Titles and abstracts

Plenary talks

A. Benjamin Weiss (Hebrew University) - What are sofic groups?

Abstract: Sofic groups were introduced around 20 years ago by M. Gromov as a common generalization of the classes of amenable and residually finite groups. I will explain what they are and give some idea of how many of the results from classical dynamical systems have been extended to actions of sofic groups.

B. Noam Lifshitz (Hebrew University) - Product free sets in the symmetric group

Abstract: A subset of a group is said to be product free if the product of each two elements in the set is inside it. In the talk we talk about the solution of the following problem：

How large can a product free set be in the alternating group?

We solve this problem via a recent analytical tool we called 'hypercontractivity for global functions in the symmetric group'. Our tool allows you to go far beyond spectral gap when considering expansions of sets of vertices in a somewhat dense Cayley graph.

Based on joint works with Filmus, Kindler, and Minzer.

C. Itay Glazer (Northwestern University) - Singularities of convolutions of polynomial maps and applications to random walks on compact p-adic groups

Abstract: Given two polynomial maps f and g from smooth algebraic varieties X and Y to an algebraic group G, we define their convolution as the map $f * g$ from $X \times Y$ to G by $f * g(x,y) \coloneqq f(x)g(y)$. Similarly to the smoothing effect of the convolution operation in analysis, this operation yields maps with improved singularity properties .

In addition, there is a strong connection between the singularities of a polynomial map f, and the analytic behavior of the pushforward $f_*(\mu)$, of a smooth, compactly supported measure μ on $X(F)$ by f, where F is a local field. This connection, and the algebraic language of convolutions, allow us to study probabilistic problems, such as random walks induced by polynomial maps, using algebro-geometric techniques .

Given a word w in a free group F_r on r elements, and a group G, one can associate a word map $w\colon G^r \to G$ (e.g. the commutator map $(x,y) \mapsto [x,y]$). We show that word maps on semisimple Lie groups and Lie algebras have good singularity properties after sufficiently many self-convolutions, with bounds depending only on the complexity of the word. Using the above philosophy, we provide applications to random walks on compact p-adic groups induced by these word maps.

Based on joint works with Yotam Hendel.

Student talks

1. Shaked Bader (Technion) - CAT(0) polygonal complexes are 2 median

Abstract: A (1-)median space is a space in which for every three points the intersection of the three intervals between them is a unique point. Having this in mind, in my talk I will define a 2-median space which is a 2 dimensional variation of the median space. I will then present some ideas in the proof of the theorem in the title.

This talk is based on my Master Thesis done under the supervision of Nir Lazarovich

2. Tomer Bauer (Bar Ilan University) - Ideal Growth in Amalgamated Powers of Nilpotent Rings

Abstract: In a seminal paper Grunewald, Segal and Smith (1988) introduced the zeta functions of groups and rings enumerating different types of sub-objects, such as subgroups of finite index or two-sided ideals. Our main focus will be on zeta functions enumerating ideals of finite (additive) index, in nilpotent rings of class 2. We show that the complexity of computing the ideal zeta functions of an amalgamated direct power of such rings does not increase by the amalgamation, up to a simple term. More generally, we prove this for the zeta functions of quiver representations introduced by Lee and Voll (2021).

These ideal zeta functions have a decomposition into an Euler product of local factors indexed by primes, and the local factors are rational functions over the rationals. The proof of rationality of the local factors relies on modern techniques from model theory, and their explicit computation in known cases uses tools from algebraic combinatorics.

This is a joint work with M. Schein.

3. Guy Blachar (Bar Ilan University) – The law of iterated logarithm on lamplighter diagonal products

Abstract: A random walk on a finitely generated group G is a sequence of the form $W_n = X_1 \dots X_n$, where $X_1, X_2, \dots$ are i.i.d. random variables distributed uniformly on some (finite) generating set S of G. Letting $|\cdot|$ denote the word distance with respect to S, we study the asymptotic behavior of the distance of the random walk.

The speed of the random walk $l_S(n) = E[|W_n|]$ was studied over the last years. In particular, works by Erschler, Amir-Virag and Brieussel-Zheng managed to realize many functions as speed functions of random walks on groups. In this talk we study the construction of Brieussel-Zheng, showing that the random walk on this group satisfies a Law of Iterated Logarithm. This gives, for any $\frac{1}{2} \leq \beta \leq 1$, an example of a group with speed of order n^{β}, that satisfies

$$0 < limsup_{n\to\infty} \frac{|W_n|}{n^{\beta}(\log\log n)^{1-\beta}} < \infty \quad \text{and} \quad 0 < liminf_{n\to\infty} \frac{|W_n|}{n^{\beta}/(\log\log n)^{1-\beta}} < \infty$$

almost surely.

Based on a joint work with Gideon Amir.

4. Adi Dickstein (Tel Aviv University) - Symplectic Topology and Ideal-Valued Measures

Abstract: I will present Gromov's notion of ideal-valued measures, which leads to a unified viewpoint on several 'big fiber theorems', for instance, the Centerpoint Theorem in combinatorial geometry (Rado, Karasev) and the Maximal Fiber Inequality in topology (Gromov).

I will discuss an adaptation of ideal-valued measures to symplectic topology, called ideal-valued quasi-measures, which allows us to prove symplectic analogues of the centerpoint theorem and which yields applications to symplectic rigidity. Necessary preliminaries will be explained.

Joint work with Yaniv Ganor, Leonid Polterovich and Frol Zapolsky.

5. Yotam Dikstein (Weizmann Institute) – New high dimensional expanders from random lifts

Abstract: Expander graphs have been studied in the past decades with many applications in probability, geometry, coding theory, networking, computational complexity and more. High dimensional expanders are a recent generalization of expander graphs, and their promise is beginning to bear fruit. However, only a few constructions of high dimensional expanders are known.

In this talk we show a new construction of high dimensional expanders. We give a novel randomized algorithm that takes as input a simplicial complex X (satisfying mild assumptions) and outputs a sub-complex $Y \subset X$ that is a high dimensional expander. The sub-complex Y will have infinitely many simplicial covers, which are a family of high dimensional expanders.

6. Chen Frenkel (Technion) - Recurrence and Embeddings in Planar Periodic Billiards

Abstract: Billiards in rational polygonal tables have long been researched, but what about 'infinite' periodic tables? The Wind-Tree model was introduced way back in 1912 by the Ehrenfests, where one places a rectangular obstacle periodically along the Z^2-lattice. Only recently several important results about its dynamics were found, showing some unexpected behavior. This is due to developments in Teichmuller Dynamics, which studies objects that initially seem unrelated to billiards -- moduli spaces of flat surfaces.

We study general rational periodic billiards in the plane, and show that for each such model one can add obstacles periodically, so that the billiard flow is recurrent in almost every direction. We use a geometric criterion, based on Avila-Hubert work on the Wind-Tree and the Eskin-Mirzakhani-Mohammadi breakthrough results. It concerns the Kontsevich-Zorich cocycle on the Hodge bundle over the moduli space of flat surfaces.

7. Amit Golan (Tel Aviv University) – Diffusion of new products with heterogeneous consumers

Abstract: Does a new product spread faster among heterogeneous or homogeneous consumers? We analyze this question using the stochastic discrete Bass model, in which consumers may differ in their individual external influence rates $\{p_j\}$ and in their individual internal influence rates $\{q_j\}$. When the network is complete and the heterogeneity is only manifested in $\{p_j\}$ or only in $\{q_j\}$, it always slows down the diffusion, compared to the corresponding homogeneous network. When, however, consumers are heterogeneous in both $\{p_j\}$ and $\{q_j\}$, heterogeneity slows down the diffusion in some cases, but accelerates it in others. Moreover, the dominance between the heterogeneous and homogeneous adoption levels is global in time in some cases, but changes with time in others. Perhaps surprisingly, global dominance between two networks is not always preserved under "additive transformations", such as adding an identical node to both networks. When the network is not complete, the effect of heterogeneity depends also on its spatial distribution within the network.

8. Renan Gross (Weizmann Institute) – Noise sensitivity from fractional query algorithms

Abstract: A randomized decision tree is an adaptive algorithm for determining the value of a function given an unknown random n-bit input. At each step, the algorithm chooses an input bit and queries its value, stopping when it has enough information to guess the value of the function.

In my talk, I will present a generalization: "fractional" algorithms, that, when they query a bit, only gain a small amount of information on what the value of the bit is likely to be. Repeated fractional queries reveal more and more information, turning the bits into time-dependent stochastic processes. I will show how these algorithms connect two seemingly far-removed fields: 1) noise-sensitivity and analysis of Boolean functions, and 2) Brownian control and partial differential equations.

9. Itamar Hadas (Tel Aviv University) - Spectral equivalence of finite groups

Abstract: Let n, k be positive integers and let p be a prime number. In this talk, we will discuss the similarities between complex valued representations of of $GL_n(F_p[t]/(t^k))$ and $GL_n(Z/p^k)$. In particular, we ask when does the group algebras of both groups are isomorphic. A conjecture of Onn states that the group algebras are isomorphic for all choices of n, k, p. In this talk, we will focus on a recent result which states that the groups algebras are isomorphic for any fixed n, k given that the prime p is large enough.

10. Tal Hershko (Bar Ilan University) – Disproving the limit law for random geometric graphs

Abstract: In the theory of random graphs, a natural and interesting class of graph properties is the class of first order properties: those expressible by means of first order logic. A classic result, discovered independently by Glebskii et al. (1969) and Fagin (1976), states that in the binomial random graph G(n, p) with a constant p, the limiting probability of every first order property is either 0 or 1. This phenomenon is known as a Zero-One law. A closely related

phenomenon is that of a Limit law, in which it is only guaranteed that a limiting probability exists.

The existence of Zero-One laws and Limit laws has been well studied in the binomial graph model. In our paper, we focus on the random geometric graph (RGG) model, denoted $G_X(n,r)$, which generates a graph by randomly placing n points in a metric space X and joining them if their distance is at most r. McColm (1999) proved that a Zero-One law holds when X is the 1-dimensional circle S^1, and conjectured that the same is also true in higher dimensions. Spencer and Agarwal (2006) disproved his conjecture, even in the simple 2-dimensional case, by constructing a first order sentence with non-trivial limiting probability. However, they conjectured that a Limit law still holds. Our paper disproves Spencer and Agarwal's conjecture: we show that there exists a first order property with no limiting probability in the 2-dimensional RGG. This result reflects a surprising, deep insight about the expressive power of first order logic in RGGs.

Joint work with Simi Haber and Tobias M¨uller.

11. Itamar Israeli (Hebrew University) - Restricted non-determinism: between the Firefighter Problem and Conway's Angel

Abstract: The Firefighter Problem is a classical solitaire game on a graph G. Starting from an initial burning set, fire spreads at every time-step from the current burning set $B(t)$ to its neighbours. At the t'th time-step the firefighter player is allowed to erase $[F(t)] - [F(t-1)]$ non-burning vertices from the graph. The player's goal is to contain the fire, namely, to guarantee that there exists a finite set which contains $B(t)$ for all t. We consider this game on the graph Z^2 with nearest L_∞ neighbour adjacency. Feldheim and Hod show that $F(t) = 3t$ is critical in this case, namely that for $F(t) = 3t$, the player cannot win, while for $F(t) = (3+\epsilon)t$, an explicit winning strategy is known.

Here, we study a two player variant of the game, where a fire player must select at turn t at most $g(t)$ vertices in the neighbourhood of $B(t-1)$ as the next step's burning set $B(t)$. For $g(t) = 1$ this becomes the classical Conway's Angel Problem. As such, this variant could be seen as a generalization of both games, allowing the angel a form of limited non-determinism - choosing a restricted amount of possible paths every turn.

We are interested in the minimum asymptotic growth of $g(t)$ under which $F(t) = 3t$ is critical. We provide a sublinear upper-bound of $t^{6/7}$ and a lower bound of $t^{1/2}$.

Joint work with Ohad Feldheim.

12. Or Kedar (Hebrew University) - Double covers and Orientors - a new calculus of orientations

Abstract: Covering spaces of manifolds are a very useful tool in algebraic topology and differential geometry. A covering space with two points in each fiber is called a double-cover. The orientation double cover is an important example. In a joint research with prof. J.

Solomon, we use double-covers to define a category of Orientors. Orientors provide a systematic approach for investigating orientation issues for non-orientable manifolds.

In the talk I will define double covers and provide examples with live illustrations, including the orientation double cover. I will introduce a multiplication operation on the set of double covers of a single manifold and demonstrate its geometric meaning. I will use this multiplication to define the category of orientors and will state its main application so far - to provide a systematic approach for fiber-integration over non-orientable submersions. If time permits, I will sketch a simple proof for the claim that the unit disk does not retract to the circle using a simple double cover of the circle.

13. Roee Leder (Hebrew University) - On Saint-Venant Compatibility in Riemannian manifolds with boundary

Abstract: On a compact Riemannian manifold, possibly with boundary, the Saint-Venant problem asks, what are necessary and sufficient conditions for a symmetric tensor field to be represented as the Lie derivative of the metric tensor by a vector field. The original motivation for this problem comes from linear elasticity: on a Euclidean domain Ω, modelling an elastic bulk of material under stain, the stress field is a symmetric tensor satisfying such a necessary and sufficient condition -- the Saint-Venant compatibility condition. More than sixty years ago, Calabi managed to extend this compatibility condition to simply-connected, closed Riemannian manifolds with constant sectional curvature. However, in the years since, little progress has been made to extend it further in terms of the underlying geometry and topology of the manifold.

In this talk, I shall present recent results on this subject and discuss how the Saint-Venant compatibility conditions may be extended to the scope of general compact Riemannian manifolds with boundary. I shall also relate this problem to Hodge-like decompositions of symmetric-tensor fields, first studied by Berger and Ebin, and present applications of these decompositions to problems in elasticity.

14. Avichai Marmor (Bar Ilan University) – On pattern avoidance and symmetry

Abstract: For a set Π of permutations (patterns) in S_k, consider the set of all permutations in S_n that avoid all patterns in Π. An important problem in current algebraic combinatorics is to find pattern sets Π such that the corresponding quasi-symmetric function is symmetric for all n. Recently, Bloom and Sagan proved that for any $k \geq 4$, the size of such Π must be at least 3 (with one exception), and asked for a general bound.

In this talk, we prove that the minimal size of such Π is exactly $k-1$. The proof uses a new variant of a theorem of Ray-Chaudhuri and Wilson in extremal combinatorics. This variant is proved using the polynomial approach of Alon, Babai and Suzuki to the original theorem.

No prior knowledge will be assumed.

This work is a part of an M.Sc Thesis, supervised by Ron Adin and Yuval Roichman.

15. Noam Pirani (Tel Aviv University) – Abhyankar's affine arithmetic conjecture for the symmetric and alternating groups

Abstract: Abhyankar's affine arithmetic conjecture states that every group which is cyclic by quasi-p can be represented as a Galois group of a finite Galois extension $K/F_q(t)$, ramified over at most a single prime. Previous work of Abhyankar and his collaborators proved many instances of the conjecture, including the symmetric and alternating groups S_n and A_n for some pairs (n, q). However, many cases remained uncovered. Building on the work of Abhyankar and recent work of L. Bary-Soroker, A. Entin and A. Fehm we prove the conjecture for A_n, and for S_n provided that F_{p^2} is not included in F_q.

The proof for $n \neq p+1$ is done by applying Abhyankar's method of removing tame ramification to a construction of Bary-Soroker et al. For $n = p+1$, we use a construction of Abhyankar. The construction depends on an integer parameter $1 \leq a \leq \frac{p-1}{2}$ such that $(a, p+1) = 1$ and the resulting Galois group is S_n or A_n , depending on whether the Legendre symbol $\left(\frac{a(a-1)}{p}\right) = -1$ or 1. We prove the existence of such a parameter a for all $p > 7 \cdot 10^7$ using the Polya-Vinogradov method, combined with an elementary sieve argument, and the case of $p < 7 \cdot 10^7$ is covered using a computer search.

Based on joint work with Alexei Entin.

16. Alexander Popov (Tel Aviv University) – Probabilistic Galois theory in function fields

Abstract: Suppose q is a power of a prime number, and let F_q be a finite field with q elements. We wish to study the arithmetic properties and the Galois group of a random polynomial with coefficients in $F_q[x]$. For given $n, d \geq 1$ choose a random polynomial of the form:

$$f(x,y) = y^n + p_{n-1}(x)y^{n-1} + \cdots + p_1(x)y + p_0(x) \in F_q[x][y],$$

where $p_0(x), \ldots, p_{n-1}(x) \in F_q[x]$ are polynomials of degree at most d. In this talk we will discuss what happens to the distribution of the Galois group of such a random polynomial f over $F_q[x]$ when we keep d fixed and take $n \to \infty$. This will be done in several steps. First we'll discuss what happens to the probability of f being irreducible over $F_q[x]$ as $n \to \infty$. Then we will see what can be said about the Galois group of f over $F_q[x]$ given that f is irreducible and separable. Finally, if time permits, we will also discuss the distribution of the Galois group if f is separable, but not necessary irreducible over $F_q[x]$.

Similar works were done for random polynomials in $Z[x]$. This work generalizes this for function fields, and also involves some new methods.

17. Shaul Ragimov (Hebrew University) – Biquandles are topological field theories

Abstract: In the 1980-s Michael Atiyah rigorously defined n-dimensional topological field theory (TFT)with values in C as symmetric monoidal functors from the n-dimensional

bordism category to C. The category of n-dimensional bordism has as objects closed n-manifolds and as morphisms cobordisms between those manifolds, i.e. an (n+ 1)-manifold with boundary W such that $\partial W = M \cup N$. A natural generalization comes from looking at embedded bordism categories where all the manifolds are embedded in R^m and bordisms are embedded in $R^m \times I$ for some fixed m. Monoidal functors from an embedded bordism category are called enhanced TFTs. We will be interested in the embedded bordism category whose objects are oriented 0-dimensional manifolds in R^2 and morphisms are oriented 1-manifolds with boundary in $R^2 \times I$, this category is usually denoted by $Tang_{0,2}$.

The category $Tang_{0,2}$ is also interesting for knot theorists. The main reason is that the set (or space in a more correct setting) $Map_{Tang_{0,2}}(\emptyset, \emptyset)$ is by definition the set (space) of links up to isotopy. The following two questions naturally arise. Do knot theoretic gadgets allow us to classify enhanced TFTs with values in some category C? Can we use TFTs in order to define or give a more pleasing definition of knot invariants? We will answer these questions for a specific natural category, where the associated knots invariants will be biquandle colorings.

18. Yotam Shomroni (Tel Aviv University) – Word measures on wreath products

Abstract: Every word w in the free group $F_r = Free\{b_1, \dots, b_r\}$ induces for every group G a word map $w: G^r \to G$, by substitution of G-elements in the letters. If G is finite, the sizes of fibers of the word map give a probability distribution on G, called the w-measure. This measure is determined by its Fourier coefficients: the w-expectations $E_w[\chi]$ of the irreducible characters of G. If the group G' is a wreath product $G' = G \wr S_n$ of a finite group with a symmetric group, it has stable characters $\chi \in \widehat{G'}$(yielded by FI_G-modules which were introduced by Sam and Snowden).

In this talk we will analyze $E_w[\chi]$ for every word $w \in F_r$, finite group G, and stable character χ of the wreath product $G \wr S_n$, generalizing the works of Hanany and Puder on stable characters of S_n, and of Magee and Puder on wreath products $Z/m \wr S_n$ with cyclic groups. The bounds we give on $E_w[\chi]$ depend on the primitivity rank $\pi(w)$, defined by Puder, making another step towards a conjecture of Puder and Hanany. As an application, we prove that some families of random Schreier graphs are a.a.s close-to-optimal expanders. The main tools we use are Stallings core graphs and representation theory of wreath products, which turn out to be surprisingly related.

19. Noy Soffer Aranov (Technion) – Minkowski's conjecture in function fields

Abstract: A fascinating question in geometry of numbers and diophantine approximation is what is the maximal covering radius of a lattice with respect to a fixed function. An important covering radius is the multiplicative covering radius, since it is invariant under the diagonal group and relates to the Littlewood's conjecture. Minkowski conjectured that the multiplicative covering radius of a unimodular lattice in R^d is bounded from above by 2^{-d} and that this upper bound is unique to the diagonal orbit of the standard lattice. Minkowski's conjecture is known to be true for $d \leq 9$, yet there is no general proof for higher dimensions.

In this talk, I will discuss the function field analogue of Minkowski's conjecture, which we stated and proved for every dimension. Time permitting, I will discuss applications of our work to dynamics as well as an improvement of Minkowski's convex body theorem in function fields. This talk is based on joint work with Uri Shapira.

20. Roy Shalev (Bar Ilan University) - Uncountable directed sets and Catalan numbers

Abstract: Recall that for two directed sets C and D, we say that C is Tukey below D and write $C \leq_T D$ iff there exists a function $f: C \to D$ such that the f-image of every unbounded subset of C is unbounded in D. In case that $C \leq_T D$ and $D \leq_T C$ we say that C and D are Tukey-equivalent. For an infinite cardinal κ, let D_κ denote the class of directed sets of dominating size no more than κ. Our talk will be motivated by the following question: How many non-equivalent Tukey types are there in D_κ?

We will present two results. The first is that for every natural number n, the number of non-Tukey-equivalent elements of $D_{\aleph_n}$ is at least C_{n+2}, the $(n+2)$'th Catalan number. In fact, we show that the class $D_{\aleph_n}$ contains an isomorphic copy, S_n, of the poset of Dyck $(n+2)$-paths. Our second result is a complete description of those intervals in S_n that contain an intermediate directed set from $D_{\aleph_n}$.

21. Yeari Vigder (Weizmann Institute) – Structure theorem for M-stationary G-spaces

Abstract: A famous theorem in the field of ergodic theory is the Furstenberg-Zimmer structure theorem, which characterizes all extensions of p.m.p. G-spaces. In this paper, we have two main goals: the first goal is to give an alternative proof to the original structure theorem for p.m.p. G-space, while the second (and the main) goal is to generalize this theorem to a larger class of Lebesgue G-spaces, the μ-stationary G-spaces.

22. Oren Yakir (Tel Aviv University) – Recovering the lattice from its random perturbations

Abstract: Given a d-dimensional Euclidean lattice, we consider the point process obtained by adding an independent Gaussian vector to each of the lattice points. In my talk, I will explain a simple procedure that recovers the underlying lattice from a single realization of this random point process.

23. Yuval Yifrach (Technion) – The Equidistribution of Grids of Rings of Integers in dimensions 3,4,5.

Abstract: It was shown by M. Bhargava and P. Harron in 2018 that for n=3,4,5, the shapes of rings of integers of S_n-number fields of degree n become equidistributed in the space of shapes when the fields are ordered by discriminant .

In a recent work we have corresponded grids instead of shapes to the number fields in such a way that more information on the number fields is preserved. We proved that those grids also equidistribute in their natural space, which extends Bhargava-Harron's result.

In the talk we will discuss our construction of grids from number fields and to compare it to the construction of Bhargava-Harron. We will quote some of the main results from our paper and discuss their methods of proof.

24. Tomer Zimhoni (Tel Aviv University) - Local Statistics of Random Permutations from Free Product

Abstract: Let $\Gamma = G_1 * \ldots * G_r$, where every G_i is either free (of finite rank) or finite. For $\gamma \in \Gamma$ and a natural number N, we consider the following probability measure on S_N, induced by γ: Choose uniformly at random $\phi: Hom(\Gamma, S_N)$ and consider $\phi(\gamma)$. This generalizes the term of "Word Measures" which is defined in the same way in the case where Γ is a free group of finite rank.

The results which will be presented in this talk generalize what's known in the well-studied topic of Word Measures on S_N and give rise to a slightly more general point of view. The main goal of the talk is to exemplify the relation we have found between the asymptotics of the expected number of fixed points of such a γ-random permutation and the Euler characteristic of subgroups which contain γ.

Joint work with my supervisor, Prof. Doron Puder.