Conference of collaborates of
IME-USP in Representations of
Algebras and related topics

22-24 July, 2019
IME-USP

CCRA 2019

Abstracts

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INSTITUTO DE MATEMATICA E ESTATÍSTICA
UNIVERSIDADE DE SÃO PAULO

CCRA 2019

Conference of collaborators of IME-USP in representations of algebras and related topics

Schedule and Abstracts

July 22–24, 2019, São Paulo, Brasil

List of Speakers

Abdenacer Makhlouf	—	University of Haute-Alsace
Adriano Moura	—	UNICAMP
Alex Sierra Cárdenas	—	UFPA
Alexander Grishkov	—	IME-USP
Bertrand Rémy	—	CNRS
Edson Ribeiro Alvares	—	UFPR
Eric Ragoucy	—	Laboratoire d'Annecy-le-Vieux de Physique Théorique
Hagen Meltzer	—	University of Szczecin
Heily Wagner	—	UFPR
João Fernando Schwarz	—	IME-USP
Marcelo Moreira da Silva	—	UNIFAL
Marcelo Muniz Alves	—	UFPR
Marcos Jardim	—	UNICAMP
Mikhail Zaicev	—	Moscow State University
Olivier Mathieu	—	Institut Camille Jordan
Philippe Gille	—	Institut Camille Jordant
Roland Berger	—	Université Jean-Monnet
Tran Giang Nam	—	Institute of Mathematics, Vietnam Academy of Science and Technology
Yury Volkov	—	Saint Petersburg State University

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ABSTRACTS

ABDENACER MAKHLOUF (UNIVERSITY OF HAUTE-ALSACE)

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

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.

1 V. Abramov, O. Liivapuu and A. Makhlouf, (q,σ,τ)-Differential Graded Al- gebras. Universe 2018, 4, 138; doi:10.3390/universe4120138 (2018)

2 F. Ammar and A. Makhlouf, Hom-Lie Superalgebras and Hom-Lie admissible Superalgebras, Journal of Algebra, Vol. 324, Issue 7, 15131528 (2010).

3 B. Hurle and A. Makhlouf, α-type Hochschild cohomology of Hom-associative algebras and bialgebras. Journal of the Korean Mathematical Society (2019).

4 G. Graziani, A. Makhlouf, C. Menini, F. Panaite, BiHom-associative algebras, BiHom-Lie algebras and BiHom-bialgebras, Symmetry Integrability Geom. Methods Appl. 11 (2015), 086, 34 pages.

5 J. T. Hartwig, D. Larsson, S. D. Silvestrov, Deformations of Lie algebras using σ-derivations, J. Algebra 295 (2006), 314–361.

6 A. Makhlouf, S. Silvestrov, Hom-algebras and Hom-coalgebras, J. Algebra Appl. 9 (2010), 553–589.

ADRIANO MOURA (UNICAMP)

Factorization Graphs and Tensor Products of Finite-Dimensional Representations of Quantum Affine Algebras.

Although the finite-dimensional representation theory of quantum affine algebras has been intensively studied since the early 1990's, several basic questions about the underlying abelian tensor categories remain unanswered. In this talk we will address two of these questions which are strongly related:
1) Determine if the tensor product of given simple objects is reducible.
2) Classify the prime simple objects.

We will introduce the concept of q-factorization graph of a simple object which is based on the answer for question (1) restricted to the class of Kirillov-Reshetikhin modules. We propose this as a natural language for expressing answers for the above questions. We end the talk presenting a few preliminary new results in the direction of answering this questions obtained in an ongoing joint work with Clayton Silva.

ALEX SIERRA CÁRDENAS (UFPA)

On composition series of a Brauer configuration algebra

Given a Brauer configuration algebra Λ, we will use non-projective uniserial Λ-modules to construct an explicit composition series of any indecomposable projective Λ-module. We also show some numerical relations between the elements of the combinatorial data that defines Λ by using the entries of the Cartan matrix associated to Λ and the length of the indecomposable projective Λ-modules.

ALEXANDER GRISHKOV (IME-USP)

Antisymmetric non-standart cohomologies and its applications

BERTRAND RÉMY (CNRS)

Topological generation of simple non-archimedean groups

We will deal with the problem of counting the minimal number of topological generators for simple algebraic groups over local fields. We have almost complete answers in the split case. The proofs make use of notions from profinite groups and the Bruhat-Tits theory of reductive groups over local fields, and uses arguments from finite simple group theory. This is joint work with Inna Capdeboscq (Warwick University).

EDSON RIBEIRO ALVARES (UFPR)

Piecewise Hereditary Algebras and its strong global dimension

In this talk we present a bound to the strong global dimension of piecewise hereditary algebras.

ERIC RAGOUCY (LABORATOIRE D'ANNECY-LE-VIEUX DE PHYSIQUE THÉORIQUE)

On Elliptic deformation of $W_{\mathfrak{n}}$ algebras

We revisit the construction of deformed Virasoro algebras from elliptic quantum algebras of vertex type, generalizing the bilinear trace procedure proposed in the 90's. It allows us to make contact with the vertex operator techniques that were introduced separately at the same period by Jimbo et al. The case of dynamical elliptic quantum algebras is also studied.

Then, we extend our method to q-deformations of quantum W_N algebras with elliptic structure functions. Their generators of spin k+1 are built from $2k$ products of the Lax matrix generators of $A_{q,p}(\mathfrak{gl}(N)_c)$. The closure of the algebras is insured by a critical surface condition relating the parameters p, q and the central charge c. Further abelianity conditions are determined, either as $c = -N$ or as a second condition on p, q, c. When abelianity is achieved, a Poisson bracket can be defined, that we determine explicitly. One connects these structures with previously built classical q-deformed W_N algebras and quantum $W_{q,p}(\mathfrak{sl}_N)$.

Based on joint works with J. Avan and L. Frappat, see arXiv:1607.05050, arXiv:1703.05223, arXiv:1810.11410.

HAGEN MELTZER (UNIVERSITY OF SZCZECIN)

Nilpotent operators with invariant subspaces

This is a report on joint work with Piotr Dowbor (Toruń) and partially also with Markus Schmidmeier (Boca Raton). We study exceptional objects in categories S of nilpotent operators on vector spaces with invariant subspaces. By joint work with Dirk Kussin and Helmut Lenzing these categories are related to stable categories of vector bundles on weighted projective lines. Using other methods they have been also studied by Claus M. Ringel and Markus Schmidmeier. Classically the problem goes back to David Birkhoff who studied subgroups of abelian groups already in 1934.

Of particular interest are the tubular cases, here almost all indecomposable objects of S, or their shifts, are modules over a certain tubular algebra, which we can realize as endomophism algebra of a tilting bundle on a weighted projective line of weight type $(3, 3, 3)$, $(2, 4, 4)$ or $(2, 3, 6)$.

For the situation, that the degree of the nilpotent operator is bounded by 6 and that we are dealing with only one subspace we determine all dimensions vectors of the exceptional objects. Further we show that each exceptional object can be exhibited by matrices having as coefficients only 0 and 1.

By extending the methods we will also discuss the case of two independent subspaces where the degree of the nilpotent operator is bounded by 3.

1 P. Dowbor, H. Meltzer. *Dimension vectors of indecomposable objects of nilpotent operators of degree 6 with one invariant subspace.* Algebras and Representation Theory, to appear, online https://doi.org/10.1007/s10468- 017-9759-z.

2 P. Dowbor, H. Meltzer. *Exceptional objects of nilpotent operators of degree 3 with two incomparable subspaces.* Preprint Toruń (2018).

3 P. Dowbor, H. Meltzer, M. Schmidmeier. *The "0,1" property of exceptional objects for nilpotent operators of degree with one invariant subspace.* Journal of Pure and Applied Algebra, to appear, https://doi.org /10.1016/j.jpaa.2018.10.013.

4 D. Kussin, H. Lenzing, H. Meltzer. *Nilpotent operators and weighted projective lines.* J. Reine Angew. Math. 685 (2013), 33–71.

5 D. Kussin, H. Lenzing, H. Meltzer. *Triangle singularities, ADE chains and weighted projective lines.* Advances in Mathematics 237, (2013). 194–251.

6 C. M. Ringel, M. Schmidmeier. *Invariant subspaces of nilpotent linear operators.* Journal der Reinen und angewandten Mathematik 614 (2008), 1–52.

HEILY WAGNER (UFPR)

On algebras of hereditary representation type

It's a joint work in progress with E. Alvares, C. Braga and S. Trepode. We study the class of artin algebras which the global dimension of the endomorphism algebras of the direct sum of all projective and injective indecomposable modules is equal three. In particular, if an algebra in this class is representation-infinite this means that its representation dimension is three and an Auslander generator is the smallest: the direct sum of all projective and all injective modules. We also show that the radical square zero algebras in this class are representation-finite.

JOÃO FERNANDO SCHWARZ (IME-USP)

Harish-Chandra Categories and Invariant Differential Operators

The notion of a Harish-Chandra module emmerged in the context of representations of algebraic lie algebras. A generak abstract framework was estabilished by Drozd, Futorny and Ovsienko in the early 90's; later a more specific and powerful notion emerged: Gelfand-Tsetlin modules for Galois Orders (Futorny and Ovsienko). We review these concepts, as they adress quite natural and important questions in representation theory. We then expose some of the newest results in this direction: the case of invariant differential operators — obtained by Futorny and Schwarz.

MARCELO MOREIRA DA SILVA (UNIFAL)

Hochschild cohomology groups of trivial extensions of one-way algebras

A one-way algebra A is a finite dimensional algebra over an algebraic closed field K endowed with a complete set S of orthogonal idempotents such that:

1. For $e \neq f$ in S, if $eAf \neq 0$ then $fAe = 0$;
2. For all $e \in S$, we have $\dim_k(eAe) = 1$;
3. S, has more than one element (that is A is not K) and A is an indecomposable algebra (that is the graph with set of vertices S and an edge between e and f in case eAf or fAe is not zero is a connected graph).

The one-way algebra was introducing in the article "Cohomology of split algebras and of trivial extensions" by Cibils, Marcos, Redondo and Solotar. An example of the one-way algebra is the incidence algebra.

Consider the trivial extension algebra $T(A) = A \times D(A)$ of A by the A-bimodule $D(A) = \mathrm{Hom}_K(A, K)$, that is, $T(A) = A \oplus D(A)$ as K-vector space and the multiplication in $T(A)$ is given by $(a, f)(b, g) = (ab, ag+fb)$ for $a, b \in A$ and f,g $\in D(A)$.

The purpose of this talk is to describe the relation between the Hochschild cohomology groups of a one-way algebra A with coefficients in the regular bimodule ${}_AA_A$, and that of its trivial extension $T(A)$ of A.

MARCELO MUNIZ ALVES (UFPR)

(co)Homology of partial representations of groups

Partial representations of groups were introduced in the end of the 90's in the context of C^*-algebras generated by partial isometries; a few years later these were studied by Exel, Piccione and Dokuchaev in a purely algebraic context. Several lines of investigation sprang from this paper, such as partial projective representations of groups and partial representations of Hopf algebras. In this talk we go back to partial representations of groups and introduce a homology and cohomology for partial representations of groups. Partial cohomology is related, via a spectral sequence, to the Hochschild cohomology of partial crossed products; both homology and cohomology can be linked with the usual homology and cohomology of group representations via a result of M. Dokuchaev and N. Zhukavets.

This is a joint work with M. Dokuchaev and D. Koshloukova.

MARCOS JARDIM (UNICAMP)

Instanton sheaves and representations of quivers

We study the moduli space of rank 2 instanton sheaves on the 3-dimensional projective space in terms of representations of a quiver consisting of 3 vertices and 4 arrows between two pairs of vertices. Aiming at an alternative compactification for the moduli space of instanton sheaves, we show that for each rank 2 instanton sheaf, there is a stability parameter theta for which the corresponding quiver representation is theta-stable (in the sense of King), and that the space of stability parameters has a non trivial wall-and-chamber decomposition. Looking

more closely at instantons of low charge, we prove that there are stability parameters with respect to which every representation corresponding to a rank 2 instanton sheaf of charge 2 is stable, and provide a complete description of the wall-and-chamber decomposition for representation corresponding to a rank 2 instanton sheaf of charge 1.

Joint work with Danilo D. Silva.

MIKHAIL ZAICEV (MOSCOW STATE UNIVERSITY)

TBA

OLIVIER MATHIEU (INSTITUT CAMILLE JORDAN)

TBA

PHILIPPE GILLE (INSTITUT CAMILLE JORDAN)

On Serre's conjecture II for groups of type E_7

Serre's conjecture II is a vanishing conjecture in non-abelian Galois cohomology. It was stated in 1962 and is still open for trialitarian groups and groups of type E. We shall discuss the state of the art on the topic focusing on the E_7 case.

ROLAND BERGER (UNIVERSITÉ JEAN-MONNET)

Koszul Calculus of Preprojective Algebras

It is a joint work with Rachel Taillefer. A Koszul calculus was defined and developed in [1] for associative algebras defined by homogeneous quadratic algebras. We study the Koszul calculus of preprojective algebras. We prove that a Poincaré duality is valid for these algebras. This duality is new when the algebra is not Koszul, showing how Koszul (co)homology can be drastically different to Hochschild (co)homology in the non-Koszul situation.

1 Roland Berger, Thierry Lambre, Andrea Solotar, *Koszul calculus*, Glasg. Math. J., 2018.

TRAN GIANG NAM (INSTITUTE OF MATHEMATICS, VIETNAM ACADEMY OF SCIENCE AND TECHNOLOGY)

Corners of Leavitt path algebras of finite graphs are Leavitt path algebras

Given a (row-finite) directed graph E and any field K, Abrams and Aranda Pino in [2], and independently Ara, Moreno, and Pardo in [4], introduced the *Leavitt path algebra* $L_K(E)$. Leavitt path algebras generalize the Leavitt algebras $L_K(1, n)$ of [5], and also contain many other interesting classes of algebras. In addition, Leavitt path algebras are intimately related to graph C^*-algebras (see [6]). During the past fifteen years, Leavitt path algebras have become a topic of intense investigation by mathematicians from across the mathematical spectrum. For a detailed history and overview of Leavitt path algebras we refer the reader to the survey article [1].

One of the interesting questions in the theory of Leavitt path algebras is to find relationships between graphs E and F such that their corresponding Leavitt path algebras are Morita equivalent. In [3] Abrams, Louly, Pardo, and Smith established some basic transformations of graphs which preserve isomorphism or Morita equivalence of the associated Leavitt path algebras. They also showed If E and F are finite graphs, and if $L_K(E)$ and $L_K(F)$ are purely simple algebras, then the K_0-groups of $L_K(E)$ and $L_K(F)$ are isomorphic and the sign of $\det(I - A_E)$ is equal to the sign of $\det(I - A_F)$ implies $L_K(E)$ is Morita equivalent to $L_K(F)$, and moreover, in this case E may be transformed into F by a sequence of these basic transformations.

Sørensen [7] extended the transformations and results on finite graphs to the case of finite vertex and infinite edge graphs and calculated the topological K-groups of the graph C^*-algebras. Sørensen proved that if E and F are graphs with a finite number of vertices and an infinite number of edges, and if the graph C^*-algebras $C^*(E)$ and $C^*(F)$ are simple C^*-algebras, then $C^*(E)$ and $C^*(F)$ are strongly Morita equivalent iff the corresponding topological K_0- and K_1-groups are isomorphic. In this case, the graphs are transformed into each other via these transformations.

Inspired by these results, it is natural to consider an interesting problem classifying up to Morita equivalent Leavitt path algebras via these basic transformations. Our idea to this problem is to try to identify when a corner of a Leavitt path algebra is again a Leavitt path algebra, or at least Morita equivalent to a Leavitt path algebra. The goal of the talk is to establish that every nonzero corner of a Leavitt path algebra of a finite graph is isomorphic to a Leavitt path algebra. Consequently, this yields in particular that every unital K-algebra which is Morita equivalent to a Leavitt path algebra is indeed isomorphic to a Leavitt path algebra.

1 G. Abrams, Leavitt path algebras: the first decade, *Bull. Math. Sci.* **5** (2015), 59-120.

2 G. Abrams and G. Aranda Pino, The Leavitt path algebra of a graph, *J. Algebra* **293** (2005), 319–334.

3 G. Abrams, A. Louly, E. Pardo, and C. Smith, Flow invariants in the classification of Leavitt path algebras, *J. Algebra* **333** (2011), 202–231.

4 P. Ara, M. A. Moreno, and E. Pardo, Nonstable K-theory for graph algebras, *Algebr. Represent. Theory* **10** (2007), 165–224.

5 W. Leavitt, The module type of a ring, *Trans. Amer. Math. Soc.* **42** (1962), 113–130.

6 I. Raeburn, *Graph Algebras*. CBMS Regional Conference Series in Mathematics, Vol. 103, American Mathematical Society, Providence, RI, 2005, vi+113 pp. Published for the Conference Board of the Mathematical Sciences, Washington, DC.

7 A. P. W. Sørensen, Geometric classification of simple graph algebras, *Ergodic Theory Dynam. Systems* **33** (2013), 1199–1220.

YURY VOLKOV (SAINT PETERSBURG STATE UNIVERSITY)

Actions generated by spherical twists on triangulated categories

In this talk we will present some results about actions of groups generated by spherical twists on enhanced triangulated categories. Mainly two results in this direction will be presented. The rest one is the description of actions generated by two twists along spherical sequences. In particular, it will be shown that A_2, B_2 and G_2 configurations of spherical sequences almost always induce actions of the corresponding Artin groups. In some exceptional cases the counterexamples will be given. Another result is the new proof of the faithfulness of braid group actions of types An and Dn induced by the corresponding configurations of spherical objects. This proof was obtained in collaboration with Anya Nordskova. Our proof works for any sphericity except 1. Note that even the action of the braid group corresponding to an A_3 configuration of 1-spherical objects can be non faithful.

1 Y. Volkov, *Groups generated by two twists along spherical sequences*, arXiv: 1901.10904.