Titles and abstracts

Plenary talks

A. Barak Weiss (Tel Aviv University) – From elementary problems in billiards in polygons, to dynamics on the moduli space of translation surfaces

Abstract: The billiard in a polygon is a concrete and simple geometrical and dynamical playground. Loosely speaking one should think of the study of reflection of laser beams in a complicated hall of mirrors. In this topic there are many simple-minded problems, some of which took a long time to solve and some of which are still open. The moduli space of translation surfaces is a manifold of finite volume, parameterizing all possible flat geometries on a compact orientable surface of genus g (more precise definitions will be given in the talk). There is a natural action of the group $SL(2,R)$ on this space, and interestingly, it is possible to solve elementary problems about billiards by considering orbits for $SL(2,R)$ and its subgroups on this moduli space. Specifically, a breakthrough result of Eskin, Mirzakhani and Mohammadi from 2013, and ensuing work of many authors using a wide range of deep techniques, led to new results on billiards. I will explain this fascinating interaction in my talk. All necessary terms will be defined in the talk.

B. Shachar Carmeli (Copenhagen University, Nessyahu Prize Recipient) – The rank-growth of the stable homotopy groups of spheres

Abstract: Understanding the structure of the stable homotopy groups of spheres, known as the "stable stems", is one of the primary motivations for developing stable homotopy theory. The stable stems are a sequence of finitely generated abelian groups, all of which but the first are finite. While deriving a closed formula for the n-th group in this sequence seems hopeless, there are still natural questions to ask about them as a whole. One such question is the asymptotics of their size, namely, how the n-th stem grows with n. For instance, one can consider the number of cyclic summands, or "rank", of their p-primary parts .

In my talk, I will present a work-in-progress joint with Burklund, Hahn, Levy, Schlank, and Yanovski, showing that these ranks grow asymptotically in the following sense: the average rank of the p-primary parts of the first n stable stems grows to infinity with n.

Student talks

1. Evgeniya Ahmedova (Weizmann Instite) – The tropical amplituhedron

Abstract: The Amplituhedron is a geometric object discovered recently by Arkani-Hamed and Trnka, that provides a completely new direction for calculating scattering amplitudes in quantum field theory (QFT). We define a tropical analogue of this object, the tropicial amplituhedron, and study its structure and boundaries.

Our construction relies on new analysis of the tropical positive Grassmannian, another space that was also recently shown to have deep connections to QFTs.

2. Ziv Bakhajian (Weizmann Institute) – Drawing outerplanar graphs using thirteen edge lengths

Abstract: A linear embedding of a graph is its embedding in the plane, mapping vertices to points and edges to the open straight-line segments connecting them. The distance-number of a graph is the number of distinct distances between pairs of adjacent vertices in a linear embedding of the graph in the plane such that there is no intersection between the image of a vertex and that of an edge not containing it.

We show that the distance-number is uniformly bounded for outerplanar graphs. This extends the work of Alon and Feldheim, where only overlap between vertices was disallowed, thus settling a problem posed by Carmi, Dujmović, Morin, and Wood.

The proof involves intersection properties of complex polynomials and rational functions, along with probabilistic, combinatorial, algebraic, and geometric arguments.

Joint work with Ohad Feldheim.

3. Guy Blachar (Bar Ilan University) – Profinite rigidity of some lamplighter groups

Abstract: We say that a finitely generated residually finite group is profinitely rigid, if the group is determined (up to isomorphism) by its set of finite quotients. Equivalently, a group is profinitely rigid if it is determined (up to isomorphism) by its profinite completion. For example, all finitely generated abelian groups are profinitely rigid. However, Baumslag (1974) showed that there exist non-isomorphic meta-cyclic groups with isomorphic profinite completion, i.e., with the same set of finite quotients.

In this talk we will prove that lamplighter groups of the form $(Z/pZ)^n \wr Z$, where p is prime and $n \geq 1$, are profinitely rigid. We do this by analyzing the finite quotients of these lamplighter groups and reconstructing the lamplighter structure from them.

4. Roi Blumberg (Tel Aviv University) – Recursive computation of open Gromov-Witten invariants

Abstract: Given a symplectic manifold X, closed Gromov-Witten invariants provide, intuitively, an enumeration of pseudo-holomorphic curves in X that satisfy specified constraints. In 1994, Konsevitch and Manin proved that under some assumptions on X, these invariants can be recursively computed from a set of initial values.

Given a Lagrangian submanifold $L \subset X$, one may analogously define, under some conditions, open Gromov-Witten invariants. These invariants provide, intuitively, an enumeration of pseudo-holomorphic disks in X with boundary in L that satisfy specified constraints. In this talk, I will present a statement analogous to Konsevitch and Manin's result, for open invariants. No previous knowledge in Gromov-Witten theory will be assumed.

5. Rotem Brand (Bar Ilan University) – What is the most reliable graph with n nodes and m edges?

Abstract: Our collaborative research with the Israel Electrical Company focuses on developing methods to construct infrastructure networks that are both reliable and cost-effective. In this context, we examine networks where each edge can independently fail with a constant probability, denoted as p. To assess the reliability of a graph, we measure the expected number of disconnected nodes from the source node. Our objective is to determine if there exists a network that is the most reliable among all graphs with n nodes and m edges in the interval $0 < p < 1$. Alternatively, we investigate whether we can address this question when p approaches zero or one.

We demonstrate that k-regular graphs with high girth exhibit high reliability. Additionally, we propose the utilization of a reliable 3-regular graph to construct sparse networks with reliable performance. Furthermore, we highlight that improving the popular tree or ring topologies with a small number of edges can significantly enhance network reliability. To aid network planners, we present a set of construction rules that serve as valuable tools for achieving improved network reliability.

6. Moti Etkind (Bar Ilan University) – Functions tiling simultaneously with two arithmetic progressions

Abstract: We consider measurable functions f on the real line, which tile simultaneously by two arithmetic progressions αZ and βZ, with respective tiling levels p and q.

We will give a tight lower bound on the measure of the support of f, and show how it depends on the arithmetic properties of α, β, p, q. To prove the lower bounds, we use combinatorial techniques and ideas from measurable graph theory, applied to a certain Bipartite Borel Graph induced by the function f. To show that the lower bounds are tight, we show a general method for construction of a measurable function f, with small support, which can give any two predefined projections $mod\ \alpha$ and $mod\ \beta$.

This is a joint work with Nir Lev.

7. Mo Jia-Li (SCE) – The Galois covers of minimal degree surfaces in CP^{n+1}

Abstract: We are interested in the fundamental groups of Galois covers of some Zappatic surfaces, especially in whether it is trivial. According to the degeneration theory of algebraic surfaces, the minimal degree surface in the $(n+1)$-dimensional projective space over the complex numbers has a planar Zappatic degeneration.

In this talk, we investigate the topological structures of Galois covers of minimal degree surfaces (i.e., degree n) in the $(n+1)$-dimensional projective space over the complex numbers. We prove that for $n > 4$, the Galois covers of minimal degree surfaces are simply connected surfaces of general type. As an application, we also discuss the Galois covers of unions of minimal degree surfaces.

8. Or Kadrawi (Ariel University) – The independence polynomials are NOT always log-concave

Abstract: In 1987, Alavi, Malde, Schwenk, and Erdös conjectured that the independence polynomials of trees are unimodal. Over the years, several attempts have been made to extend the above conjecture. One of them was in 2004 when Levit and Mandrescu conjectured that the independence polynomials of all forests are log-concave, and got support from other researchers. As of 2023, the conjecture still remained open.

Using a new dynamic programming algorithm, we discovered two trees of order 26 to have non-log-concave independence polynomials. Additionally, we expanded upon these findings and generated multiple new infinite families of counterexamples.

9. Noam Kimmel (Tel Aviv University) – Consecutive sums of two squares $mod\ q$

Abstract: In 1837, Dirichlet's groundbreaking proof established that for positive coprime integers a and q, there are infinitely many primes congruent to $a\ mod\ q$. Despite this achievement, our understanding of more intricate prime patterns modulo q remains limited. For example, if a and b are two different congruence classes $mod\ q$, then it is still unknown whether there are infinitely many primes p congruent to $a\ mod\ q$, which are immediately followed by a prime congruent to $b\ mod\ q$. In other words, we do not know whether the pattern ab appears infinitely often in the sequence of increasing primes $mod\ q$.

In this talk we will explore analogous patterns within the sequence of sums of two squares in place of the primes. We will show that if a, b, and c are congruence classes $mod\ q$ (which are sums of two squares $mod\ q$), the patterns abc (any pattern of length 3) and $aaa \dots abbb \dots b$ (arbitrarily many a's followed by arbitrarily many b's) each appear infinitely often in the sequence of sums of two squares $mod\ q$.

Joint work with Vivian Kuperberg.

10. Jonatan Kogan (Hebrew University) – Searching for the Cup Product in Random Simplicial Complexes

Abstract: The theory of random simplicial complexes is a generalization of the theory of random graphs and has received extensive research in recent years. In particular, the topological properties of these complexes are investigated in what can be seen as a generalization of the Erdős–Rényi theorem on the threshold probability of random graph connectivity.

One of the models being studied is the lower multiparametric model. In this model, n vertices are taken, and then each pair is connected by an edge with probability p_1. Then, each triangle in the resulting graph is filled with probability p_2, each tetrahedron is filled with probability p_3, and so on. C. F. Fowler proved in a 2019 paper that this model can exhibit multiple non-zero cohomologies simultaneously (a.a.s) for certain parameters. But

the cohomologies (both in this article and the field in general) are usually studied as a list of separate properties, without studying the relationship between them. In my research I extend this result and investigate the ring structure of the cohomology under the cup product, and conclude that it is almost always trivial in this model.

11. Rishi Kumar (Ben Gurion University) – Simultaneous Visibility in the Integer Lattice

Abstract: Two lattice points are visible from one another if there is no lattice point on the open line segment joining them. Let S be a finite subset of a k-dimensional integer lattice. The asymptotic density of the set of lattice points, visible from all points of S, was studied by several authors.

Our main result is an improved upper bound on the error term. We also find the Schnirelmann density of the set of visible points from some sets S.

12. Sobhi Massalha (Hebrew University) – The theory of random groups

Abstract: The Tarski conjecture states that two finitely generated free groups cannot be distinguished by the truthness of a given first order sentence. That is, a given sentence is true over any finitely generated free group if and only if it is true over the free group on two generators. Given a sentence, we can naturally seek for finitely generated groups that can be distinguished from free groups by the given sentence. An open question in this context states that given a sentence, the collection of finitely generated groups that can be distinguished from free groups by the given sentence is negligible, that is, if the sentence is true over finitely generated free groups, then it is true over almost all the finitely generated groups. In our talk, we will present the formal ground of this question, and if the time permits, we present some of the strategies that we plan to use in order to prove it.

13. Egor Nechaev (Technion) – $O(b)$ is the highest weight category

Abstract: Highest weight categories are a tool to study the derived category of a non-semisimple abelian category. They were introduced by Cline, Parshall, and Scott as a generalization of BGG category O for a semisimple Lie algebra. In the talk we will prove that a category O (that is, a category of finite-dimensional h-semisimple modules) for a Borel subalgebra of a simple Lie algebra is a highest weight category with Cherednik order on the weight lattice.

14. Adi Ostrov (Bar Ilan University) – Recurrence Sequences as Almost Universal Hilbert Sets

Abstract: Hilbert's irreduciblity theorem states that for an irreducible polynomial $P(t,x)$ in $Q(t)[x]$, for infinitely many specializations t_0 in Q, $P(t_0,x)$ in $Q[x]$ will remain irreducible .

This leads to the question of identifying *univesal Hilbert sets*, i.e. sets $U \subset Q$ such that for any irreducible $P(t,x)$, at most finitely many specializations t_0 in U result in a reducible polynomial.

Do the elements of the Fibonacci sequence F_n form a universal Hilbert set? We will present a recent result which answers the question negatively, but identifies the exceptional set of P for which $P(F_n, x)$ is reducible for infinitely many values of n. We shall describe the geometric connection such polynomials P have with the Fibonacci sequence.

We will see that this result strongly mirrors a certain result about the geometric sequence a^n.

15. Ohad Sheinfeld (Bar Ilan University) – On t-intersecting families of permutations

Abstract: We prove that there exists a constant c_0 such that for any $t \in N$ and any $n \geq c_0 t$, if $A \subset S_n$ is a t-intersecting family of permutations, then $|A| \leq (n-t)!$. Furthermore, if $|A| \geq 0.75(n-t)!$, then there exist $i_1, \dots, i_t$ and $j_1, \dots, j_t$ such that $\sigma(i_1) = j_1, \dots, \sigma(i_t) = j_t$ holds for any $\sigma \in A$. This shows that the conjectures of Deza and Frankl (1977) and of Cameron (1988) on t-intersecting families of permutations hold for all $t \leq c_0 n$. Our proof method, based on hypercontractivity for global functions, does not use the specific structure of permutations, and applies in general to t-intersecting sub-families of 'pseudorandom' families in $\{1,2, \dots, n\}^n$, like S_n.

Based on a joint work with Nathan Keller, Noam Lifshitz and Dor Minzer

16. Guy Shtotland (Ben Gurion University) – Relative Iwahori Matsumoto relations

Abstract: Let H_{aff} be the algebra of compactly supported functions on a p-adic group G that are bi-invariant with respect to a certain compact open subgroup I, called an Iwahori subgroup. In 1965, Iwahori and Matsumoto provided a presentation of the algebra H_{aff} using generators and braid relations.

I will talk about a relative version of this result. Let $X = G/H$ be a symmetric space over a p-adic field, the space of I invariant locally constant compactly supported functions on X, $S(X)^I$, is a module over $H_{aff} = S(G)^{I \times I}$. The action is given by convolution.

On the set $I \setminus X$, the set of I orbits on X, I construct an action of the affine Weyl group of G, W_{aff}. I provide a description of the module similar to the one provided by Iwahori and Matsumoto for H_{aff}. This description shows that the action of H_{aff} on $S(X)^I$ is a q-analog of the action of$C[W_{aff}]$ on $C[I \setminus X]$.

17. Michael Trushkin (Ariel University) – Smoothed Analysis of the Komlós Conjecture: Rademacher Noise

Abstract: The discrepancy of a matrix $M \in R^{d \times n}$ is given by $DISC(M) = \min_{x \in \{-1,1\}^n} \left||Mx|\right|_\infty$. An outstanding conjecture, attributed to Komlós, stipulates that $DISC(M) = O(1)$ whenever M is a Komlós matrix, that is, whenever every column of M lies within the unit sphere. Our main result asserts that $DISC\left(M + \frac{R}{\sqrt{d}}\right) \leq 1 + O(d^{-1/2})$ holds asymptotically almost surely, whenever $M \in R^{d \times n}$ is a Komlós matrix, $R \in R^{d \times n}$ is a Rademacher random matrix, $d = \omega(1)$, and $n = \omega(\widetilde{d^{5/4}})$. We conjecture that

$n = \omega(d log\ d)$ suffices for the same assertion to hold. The factor $d^{-1/2}$ normalizing R is essentially best possible.

18. Daniel Tsodikovitch (Tel Aviv University) – An analogue of the Blaschke-Santaló inequality for billiard dynamics

Abstract: The Blaschke-Santaló inequality is a classical inequality in convex geometry concerning the volume of a convex body and that of its dual. In this talk we investigate an analogue of this inequality in the context of billiard dynamical system: we replace the volume with the length of the shortest closed billiard trajectory. We define a quantity called the "billiard product" of a convex body K, which is analogous to the volume product studied in the Blaschke-Santaló inequality. In the planar case, we derive an explicit expression for the billiard product in terms of the diameter of the body. We also investigate upper bounds for this quantity in the class of polygons with a fixed number of vertices.

19. Itamar Vigdorovich (Weizmann Institute) – Spectral gap and character limits in arithmetic groups

Abstract: To any group G is associated the space of characters, often called the Thoma dual of G. This space is central for harmonic analysis on abstract groups. After defining this space properly, I will discuss its geometry in the case the group exhibits certain rigidity properties, most notably Kazhdan's property (T). Further restricting to a class of arithmetic groups, I will explain why any sequence of characters must converge to the Dirac character at the identity, and demonstrate this with certain examples and applications. Time permitting, I will discuss another result on the free group which is somewhat complementary (and yet opposite) to the case above. The talk is based on a few works, and the collaborators include Levit, Orovitz and Slutsky.

20. Yoav Zimhony (Tel Aviv University) – Smooth deformation retraction of locally trivial stratified spaces

Abstract: Let C be a stratified subspace of a manifold M, i.e., a closed set with a decomposition into disjoint union of submanifolds of M fitting together "nicely". Can we find a neighborhood of C which smoothly deformation retracts to C?

We present the outline of a positive answer for a family of stratified spaces admitting a strong regularity condition - smooth local triviality with conical fibers. We discuss the main technical tool used in the construction, Euler-like vector fields, and how it helps translate the question from a global one to a local one.