramsey Tilings

The Alon–Frankl–Lovász theorem determines the sharp guaranteed size of a monochromatic matching in every r-colouring of the complete t-uniform hypergraph, with known exact proofs relying on topology. In this talk, I will present a topology-free structural approach to its asymptotic form.

The main result shows that every colouring of a pseudorandom t-graph can be compressed, up to an $o(n)$ loss in the largest monochromatic matching, into a bounded-complexity template depending only on the intersection profile with at most r vertex parts. The proof uses hypergraph regularity, LP duality, and convex-geometric compression.

As applications, we recover the asymptotic Alon–Frankl–Lovász theorem, obtain sparse transference results, and extend the method to multicolour Ramsey-tiling problems in complete graphs, giving effective asymptotic formulas for the largest forced monochromatic H-tiling.

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Sam Mattheus
Vrije Universiteit Brussel, Belgium

Off-Diagonal Ramsey Numbers for Slowly Growing Hypergraphs

I will discuss how a method for lower bounding off-diagonal graph Ramsey numbers, pioneered by Mubayi and Verstraete, and refined over the last few years, can lead to results in hypergraph Ramsey theory. In our case, we were able to determine off-diagonal Ramsey numbers for a class of hypergraphs, which we call slowly growing. For specific examples in this class, the lower bounds we obtain are sharp up to polylogarithmic factors. We will given an overview of the method, the algebraic construction that lies at the foundation of our result, and survey some related work.

Based on joint work with Dhruv Mubayi, Jiaxi Nie, and Jacques Verstraete

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Dhruv Mubayi
University of Illinois Chicago, USA

Pentagons in Triple Systems

We consider the question of determining the minimum number of pentagons in a linear triple system with many edges and show some connections to number theory, graph theory, theoretical computer science, and geometry. This is joint work with Jozsef Solymosi.

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Cosmin Pohoata
Emory University, USA

Sidon Sets in the Squares, Repeated Distances, and
the Elekes–Ronyai Problem

We discuss a new combinatorial large-sieve method that uses algebraic splitting modulo many small primes to turn local congruence restrictions into global constraints on repeated values. This has various applications, for example: (i) every Sidon subset of $\{1^2, 2^2, \cdots, N^2\}$ has size at most $N \cdot \exp(-c \cdot logN/loglogN)$, the first super-polylogarithmic saving for a classical problem of Alon and Erdös; (ii) a new upper bound on the largest subset of $[N]^2$ with no repeated distances, a problem of Erdös and Guy; and (iii) a new upper bound on the largest subset of $[N]^2$ with no isosceles triangle, a problem recently popularized by Charton, Ellenberg, Wagner, and Williamson. Based on recent joint work with Ernie Croot, Junzhe Mao, Adam Sheffer, and Kyle Yip. We will also discuss how these ideas recently led to a counterexample for the Elekes–Ronyai problem (and to a few other constructions).

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Alexey Pokrovskiy
University College London, UK

Towards the Lovász Conjecture via Sublinear Expanders

Loász' Hamiltonicity conjecture states that every connected vertex-transitive graph has a Hamiltonian path. A stronger version of the conjecture, often attributed to Thomassen, states that every sufficiently large such graph even has a Hamiltonian cycle. Despite attention these conjectures have attracted from both the combinatorial and algebraic communities, for a long time the best known lower bound for the maximum length of a path/cycle in a connected vertex-transitive graph of order n remained of the form $\Omega(\sqrt{n})$, due to Babai. A series of recent works has successively improved the exponent in this lower bound culminating in the bound $\Omega(n^{9/14})$ due to Norin, Steiner, Thomassé, Wollan. In this talk we'll discuss an improvement - that every connected vertex-transitive graph of order n contains a cycle of length at least $n^{2/3-o(1)}$. This hits a natural barrier for several existing approaches from previous work. Our proofs combine recent embedding techniques for paths in sublinear expanders, sublinear expander decompositions of almost-regular graphs, and additional combinatorial ideas.

Joint work with Bucić, Christoph, and Steiner

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Rao Rui
National University of Singapore, Singapore

On the *(k+2)*-th Largest Degree of an Intersecting Family

Consider the family of all k-element subsets of $\{1, \ldots ,n\}$. A subfamily F is called intersecting if any two of its sets have non-empty intersection. Huang and Zhao proved that when $n>2k$, every intersecting family F contains an element i in $[n]$ that belongs to at most $\binom{n-2}{k-2}$ members of F. This bound is tight, being attained by 1-star: all k-sets containing a fixed element.

We show that, for n sufficiently large (depending on k), all but at most $k+1$ elements of $[n]$ have the same property: each of those elements appears in at most $\binom{n-2}{k-2}$ sets of F. The number $k+1$ is tight because of the Hilton--Milner construction of non trivial intersecting family.

Joint work with Hao Huang

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Jozef Skokan
London School of Economics and Political Science, UK

Breaking the Bollobás–Eldridge–Catlin Barrier for Bipartite Graphs

The celebrated Bollobás–Eldridge–Catlin packing conjecture states that every n-vertex graph G with minimum degree at least $\left(1 - \frac{1}{\Delta+1}\right) n$ contains every n-vertex graph H of maximum degree at most Δ. Despite considerable attention, the conjecture remains widely open.

We show that for bipartite H this threshold can be greatly improved: there is an absolute constant $c > 0$ such that every n-vertex graph G with minimum degree at least $\left(1 - c\frac{log\Delta}{\Delta}\right) n$ contains every n-vertex bipartite graph H of maximum degree at most Δ, provided Δ is not too large compared to n. Moreover, we prove that this logarithmic improvement is best possible up to the value of the constant.

Joint work with Peter Allen, Julia Böttcher and Benny Sudakov

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Benny Sudakov
ETH Zurich, Switzerland

Random Geometric Graphs: Ramsey Bounds and Testing Thresholds

The random geometric graph $G(n, S^d, p)$ is obtained by placing n random points independently and uniformly on the unit sphere S^d, and connecting two points whenever they are sufficiently close, with the threshold chosen so that each edge appears with probability p. The underlying geometry of the model creates correlations between edges, making its behavior richer than that of the corresponding binomial random graph $G(n, p)$.

A striking recent application of these correlations is due to Ma, Shen, and Xie, who used high-dimensional random geometric graphs to obtain an exponential improvement over Erd˝s's celebrated lower bound for $R(k, Ck)$, where $C > 1$ is fixed. I will discuss a simplification of their approach using Gaussian random geometric graphs, leading to a much shorter analysis and sharper quantitative bounds.

I will then turn to a complementary question: when does the geometry disappear? More precisely, for which dimensions d is $G(n, S^d, p)$ statistically indistinguishable from $G(n, p)$? This problem, introduced by Bubeck, Ding, Eldan, and Rácz, has attracted considerable interest across probability, theoretical computer science, and high-dimensional statistics. They conjectured that the threshold is governed by the signed triangle count, namely $d \asymp n^3p^3$ up to logarithmic factors. I will outline a proof of this conjecture for a wide range of p.

Based on joint work with Zach Hunter and Aleksa Milojevic

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Tuan Tran
University of Science and Technology of China, China

Tower Heights for Colour-avoiding Ramsey Numbers of Monotone Paths

For integers $q > p$, let $A_k(n; q, p)$ be the least integer N such that every q-coloring of the ordered complete k-uniform hypergraph on $\{1, \dots, N\}$ contains a monotone path of length n whose edges use at most p colors. We prove that, for every fixed p and all sufficiently large q, the exact tower height of $A_k(n; q, p)$ is $\left\lceil \frac{(k-1)}{p} \right\rceil$. Thus the number of colors allowed on the path affects the Ramsey number at the level of tower height: allowing p colors lowers the height from $k-1$ in the monochromatic problem to $\left\lceil \frac{(k-1)}{p} \right\rceil$. This answers questions of Mulrenin, Pohoata, and Zakharov.

The upper bound follows from a simple block-compression argument. The main contribution is the matching lower bound, for which we develop a novel variant of the stepping-up method. A surprising feature of the proof is the appearance of the Morse–Hedlund theorem, a foundational result in symbolic dynamics and combinatorics on words. We establish and use a finite version of this theorem, which may be of independent interest.

Joint work with Jigang Choi and Hyunwoo Lee

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Jacques Verstraete
University of California, San Diego, USA

Recent Progress on Erdös–Rogers Function

We let $f_{H,G}(n)$ denote the maximum k such that every n-vertex G-free graph contains an induced F-free subgraph with k vertices. When $F = K_2$ these are determined by Ramsey numbers $r(k, G)$, and the case $F = K_s$ and $G = K_{s+1}$ are the classical Erdös–Rogers functions, denoted $f_{s,s+1}(n)$. In this talk we survey recent progress, including the recent result of Morris, Saharasbudhe and the author showing for each $s \geq 2$ that $f_{s,s+1}(n) = \Theta\left(\sqrt{nlogn}\right)$ as $n \to \infty$.

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Fan Wei
Duke University, USA

Spectral and Trace Positivity of Matrix Words

Under what precise combinatorial conditions does a word in noncommuting matrix variables and their formal transposes universally evaluate to matrices with nonnegative eigenvalues or nonnegative trace, regardless of the dimension or entries of the substituted matrices? We provide a complete structural characterization of universally spectral positive matrix words. Crucially, we establish that in the pure monomial setting, both spectral and trace positivity exhibit an exact rigidity phenomenon analogous to Hermitian-square representations. This contrasts sharply with the broader polynomial setting, where tracial rigidity is known to fail even for approximation. As one application of our main theorems, we fully resolve open questions initially posed by Lieb and Pierce, and later conjectured by Hillar and Johnson from quantum statistical mechanics.

Joint work with Frederik Garbe

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Hehui Wu
Fudan University, China

The Product of Intersecting Families

For integers $k, \ell \geq 2$ let $m(k, \ell)$ denote the maximum of $|F||G|$ where the maximum is taken over all pairs of cross-intersecting families, F being a k-graph with covering number ℓ and G a ℓ-graph with covering number k (see the paper for the definitions). Erdos and Lovász initiated the study of the one family version. That is, they provided lower and upper bounds on the maximal size $m(k) = |F|$ where F is an intersecting k-graph with covering number k. In many similar situations $m(k, k) = m(k)^2$ holds. However, as our results show $\frac{m(k,k)}{m(k)^2}$ is tending to infinity as k grows. For $k > k_0$ we establish the exact value $m(k, \ell) = (\ell^{k-1} + \ell - 1)\left(k^{\ell-1} + k - 1\right)$ when $1 \ll logk < \ell < 2^k$. As to smaller values we prove $m(3,3) = 121$ and determine $m(2, k) = k2^k$ for all $k \geq 2$.

Joint work with Peter Frankl and my student, Long Lin

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Shengjie Xie
University of Science and Technology of China, China

Hypergraphs without Subgraphs of Given Connectivity

In this paper, we study the problem of determining the maximum number $F_r(n, k)$ of edges in an n-vertex r-uniform hypergraph that contains no $(k+1)$-connected subgraph.

The graph case, initiated by Mader, is a classical problem in graph theory that remains open. We first establish a limit theorem for $F_r(n, k)$ for all $k \geq r \geq 2$. As a consequence, we prove for the first time that, in Mader's problem (i.e., $r = 2$), there exists a constant $c_k > 0$ such that $F_2(n, k) = c_k n + O_k(1)$, and, for every $r \geq 3$, we determine $F_r(n, k)$ up to an $O(n)$ error term, thereby identifying its leading asymptotic term.

We also address a related question of Carmesin by establishing a tight bound for r-uniform hypergraphs with no $(k+1)$-connected subgraph on more than Ck vertices for any constant $C > 2$ and sufficiently large r, and further obtain an asymptotically tight bound in the case $C = 2$. Our proof combines the separator tree method introduced by Carmesin with several new combinatorial and optimization techniques, and we conclude with related remarks and open problems.

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Wei-Hsuan Yu
National Central University, Taoyuan

Semidefinite Programming Bounds for Designs on Spheres and Hamming Spaces

We use semidefinite programming (SDP) methods for spherical codes and energy minimization to improve lower bounds for designs on spheres and Hamming spaces in low-dimensional cases. In particular, we use the SDP to improve the bounds for Hamming designs (or orthogonal arrays, equivalently) and the harmonic index 4-designs on spheres.

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Ziyuan Zhao
University of Science and Technology of China, China

Longest Cycles meet Linearly in Highly Connected Graphs

A folklore conjecture in graph theory, often attributed to Smith (1979), asserts that any two longest cycles in a k-connected graph share at least k vertices. In this paper, we prove that, for every integer $k \geq 2$, any two longest cycles in a k-connected graph have at least $\frac{k}{4000}$ common vertices, establishing the first linear lower bound toward this conjecture. In contrast to previous approaches based on extremal techniques, our proof takes a novel structural approach. The proof combines a graph decomposition theorem, an extension of the Bondy–Locke theorem, and a weak form of Jung's conjecture. Joint work with Jie Ma and Bo Ning.

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