Rings, Modules, and Hopf Algebras

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Abstracts

Sponsored by:

Nichols algebras with finite Gelfand-Kirillov dimension

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Joint work with Iván Angiono and István Heckenberger.

In previous work we have described several families of Nichols algebras with finite Gelfand-Kirillov dimension over abelian groups which are not of diagonal type. In this talk we will show that many of these families give new examples of finite-dimensional Nichols algebras in positive characteristic by considering the analogous braided vector spaces.

Examples of finite-dimensional Nichols algebras in positive characteristic

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Joint work with Nicolás Andruskiewitsch and István Heckenberger.

The classification of Hopf algebras with finite Gelfand-Kirillov dimension has received attention recently. Nichols algebras play an important role in this question that will be explained in the talk together with an overview of examples and partial results.

Quantum differentials by super-bosonisation

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We expand the Majid's bosonisation $A \rtimes\!\!\!\!\ltimes B$, where B is a braided-Hopf algebra in the category of crossed-A-modules, to the bosonisation of their exterior algebras $\Omega(A) \rtimes\!\!\!\!\ltimes \Omega(B)$, where $\Omega(B)$ is now a super-braided Hopf algebra in the category of super-crossed-$\Omega(A)$-modules. The latter is then defined as an exterior algebra of $A \rtimes\!\!\!\!\ltimes B$, and we proved that it is a strongly bicovariant calculus. Using this method, we then found a strongly bicovariant calculus of quantum Borel subalgebra of a matrix quantum groups $\mathbb{C}_q[G]$ of Hecke-type R-matrix. This is a joint work with Shahn Majid.

Connected Hopf algebras

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I will give a review of results (some new, some old) and open questions on connected Hopf algebras. Here and in the title, the word "connected" can and will be interpreted in two different senses - as referring to a Hopf algebra H whose coalgebra structure is connected (that is, H has a unique simple subcoalgebra), or to a Hopf algebra whose algebra structure is connected graded.

Frobenius Galois cowreaths

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For a Galois cowreath, we present a one to one correspondence between the Frobenius systems of the algebra extension induced by the cowreath and the Frobenius systems of the cowreath itself. In particular this says that the algebra extension is Frobenius if and only if the cowreath defining it is Frobenius. (Joint work with Blas Torrecillas.)

Additive discount functions through Arbitrage Theory

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This paper aims to derive the decomposability of discount functions from the Arbitrage Theory proposed by Kreps and Clark which involves a certain number of well-known financial markets. The framework of this model is a locally convex real linear topological space X in which a convex cone C defines a vector order. Additionally, there exist markets for only some of the contingent claims of X which assigns a price p_i to the marketed claim m_i. Later, the time has been included in this model as a characteristic inherent to contingent claims. In this way, the additivity of discount functions has been derived as a particular case of the general theory and by using some specific trading strategies.

Group gradings on matrix algebras

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We discuss group gradings on the full matrix algebra $M_n(k)$ over a field k, and on certain subalgebras of $M_n(k)$, called structural matrix algebras. Particular attention is given to the gradings with the property that all the matrix units lying in the subalgebra are homogeneous elements; these are called good gradings, and they play a key role in the description of all gradings.

Quantum geometry, exceptional quantum geometry and particle physics

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We first review the analysis of Jordan, von Neumann and Wigner showing that the finite-dimensional Euclidean Jordan algebras are the algebras of observables for finite quantum systems, that is the quantum analogs of the algebras of real functions on finite sets.

We then describe in details our approach involving the exceptional Jordan algebra of hermitian 3×3 octonionic matrices for the classification of fundamental particles of matter, the description of their symmetry group and their interactions.

Pretorsion theories in general categories

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We will present a notion of pretorsion theory in general categories and two, or more, interesting examples of such pretorsion theories. Torsion theories in arbitrary categories have been studied by Grandis, Janelidze and Márki. Our main examples will be in the category of preordered sets and the category of finite algebras with one operation, unary, and no axioms (i.e., the category of all mappings $f\colon X \to X$, where X is a finite set). Our results appear in joint papers with Carmelo Antonio Finocchiaro, Marino Gran and Leila Heidari Zadeh.

Hopf sheaves and affine extensions of abelian varieties

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We present a proposal of a representation theory for extensions of an Abelian variety A by a group scheme G affine over A. This is work in progress done jointly with Pedro Luis del Angel (Cimat/Mexico) and Alvaro Rittatore (Udelar/Uruguay). We aim to generalize in this way the classical theory of Tannaka Duality established for affine group schemes. In this talk we concentrate on the generalization to this context of the well-known equivalence between the categories of affine group schemes and commutative Hopf algebras.

New Hopf algebras arising from the generalized lifting method

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The problem of classifying all Hopf algebras over an algebraically closed field k of a given dimension was posed by Kaplansky in 1975. Some progress has been made but, in general, it is a difficult question. One of the few general techniques is the so-called Lifting Method developed by Andruskiewitsch and Schneider [AS], under the assumption that the coradical is a subalgebra, i.e., the Hopf algebra has the Chevalley Property. More recently, Andruskiewitsch and Cuadra [AC] proposed to extend this technique by considering the subalgebra generated by the coradical and the related wedge filtration. Using this *generalized lifting method* is it possible to produce new examples of Hopf algebras and to discover new Nichols algebras through the process.

In this talk we will show new examples of Hopf algebras and Nichols algebras which arises from the analysis of the cases when the Hopf algebra generated by the coradical is isomorphic to the dual of a Radford algebra. We will discuss also briefly the relation of this problem and the classification of Nichols algebras of diagonal type as appeared in [AA], see also [X].

This talk is based on joint work with D. Bagio, J. M. Jury Giraldi and O. Marquez [GJG], [BGJM].

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An application of twisted group rings in Cryptography

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Cryptography is the science of information security. We have used some protocols for a long time to secure our communications, but these protocols could be not enough to preserve our confidentiality anymore. Because of that, new structures and problems are being proposed. In this work, we focus on ring theory, which could provide a setting in order to get secure public key protocols. We give a proposal for a key exchange using a twisted group ring as a platform, and compare it with some currently used protocols.

Crossed products of crossed modules of Hopf monoids in a braided setting

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In this talk we introduce a notion of crossed module of Hopf monoids in a braided monoidal category. This new definition contains as a particular instances the notion of crossed module of Hopf algebras defined by J.M. Fernández Vilaboa, M.P. López López and E. Villanueva Nóvoa in 2007, the notion of crossed module of Hopf algebras defined by Y. Fregier and F. Wagemann in 2011 and the notion of Hopf algebra crossed module introduced by S. Majid in 2012. Also we consider a crossed product of two crossed modules of Hopf monoids and give the necessary and sufficient

conditions to get a new crossed module of Hopf monoids. Moreover we introduce the notion of projection of crossed modules of Hopf monoids and show that with some additional hypothesis, any of these projections defines a new crossed module of Hopf monoids and allows us to construct an example of crossed module of Hopf monoids using the bosonization process.

Partial morphisms in additive exact categories

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We develop a general theory of partial morphisms over an exact category, extending the notion introduced by Ziegler for the special case of pure-exact sequences in the in the category of modules over a ring. We relate these partial morphisms with injective approximations and phantom maps and study the existence of such approximations in an exact category.

Model structures and relative Gorenstein flat modules

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A recent result by J. Šaroch and J. Šťovíček shows that there is a unique abelian model structure on the category of left R-modules, for any associative ring R with identity, whose (trivially) cofibrant and (trivially) fibrant objects are given by the classes of Gorenstein flat (resp., flat) and cotorsion (resp., Gorenstein cotorsion) modules. We generalise this result. We introduce a relative version of Gorenstein flat modules, which we call Gorenstein $\mathcal{B}$-flat modules, where $\mathcal{B}$ is a class of right R-modules. We give sufficient conditions on the class $\mathcal{B}$ so that the class of Gorenstein $\mathcal{B}$-flat modules is closed under extensions. We also obtain a relative version of the model structure described above.

This is joint work with Sergio Estrada and Marco Perez.

Lattice theory and module theory

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Our aim in this talk is twofold. First we study decomposition of lattices and the consequences in the module theory. It is well known that if a ring R has a ring decomposition, the lattice of right ideals is a direct product of two module lattices. We study what happens whenever the lattice of a right R-module has such a decomposition, and apply it in different contexts. For the second approach let us consider a poset P, the preadditive category $\mathcal{P}$, and the well known functor category Mod-$\mathcal{P}$. Working in Mod-$\mathcal{P}$ we build a hereditary torsion theory, and a class of modules that parameterizes the category of fuzzy modules over a given ring, and provide a well founded algebraic approach.

Group gradings on the algebras of block-triangular matrices

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Recently there has been a considerable interest in classifying gradings by arbitrary groups on nonassociative algebras. The situation is well understood for finite-dimensional simple algebras of several important varieties including associative, Lie and Jordan (over sufficiently good fields). Much less is known about gradings on non-simple algebras. In this talk, we will discuss a classification up to isomorphism of gradings by abelian groups on the upper block-triangular matrices over an algebraically closed field, regarded as an associative, Lie or Jordan algebra, assuming zero characteristic in the latter two cases.

This is a joint work with Felipe Yasumura. The associative case was originally done by A. Valenti and M. Zaicev (2012) under some technical assumptions.

q-Deformations, twisted algebraic structures and new-type cohomologies

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A quantum deformation or q-deformation consists of replacing usual derivation by a σ-derivation or (σ, τ)-derivation in algebras of vector fields. The main example is given by Jackson derivative and lead for example to q-deformation of $\mathfrak{sl}_2$, Witt algebra, Virasoro algebra and also Heisenberg algebras (oscillator algebras). The description of the new structures gave rise to a structure generalizing Lie algebras, called Hom-Lie algebras or quasi-Lie algebras studied first by Larsson and Silvestrov. Since then various classical algebraic structures and properties were extended to the Hom-type setting. The main feature is that the classical identities are twisted by homomorphisms.

The purpose of my talk is to give an overview of recent developments and provide some key constructions and examples on Hom-algebras, BiHom-algebras and their dualization. I will show that they lead to new-type cohomologies. Moreover, I will describe (σ, τ)-differential graded algebra which generalizes the notion of differential graded algebra, and show an example involving Generalized Clifford algebra.

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Brackets, superalgebras and spectral gap

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During the talk we will discuss Poisson and contact brackets and related infinite dimensional superalgebras. All vector spaces are considered over the field of complex numbers.

The talk is based in a recent paper joined with E. Zelmanov and in a forthcoming paper with O. Mathieu and E. Zelmanov.

Heavily separable functors

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Motivated by an example related to the tensor algebra functor, we introduce and investigate a stronger version of the notion of separable functor that we call heavily separable. We test this notion on some adjunctions traditionally connected to the study of separability.

The Nulsstellensatz for supersymmetric polynomials

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This paper gives a proof of conjecture 13.5.1 from [M]. The result gives a geometric interpretation of maximal ideals in the algebra of supersymmetric polynomials and can be thought of as an analog of the weak Nullstellensatz. There is also a version of the strong Nullstellensatz. This gives a bijection between radical ideals and algebraic sets which are invariant under the Weyl groupoid of Sergeev and Veselov, [SV]. Note that the algebra of supersymmetric polynomials is not Noetherian, so the usual Nullstellensatz does not apply.

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Non-unique factorizations in rings of integer-valued polynomials

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Let D be a domain with quotient field K. The ring of integer-valued polynomials on D,

$$\mathrm{Int}(D) = \{f \in D[x] \mid \forall a \in D, f(a) \in D\}$$

in general does not have unique factorization of elements.

In this talk, we discuss non-unique factorizations in $\mathrm{Int}(D)$ where D is a Dedekind domain with infinitely many maximal ideals of finite index.

We present two main results. First, for any finite multiset N of natural numbers greater than 1, there exists a polynomial $f \in \mathrm{Int}(D)$ which has exactly $|N|$ essentially different factorizations of the prescribed lengths. In particular, this implies that every finite non-empty set N of natural numbers greater than 1 occurs as a set of lengths of a polynomial $f \in \mathrm{Int}(D)$. Second, we show that the multiplicative monoid $(\mathrm{Int}(D) \setminus \{0\}, \times)$ of $\mathrm{Int}(D)$ is not a transfer Krull monoid.

On clean comodules and clean coalgebras

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Throughout R is a commutative ring with multiplicative identity. We have already known the notions of cleanness on rings and modules. In this research, we applied cleanness property on modules and rings to comodule and coalgebra structure. Since every C-comodule M is a module over the dual algebra of C, we define a clean comodule based on this fact. A C-comodule M is a clean comodule when M is clean as a module over the dual algebra of C. Furthermore, a clean coalgebra defines by considering any coalgebra C as a comodule over itself. Here, we give some sufficient conditions of clean comodules and clean coalgebras.

Moreover, let P be a finitely generated (f.g) projective R-module. The tensor product $P^* \otimes_R P$ is an R-coalgebra and P, P^* can be consider as a comodule over coalgebra $P^* \otimes_R P$. Using the Morita context, this paper give sufficient conditions of clean coalgebra $P^* \otimes_R P$ and clean $P^* \otimes_R P$-comodule P and P^*. This sufficient conditions are determined by the conditions of module P and ring R.

This is a joint work with Indah Emilia Wijayanti and Budi Surodjo.

Positive primitive torsion

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Martsinkovsky and Russell introduced a torsion radical –called *injective torsion*– as the injective stabilization of the tensor product with the module, evaluated at the ring. In joint work with Martsinkovsky I proved that this torsion coincides with what I earlier called *elementary torsion* for the case where the vanishing class of modules is that of flat modules (on the other side) and the pp formulas in question are those which vanish on that class (or simply, on the regular module).

I will discuss this and a generalization –now called *pp torsion*– to arbitrary classes of modules resp., arbitrary sets of pp formulas.

On finiteness properties of Grothendieck hearts

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The problem addressed in this talk is the following. Suppose that $\mathcal{G}$ is a Grothendieck category, which in many cases will be required to be also locally finitely presented, and that $\mathbf{t} = (\mathcal{T}, \mathcal{F})$ is a torsion pair of finite type in $\mathcal{G}$. By results of Carlos Parra and the speaker, this last condition is equivalent to say that the associated Happel-Reiten-Smalo t-structure in the (unbounded) derived category $\mathcal{D}(\mathcal{G})$ has a heart which is itself a Grothendieck category.

We will study under which conditions, both on $\mathcal{G}$ and the torsion pair $\mathbf{t}$, that heart is locally finitely presented or even locally coherent. We will also study, under the hypothesis that $\mathcal{G}$ be locally coherent, the relation between the local coherence of the mentioned heart and the fact that the torsion pair $\mathbf{t}$ restricts to the (abelian) subcategory $\mathrm{fp}(\mathcal{G})$ of finitely presented objects.

A pair of Frobenius pairs for Hopf modules

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We report on the existence of two adjoint triples for Hopf (bi)modules over a bialgebra H and we investigate under which conditions these form a Frobenius pair.

Namely, on the one hand the functor $- \otimes H$ from vector spaces to right Hopf modules over H admits both a left and a right adjoint. While studying when these form a Frobenius pair, we run into an equivalent characterization of (some) one-sided Hopf algebras in the sense of Green, Nichols and Taft, *Left Hopf Algebras*, J. Algebra (1980). On the other hand, also the functor $- \otimes H$ from left H-modules to right Hopf bimodules admits both a left and a right adjoint. The analysis of this case is still under consideration, but it is already evident that being Frobenius for the latter is strictly connected to the category of left H-modules being rigid.

A new proof of a theorem of I. Angiono

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This is joint work with I. Heckenberger. Using the theory of reflections of Nichols systems we give a new proof of the following theorem of Angiono: Any finite-dimensional pointed Hopf algebra with abelian group of group-like elements over an (algebraically closed) field of characteristic 0 is generated as an algebra by group-like and skew-primitive elements.

Basic ideals in evolution algebras

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We will speak about the notion of basic ideal in an evolution algebra, which will provide with a useful tool in order to classify finite dimensional evolution algebras. We show that any n-dimensional perfect evolution algebra has a maximal basic ideal; it will be unique except when its dimension is $n-1$. As an application we will provide the classification of the four dimensional perfect non-simple evolution algebras over a field with mild restrictions.

Graded quasi Lie algebras and hom-Lie algebras structures

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In this talk, an overview will be presented about hom-algebra structures, with focus on foundations and recent advances on graded (color) quasi Lie algebras, quasi-hom Lie algebras, hom-Lie algebras and related hom-algebra structures. These interesting algebraic structures appear for example when discretizing the differential calculus as well as in constructions of differential calculus on non-commutative spaces. Quasi Lie algebras encompass in a natural way the Lie algebras, Lie superalgebras, color Lie algebras, hom-Lie algebras, q-Lie algebras and various algebras of discrete and twisted vector fields arising for example in connection to algebras of twisted discretized derivations, Ore extension algebras, q-deformed vertex operators structures and q-deferential calculus, multi-parameter deformations of associative and non-associative algebras, one-parameter and multi-parameter deformations of infinite-dimensional Lie algebras of Witt and Virasoro type, multi-parameter families of quadratic and almost quadratic algebras that include for special choices of parameters algebras appearing in non-commutative algebraic geometry, universal enveloping algebras of Lie algebras, Lie superalgebras and color Lie algebras and their deformations. Common unifying feature for all these algebras is appearance of some twisted generalizations of Jacoby identities providing new structures of interest for investigation from the side of associative algebras, non-associative algebras, generalizations of Hopf algebras, non-commutative differential calculi beyond usual differential calculus and generalized quasi-Lie algebra central extensions and Hom-algebra formal deformations and co-homology. Hom-algebra generalizations of Nambu algebras, associative algebras and Lie algebras to n-ary structures are also actively studied and some constructions and results on n-ary hom-Lie algebras will be presented in this talk.

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Mixed perverse sheaves on flag varieties of Coxeter groups

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We construct an abelian category of "mixed perverse sheaves" attached to any realization of a Coxeter group, in terms of the associated Elias-Williamson diagrammatic category. This construction extends previous work of Achar and Riche, where they worked with parity complexes instead of diagrams, and we extend most of the properties known in this case to the general setting. As an application we prove that the split Grothendieck group of the Elias-Williamson diagrammatic category is isomorphic to the corresponding Hecke algebra, for any choice of realization.

This talk is based on a joint work with Pramod Achar and Simon Riche [Canad. J. Math. (2018), https://doi.org/10.4153/CJM-2018-034-0].

The ideal generated by the primitive idempotent in a Leavitt path algebra over a commutative ring

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The Reduction Theorem in Leavitt path algebra over a commutative unital ring is very important to prove that the Leavitt path algebra is semiprime if and only if the ring is also semiprime. The socle of the semiprime Leavitt path algebra is constructed by minimal ideals of the ring and the set of all line points. Any vertex in the cycle without exits will generate a basic ideal in Leavitt path algebras over a commutative unital ring.

Lattices and cohomological Mackey functors for finite cyclic p-groups

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(Joint work with Blas Torrecillas.)

For a complete discrete valuation domain $\mathcal{O}$ of characteristic 0 with residue field of characteristic p and a finite cyclic group G of p-power order, the category of left $\mathcal{O}G$-lattices is in general too wild to permit a satisfactory description. In 2012 we showed that every such $\mathcal{O}G$-lattice L fits in a short exact sequence

$$0 \longrightarrow Q \longrightarrow P \longrightarrow L \longrightarrow 0$$

for permutation $\mathcal{O}G$-lattices Q and P, i.e., there exist left G-sets Ω and Υ such that $Q = \mathcal{O}[\Omega]$, $P = \mathcal{O}[\Upsilon]$. The proof of this somehow astonishing result is achieved by showing that the category of cohomological G-Mackey functors with coefficients in the category of $\mathcal{O}$-modules has global cohomological dimension 3.

On the generalization of Dedekind modules

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Let R be an integrally closed commutative domain with its quotient field K. Let M be a finitely generated torsion free R-module. We define first the concepts of v-submodules and study some elementary properties. Moreover, we introduce the notion of G-Dedekind modules, as the generalization of Dedekind modules. A module M is called a generalized Dedekind module (a G-Dedekind module for short) if any v-submodule of M is invertible. Furthermore, we show that under some conditions, if R is a Dedekind domain and M is an R-module, then M is a G-Dedekind module. We also give some results related to polynomial modules $M[X]$ as an $R[X]$-module.

Braided Bi-Galois theory and its application to Brauer groups

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Let $(H, \mathcal{R})$ be a quasi-triangular Hopf algebra or a quantum group, $\mathcal{C}$ the representation category of H, which is a braided tensor category. The transmutation of (H, R) is a braided Hopf algebra in the category $\mathcal{C}$. We study the braided autoequivalences of the Drinfeld center $\mathcal{Z}(\mathcal{C})$ which are trivializable on $\mathcal{C}$. To this end, we need to develop a general braided bi-Galois theory for Hopf algebras in braided tensor categories, and study quantum-commutative bi-Galois objects in the braided tensor categories. After establishing the aforementioned theory, we will apply it to compute the Brauer group of the quantum group (H, R).