Institute of Mathematics of the Vietnam Academy of Science and Technology
Laboratory on Algebraic Transformation Groups at HSE University
Leonhard Euler International Mathematical Institute in Saint Petersburg

Russia-Vietnam Conference on Algebraic Geometry, Algebraic Groups, Commutative Algebra, and Applications

Saint Petersburg, Russia
August 24 – August 28, 2026

ABSTRACTS

Contents

Generators of Linear Algebraic Groups

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By analogy with the case of unipotent elements, we describe the subgroup of a connected linear algebraic group G generated by all semisimple elements in G. We also discusses what minimal number of factors is needed to represent each element of a given group as a product of unipotent/semisimple elements, and how many one-dimensional unipotent/multiplicative subgroups are required to generate a given group.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

Additive Actions on Degenerate Projective Hypersurfaces

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An additive action is an effective regular action of the algebraic group $\mathbb{G}_a^m$ on an algebraic variety X. In the case when X is a closed subvariety of $\mathbb{P}^n$, one can consider so-called induced additive actions, i.e., additive actions on X that can be extended to a regular action on the ambient projective space.

The most well-studied case is when X is a projective hypersurface. It was proved recently by I. Arzhantsev and Y. Zaitseva that a non-degenerated hypersurface (i.e., a hypersurface that is not a projective cone over a hypersurface in a smaller projective space) admits at most one induced additive action up to equivalence. In this talk, we will discuss how to prove the converse statement: a degenerate hypersurface admitting an induced additive action admits at least two non-equivalent induced additive actions.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

Flexibility and the Cox Construction

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(Based on a joint work with D. Chunaev and K. Shakhmatov)

Let us remind that a point x of an affine variety X is called flexible if the tangent space in x is spanned by tangent vectors to orbits of algebraic $\mathbb{G}_a$-subgroups. If each regular point is flexible, the variety X is called flexible. We say that X is generically flexible if X admits a flexible point. This is equivalent to that X contains an open subset consisting of flexible points. Finally, X is called flexible in codimension one if the complement of this open subset does not contain a divisor.

In this talk we discuss connection between flexibility of X and its total coordinate space Y, i.e. the spectrum of its Cox ring. We prove that generic flexibility of X does not imply generic flexibility of Y, but flexibility in codimension one of X implies flexibility in codimension one of Y.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

Homological Invariants of Ideals Associated with Ferrers Diagrams

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Ferrers diagrams have long played a central role in the representation theory of symmetric and general linear groups, as well as in Schubert calculus. More recently, monomial ideals associated with these combinatorial structures have attracted considerable attention, offering a rich framework for studying interactions between combinatorics, commutative algebra, and homological methods.

In this talk, we present several recent results on tableau ideals and skew tableau ideals. We describe formulas for fundamental homological invariants, including projective dimension, depth, and Castelnuovo–Mumford regularity. We further investigate tableau ideals and skew tableau ideals arising from fillings of Ferrers and skew Ferrers diagrams. For these classes of ideals, we establish complete characterizations of unmixedness and sequential Cohen–Macaulayness, leading to applications to the Cohen–Macaulay, generalized Cohen–Macaulay, and Buchsbaum properties.

These results highlight deep connections between the combinatorial geometry of tableaux and the homological behavior of the associated monomial ideals, and illustrate how combinatorial structures can be effectively used to understand algebraic properties.

This is joint work with Thanh Vu (IM VAST).

GammaZero: Hierarchial Search for Automated Theorem Proving

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Automated theorem proving aims to construct mathematical proofs that can be checked rigorously by a formal proof system. Recent large language models can generate promising proof ideas, but a small local error may cause an entire proof to be rejected, while searching one elementary step at a time can be computationally expensive. We present GammaZero, a hierarchical proof-search framework that operates between these two extremes. Instead of only generating complete proofs, GammaZero constructs partial proof plans containing intermediate claims, solves the resulting subproblems, and assembles them into a complete proof verified by Lean. Experiments on the miniF2F benchmark show that GammaZero solves 190 out of 244 problems and substantially improves over repeated whole-proof generation. The results suggest that structured decomposition can make AI-based theorem proving more reliable and efficient.

Tangent Cones to Schubert Varieties for Affine Kac–Moody Groups and Embeddings of Weyl Groups

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Let G be an affine Kac–Moody group of type A, B a Borel subgroup of G, $F = G/B$ the flag variety, and W the Weyl group of G. For distinct involutions $w_1, w_2 \in W$, we prove that the tangent cones C_{w_1} and C_{w_2} to the corresponding Schubert subvarieties X_{w_1} and X_{w_2} of F at the point $p = e \bmod B$ do not coincide as subvarieties of the tangent space to F at p. This generalizes analogous results in the finite-dimensional setting. The main technical tools we employ are the combinatorics of embeddings of Weyl groups of various ranks and coadjoint orbits for the unipotent radical of B.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

A Survey of Large Language Models in Automated Theorem Proving

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Theorem proving is a fundamental aspect of mathematics, spanning from informal reasoning in natural language to rigorous derivations in formal systems. In recent years, the advancement of deep learning, especially the emergence of large language models (LLMs), has sparked a notable surge of research exploring these techniques to enhance the process of theorem proving. This survey reviews recent progress in applying large language models to automated theorem proving, with a focus on formal proof systems such as Lean. We summarize representative models, datasets, training methods, and proof-search frameworks for tasks including tactic prediction, proof generation, and formalization. We also discuss applications in mathematical reasoning, software verification, and AI-assisted mathematics. This survey aims to provide a structured overview of the field and identify promising directions for future research.

Flexibility of Affine Horospherical Varieties

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Let $\mathbb{K}$ be an algebraically closed field of characteristic zero. By $\mathbb{G}_a$ we denote the additive group of $\mathbb{K}$. An affine algebraic variety X is called *flexible* if every regular point $x \in X_{reg}$ is flexible, that is, its tangent space is spanned by tangent vectors to $\mathbb{G}_a$-orbits.

An irreducible algebraic variety X is called *horospherical* if it admits an action of a connected linear algebraic group G such that the stabilizer of a generic point contains a maximal unipotent subgroup of G. Note that in this definition we do not require X to be normal. We say that a horospherical variety X is *complexity-zero* if the action of G on X possesses an open orbit. Detailed information on horospherical varieties can be found in [5].

Several papers study flexibility for certain subclasses of horospherical varieties. As a first step, [1] proves flexibility of non-degenerate normal toric varieties. Subsequently, in [6], flexibility of possibly non-normal complexity-zero horospherical varieties corresponding to a semisimple group G is proved. In [4], it is proved that every normal complexity-zero horospherical variety with only constant invertible functions is flexible for an arbitrary algebraic group G. In [2], a criterion for a not necessarily normal toric variety to be flexible is obtained.

In this talk we discuss a flexibility criterion for affine complexity-zero horospherical varieties; this generalizes the previous results. The talk is based on the joint work [3].

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

Key words — horospherical variety, automorphism group, flexible variety, locally nilpotent derivation.

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Flat Surfaces in Three Homogeneous Space

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In this work we classified translation invariant surfaces with zero Gaussian curvature in the three-dimensional Heisenberg group and in three-dimensional Sol group equipped with Lorentzian metric .

Key words and phrases: Flat Surfaces, Homogeneous Space, Heisenberg group, Sol_3 group.
Mathematics Subject Classifications (2010): 49Q20. 53C22.

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On the Regular Borel subalgebras of
the Lie algebra of Aut($\mathbb{A}^2$)

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In this talk we consider Borel subalgebras of Lie(Aut($\mathbb{A}^2$)) generated by homogeneous derivations with respect to the standard $\mathbb{Z}^2$-grading (regular Borel subalgebras) and give an explicit description of them. In particular, we will show that they have derived length 2 or 3. We will also discuss their isomorphism classes.

On the way, we shall explore the regular Abelian subalgebras and the regular solvable subalgebras of Lie(Aut($\mathbb{A}^2$)).

Additive Actions on Projective Surfaces with Finitely Many Orbits

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An additive action on an algebraic variety is an effective action of the vector group $\mathbb{G}_a^n$ with an open orbit. Such actions arise naturally as equivariant compactifications of affine spaces. Their classification is part of a long-standing research program in the geometry of algebraic group actions, initiated by Brendan Hassett and Yuri Tschinkel in 1999 and still actively pursued today.

In this talk we focus on the two-dimensional case and classify projective surfaces with at most du Val (ADE) singularities that admit a $\mathbb{G}_a^2$-action with only finitely many orbits. The orbit structure of such surfaces resembles that of toric varieties: there is one open orbit, at most three one-dimensional orbits, and exactly one fixed point. A key tool is the bubble space of equivariant blowups of Hirzebruch surfaces, combined with an explicit description of the $\mathbb{G}_a^2$-action in local coordinates near exceptional curves.

A notable outcome is that the blowup of a Hirzebruch surface $\mathbb{F}_r$ $(r \geq 2)$ at two points of a distinguished fiber admits a one-parameter family of pairwise non-isomorphic additive actions — answering a question posed by Hassett and Tschinkel.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

Flexibility of Spherical Varieties

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A smooth point x of an algebraic variety X is called *flexible* if the tangent space T_xX is spanned by tangent vectors to the orbits of $\mathbb{G}_a$-actions passing through x. A variety X is called *flexible* if all its smooth points are flexible.

Let $\mathrm{SAut}(X)$ denote the subgroup of the group $\mathrm{Aut}(X)$ generated by all $\mathbb{G}_a$-subgroups. It was proved by Arzhantsev, Flenner, Kaliman, Kutzschebauch, and Zaidenberg that an affine variety X is flexible if and only if the group $\mathrm{SAut}(X)$ acts transitively on the set of smooth points of X. Moreover, in this case, the group $\mathrm{SAut}(X)$ acts m-transitively on the set of smooth points for any m.

Flexible varieties must have a sufficiently large automorphism group. Therefore, algebraic varieties on which an algebraic group acts with an open orbit are natural candidates for flexibility. Among examples of flexible varieties, one can distinguish affine toric varieties without nonconstant invertible regular functions, affine cones over flag varieties, and smooth almost homogeneous spaces of semisimple groups.

Affine toric varieties and affine cones over flag varieties are examples of spherical varieties. Spherical varieties are normal varieties equipped with an action of a reductive group for which a Borel subgroup has an open orbit. It has been conjectured that affine spherical varieties are flexible if and only if they have no nonconstant invertible regular functions. In the talk, I will explain why this conjecture is true. Furthermore, I will show that for any affine spherical variety, the group $\mathrm{Aut}(X)$ acts transitively on the set of smooth points. The talk is based on the preprint arXiv:2512.07031.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

On Flexibility of Affine Factorial Varieties

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Let Y be an affine algebraic variety and f be a regular function on Y. A suspension over Y is the variety given in the direct product $\mathbb{A}^2 \times Y$ by the equation $uv = f$. We give a criterion of factoriality of a suspension. This allows to construct many examples of flexible affine factorial varieties. In particular, we find a homogeneous affine factorial threefold that is not a homogeneous space of an algebraic group. The talk is based on a joint work with Ivan Arzhantsev and is prepared within the framework of the project "International Academic Cooperation" HSE University.

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On the Christopherson Problem and S-structures

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Finite-dimensional local algebras are a classical object of commutative algebra. Let A be a local algebra of dimension n. Consider its automorphism group $\mathrm{Aut}(A)$. Clearly, this is an algebraic group of dimension at most n^2. At the beginning of the twenty-first century, Jan Christopherson posed an interesting question: Is it true that the dimension of the group $\mathrm{Aut}(A)$ is at least $n-1$?

The answer to this question remains unknown to this day. In the talk, we will consider several interesting questions related to this problem, and also apply the technique of constructing S-structures, well developed by É. B. Vinberg for Lie algebras, to local algebras of a special type.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

On the Generalized Bass-Quillen Conjecture in Dimension 2

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Let A be a regular ring of dimension less or equal to 2. Let G be a split, i.e. Chevalley-Demazure, reductive group. We prove that every Zariski-locally trivial principal G-bundle over a ring of polynomials $A[x_1, ..., x_n]$ is extended from A. This result generalizes to split reductive groups the dimension 2 case of the Bass-Quillen conjecture on finitely generated projective modules, settled in positive by M. P. Murthy, D. Quillen and A. Suslin.

Normalizers of Certain Subgroups of a Chevalley Group Over a Ring

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Let R be a commutative ring and let $H(R) \leq G(R)$ be Chevalley groups over R. Denote by $D(R)$ the elementary subgroup of $H(R)$. We study the lattice of subgroups of $G(R)$, containing $D(R)$. The standard answer asserts that given such a subgroup H there exists a unique ideal I of R such that

$$D(R)E(R,I) \leq H \leq N(R,I),$$

where $E(R,I)$ denotes the relative elementary subgroup of $G(R)$ and $N(R,I)$ stands for the normalizer of $D(R)E(R,I)$ in $G(R)$. It is easy to see that the group $N(R,I)$ is the inverse image of $N(R/I) := N(R/I,0)$ under the homomorphism, induced by the ring homomorphism $R \to R/I$.

In the talk we discuss properties of the normalizer $N(R)$ that are crusial for the standard description of the above lattice. In particular, we show that under some mild assumptions $N(R)$ is Zariski closed in $G(R)$ and coincides with the transpoter from $D(R)$ to $N(R)$.

Explicit Formulas and Bounds for the Depth of Cover Ideals of Graphs

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Let $J(G)$ denote the cover ideal of a graph G. The study of the depth function for ordinary and symbolic powers of cover ideals, $t \mapsto \operatorname{depth}(R/J(G)^t)$ and $t \mapsto \operatorname{depth}(S/J(G)^{(t)})$, is a central topic in commutative algebra and graph theory. In this report, we present a unified approach to investigate these depth functions. First, we determine complete explicit formulas for the depth function of cover ideals of path graphs for all powers, combining Hochster's depth formula with a combinatorial analysis of induced matchings in associated forests. Second, we establish general upper bounds for the depth of symbolic powers in terms of ordered alternating matchings $\alpha_t(G)$, proving that equality holds for forests.

This is joint work with Nguyen Thu Hang (TNUS), Thanh Vu (IM VAST).

Regularity Functions of Powers of Graded Ideals

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It is known that for a graded ideal I in a standard graded algebra R, the regularity function reg I^n is a linear function for n large enough. If I is generated by homogeneous elements of the same degree d, then $e_n :=$ reg $I^n - dn$ is a convergent function of non-negative numbers. That has led to the problem of whether there are other constraints on the sequence e_n. If dim $R/I = 0$, Eisenbud-Harris showed that e_n is a weakly decreasing (non-increasing) sequence, and Eisenbud-Ulrich have asked whether $e_n - e_{n+1}$ is also weakly decreasing. Similar questions can be also raised for the functions reg R/I^n and reg I^{n-1}/I^n. We are able to construct ideals with prescribed regularity functions reg I^{n-1}/I^n, reg R/I^n, and reg I^n, which gives a negative answer to the above question of Eisenbud and Ulrich.

Polar Cylinders and $\mathbb{G}_a$-actions on Affine Cones of Cubic Fourfolds Containing a Plane

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Let $X \subseteq \mathbb{P}^5$ be a smooth cubic fourfold containing a plane Π whose associated quadric surface bundle $p\colon \widetilde{X} = \mathrm{Bl}_\Pi X \to \mathbb{P}^2$ admits a rational section, equivalently the Brauer class $\alpha_X \in \mathrm{Br}(S)[2]$ of the associated K3 surface S vanishes. In this paper, we prove that X carries an $\mathcal{O}_X(1)$-polar cylinder, and hence the affine cone $\widehat{X} \subseteq \mathbb{A}^6$ admits a nontrivial $\mathbb{G}_a$-action.

Induced and Restricted Representations of Kumjian–Pask Algebras of Higher-Rank Graphs

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In this paper, we develop a unified theory of induced and restricted representations for Kumjian–Pask (KP) algebras of higher-rank graphs (k-graphs) over a unital commutative ring R. On the induction side, we construct two classes of induction functors: from vertex corners $s_v KP_R(\Lambda) s_v$ and from KP algebras of hereditary saturated subgraphs, and prove Frobenius reciprocity, graded compatibility, and a flatness theorem establishing exactness over fields. On the restriction side, we analyse restriction from the Steinberg algebra of the boundary-path groupoid $\mathcal{G}_\Lambda$ to the group algebra of an isotropy group $R[\mathcal{G}_{\Lambda,x}]$ at a fixed infinite path x, and establish a weight-space decomposition governed by the periodicity group $\mathrm{Per}(x) \leq \mathbb{Z}^k$. We then prove transitivity of induction for nested hereditary subgraphs (a Mackey-type transitivity formula) and derive how induction and restriction interact along boundary paths. The intersection property for both induced and restricted modules is established with complete proofs, correcting and strengthening the degree-ordering argument to handle the partial order on $\mathbb{N}^k$. New simplicity criteria are obtained, including a biconditional in the aperiodic case. The theory is illustrated by detailed worked examples in ranks 1–3, including a two-vertex rank-2 example with an explicit computation of the module structure. Applications to graded module theory, Morita equivalence for hereditary subgraphs, the algebraic counterpart of Rieffel induction for $C^*(\Lambda)$, and algebraic spectral triples are also discussed.

Flexibility of Trinomial Varieties

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The talk is based on joint work of the author with M.V. Ignatev.

Let $\mathbb{K}$ be an algebraically closed field of characteristic zero. Let X be an affine algebraic variety, and let $\mathrm{SAut}(X)$ be the subgroup of the automorphism group of X generated by all algebraic subgroups isomorphic to the additive group of the field $\mathbb{G}_a$. Recall that an affine variety X is called *flexible* if the group of special automorphisms $\mathrm{SAut}(X)$ acts transitively on the set of its smooth points. Flexibility of an affine algebraic variety implies infinite transitivity of the action of $\mathrm{SAut}(X)$ on the set of smooth points.

The poster talk is devoted to trinomial varieties, that is, affine varieties given by systems of equations of the following form:

$$c_0T_0^{l_0} + c_1T_1^{l_1} + c_2T_2^{l_2} = 0,$$

where $T_i^{l_i} = T_{i1}^{l_{i1}} \dots T_{in_i}^{l_{in_i}}$ are monomials in the variables T_{ij}, the constants $c_i \in \mathbb{K} \setminus \{0\}$ satisfy certain conditions, $n_0 \geq 0$, $n_1, n_2 > 0$, and l_{ij} are positive integers. If $n_0 = 0$, then the first monomial is understood to be equal to 1. In the work [2], sufficient conditions for the flexibility of trinomial hypersurfaces were proved. In the work [3], a generalization of this result to arbitrary trinomial varieties was obtained.

In the poster talk, we will present sufficient conditions for the flexibility of arbitrary trinomial varieties.

This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

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Nilpotency of Locally Isotropic K_1-functor

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Consider a reductive group scheme G over any finite dimensional commutative ring K. If this group scheme is sufficiently locally isotropic, then its group $G(K)$ of K-points has a well defined normal elementary subgroup $E_G(K)$, and this subgroup is perfect. We prove that the factor-group is solvable under mild assumptions, i.e. $E_G(K)$ is the largest perfect subgroup of $G(K)$. For Chevalley groups and classical matrix groups analogous results are already known.

Root monoids

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An affine algebraic monoid is an irreducible affine algebraic variety with an associative multiplication, which is a morphism of algebraic varieties and admits a unit element. We will discuss several classification results about these natural objects. In particular, we provide a classification of monoids, whose group of invertible elements is an active semidirect product of a unipotent group and a torus, and introduce the notion of a root monoid. This work is prepared within the framework of the project "International Academic Cooperation" HSE University.

Key words — affine algebraic monoid, torus, commutative unipotent group, Demazure root, locally nilpotent derivation.

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