ManoloFest

Categorical, homological and computational methods in Algebra

A conference honouring the mathematical contribution of Manuel Ladra

Book of Abstracts

Faculty of Mathematics, University of Santiago de Compostela

Santiago de Compostela, Spain

24th – 26th June, 2026

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Invited Talks

Cohomology of Presheaves of Monoids.

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Abstract.

I will present an extension of Leech cohomology for monoids (and so Eilenberg-Mac Lane cohomology of groups) to presheaves of monoids on an arbitrary small category. Our main result states and proves a cohomological classification of monoidal prestacks on a category with values in groupoids with abelian isotropy groups. We also prove a cohomological classification for extensions of presheaves of monoids, Our results apply directly in several settings such as presheaves of monoids on a topological space, simplicial monoids, presheaves of simplicial monoids on a topological space, monoids or simplicial monoids enriched with an action of a fixed monoid or group of operators, etc.

$\mathcal{D}$–modules and Logarithmic Comparison Theorems

F.J. Castro Jiménez

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Abstract.

This talk is part of the paper: *Logarithmic Comparison Theorems*, F.J. Castro-Jiménez, D. Mond, and L. Narváez-Macarro. *Chapter 12 of Handbook of Geometry and Topology of Singularities IV. Cisneros-Molina, J. L., Tráng, L. D., & Seade, J. (Eds.). (2023).* Springer Nature Switzerland AG.

Let us denote X a complex manifold of dimension n, $\mathcal{O}_X$ the sheaf of holomorphic functions on X and $\mathcal{D}_X$ the sheaf of linear differential operators with holomorphic coefficients.

Roughly speaking, a $\mathcal{D}_X$–module $\mathcal{M}$ (with some good finiteness properties) represents a system of linear partial differential equations with holomorphic coefficients on X. We are able to apply geometric and algebraic methods in the study of such systems. This is the central objective of $\mathcal{D}$–module Theory with applications in Singularity Theory. $\mathcal{D}$–module Theory was initiated by M. Sato, M. Kashiwara, and the *Kyoto School*, in the 60's of the last century with main contributions of Z. Mebkhout, and A. Grothendieck, B. Malgrange, D.C. Spencer along with others.

The use of (co)homological methods to study the singularities of a complex hypersurface $D \subset X$ dates back to the pioneering work of H. Cartan, J. Leray, J.-P. Serre and A. Grothendieck, among others.

Grothendieck's Comparison Theorem states that the cohomology of the complex of meromorphic forms with poles on D (denoted $\Omega_X^\bullet(*D)$) is (isomorphic to) the singular cohomology of the complement $U := X \setminus D$, *i.e.* $H^\bullet(U;\mathbb{C})$.

The isomorphism between these two cohomology vector spaces is the *de Rham morphism* of "integration along cycles". Since each cohomology class in $H^\bullet(U;\mathbb{C})$ is represented by a meromorphic form, what can be said about the order of its pole along D?

The order of the pole question has been studied by several authors and, in particular, by Ph. Griffiths. P. Deligne proved that, if D is a normal crossing divisor, then each cohomology class on U corresponds, via the de Rham morphism, to a differential form in $\Omega^\bullet(\log D)$, the subcomplex of $\Omega^\bullet(*D)$ of *logarithmic meromorphic forms* with respect to D. Thus, for this class of divisors, the natural inclusion map

$$i(D) : \Omega^\bullet(\log D) \to \Omega^\bullet(*D)$$

is a quasi-isomorphism.

We say that a general divisor $D \subset X$ satisfies the *Logarithmic Comparison Theorem* if the inclusion map $i(D)$ is a quasi-isomorphism. For a general divisor D the notion of logarithmic meromorphic form was introduced by K. Saito. In the last 30 years, an important number of publications have addressed the Logarithmic Comparison Theorem. $\mathcal{D}$–module Theory plays a relevant role in these works, mainly because the complex $\Omega^\bullet(*D)$ is the de Rham complex of the $\mathcal{D}_X$–module $\mathcal{O}_X(*D)$ of meromorphic functions with poles on D. F.J. Calderón has proved that when the divisor D is *Koszul free*, the

A magic square of Lie superalgebras via tensor categories

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Abstract.
A Lie superalgebra will be attached to any finite-dimensional J-ternary algebra over an algebraically closed field of characteristic 3, using a process of semisimplification via tensor categories. Some of the exceptional simple Lie algebras, specific of this characteristic, will be obtained in this way and, in particular, a new magic square of Lie superalgebras will be constructed, with entries depending on a pair of composition algebras.

(Based on joint work with Isabel Cunha (Universidade da Beira Interior).)

References

[1] I. Cunha and A. Elduque, *J-ternary algebras, structurable algebras, and Lie superalgebras*, Rev. Real Acad. Cienc. Exactas Fis. Nat. Ser. A-Mat. (2026) 120:59.

[2] M. Smet, *Semisimplifying Lie algebras of J-ternary algebras in characteristic* 3, Commun. Algebra (2026).

Weak commutativity and nonabelian tensors revisited

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Abstract.
In 1980 Sidki introduced his weak commutativity construction $\mathcal{X}(G) = \{G, G^\psi \mid [x, x^\psi] \text{ all } x \in G\}$ defined for any group G and isomorphism $\psi\colon G \to G^\psi$. In 1984 Brown and Loday introduced their nonabelian tensor square $G \otimes G$ generated by symbols $x \otimes y$ with $x, y \in G$ subject to relations $xx' \otimes y = (x^{x'} \otimes y^{x'})\,(x' \otimes y)$ and $x \otimes yy' = (x \otimes y')\,(x^{y'} \otimes y^{y'})$. Both constructions are known to inherit properties from G such as π-finite (π a set of primes), perfect, soluble, finite nilpotent , ... Both constructions are related to the Schur multiplier of G. In this talk I'll begin with a review of weak commutativity and nonabelian tensor products. I'll then introduce a variant $\widetilde{\mathcal{X}}(G)$ of Sidki's weak commutativity group $\mathcal{X}(G)$ and a variant $G \otimes_r G$ of the non-abelian tensor square $G \otimes G$ $(r \geq 2)$ of a group G. These variants are modelled on universal commutator relations, inherit various properties from G, and admit homomorphic surjections $\widetilde{\mathcal{X}}(G) \twoheadrightarrow \mathcal{X}(G)$, $G \otimes_r G \twoheadrightarrow G \otimes G$ $(r \geq 2)$. This is joint work with Dessislava Kochloukova.

References

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[2] S. Mac Lane, *Categories for the Working Mathematician*, second ed., Grad. Texts in Math., vol. 5, Springer, 1998.

[3] A. Preprint, Here it goes the full name of the article, preprint arXiv:9999.1122, 2020.

Full Schedule

11:30 – Thursday 25

Waring type problems in Groups and Algebras

C. Martínez

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Abstract.
Waring problem, well known in Number Theory, has inspired several similar questions in Algebras and Groups. Here we will revisit some of these questions in groups and Lie algebras and some new results will be included.

References

[1] M. Bresar, C. Martínez , Waring Problems Across Algebra, preprint arXiv:2603.07033, 2026.

The tangent Lie algebras of automorphism groups of free algebras

I. Shestakov

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Abstract.
We introduce the notion of tangent Lie algebras for certain automorphism groups of free algebras as a subalgebra of the algebra of derivations. We show that for many classical varieties of algebras the tan-gent Lie algebra is a subalgebra of the Lie algebra of all derivations with constant divergence. We also introduce the notions of approximately tame and absolutely wild automorphisms of free algebras of any variety of algebras and use tangent Lie algebras for their study. It is shown that almost all known examples of wild automorphisms of free algebras are absolutely wild except Nagata and Anick automorphisms. We show that the Bergman automorphism of free matrix algebras of order two is absolutely wild. It is also shown that free algebras of any variety of polynilpotent Lie algebras, except abelian and metabelian varieties, have absolutely wild automorphisms.

(A joint work with U.Umirbaev).

Intrinsic tensor products and a Ganea-type extension of the five-term exact sequence

Tim Van der Linden

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Abstract.

In the context of group homology, Ganea extended the five-term exact homology sequence with an additional term involving a tensor product [12]. Work by Arias, Casas, Ladra, Pirashvili and others [17, 10, 5, 7, 19, 6, 1] investigates versions of this theorem in diverse settings, such as (pre)crossed modules, associative algebras, Lie and Leibniz algebras. The aim of this talk, based on the preprint [8], is to explain how and when these results can be understood as instances of a general categorical phenomenon, founded on a characterisation of the tensor product in terms of limits and colimits, relying on tools borrowed from abstract polynomial functor calculus [2, 15, 13].

We define an intrinsic symmetric bi-right-exact (and for varieties, bi-cocontinuous) bilinear product on objects of a semi-abelian category [16], constructed as the cosmash product [4, 14] in the two-nilpotent reflection. When applied to abelian objects, this recovers classical tensor products in many cases (the oldest known one being the case of groups [18]). A recognition theorem states that any symmetric bi-cocontinuous bifunctor on an abelian variety of algebras is realised as the bilinear product in the variety of algebras over a suitable two-nilpotent symmetric operad.

This rests on a right-exactness theorem for cross-effects of bifunctors, and consequently for cosmash products. We develop basic properties, compare the bilinear product to the Brown–Loday non-abelian tensor product [3, 9], and prove a categorical Ganea-type six-term exact homology sequence, extending the five-term exact sequence of [11]. We further obtain explicit descriptions of bilinear products in categories of representations; in particular, the bilinear product of the associated Beck modules generalises the classical tensor product of representations for groups and Lie algebras.

This is joint work with Bo Shan Deval and Manfred Hartl.

References

[1] D. Arias and M. Ladra, *Ganea term for homology of precrossed modules*, Comm. Algebra **34** (2006), no. 10, 3817–3834.

[2] H.-J. Baues, M. Hartl, and T. Pirashvili, *Quadratic categories and square rings*, J. Pure Appl. Algebra **122** (1997), no. 1, 1–40.

[3] R. Brown and J.-L. Loday, *Van Kampen theorems for diagrams of spaces*, Topology **26** (1987), no. 3, 311–335.

Computing the regularity of the deficiency modules

Santiago Zarzuela

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Abstract.
The regularity is one of the most studied invariants of a finitely generated graded module M over a polynomial ring R in the last years in Commutative Algebra. At first instance, it provides a bound for the degrees of the generators of M and it is also related with the complexity of its minimal graded free resolution. In the case of the graded deficiency modules $K^j(R/I)$ of a graded quotient ring R/I there is also a relation with the behaviour of the h-vector of R/I. Explicit computations of the regularity of the deficiency modules are scarce and, in general, only large bounds are known except for a celebrated result by Kumini and Murai in [3] for the monomial case, which states that $\operatorname{reg}(K^j(R/I)) \leq j$. In this talk I will explain how to obtain upper bounds for the regularity of graded deficiency modules building upon the spectral sequence formalism developed by Àlvarez Montaner, Boix and Zarzuela in [1]. This spectral sequence formalism allows us not only to recover Kummini–Murai's upper bound for monomial ideals, but also to extend it for other types of rings, which include toric face rings and some binomial edge rings, producing new upper bounds for the regularity of graded deficiency modules of this type of rings.

Based on a joint work with A. F. Boix [2].

References

[1] J. Àlvarez Montaner, A. F. Boix, and S. Zarzuela, *On some local cohomology spectral sequences*, Int. Mat. Res. Not. IMRN 19 (2020), 6197–6293.

[2] A. F. Boix, and S. Zarzuela, *Regularity of deficiency modules through spectral sequences*, Mediterr. J. Math. (2026), no. 2 Paper No. 79, 19 pp.

[3] M. Kummini, and S. Murai, *Regularity of canonical and deficiency modules for monomial ideals*, Paciific J. Math. 377 (2011), no. 2, 377–383.

Infinite-dimensional nonassociative superalgebras.

E. Zelmanov

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

References

[1] C. Martinez, O. Mathieur, and E. Zelmanov, *Cuspidal modules over superconformal algebras of rank* ≥ 1, preprint arXiv:2505.20974, 2025.

Contributed Talks

Mathematics in the Age of AI

J. Brox

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Abstract.
Automatic resolution of famous conjectures, autoformalization, algorithms more efficient than any previously devised by humans... The emergence of the latest generation of artificial intelligence models is causing a seismic shift in mathematics at every level. In this talk we will analyze this phenomenon within its historical context, explain the mechanisms that make this revolution possible, examine our current position by reviewing the most recent mathematical breakthroughs achieved with AI, and attempt to predict what the future may hold.

Projective crossed modules in semi-abelian categories

M. Culot

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Abstract.
We characterize the projective objects in the category of internal crossed modules [4, 5] within any (Janelidze–Márki–Tholen [6]) semi-abelian category. When this category forms a variety of algebras, the internal crossed modules again constitute a semi-abelian variety, ensuring the existence of free objects, and thus of enough projectives. We show that such a variety is not necessarily Schreier—subojects of free objects are again free—, but does satisfy the so-called Condition (P) [3]—meaning the class of projectives is closed under protosplit subobjects—if and only if the base variety satisfies this condition. As a consequence, the non-additive left chain-derived functors of π_0, the connected components functor, are well defined (in the sense of [3]) in this context.

This presentation aims to revisit key results regarding projective and free crossed modules over groups, as established in [1]. It will subsequently demonstrate how these results are employed to construct the non-additive left derived functors for $\pi_0\colon \mathsf{XMod} \to \mathsf{Gp}$, following the framework outlined in [3]. Lastly, the discussion will be generalized to encompass $\pi_0\colon \mathsf{XMod}(\mathcal{V}) \to \mathcal{V}$, where $\mathcal{V}$ is a semi-abelian variety of algebras satisfying Condition (P), as referenced in [2].

References

[1] P. Carrasco and A. M. Cegarra and A. R.-Grandjeán, *(Co)Homology of crossed modules*, J. Pure Appl. Algebra 168 (2002), no. 2-3, 147–176.

[2] M. Culot, *Projective crossed modules in semi-abelian categories*, Appl. Categ. Structures 34 (2026).

[3] M. Culot, and F. Renaud, and T. Van der Linden, *Non-additive derived functors via chain resolutions*, Glasgow Math. J. 67 (2025), no. 3, 423–466.

[4] M. Hartl, and T. Van der Linden, *The ternary commutator obstruction for internal crossed modules*, Adv. Math. 232 (2013), no. 1, 571–607.

[5] G. Janelidze, *Internal Crossed Modules*, Georgian Math. J. 19 (2003), no. 1, 99–114.

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Automorphism group schemes on Kantor pairs related to associative algebras with involution.

A. Daza-Garcia

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Abstract.
In the same way Jordan pairs and Jordan triples are a generalization of Jordan algebras which coordinatize 3-graded Lie algebras, Kantor pairs and Kantor triples are a generalization of Structurable algebras which coordinatize 5-graded Lie algebras. One example of Kantor pairs and Kantor triples are those which can be constructed form structurable algebras (Jordan algebras, tensor product of Hurwitz algebras, associative algebras with involution...).

Automorphism group schemes of algebraics structures are interesting because they carry information structure of them such as their gradings or their decomposition as tensor products. The description of automorphism group schemes of Jordan and Kantor Systems has been carried out in the past in different papers (see [1, 2, 3]). The purpose of this talk is to describe the automorphism group schemes of those Kantor Pairs related to associative algebras with involution.

References

[1] D. Aranda-Orna, and A. Daza-Garcia, *Automorphism group schemes of special simple Jordan pairs of types I and IV*, J. Algebra 679 (2025) 67–85.

[2] D. Aranda-Orna, and A.S. Córdova-Martínez *Fine gradings on Kantor systems of Hurwitz type*, Linear Algebra Appl. 613 (2021) 201–240.

[3] D. Aranda-Orna, *Fine gradings on simple exceptional Jordan pairs and triple systems.*, J. Algebra 491 (2017) 201–240.

Inner ideal structure of orthogonal Lie algebras

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Abstract. We describe the inner ideal structure of the orthogonal Lie algebras, not necessarily finite dimensional, over a field $\mathbb{F}$ of characteristic not 2, dealing with linear maps instead of with matrices. Nevertheless, we will put particular emphasis on the finite dimensional case, where the Witt index of the bilinear form plays a fundamental role. It is amazing the fact that in D_4 the Clifford inner ideal is conjugate (by a diagram automorphism) to the maximal isotropic inner ideal. A phenomenon that has a Jordan counterpart: the isomorphism (obtained by functoriality) of the Jordan pair $\mathcal{K}_4$ of skew-symmetric matrices with entries in $\mathbb{F}$ and the Jordan pair $\mathcal{Q}_6$ of a 6-dimensional nondegenerate symmetric bilinear form of maximal Witt index. A result known in the classification of the simple finite dimensional Jordan pairs over an algebraically closed field of characteristic 0.

References

[1] G. Benkart, and A. Fernández López, *The Lie inner ideal structure of associative rings revisited*, Comm. Algebra. 37 (2009), 3833–3850.

[2] C. Draper, and J. Meulewaeter, *Inner ideals of real simple Lie algebras*, Bull. Malays. Math. Soc. 45 (2022), 23133–2345.

[3] A. Fernández López, *Jordan Structures in Lie Algebras*, Mathematical Surveys and Monogrphs, vol. 240, AMS, 2019.

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Some recent results on evolution algebras

Amir Fernández Ouaridi

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Abstract. The aim of this talk is to discuss some recent results on evolution algebras. We will focus on two related directions. On the one hand, we will consider polynomial identities for evolution algebras through a combinatorial approach based on rooted binary trees. On the other hand, we will discuss how finite-dimensional commutative algebras can be embedded into evolution algebras. Finally, we will mention some questions motivated by these problems.

This talk is based on joint work with the authors cited in the references.

References

[1] Y. Cabrera Casado, A. Fernández Ouaridi, D. Martín Barquero, and C. Martín González, *Polynomial identities in evolution algebras*, preprint, in preparation.

[2] C. Costoya, A. Fernández Ouaridi, and A. Viruel, *Commutative algebras are ideals of evolution algebras*, preprint, in preparation.

Experimental Mathematics: Using Symbolic Computation to Analyze Conjectures Involving Matrices and Polynomials

L. Gonzalez-Vega

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Abstract.

The availability of Symbolic Computation tools enables us to introduce an experimental approach into the research we do in mathematics, when appropriate. I will present three concrete examples where the use of these tools has been essential to discover, conjecture and, in some cases, demonstrate new properties of the mathematical objects that we were considering - mostly polynomials and matrices.

P-matrices are matrices all of whose principal minors are positive. Q-matrices are matrices whose sums of principal minors of the same order are positive. A matrix is a PM-matrix if all its powers are P-matrices. A matrix is a QM-matrix if all its powers are Q-matrices. The study of the eigenvalues of these matrices brings many open questions. For example, until 2024 (see [6]), it was not known if the eigenvalues of a PM-matrix were necessarily positive (solving a longstanding conjecture raised in [5]). Or it is not known if the eigenvalues of a matrix A such that A and A^2 are P-matrices necessarily have positive real parts (see [4]). Taking into account that a P (resp. PM) matrix is a Q (resp. QM) matrix, we will study these questions for Q-matrices and QM-matrices in order to find an answer for the original problems. By using Symbolic Computation, we will show how to characterise the real QM-matrices up-to size 5 and we characterise those real matrices A, 4×4, such that A and A^2 are Q-matrices but not all eigenvalues of A have positive real part.

The second example will illustrate how Symbolic Computation helps to generate and to characterize correlation matrices when their entries come from a finite set. Bohemian matrices are families of matrices whose entries come from a fixed discrete set of small integers. A symmetric matrix is a correlation matrix if it has ones on the diagonal and its eigenvalues are nonnegative. We will introduce a new characterization of correlation matrices (based on Descartes Law of Signs, see [3]) that will be used to show that the number of Bohemian Correlation Matrices over -1, 0 and 1 corresponds to Bell or exponential numbers, the number of ways to partition a set of n labeled elements (see `https://oeis.org/A000110`), and to solve some correlation matrix completion problems.

Last example will be devoted to introducing the use of Symbolic Computation for trying to prove (or disprove) a conjecture about the spread of a symmetric matrix (i.e. the maximum absolute value of the difference between any two eigenvalues) with entries in the closed interval $[a, b]$. Let A be a square matrix with entries in $\mathbb{R}$. The spread of A is defined as the maximum of the distances between the eigenvalues of A. Let $S_m[a, b]$ denote the set of all $m \times m$ symmetric matrices with entries in the real interval $[a, b]$ and let $S_m\{a, b\}$ be the subset of $S_m[a, b]$ of Bohemian matrices with population from only the extremal elements $\{a, b\}$. S. M. Fallat and J. J. Xing in 2012 proposed the following conjecture: the maximum spread in $S_m[a, b]$ is attained by a rank 2 matrix in $S_m\{a, b\}$. X. Zhan had proved previously that the conjecture was true for $S_m[-a, a]$ with $a > 0$. We will show how

15:30 – Friday 26

Quantum immanants for the queer Lie superalgebra

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Abstract.

We apply the recently introduced idempotents for the Sergeev superalgebra to construct quantum immanants for the queer Lie superalgebra qN as central elements of its universal enveloping algebra. We prove a universal Capelli identity for qN and use it to calculate the images of the quantum immanants under the action of qN in differential operators. We show that the Harish-Chandra images of the quantum immanants coincide with the factorial Schur Q-polynomials. This is joint talk with Alexander Molev.

Poisson derivations of Poisson nilpotent algebras

Samuel Lopes

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Abstract.
Poisson nilpotent algebras are an axiomatically defined class of Poisson algebras including Poisson affine spaces and semiclassical limits of many quantum algebras, including quantum matrices and quantum Schubert cell algebras. In this talk I will show that the first hochschild cohomology of these algebras is a free module of rank n over the Poisson center, generated by Eulerian derivations, where n is the rank of the maximal torus acting rationally on the Poisson algebra. This is joint work with S. Launois (U. Caen) and I. Oppong (U. Greenwich).

Brill-Noether Theory of stable bundles on ruled surfaces

I. Macías Tarrío

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Abstract.

Let X be a smooth projective surface over an algebraically closed field K of characteristic 0 and H an ample divisor on X. Consider $M_H := MX, H(r; c_1, c_2)$ the moduli space of H-stable rank-r vector bundles on X with fixed Chern classes $c_i := c_i(E) \in H^{2i}(X, \mathbb{Z})$ for $i = 1, 2$.

One way to study the geometry of the moduli space M_H is by considering its subvarieties. In particular, one can consider the subvarieties called Brill-Noether loci, whose points are stable vector bundles having at least k independent global sections. In this talk, we will focus the attention on study the non-emptiness and the geometry of the Brill-Noether locus in the case when X is a ruled surface.

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Rota-Baxter type operators on Trusses and Derived structures

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Abstract.
The aim of this talk is to introduce the concepts of Rota-Baxter and Reynolds operators within the framework of trusses. We also define and discuss dendriform trusses, tridendriform trusses, and NS-trusses as foundational algebraic structures associated with these classes of operators. Furthermore, we extend the notions of Nijenhuis and averaging operators to trusses, investigating their properties and exploring their potential to generate new algebraic structures.
Joint work with T. Chtioui, M. Elhamdadi, S. Mabrouk.

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Morita theory for quantales

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Abstract.
In this talk, we give a characterization of those quantaloids (categories enriched in the symmetric monoidal closed category of sup-lattices) that are equivalent to modular categories over quantales. Based on this characterization, necessary and sufficient conditions are derived for two quantales to be Morita-equivalent, i. e. have equivalent module categories. As an application, it is shown that the category of internal sup-lattices in a Grothendieck topos is equivalent to the module category over a suitable chosen ordinary quantale.

Acknowledgments

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Relative Gorenstein dimensions under change of rings results

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Abstract. In this talk, we study change-of-ring results for Gorenstein projective (respectively, Gorenstein injective) modules relative to weakly Wakamatsu tilting (respectively, weakly cotilting) modules. We establish sufficient conditions under which these relative Gorenstein properties are preserved under change of rings. Our approach provides a unified framework that extends and generalizes several previously known results.

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Cohomological rigidity of solvable Lie algebras of maximal rank

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Abstract.
The second adjoint cohomology group $H^2(\mathfrak{g}, \mathfrak{g})$ occupies a central place in study of Lie algebras, linking cohomological algebra, geometric deformation theory, and the structure of the algebraic variety of Lie laws. Despite its importance, obtaining explicit criteria for the vanishing or non-vanishing of this invariant remains highly nontrivial.

We discuss on the developing of a general framework for computing the second adjoint cohomology group of solvable Lie algebras of the form semidirect product of $\mathcal{R}_{\mathcal{T}} = \mathcal{N} \rtimes \mathcal{T}$, where $\mathcal{N}$ is a nilpotent Lie algebra of maximal rank and $\mathcal{T}$ is a maximal torus acting diagonally on $\mathcal{N}$. Building on and significantly extending the classical Leger–Luks' method [1], we derive explicit sufficient conditions for the vanishing of $H^2(\mathcal{R}_{\mathcal{T}}, \mathcal{R}_{\mathcal{T}})$. Our results apply to broad families of solvable Lie algebras, including all cohomologically rigid algebra of the form $\mathcal{R}_{\mathcal{T}}$ appearing in low-dimensional (up to 9) and maximal solvable extensions of the well-known model filiform and model nilpotent Lie algebras.

In addition, we establish sufficient conditions for the non-vanishing of the second adjoint cohomology, thereby clarifying the precise situations in which rigidity fails. The interaction between the root configuration of the nilradical and the pattern of $\mathcal{T}$-invariant cocycles plays a key role in these results. Our results also yield a conjectural lower bound on $\dim H^2(\mathcal{R}_{\mathcal{T}}, \mathcal{R}_{\mathcal{T}})$.

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Flows of algebras: classification in a rotational flow

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Abstract.

A flow of algebras (FA) is a continuous-time dynamical system in which each state is a finite-dimensional algebra determined by a cubic matrix of structural constants that satisfies a Kolmogorov-Chapman type equation (KCE).

We establish conditions on the multiplication of cubic matrices under which the KCE admits a solution, with particular attention to algebras of cubic matrices equipped with a fixed multiplication.

Drawing on ideas from continuous-time Markov processes, we construct a class of flows of algebras using the matrix exponential of cubic matrices.

In addition, we describe a time-dependent family of two-dimensional algebras and determine when algebras corresponding to different times are isomorphic.

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Associative representations of evolution algebras of dimension two.

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Abstract.

In this talk, we establish a connection between evolution algebras of dimension two and Hopf algebras, via the algebraic group of automorphisms of an evolution algebra. Initially, we describe the Hopf algebra associated with the automorphism group of a 2-dimensional evolution algebra. Subsequently, we center our study in the notion of associative representation for nonassociative algebras, as introduced by Shestakov and Kornev in [2]. Furthermore, for a 2-dimensional evolution algebra A over a field K, we detail the relation between the algebra associated with the (tight) universal associative and commutative representation of A, referred to as the (tight) p-algebra, and the corresponding Hopf algebra, $\mathcal{H}$, representing the affine group scheme $\mathrm{Aut}(A)$.

Our analysis involves the computation of the (tight) $p-$algebra associated with any 2-dimensional evolution algebra, whenever it exists. We find that $\mathrm{Aut}(A) = 1$ if and only if there is no faithful associative and commutative representation for A. Moreover, there is a faithful associative and commutative representation for A if and only if $\mathcal{H} \ncong K$ and $\mathrm{char}(K) \neq 2$, or $\mathcal{H} \ncong K(\epsilon)$ (the dual numbers algebra) and $\mathcal{H} \ncong K$ in case of $\mathrm{char}(K) = 2$. Furthermore, if A is perfect and has a faithful tight p-algebra, then this p-algebra is isomorphic to $\mathcal{H}$ (as algebras). Finally, we derive implications for arbitrary finite-dimensional evolution algebras.

Nonassociative Methods in Pure Matrix Algebras

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Abstract.
A central problem in invariant theory is the description of generators and relations for the algebra of invariants of d-tuples of $n \times n$ matrices under simultaneous conjugation. While in general the generators and relations have been known since the work of Procesi and Razmyslov, finding a minimal set of generators and theird defining relations remains a formidable computational challenge as n increases.

In this talk, we present recent results joint with X. García-Martínez and F. Eshmatov, that utilize nonassociative structures, specifically the Poisson algebra structure, to navigate this complexity. By treating the algebra of invariants as a Poisson algebra, we demonstrate how higher-degree relations can be systematically generated from lower-degree ones. This methodology has allowed us to solve the problem for 4×4 matrices, where we identify a minimal set of just 8 relations that generate the associative ideal of 105 polynomials. We further discuss the applications of these results to the geometry of Calogero-Moser spaces and the invariant commuting variety of matrices.

Spectral Galois Theory for the KdV Variational Equation

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Abstract.

This talk addresses the Galoisian study of integrability for nonlinear partial differential equations, a problem that remains largely open within the framework of differential Galois theory. Our approach is motivated by the classical example of the Korteweg–de Vries (KdV) equation [4], whose integrability is understood through its associated Lax pair—a pair of differential operators for which the KdV equation arises as the compatibility condition.

A foundational step in this direction was taken by Morales-Ruiz, Rueda and Zurro [1], who developed a spectral Galois theory for the Schrödinger operator with stationary KdV potential. More recently, an alternative categorical framework has been proposed by Tomašić [3]. Building on these contributions, and on the algebro-geometric third-order operators studied by Rueda and Zurro [2], we present a Galoisian approach to the variational equation associated with a KdV-type evolution equation in dimension 1+1, exploiting the spectral techniques arising from third-order operator theory.

As a central application, we carry out explicit computations of solutions to the variational equation of KdV around a cnoidal wave. These calculations have been performed and verified using the computer algebra system MAPLE.

This work is part of an ongoing collaboration with J. J. Morales-Ruiz and J. P. Ramis.

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Poster Session

Graded contractions of the $\mathbb{Z}_2^3$-gradings on the exceptional Lie algebras coming from octonions

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Abstract.

Given a G-graded Lie algebra $\mathcal{L}$, a graded contraction on the grading is a map $\varepsilon\colon G \times G \to \mathbb{F}$ such that, by modifying the Lie bracket according to $[x,y]^\varepsilon = \varepsilon(g,h)[x,y]$ if $x, y \in \mathcal{L}$ with degrees g and h respectively, the resulting product still preserves the Lie algebra structure. In this way, such maps allow us to modify the original Lie algebra and obtain a new one with different properties: solvable, nilpotent, with a more abelian structure, or even reductive. Recently, the graded contractions on the $\mathbb{Z}_2^3$-grading on the complex Lie algebras $\mathfrak{g}_2$, $\mathfrak{b}_3$ and $\mathfrak{d}_4$ induced by the octonions have been completely classified up to isomorphism [1, 2]. This classification was carried out using combinatorial techniques on their supports $Supp(\varepsilon) := \{(g,h) \in G \times G : \varepsilon(g,h) \neq 0\}$.

This combinatorial framework is extended to the case of generic graded contractions of the same grading group in order to obtain new examples applicable to the Tits construction. This leads to 860 $\mathbb{Z}_2^3$-graded Lie algebras of dimensions 52, 78, 133, and 248 are obtained as graded contractions of the $\mathbb{Z}_2^3$-gradings on the exceptional Lie algebras (excluding $\mathfrak{g}_2$) arising from the octonions in [3]. Moreover, the resulting algebras are distinguished by their Levi decompositions, the derived series of their radicals, their centers, and other structural features.

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Rational canonical form for algebraic elements in general rings

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Abstract.

Following the ideas of the work [1] in which we built the Jordan canonical form for nilpotent elements whose last nonzero power was von Neumann regular, in this work we study when algebraic elements can admit representations as companion matrices with respect to certain matrix unit elements. This is joint work in progress together with M. Gómez Lozano and S. Balda.

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On Spaces of Nilpotent Matrices and a Problem of Albert

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Abstract.
In the past half-century, M. Gerstenhaber established the seminal results relating nilpotent subspaces of matrices over fields [2, 3, 4, 5]. These works emerge in connection with a problem in finite-dimensional commutative algebras proposed by A. Albert [1]. Here, we will show new results about space of nilpotent $n \times n$ matrices over arbitrary fields. In [8], the author describes, up to similarity, the maximal nilpotent linear subspaces of $M_4(\mathbb{C})$. The main result of [6] consists of the classification, up to similarity, of all maximal nilpotent linear subspaces of $M_4(F)$, where F is a field with at least three elements. In particular, we find a new maximal nilpotent subspace of $M_4(\mathbb{C})$ which is not similar to the subspaces given in [8]. In [7] we describe all two-dimensinal nilpotent linear subspaces of $M_5(\mathbb{C})$ that attain maximal rank. I expect that these results will allow us to describe every maximal nilpotent linear subspace of $M_5(\mathbb{C})$.

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Generalized Lie structures of associative graded algebras with special involutions.

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Abstract.
Every associative algebra A gives rise to a Lie algebra A^- by replacing the associative product ab by the commutator $ab - ba$. The ideals of A^- are usually called Lie ideals of A. The study of the Lie ideal structure of A dates back to the 50s with the works of Baxter [1] and Herstein [4, 5] in associative rings. More precisely, they investigated the Lie ideal structure of an associative simple ring A, as well as, the Lie ideal structure of K and $[K, K]$, for K the skew symmetric elements of a simple ring with involution and characteristic not 2. Their results were generalized in several ways: Erickson [6] extended them to prime rings with involution which are 2-torsion-free, while Lanski and Montgomery [7] dealt with prime rings of characteristic 2. All these results are known nowadays as Herstein's Lie Theory.

In the past few years, Herstein's Lie Theory has been extended to other algebraic structures like superalgebras [8, 9, 10, 11] and Lie color algebras [2, 12, 14]. Here, we focus our attention on the skew symmetric elements K of an (ε, G)-Lie color algebra with an ε-involution. See [3, 13] for some background on Lie color algebras. More specifically, we investigate the ε-Lie structure of K and $[K, K]$ and we explore the relationship with the (associative) ideals of A.

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An elementary proof that algebras over an operad are semi-abelian

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Abstract.
The operad theory provides a fundamental framework for the study of algebraic structures and their categorical properties together. In that sense, it is useful to understand and systematise the link between the properties of and operad and the properties of the category of algebras over it. This poster is a particular example of that link. We expose an accessible and explicit proof of the fact that the category of algebras over a reduced (meaning we have no constant operations) operad is a semi-abelian category. It is a particularly useful example, since it allows us to "translate" all the machinery and properties that already have been studied for semi-abelian categories to the operad world. Over all, it represents a really good starting point for future work in the relations between an operad and the category of algebras associated to it.

Some properties of Lotka-Volterra Coalgebras

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Abstract. We will report on recent advances in Lotka-Volterra coalgebras, stressing their structure, and the description of their in-evolution operators, automorphisms and coderivations.

This is a joint work with Manuel Arenas (Universidad Tecnólogica Metropolitana de Chile) and Alicia Labra (Universidad de Chile).

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On formal deformations of evolution algebras

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Abstract.

Deformation theory was introduced by Gerstenhaber in [1] for associative algebras and later extended to other algebraic structures, especially Lie algebras, by Nijenhuis and Richardson in [3]. Roughly speaking, a deformation of an algebraic structure $\mathcal{A}$ with multiplication μ consists of constructing a family of new multiplications

$$\mu_t = \mu + \sum_{i \geq 1} \mu_i t^i$$

on the formal power series space $\mathcal{A}[[t]]$, where each μ_i is a bilinear map on $\mathcal{A}$. The purpose of deformation theory is to understand how these new multiplications modify and enrich the original algebraic structure.

In this poster, we focus on our investigation [2] concerning deformations of *evolution algebras*, a class of commutative non-associative algebras introduced by Tian and Vojtěchovský in [4] in connection with non-Mendelian genetics.

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Explicit canonical cycle at the virtual cohomological dimension of $\mathrm{SL}_n(\mathbb{Z})$ through Voronoi complex

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Abstract.
We construct an explicit canonical cycle in the top-dimensional homology of the Voronoi complex associated with an arithmetic group. This cycle relates to the cohomology of $\mathrm{SL}_n(\mathbb{Z})$ with rational coefficients at the virtual cohomological dimension. It had previously been identified in computational works and conjectured to provide an intrinsic generator.

Our approach relies on a geometric rigidity property of the Voronoi tessellation. More precisely, we show that codimension-one facets split into two types: non-self-intersecting facets, whose contributions cancel pairwise between neighbouring top cells, and self-intersecting facets, whose cancellation is internal to the stabilizer of a single top cell. Together with the connectedness of the Voronoi graph, this yields a canonical non-trivial cycle of the form

$$\sum_{\sigma \in \Sigma_{d(n)}} \frac{1}{|\Gamma_\sigma|}\, \sigma.$$

Furthermore, we formulate an abstract framework for polyhedral tessellations of convex cones under group actions, clarifying the mechanism behind the construction of such cycles. As a consequence, we prove that this canonical cycle generates the top homology group of the Voronoi complex with rational coefficients.

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