

Algebra, Geometry, Dynamics

Dedicated to the memory of Boris I. Plotkin, commemorating the centenary of his birth

November 10-13, 2025

Conference Abstracts

By order of appearance

- **Zlil Sela** (Hebrew U) “Varieties over free associative algebras”

Abstract. In the 1960’s and 70’s, ring theorists (Cohn, Bergman and others) tried to study the structure of sets of solutions to systems of equations (varieties) over free associative (non-commutative) algebras. They tackled some fundamental pathologies that prevented any attempt to conjecture what can be the structure of these varieties.

In an ongoing work with Agatha Atkarskaya, we apply techniques and structures that were previously used to study varieties over free groups and semigroups to study varieties over free associative algebras. Our results demonstrate the central role of low dimensional topology in understanding the structure of these varieties.

- **Pavel Gvozdevsky** (Bar-Ilan U) “Abstract isomorphisms of isotropic algebraic groups over rings”

Abstract. Let G_1 be a group scheme over the ring R_1 , and G_2 be a group scheme over the ring R_2 . Suppose that the groups of points $G_1(R_1)$ and $G_2(R_2)$ are isomorphic. We ask under what conditions this isomorphism arises from the isomorphism of group schemes G_1 and G_2 (and the ring isomorphism between R_1 and R_2). In the talk we discuss old and new results on this problem for the class of isotropic reductive group schemes. We also discuss certain applications these results have for model theory (namely the theory of interpretations).

- **Rostislav Grigorchuk (via Zoom)** (Texas A&M) “A hunt for spectral Gaps”

Abstract. The talk will be based on a series of results of the speaker with collaborators concerning spectral theory of graphs and groups. A general feature of the method invented 25 years ago will be described and some old and new results concerning appearance of spectral gaps, existence or absence of eigenvalues for discrete Laplace operator will be formulated and explained.

- **Yuri Zarhin** (Penn State) “Jacobians and intermediate Jacobians with additional symmetries”

Abstract. We study principally polarized complex abelian varieties X of positive dimension g that admit a periodic automorphism of prime order $p > 2$ such that its set of fixed points is finite. By functoriality, this automorphism acts as a diagonalizable linear operator in the g -dimensional complex vector space of differentials of the first kind on X ; its spectrum consists of primitive p th roots of unity. We describe explicitly all the possible multiplicity functions on the set of such roots of unity that arise from canonically polarized jacobians of smooth irreducible projective curves of genus g . As an application, we sketch another proof of a result of Griffiths-Harris about intermediate jacobians of certain cubic threefolds.

- **Evelina Daniyarova** (Sobolev Inst Math) “Boris Plotkin’s Logical Geometry and theory of interpretations”

Abstract. Boris Plotkin’s famous question, “When do two algebraic structures have the same algebraic geometries?”, gave rise to the concept of geometric equivalence and its generalizations, which were studied in conjunction with Plotkin’s problem on criteria, necessary, and sufficient conditions for geometric equivalence. Thus, the geometric equivalence of algebraic structures implies the isomorphism of the categories of algebraic sets over them, in particular, their equivalence. Boris Plotkin termed the existence of the equivalence of these categories “geometric compatibility”. One of the directions in which Boris Plotkin developed his ideas was the transition from the category of algebraic sets to the category of logical sets, and hence logical equivalence and logical compatibility. Again, logical equivalence entails logical compatibility, that is, the equivalence of the categories of logical sets. In this talk, we will discuss the subsequent generalizations of Boris Plotkin’s ideas, demonstrating that bi-interpretation between algebraic structures in arbitrary languages implies the equivalence of

their categories of (projective) logical sets. Furthermore, Boris Plotkin’s categorical constructions have proven to be a convenient and indispensable tool for proving a number of general assertions in the theory of interpretation.

- **Be’eri Greenfeld (via Zoom) (CUNY)** “How complicated can words be?”

Abstract. Consider an infinite sequence of letters from a finite alphabet (such as decimal digits, bits, or the ABC). A quantitative measure of its combinatorial complexity is given by the complexity function, which counts, for each natural number n , how many distinct subwords of length n occur in the sequence. This fundamental notion is deeply connected to dynamical systems, computer science, diophantine analysis, and more.

We solve the “inverse problem” of determining which functions can occur (asymptotically) as the complexity functions of infinite words, and further discuss the possible complexity under additional dynamical assumptions such as minimality and unique ergodicity, answering several open problems in the field.

This is joint work with Carlos Gustavo Moreira and Efim Zelmanov.

- **Yuri Gurevich (U Michigan)** “What is an algorithm?”

Abstract. The basic notion of algorithm was elucidated in the 1930s–1950s. Starting from the 1960s, this notion has been expanded to probabilistic algorithms, quantum algorithms, etc. In the 1980s the speaker introduced abstract state machines (ASMs), and in 2000 he axiomatized basic algorithms and proved that every basic algorithm is step-for-step simulated by an appropriate basic ASM. The axiomatization has served both theoretical purposes (notably, proving the original Church-Turing thesis) and for practical purposes (notably, enabling the development of an ASM-based tool that Microsoft’s Windows Division used to produce numerous high-level executable specifications required by the EU). In the talk we define an elegant (at least in our view) generalization of basic algorithms: basic interactive algorithms, which may interact with human and artificial partners. It turns out that probabilistic and quantum algorithms are naturally such interactive algorithms. We axiomatize basic interactive algorithms and prove that every such algorithm can be step-for-step simulated by a basic interactive ASM – opening the door to new applications.

- **Shmuel Weinberger (U Chicago)** “Morse complexity of homology classes”

Abstract. The Morse complexity of a manifold is the minimum number of critical points in any Morse function on the manifold. One can also specify a degree for the critical points. In that case the first complexity is basically the number of generators of the fundamental group, and the second is at least the number of relations necessary. Gromov suggested using work of Thom (that I’ll explain) to use this idea to define a pseudonorm on homology of spaces. We will see that it descends to group homology, and I will explain the little we understand about this notion (e.g., why it’s trivial in all odd dimensions, and not trivial for some examples in each even dimension). (Joint work with Manin and Tshishiku)

- **Alex Lubotzky (Weizmann Inst)** “Uniform stability of high-rank arithmetic groups”

Abstract. Lattices in high-rank semisimple groups enjoy several special properties like super-rigidity, quasi-isometric rigidity, first-order rigidity, and more. In this talk, we will add another one: uniform (a.k.a. Ulam) stability. Namely, it will be shown that (most) such lattices D satisfy: every finite-dimensional unitary “almost-representation” of D (almost w.r.t. to a sub-multiplicative norm on the complex matrices) is a small deformation of a true unitary representation. This extends a result of Kazhdan (1982) for amenable groups and Burger-Ozawa-Thom (2013) for $SL(n, \mathbb{Z})$, $n > 2$.

The main technical tool is a new cohomology theory (“asymptotic cohomology”) that is related to bounded cohomology in a similar way to the connection of the last one with ordinary cohomology. The vanishing of H^2 w.r.t. to a suitable module implies the above stability.

The talk is based on joint work with L. Glebsky, N. Monod, and B. Rangarajan (to appear in *Memoirs of the EMS*).

- **Yasmine Fittouhi (Weizmann)** “The Geometry of the Nilfibre $\mathcal{N}$ ”

Abstract. Let G be a simple algebraic group over $\mathbb{C}$, P a parabolic subgroup containing a Borel subgroup B , P' its derived subgroup, and $\mathfrak{m}$ the Lie algebra of the nilradical of P . The *nilfibre* $\mathcal{N}$ associated with this action is defined as the zero locus of the augmentation ideal I_+ of the semi-invariant algebra $I = \mathbb{C}[\mathfrak{m}]^{P'}$. For $G = SL(n)$, the structure of $\mathcal{N}$ has remained largely unknown.

This talk examines the geometry of $\mathcal{N}$ through its irreducible components in the case $G = SL(n)$. The number of these components might grow exponentially with n , showing no evident combinatorial structure. I will present a method for constructing an admissible set of numerical data C , which determines a semi-standard tableau T^C and gives rise to a subspace $\mathfrak{u}_C \subset \mathfrak{m}$ with striking properties: it forms a Lie subalgebra, defines an irreducible component $\mathcal{C} = \overline{B \cdot \mathfrak{u}_C} \subset \mathcal{N}$, and admits a Weierstrass section. This induced correspondence $T^C \mapsto \mathcal{C}$ is shown to be injective establishing a precise link between semi-standard tableaux and the components of $\mathcal{N}$, with strong evidence indicating its surjectivity.

- **Arkady Tsurkov** (U Rio Grande do Norte) “Categories and functors of universal algebraic geometry; and automorphic equivalence of algebras”

Abstract. Universal algebraic geometry allows considering of geometric properties of every universal algebra. When do two algebras have the same algebraic geometry? We must consider the categories of algebraic closed sets of these algebras to answer this question. The complete coincidence of these categories gives us a concept of the geometric equivalence of algebras.

Some kinds of isomorphisms between these categories gives us a concept of the automorphic equivalence of algebras. This concept has been considered since Boris Plotkin’s article in 2003. We will give by language of category theory one more elegant definition of this concept and recall some theorems related to this concept.

- **Agatha Atkarskaya (via Zoom)** (Guangdong-Technion) “ n -Engel groups for large n ”

Abstract. Let $E_n(x, y) = [x, y, \dots, y]$ be an n -iterated group commutator. A group that satisfies the group law $E_n(x, y) = 1$ is called n -Engel. The Engel problem asks whether a finitely generated n -Engel group is necessarily nilpotent of some class. Boris Plotkin was particularly interested in this problem when he introduced the Hirsch–Plotkin radical of a group. The Engel problem has a positive solution for $n \leq 4$. It also has a positive solution if a group satisfies some extra property, e.g., residually finite, solvable, or Noetherian. However, we expect that in general the answer is negative. Significant preparatory work was done by Juhasz and Rips. The Engel problem is closely connected with the Burnside problem, which asks whether a finitely generated group of exponent n is necessarily finite. For large enough n the answer is known to be negative. Recently in a joint work of Rips, Tent and the speaker a new solution of the Burnside problem for large odd exponents with a new lower bound for the exponent was given. In the talk I will explain how the methods, which were developed for the Burnside problem, will work for n -Engel groups.

- **Guy Blachar** (Weizmann Inst) “When is an almost-solution, almost a solution?”

Abstract. Suppose two matrices A, B almost commute, in the sense that their commutator $AB - BA$ has small rank. Can we perturb A and B by small-rank matrices to obtain two commuting matrices? We study this stability property for general systems of polynomial equations over matrices, in terms of the algebra defined by the equations. This leads to a rich theory of stable associative and Lie algebras, with connections to linear soficity, amenability, growth, and group stability.

Based on joint work with Tomer Bauer and Be’eri Greenfeld.

- **Alexei Miasnikov** (Stevens Inst) “Non-standard group theory”

Abstract. Similar to non-standard arithmetic and non-standard analysis, one can introduce non-standard groups (and rings). On the one hand, a nonstandard version G^* of a “standard group” G appears as obtained from G by adding suitable infinite products of elements of G in such a way that the new group G^* inherits similar combinatorial and geometric properties of the group G . On the other hand, every finitely (or recursively) presented group G is associated with a Diophantine algebraic scheme such that the group G is the group of $\mathbb{Z}$ -points of such a scheme and the non-standard versions G^* of G are K -points of the same scheme for a suitable ring K .

This leads to a “non-standard” combinatorial and geometric group theory. In this talk, I will describe

some interesting examples and unusual applications. In particular, I will describe non-standard versions of free and hyperbolic groups, non-standard polynomial rings, and free associative algebras.

- **Grigory Mashevitzky** (Ben Gurion U) “Non elementary and quasi-elementary inclusive varieties of groups and semigroups”

Abstract. The class of identical inclusions is the class of universal formulas lying strictly between identities and universal positive formulas. Such a formula can be expressed as a (possibly infinitary) disjunctive identity $u = v_1 \vee u = v_2 \vee u = v_3 \vee \dots$, in general infinitary or, equivalently, as a universally closed identical equality of subsets of words (terms). For groups and rings, the classes defined by identical inclusions and by infinitary disjunctive identities coincide, for semigroups they do not.

Classes of semigroups defined by sets of identical inclusions are called inclusive varieties. Inclusive varieties that cannot be defined by first order formulas are called nonelementary inclusive varieties. Inclusive varieties defined by identical inclusions involving only finitely many variables are called quasidelementary inclusive varieties. We establish criteria for an inclusive variety to be nonelementary and for a quasidelementary inclusive variety to be nonelementary as well and use it for investigation of nonelementary and quasidelementary inclusive varieties of groups and nilsemigroups. In particular, limit nonelementary inclusive varieties of abelian groups are described.

- **Alexander Treyer** “On the equational Noethericity for groups and graphs and Kotov’s lemma.”

Abstract. Kotov in his 2010 paper formulated a lemma – a convenient criterion for when an algebraic system is not equationally Noetherian. The talk will present results on the equational Noethericity for some groups and graphs obtained using this lemma. In particular, an answer will be given to the question about the existence of a group that is not equationally Noetherian but is equationally Noetherian in one variable, posed by Baumslag, Miasnikov, and Remeslennikov (1999).

- **Andrei Rapinchuk (via Zoom)** (U of Virginia) “On almost strong approximation in reductive groups”

Abstract. A criterion for strong approximation in algebraic groups was obtained by Platonov in characteristic zero, and by Margulis and Prasad in positive characteristic. It follows from this criterion that strong approximation never holds for non simply connected groups (in particular, algebraic tori) and a finite set of places. We will report on a recent work where we show that a slightly weaker property, which we termed “almost strong approximation” can hold for non simply connected reductive groups and some special infinite sets of places. Applying this fact to maximal tori of an absolutely almost simple simply connected group, we generalize some results on the congruence subgroup problem. Joint work with Wojciech Tralle.

- **Alexei Kanel-Belov** (Bar-Ilan U) “Solution of an open problem from ICM 2022 on outer billiards”

Abstract. Outer billiards were introduced by Neumann in the 1950s, but became popular only in the 1970s thanks to the work of Moser, where the outer, or dual, billiard was proposed as a model problem for smoothness in the KAM theory of the many-body problem. Tabachnikov, using KAM theory, established that for external billiards around a convex figure with a boundary of class C_7 , the trajectory remains bounded. On the other hand, R. Schwartz established that for a wide class of quadrangles, there are unbounded trajectories.

Consider a polygon M . From a point p on the plane, draw a tangent (i.e., a support line) to M and reflect the point p relative to the point of tangency. Such a transformation is called the external billiard transformation. When such an operation is applied sequentially, the point may turn out to be periodic (i.e., return to itself at some point), aperiodic (never return to itself), and also degenerate (external billiards can be applied a finite number of times). Symbolic dynamics can be associated with external billiards – a sequence of vertex numbers relative to which reflection occurs.

The classical case is when M is a regular n -gon. If $n = 3, 4, 6$, then the plane is divided into periodic regions. Tabachnikov discovered self-similarity for the case $n = 5$. His research was continued in the work of Bedaride and Cassaigne. The case $n = 8$ is the subject of the monograph by Schwartz. In the paper by Rukhovich, the case $n = 10, 8, 12$ is studied.

We discuss the outer billiard systems and our result is the proof of the conjecture of Schwartz (a

student of Thurston) given by him in a plenary talk at the International Congress of Mathematicians 2022. The cases $n = 8; 10; 12$ also have a self-similar structure. Without having a reference, I have the sense that the case $n = 7$ is somewhat understood in the sense that there are some regions of renormalization. I think that the cases $n = 9; 11$ are not understood at all. Hughes has made beautiful and detailed pictures of outer billiards on regular polygons. These pictures (and earlier ones) suggest the following conjecture: Outer billiards on the regular n -gon has an aperiodic orbit if $n \neq 3; 4; 6$.

I think that this is not known aside from $n = 5; 8; 10; 12$, and perhaps $n = 7$. In the talk, we describe what outer billiards are and discuss an important conjecture by Schwartz about aperiodic points and self-similarity phenomena.

This conjecture was recently proved in a joint work by Belov-Bely-Rukhovich-Timorin: For any outer billiard, the regular n -gon for $n \neq 3, 4, 6$ there is an aperiodic point.

We also discuss *self-similarity*. Initially (before our series of reports) Schwartz, based on computer experiments, suggested that ONLY for the cases $n = 5, 10, 8, 12$ there is exact self-similarity, which allows one to fully describe periodic structures and find aperiodic points. Schwartz conducted experiments for the case $n = 7$, and he failed to find self-similarity. We have established that in the case $n=7$ self-similarity and aperiodicity do exist. Using this, it is easy to show the existence of an aperiodic point. Unlike the previously studied case of regular n -gons for $n=3, 4, 6, 8, 10, 12$, we have established fundamentally new phenomena: (1) There are self-similarities with multiplicatively independent coefficients. (2) There is a continuum of pairwise disjoint closed invariant sets (with different symbolic dynamics) — closures of aperiodic orbits of points. Thus, it is shown that there are trajectories encoded by non-permutation systems.

We have established in the framework of Project 2022 that for $n = 9$ and 18 there are self-similarities and an infinite number of aperiodic orbits located on a limited region, as well as aperiodic points.

- **Ivan Shestakov** (U of Sao Paulo) “On simple Jordan superalgebras”

Abstract. We prove that a simple unital Jordan superalgebra of arbitrary dimension belongs to the list of known simple unital superalgebras or satisfies a certain polynomial identity.

Joint work with Efim Zelmanov.

- **Misha Volkov (via Zoom)** (Ekaterinburg) “An optimal Boolean triangular representation for Catalan semirings”

Abstract. We construct a faithful representation of the semiring of all order-preserving decreasing transformations of a chain with $n + 1$ elements by Boolean upper triangular $n \times n$ -matrices.

- **Elena Aladova Chestakov** (U Sao Paulo) “Equivalences of Algebras in Universal Algebraic Geometry”

Abstract. Investigations in universal algebraic geometry give rise to various types of equivalences of algebras related to the geometry of algebras under consideration. The main idea of this approach is to compare the abilities of algebras with respect to solving systems of equations. This point of view leads to various types of equivalences of algebras: geometric equivalence, geometrically automorphic equivalence, geometric similarity and geometric compatibility. In this talk we will discuss some results concerning the first two types of equivalences.

- **Igor Rapinchuk (via Zoom)** (Michigan State U) “Groups with good reduction and buildings”

Abstract. Over the last few years, the analysis of algebraic groups with good reduction has come to the forefront in the emerging arithmetic theory of algebraic groups over higher-dimensional fields. Current efforts are focused on finiteness conjectures for forms of reductive algebraic groups with good reduction that share some similarities with the famous Shafarevich Conjecture in the study of abelian varieties. Most results on these conjectures obtained so far have ultimately relied on finiteness properties of appropriate unramified cohomology groups. However, quite recently, methods based on building-theoretic techniques have emerged as a promising alternative approach. I will showcase some of these developments by sketching a new proof of a theorem of Raghunathan-Ramanathan concerning torsors over the affine line.

- **Efim Zelmanov** (UCSD and SUSTech) “Infinite-dimensional Lie superalgebras.”

Abstract. We will discuss superconformal Lie algebras, their generalizations and representations.