August 3-12

20th ICRA 2022

Workshop and the 20th International Conference on Representations of Algebras 2022

Workshop Speakers

- Anna Barbieri (Università degli Studi di Milano)
- Karin Erdmann (University of Oxford)
- Julian Külshammer (Uppsala Universitet)
- Rosanna Laking (Università degli Studi di Verona)
- Hipolito Treffinger (Université Paris Cité)

Conference

- Nicolás Andruskiewitsch (Universidad Nacional de Córdoba)
- Karin Baur (University of Leeds and Universität Graz)
- Xiao Wu Chen (University of Science and Technology of China)
- Radha Kessar (University of London)
- Ivan Shestakov (Universidade de São Pablo)
- Bertrand Toën (Université de Toulouse)

Scientific Committee

Lidia Angeleri Hügel, Aslak Bakke Buan, Claude Cibils, Bernhard Keller, Henning Krause, Eduardo Marcos, Octavio Mendoza, Manuel Saorín, Sibylle Schroll, Andrea Solotar, Gordana Todorov, Michael Wemyss, Pu Zhang.

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Argentina: Andrea Solotar (Chair), Claudia Chaio, Cristian Chaparro, Elsa Fernández, María Julia Redondo, Mariano Suárez-Álvarez, Sonia Trepode, Hipólito Treffinger.

Montevideo

Buenos Aires

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Workshop and 20th International Conference on Representations of Algebras

Abstracts (workshop courses, plenary talks and parallel sessions)

Montevideo and Buenos Aires - August 3rd to 12nd of 2022

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Workshop Courses

Salón de Actos (Polifuncional Massera)

- **Anna Barbieri (Università degli Studi di Padova)** `August 3rd (Wed) 11:00 - 12:00`
  Spaces of Bridgeland stability conditions `August 4th (Thur) 11:00 - 12:00`
  `August 5th (Fri) 11:00 - 12:00`

  I will give an introduction to the notion of Bridgeland stability conditions for triangulated category and the stability manifold associated, with a focus on the case of the Ginzburg 3-Calabi-Yau category associated with a quiver arising from a triangulation of a surface.

- **Karin Erdmann (University of Oxford)** `August 3rd (Wed) 09:30 - 10:30`
  Tame symmetric algebras `August 4th (Thur) 09:30 - 10:30`
  `August 5th (Fri) 09:30 - 10:30`

  These lectures will investigate tame symmetric algebras, which are constructed and described via surface triangulations, and which generalize naturally tame blocks of group algebras. Such blocks have groups as invariants: dihedral, or semidihedral, or quaternion.

  Inspired by cluster theory, we introduce weighted surface algebras. They are almost all periodic as algebras, of period 4, and are a geometric generalization for quaternion type. We take these as a frame for several more algebras: Degenerating minimal relations gives rise to a generalization for dihedral type, and semidihedral type.

  Towards a unified approach, we introduce hybrid algebras. These include all Brauer graph algebras, weighted surface algebras, and in addition many other tame symmetric algebras. Hybrid algebras are precisely the block components of idempotent algebras eAe where A is a weighted surface algebra and e an idempotent of A.

  We discuss what is known about indecomposables, Auslander-Reiten components, and derived equivalence.

  This is mostly joint work with Andrzej Skowrónski.

- **Julian Külshammer (Uppsala Universitet)** `August 3rd (Wed) 16:00 - 17:00`
  Towards bound quivers for exact categories `August 4th (Thur) 14:30 - 15:30`
  `August 6th (Sat) 10:00 - 11:00`

  The proceedings of the first ICRA in 1974 contain an article by Roiter and Kleiner describing a theory of representations of semi-free differential graded categories. While the theory has been successfully applied in a number of cases, most notably in the proof of Drozd's tame-wild dichotomy, it is today not as well-known as e.g. the theory of almost split sequences described in articles by Auslander and Reiten in the same proceedings.

In this lecture series, I will explain how such semi-free differential graded categories are a convenient way to talk about certain ring extensions and provide evidence that they are a way to develop a theory of quivers and relations for exact categories. The most developed special case right now is that of the category of filtered modules over a quasi-hereditary algebra.

This builds on joint work with several people over the last decade, let me in particular mention Steffen Koenig, Sergiy Ovsienko, and Vanessa Miemietz.

- **Rosanna Laking (Università degli Studi di Verona)** `August 3rd (Wed) 14:30 - 15:30`

  Torsion pairs and mutation `August 5th (Fri) 14:30 - 15:30`

  `August 6th (Sat) 11:30 - 12:30`

  The complete lattice tors-A formed by the collection of all torsion pairs in the category of finitely generated modules over a finite-dimensional algebra A encodes a wealth of combinatorial and homological information about the representation theory of A. This is due, in part, to its connections with t-structures, tau-tilting theory and stability conditions. The connection with tau-tilting theory has been a particularly powerful tool for understanding tors-A, since the functorially finite torsion pairs are parametrised by two-term silting objects in the bounded derived category of mod(A) and the adjacent edges of the Hasse quiver are controlled by silting mutation.

  In these talks we will introduce an approach to the study of tors-A that goes beyond tau-tilting theory and the functorially finite torsion classes. We will give an overview of the Demonet-Iyama-Reading-Reiten-Thomas brick labelling of the Hasse quiver in terms of simple tilts between the corresponding HRS-t-structures. By lifting these t-structures to the derived category of all modules we will see that the simple tilts induce irreducible mutations of associated (large) two-term cosilting complexes. Finally we will explain how the two-term cosilting complexes are parametrised by certain closed sets of the Ziegler spectrum and their mutations are determined by the open sets of the induced topology.

  The topics covered by these talks are contained in joint work with Lidia Angeleri Hügel, Ivo Herzog, Francesco Sentieri, Jan Šťovíček and Jorge Vitória.

- **Hipolito Treffinger (Université Paris Cité)** `August 4th (Thur) 16:00 - 17:00`

  Wall-and-chamber structures of Artin algebras `August 5th (Fri) 16:00 - 17:00`

  and τ-tilting theory `August 6th (Sat) 09:00 - 10:00`

  The aim of this course is to give an overview of the deep relationship between a geometric object associated to an Artin algebra, known as its wall-and-chamber structure, and the τ-tilting theoretic properties of the algebra. Being more precise, in this course we will show how several important notions of τ-tilting theory are encoded in the geometry of the wall-and-chamber structure of the algebra.

  We will start this course by showing the (top-down) construction of the wall-and-chamber structure of an algebra using the stability conditions defined by King and how we can use stability conditions to calculate torsion pairs in the module category of our algebra. We then will change gears slightly to introduce τ-tilting theory and present the (bottom-up) construction of (part of) the wall-and-chamber structure of the algebra using the g-vectors of the indecomposable τ-rigid objects of the algebra.

Once these two complementaries constructions of the wall-and-chamber structure are presented, we will profit the interplay between the two to recover several important objects which are central to τ-tilting theory, including τ-tilting pairs and their mutation, (semi)bricks, torsion pairs and wide subcategories.

Conference Plenary Lectures

Monday - August 8$^{\text{th}}$ - Aula Magna (UBA - Exactas)

- **Nicolás Andruskiewitsch (Universidad Nacional de Córdoba)** `09:30 - 10:20`

  On a family of Hopf algebras arising from finite-dimensional Nichols algebras of diagonal type

  The classification of the finite-dimensional Nichols algebras of diagonal type, obtained by Heckenberger, can be organized in terms of Lie theory. Such Nichols algebras give rise to several classes of Hopf algebras. In the talk we will focus on a class introduced by Angiono and defined from families that depend on a parameter; this extends a construction by De Concini, Kac and Procesi. The class includes quantum super groups and characteristic 0 deformations of some Lie algebras in characteristic 2 and 3. We show that these algebras give rise to Poisson orders in the sense of Brown and Gordon and we describe the corresponding symplectic leaves.

  This is joint work with Iván Angiono and Milen Yakimov.

- **Charley Cummings (Aarhus Universitet)** `(Online) 10:50 - 11:40`

  The left-right symmetry of the finitistic dimension

  The finitistic dimension is a numerical invariant of a ring that measures the complexity of its representation theory. This invariant need not be finite, but the longstanding, open finitistic dimension conjecture asserts that it is finite for finite dimensional algebras. The dimension can be defined in terms of left or right modules, and, in general, these two invariants are distinct. However, it is unknown if the finiteness of the two dimensions is connected. In this talk, we use quiver operations to show that such a connection exists if and only if the finitistic dimension conjecture holds.

- **Eric J. Hanson (UQÀM and Université de Sherbrooke)** `11:50 - 12:40`

  Homological approximations in persistence theory

  (Joint with Benjamin Blanchette and Thomas Brüstle)

  The study of persistent homology offers an exciting application of quiver representations. Since this application often involves working over wild algebras, one active area of research is to establish "invariants" that can be used to distinguish two non-isomorphic persistence modules. In this talk, we define a large class of such invariants using techniques from relative homological algebra. We show that several classical invariants, in particular the dimension vector and the rank invariant, fit into this new framework. We also provide an example of a new invariant which is finer than the rank invariant. This talk will not assume prior knowledge of persistence modules and their invariants.

Tuesday - August 9$^{\text{th}}$ - Aula Magna (UBA - Exactas)

- **Ivan Shestakov (Universidade de São Pablo)** `10:00 - 10:50`

  The structure and representations of Jordan superalgebras

  This will be a survey on the structure and representations of Jordan superalgebras.

- **Karin Baur (University of Leeds and Universität Graz)** `11:20 - 12:10`

  Module categories for coordinate rings of Grassmannians

  The category of maximal Cohen-Macaulay modules over a certain quotient of a preprojective algebra is known to provide a categorification of Scott's cluster algebra structure of the coordinate ring of the Grassmannian.

  This category is of infinite type in general - we study these types. We show that it is a tubular category. This makes it a very interesting examples of categories of infinite types and allows us to characterise certain modules of small rank.

  Joint work with Dusko Bogdanic, Jianrong Li and with Ana Garcia Elsener.

Wednesday - August 10$^{\text{th}}$ - Aula Magna (UBA - Exactas)

- **Xiao Wu Chen (University of Science and Technology of China)** `(Online) 09:00 - 09:50`

  An invitation to the singular Yoneda dg category

  This is an introduction to a new dg category associated to any algebra, called the singular Yoneda dg category; it is a singular analogue of the Yoneda dg category (implicitly due to Keller), and provides a new dg enhancement for the singularity category. Using this explicit dg enhancement, we describe the singularity category of a finite dimensional algebra using the dg Leavitt path algebra of its radical quiver. The Hom complexes in the singular Yoneda dg category are related to the stabilization functor in the sense of Krause. This is based on joint work with Zhengfang Wang.

- **Bertrand Toën (Université de Toulouse)** `10:00 - 10:50`

  Algebraic foliations and derived geometry

  (joint work with G. Vezzosi)

  Foliations defined on algebraic varieties are rarely without singularities. These singularities can be studied using derived techniques via a notion of "derived foliations", in the same way than singularities of algebraic varieties can be studied using the notion of derived schemes. In this talk, I will explain the notion of derived foliations and report on recent applications for the study of singular foliations. These include results in the complex case, as well as foliations defined over base fields of arbitrary characteristics.

- **Véronique Bazier-Matte (Université Laval)** `11:20 - 12:10`

  Knots and cluster algebras

  (Joint with Ralf Schiffler)

  In knot theory, it is known that we can compute the Alexander polynomial of a knot from the lattice of Kauffman states of a knot diagram. Recently, my collaborator and I associated a quiver with a knot diagram. From this quiver, one can obtain a Jacobian algebra. It appears that the lattice of submodules of indecomposable modules over this algebra is in bijection with the lattice of Kauffman states with regards to a segment of the knot. This bijection allows us to compute the Alexander polynomial of a knot with a specialization of the F-polynomial of any indecomposable module over this algebra. Besides, the set of modules corresponding to different maximal Kauffman states gives a cluster.

- **Sondre Kvamme (Norwegian University of Science and Technology)** `12:20 - 13:10`

  Indecomposable representations in the monomorphism category

  (Joint with Nan Gao, Julian Külshammer, Chrysostomos Psaroudakis)

  Let A be a finite-dimensional algebra, or more generally an Artin ring. The submodule category of A consists of tuples (M_0, M_1, f) where $f\colon M_0 \to M_1$ is a monomorphism of finitely generated A-modules. Describing this category is an old topic in representation theory, which can be traced back to the beginning of the 20th century by work of Miller and Hilton. There has also been more recent work on this topic, for example by Ringel and Schmidmeier in 2008 where they study the Auslander–Reiten theory of submodule categories, and introduce the important Mimo-construction.

  Now let Q be a finite acyclic quiver. Associated to Q and A, one can define the generalized monomorphism category, denoted $\mathrm{Mono}(\mathrm{mod}\, A, Q)$. By putting $Q = \mathbb{A}_2$ one recovers the submodule category of A. This generalization has been considered by many authors, and occurs for example naturally in the study of persistence homology. Let $\overline{\mathrm{mod}}A$ denote the injectively stable module category of A, and let $\mathrm{rep}(\overline{\mathrm{mod}}A, Q)$ denote the category of representations of Q in $\overline{\mathrm{mod}}A$. In this talk I will explain how there is a bijection between the indecomposable non-injective representations in $\mathrm{Mono}(\mathrm{mod}\, A, Q)$, and the indecomposable representations in $\mathrm{rep}(\overline{\mathrm{mod}}A, Q)$. This bijection is obtained by generalizing the Mimo-construction of Ringel and Schmidmeier to Q. I will also say something about the proof, which uses the notion of free monads on abelian categories. If time permits, I will explain how one can use this result to obtain the AR-quiver of $\mathrm{Mono}(A, Q)$ from the AR-quiver of $\mathrm{rep}(\overline{\mathrm{mod}}A, Q)$.

Thursday - August 11th - Aula Magna (UBA - Exactas)

- **Sebastian Opper (Charles University, Prague)** `09:00 - 09:50`

  Categories associated to punctured surfaces and surface braid groups on triangulated categories

  (Joint with Wassilij Gnedin and Alexandra Zvonareva)

The talk is about a new class of A_∞-categories which can be associated to punctured surfaces with suitable line fields. They can be thought of as (shifted) trivial extensions of gentle algebras, or equivalently, partially wrapped Fukaya categories of surfaces in the sense of Haiden, Katzarkov and Kontsevich. For certain line fields they also include the class of Brauer graph algebras, which previously appeared in modular representation theory of finite groups. I aim to talk about their (currently conjectural) connection to surface braid group actions on triangulated categories and their interpretation as Fukaya categories in some cases.

- **Cristian Chaparro (Universidad ECCI, Colombia)** `10:00 - 10:50`

The first Hochschild cohomology space of the trivial extension of quadratic monomial algebras

(Joint with Sibylle Schroll and Andrea Solotar)

The first Hochschild cohomology of the trivial extension of a finite dimensional algebra can be computed as a direct sum of four vector spaces. We compute the four vector spaces for the trivial extension of quadratic monomial algebras and give an explicit description of the Lie algebra structure of the first Hochschild cohomology space.

Friday - August 12^{th} - Aula Magna (UBA - Exactas)

- **Jorge Vitória (Università degli Studi di Padova)** `09:00 - 09:50`

Mutations and derived equivalences in the representation theory of commutative rings

(Joint work with Sergio Pavon, and with Lidia Angeleri Hügel, Rosanna Laking and Jan Šťovíček)

It is well-known that the structure of both the category of modules over a commutative noetherian ring R and its derived category are controlled by the prime spectrum of R. Through the notion of support, numerous classification results have been obtained for relevant subcategories of both categories.

In this talk we discuss t-structures in $D^b(\mathsf{mod}(R))$ via their lifts to $D(\mathsf{Mod}(R))$, following the recent approach of Marks and Zvonareva. We show that every intermediate t-structure in $D^b(\mathsf{mod}(R))$ can be obtained by a sequence of right mutations of the injective cogenerator in $\mathsf{Mod}(R)$, and that each mutation step induces a derived equivalence between the new heart and $\mathsf{Mod}(R)$. This relies on the fact that hereditary torsion pairs of finite type in the hearts arising in this sequence of mutations are parametrised in the same way as in $\mathsf{Mod}(R)$: via specialisation-closed subsets of $\mathsf{Spec}(R)$.

- **Xiaofa Chen (Université Paris Cité)** `(Online) 10:00 - 10:50`

What is an exact dg category?

In his recent preprint "Exact DG-Categories", Positselski proposes an answer to the question in the title. In this talk, we will propose an entirely different answer based on the work of Barwick, who introduced exact ∞-categories in 2012 as an ∞-categorical generalization of Quillen's notion of exact category. We define exact dg categories in such a way that their dg nerves are exact ∞-categories in the sense of Barwick. In analogy with a theorem by Nakaoka-Palu (2020), we show that the H^0-category of an exact dg category carries a canonical extriangulated structure. We call such extriangulated categories algebraic. This extends the corresponding notion for triangulated categories. Typical examples are Yilin Wu's Higgs categories and Haibo Jin's categories of dg Cohen-Macaulay modules. We also show that each connective exact dg category embeds fully exactly into its dg derived category, in analogy with a theorem by Klemenc for exact ∞-categories. We expect that the connectivity assumption cannot be dispensed with in general.

- **Radha Kessar (City, University of London)** `11:20 - 12:10`

  On Hilbert series of Hochschild Cohomolgy of symmetric groups

  I will report on recent joint work with Dave Benson and Markus Linckelmann on computing dimensions of the Hochschild cohomology groups of symmetric groups.

Non-plenary Talks (Parallel Sessions)

Monday - August 8^{th}

Session 1 - Pabellón Cero+Infinito, Room 1204

- **Víctor Becerril (Centro de Ciencias Matemáticas, UNAM)** `14:40 - 15:10`

  Gorenstein flat modules relative to duality pairs

  In this talk we introduce the class of Gorenstein flat R-modules $\mathcal{GF}_{(Flat,\mathcal{A})}$ relative to a *duality pair* $(\mathcal{L},\mathcal{A})$. We study their homology and $(-\otimes_R -)$-balancing properties from the point of view of Auslander-Buchweitz approximation theory. Such class of relative Gorenstein flat modules has recently been introduced by J. Gillespie [Gill19] from a class of right R-modules $\mathcal{A}$ which forms part of a *duality pair* $(\mathcal{L},\mathcal{A})$ in the sense of H. Holm and P. Jørgensen [HoJor].

  This class of Gorenstein flat R-modules has recently attracted the interest of several authors [Gill19,Gill21,WangDi,WangYang], because of the richness of its structure, since on the one hand it is possible to obtain model structures and cotorsion pairs associated to the class $\mathcal{GF}_{(Flat,\mathcal{A})}$ [Gill19]. In addition, for a fix duality pair $(\mathcal{L},\mathcal{A})$ the classes of Gorenstein projective $\mathcal{GP}_{(Proj,\mathcal{L})}$ and Gorenstein injective $\mathcal{GI}_{(\mathcal{A},Inj)}$ R-modules can also be defined. For which the $\mathrm{Hom}_R(-,-)$-balance is given on the whole category $\mathrm{Mod}(R)$ [WangDi]. In this talk we also study the relationship of the class $\mathcal{GF}_{(Flat,\mathcal{A})}$ with the classes $\mathcal{GP}_{(Proj,\mathcal{L})}$ and $\mathcal{GI}_{(\mathcal{A},Inj)}$, by comparing their homological dimensions.

  We define the Gorenstein flat global dimension of the ring R, relative to the class $\mathcal{GF}_{(Flat,\mathcal{A})}$, denoted $\mathrm{gl.GF}_{(Flat,\mathcal{A})}(R)$ and we see that it is possible to characterize it by the flat dimension of $\mathcal{A}$. As a main result we show that the functor $(-\otimes_R -)$ is balanced under the same conditions under which the balance of the functor $\mathrm{Hom}_R(-,-)$ is achieved with the classes $\mathcal{GP}_{(Proj,\mathcal{L})}$ and $\mathcal{GI}_{(\mathcal{A},Inj)}$, and give applications to specific cases of duality pairs. $(\mathcal{L},\mathcal{A})$, on different types of rings.

  These results have been obtained during the postdoctoral stay of the speaker with Professor Raymundo Bautista and are compiled in the preprint [GFlat].

  - [GFlat] V. Becerril $(\mathcal{F},\mathcal{A})$-*Gorenstein flat homological dimensions*, arXiv:2203.09012v2
  - [Gill19] J. Gillespie, *Duality pairs and stable module categories.* J. Pure Appl. Algebra (2019) 223(8):3425-3435.
  - [Gill21] J. Gillespie, A. Iacob, *Duality pairs, generalized Gorenstein modules, and Ding injective envelopes*, arXiv preprint arXiv:2105.01770, 2021.
  - [HoJor] H. Holm, P. Jørgensen, *Cotorsion pairs induced by duality pairs*, J. Commut. Algebra vol. 1, no. 4, 2009, pp. 621-633.
  - [WangDi] J. Wang, Z. Di, *Relative Gorenstein rings and duality pairs*, Journal of Algebra and Its Applications 2020.
  - [WangYang] Zhanping Wang, Gang Yang, Rongmin Zhu *Gorenstein flat modules with respect to duality pair*, Communications in Algebra, 1532-1519 (2019).

- **Tiago Cruz (University of Stuttgart)** `15:10 - 15:40`

  Relative dominant dimension with respect to a module

  (Joint with Karin Erdmann)

  Given a finite-dimensional algebra A, understanding the homological properties that A and its modules possess is a worthwhile goal.

  Over quasi-hereditary algebras, and more generally over stratified algebras, the existence of a simple preserving duality leads to many homological invariants over such algebras to be even numbers. The class of Schur algebras and the Ringel duals of Schur algebras are prominent examples of quasi-hereditary algebras with a simple preserving duality.

  In this talk, we discuss a new generalisation of dominant dimension and explain how this homological invariant fits in this picture. As a byproduct, the faithful dimension, in the sense of Buan and Solberg, of summands of the characteristic tilting module can be used to distinguish quasi-hereditary covers, in the sense of Rouquier, having a simple preserving duality.

- **Francesca Fedele (Università degli Studi di Verona)** `16:10 - 16:40`

  Universal localizations of d-homological pairs

  Let k be an algebraically closed field and Φ a finite dimensional k-algebra. The universal localization of Φ with respect to a set of morphisms between finitely generated projective Φ-modules always exists. Moreover, when Φ is hereditary, Krause and Šťovíček proved that the universal localizations of Φ are in bijection with various natural structures.

  In this talk, I will introduce the higher analogue of universal localizations, that is universal localizations of d-homological pairs with respect to certain wide subcategories, and show a (partial) generalisation of Krause and Šťovíček result in the higher setup.

- **Magnus Hellstrøm-Finnsen (Østfold University College)** `16:40 - 17:00`

  Hochschild cohomology of monads

  In this talk I report on some work in progress on Hochschild cohomology of monads. We discuss some basic combinatorics of the Hochschild cochain complex and how a monad fit somewhat naturally into that. Then we define the complex and the cohomology of a monad. We interpret the lower dimensional cohomology groups. Finally, we define the cohomology ring, the cup-product on the cohomology ring and outline a proof that it is graded-commutative.

- **Gastón Andrés García (Universidad Nacional de La Plata)** `14:40 - 15:10`

  Representations of generalized small quantum groups

  (Joint with Cristian Vay)

  We present new techniques to compute the simple modules of a family of algebras with triangular decomposition. In particular, they can be applied to Drinfeld doubles of bosonizations of Nichols algebras over any Hopf algebra. These type of algebras may be seen as generalizations of small quantum groups, for the latter are given by quotients of Drinfeld dobles of bosonizations over abelian groups. As an example, we apply these techniques in the case that the Hopf algebra is the group algebra over a dihedral group $\mathbb{D}_{4t}$ with $t \geq 3$, where the classification of finite-dimensional Nichols algebras is at hand. Roughly speaking, all simple modules can be obtained as heads of *generalized Verma modules*, but the explicit description in each case depends strongly on the structure of the Nichols algebra. We will show how to construct recursively irreducible representations when the Nichols algebra is generated by a decomposable module, and prove that the highest-weight of minimum degree in a Verma module determines its socle.

  This talk is based on the paper *Simple modules of small quantum groups at dihedral groups* available at `https://arxiv.org/abs/2012.09323`.

- **Amrei Oswald (University of Washington)** `15:10 - 15:40`

  Decomposing tensor products of bimodules in pointed fusion categories

  Quantum symmetries of path algebras can be understood as instances of tensor algebras in the category of representations of the appropriate quantum group, as in the framework developed by Etingof, Kinser, and Walton. Motivated by this framework, we investigate bimodules in pointed fusion categories. More specifically, we decompose tensor products of these bimodules based on the classification by Ostrik and Natale. This result also has applications in determining fusion rules in group-theoretical fusion categories.

- **František Marko (The Pennsylvania State University)** `16:10 - 16:40`

  Donkin-Koppinen filtration for $GL(m|n)$ and generalized Schur superalgebras

  (Joint with Alexandr N. Zubkov)

  We characterize the Donkin-Koppinen filtration of the coordinate superalgebra $K[G]$ of the general linear supergroup $G = GL(m|n)$ by its subsupermodules $C_\Gamma = O_\Gamma(K[G])$. Here, the supermodule C_Γ is the largest subsupermodule of $K[G]$ whose composition factors are irreducible supermodules of highest weight λ, where λ belongs to a finitely-generated ideal Γ of the poset $X(T)^+$ of dominant weights of G. A decomposition of G as a product of subsuperschemes $U^- \times G_{ev} \times U^+$ induces a superalgebra isomorphism $\phi^* : K[U^-] \otimes K[G_{ev}] \otimes K[U^+] \simeq K[G]$. We show that $C_\Gamma = \phi^*(K[U^-] \otimes M_\Gamma \otimes K[U^+])$, where $M_\Gamma = O_\Gamma(K[G_{ev}])$. Using the basis of the module M_Γ, given by generalized bideterminants, we describe a basis of C_Γ.

- **Flávio Coelho (University of São Paulo)** `16:40 - 17:10`

  A trisection in the Auslander-Reiten quiver

  We discuss the existence of a trisection in the components of the Auslander-Reiten quiver of an algebra.

- **Karen Lizeth Martinez Acosta (Ruhr-University Bochum)** `17:10 - 17:40`

  Ample stability

  A dimension vector $\mathbf{d}$ for a quiver Q is called *ample stable* if there are no divisors in the unstable locus of the representation variety $R_{\mathbf{d}}(Q)$. This notion can be reduced to a combinatorial criterion that allows us to determine algebro-geometric invariants of quiver moduli spaces. In particular, combined with results by Reineke and Schröer [ReinekeSchr] and, Franzen, Reineke, and Sabatini [FranzenReinekeSabatini], ample stability allows us to obtain an explicit description of the Brauer group and, under a mild condition, to derive the Fano property.

  In this talk, we will explore this combinatorial condition in the promising class of fundamental dimension vectors and present a list of wild quivers for which we classified the amply stable ones. Moreover, we will discuss a recent progress that links moduli spaces, stability conditions and reflections functors.

  – [ReinekeSchr] M. Reineke and S. Schröer *Brauer groups for quiver moduli.* Algebr. Geom. **4**:4 (2017), 452–471.
  – [FranzenReinekeSabatini] H. Franzen, M. Reineke and S. Sabatini. *Fano quiver moduli.* Canad. Math. Bull. (2020), 1–17.

Session 3 - Pabellón Cero+Infinito, Room 1206

- **Maria Bertozzi (Ruhr Universität Bochum)** `14:40 - 15:10`

  Moduli spaces of real quiver representations

  Moduli spaces of quiver representations were introduced by A. King in 1994. Since then they have been intensively studied as they provide a geometric approach to the problem of classification of quiver representations. Nevertheless, the underlying field is commonly assumed to be algebraically closed or finite.

  Using the symplectic reduction, I will define these spaces for *real* quiver representations, which parametrises the isomorphism classes of *real* polystable representations. These new spaces are homeomorphic to semialgebraic sets and, in particular, they are stratified Lagrangian submanifolds inside the corresponding moduli space of complex representations. I plan to describe this, among other geometric properties and present many examples.

- **Daniel Bissinger (University of Kiel)** `15:10 - 15:40`

  Relative projective Kronecker representations and Steiner bundles on Grassmannians

  (Joint with Rolf Farnsteiner)

  Let k be an algebraically closed field, $1 \leq d < r \in \mathbb{N}$ and $K_r = \begin{pmatrix} k & 0 \\ A_r & k \end{pmatrix}$ be the generalized Kronecker algebra with arrow space $A_r := \bigoplus_{i=1}^{r} k\gamma_i$. A vector bundle $\mathcal{F}$ on the Grassmannian $\mathrm{Gr}_d(A_r)$ of d-planes is called **Steiner bundle**, provided there exist finite dimensional vector spaces M_1, M_2 and a short exact sequence

  $$0 \to \mathcal{U}_{(r,d)} \otimes_k M_1 \to \mathcal{O}_{\mathrm{Gr}_d(A_r)} \otimes_k M_2 \to \mathcal{F} \to 0,$$

  where $\mathcal{U}_{(r,d)}$ denotes the universal subbundle on $\mathrm{Gr}_d(A_r)$. It is know, at least since [Jardim-Prata], that the category of Steiner bundles is equivalent to a full subcategory of Kronecker modules.

  We describe these subcategories as relative projective Kronecker representations and study them systematically using homological descriptions and AR theory.

  For $\mathrm{Gr}_1(A_r) \cong \mathbb{P}^{r-1}$, we obtain the category of equal kernels representations and discuss properties of Steiner bundles that can be detected in this category.

  In particular, we show that uniform Steiner bundles that are not homogeneous occur almost everywhere if we arrange them via regular Auslander-Reiten components.

  – [JardimPrata] M. Jardim and D. Prata: *Vector bundles on projective varieties and representations of quivers*. Algebra Disc. Math. **20** (2015), 217-249.

- **Alejandro Argudín Monroy (Centro de Ciencias Matemáticas, UNAM)** `16:10 - 16:40`

  Universal extensions in abelian categories

  (Joint with Carlos E. Parra)

  Let A and B be objects in an abelian category $\mathcal{A}$ and $\mathrm{Ext}(B, A)$ be the class of equivalence classes of short exact sequences of the form $0 \to A \to E \to B \to 0$. A universal extension of B by A is an element $\bar{\eta} \in \mathrm{Ext}(B^{(X)}, A)$ such that for all $\bar{\epsilon} \in \mathrm{Ext}(B, A)$ there exists a morphism $g : B \to B^{(X)}$ such that $\bar{\eta} \cdot g = \bar{\epsilon}$. Recently, such extensions have been used in the study of tilting objects in abelian categories by Carlos E. Parra, Manuel Saorín, and Simone Virili (see https://arxiv.org/abs/2103.14159). It should be noted that there are abelian categories where we can find pairs of objects that do not admit universal extensions. In this talk, we will approach the problem of characterising the categories where every pair of objects admits a universal extension. In particular, we will see that an Ab3 abelian category satisfies the above if and only if it is Ab4 and Ext-small. From this arises the necessity of studying the objects V that admit a universal extension of V by A for any object A in an non-Ab4 Ab3 abelian category. In particular, we will be able to give a characterisation of such objects for the dual category of the category of abelian torsion groups.

- **Yasuaki Ogawa (Nara University of Education)** 16:40 - 17:10

  Localization of triangulated categories with respect to extension-closed subcategories

  In this talk, we develop a framework for localization theory of triangulated categories $\mathcal{C}$ with respect to an extension-closed subcategory $\mathcal{N}$ which is not necessarily thick. The aim of such a generalization is to find a common principle of the Verdier quotient and some cohomological functors, e.g., the heart of t-structures, the abelian quotient by 2-cluster tilting subcategories and a more general phenomenon, the heart of cotorsion pairs. In fact, such phenomena can be understood through the extriangulated localization which is a unification of the Serre/Verdier quotient. Thus, the obtained quotient category $\widetilde{\mathcal{C}}_{\mathcal{N}}$ of $\mathcal{C}$ by $\mathcal{N}$ becomes an extriangulated category equipped with the "exact" functor $Q : \mathcal{C} \to \widetilde{\mathcal{C}}_{\mathcal{N}}$ satisfying suitable universality. The formulation of our localization is divided in two steps:

  - *Relative theory*: There exists a weaken structure $(\mathcal{C}, \mathbb{E}_{\mathcal{N}}, \mathfrak{s}_{\mathcal{N}})$ relative to the triangulated category $\mathcal{C}$ which is determined by $\mathcal{N}$.
  - *Localization*: Then, $\mathcal{N}$ becomes a thick subcategory in $(\mathcal{C}, \mathbb{E}_{\mathcal{N}}, \mathfrak{s}_{\mathcal{N}})$, which enables us to define the quotient category of $\mathcal{C}$ by $\mathcal{N}$.

  Furthermore, we provide necessary and sufficient conditions for $\mathcal{N}$ to make $\widetilde{\mathcal{C}}_{\mathcal{N}}$ to be triangulated and abelian.

- **Davide Morigi (University of East Anglia)** 17:10 - 17:40

  Presentations of braid group of type A arising from $(m+2)$*-angulations of regular polygons*

  The concept of $(m+2)$-angulation of a regular polygon was studied by Baur and Marsh to give a geometric description of m-cluster categories of type A. A few years later, Buan and Thomas introduced m-coloured quivers and m-coloured quiver mutations, adapting the classical concept of quiver mutation given by Fomin and Zelevinsky to a higher setting.

  In this talk we will see how these two notions are strictly related, and how we can use them to give new presentations for the braid group of type A.

Session 4 - Pabellón Cero+Infinito, Room 1207 (online talks)

- **Edson Ribeiro Alvares (Universidade Federal do Paraná-UFPR)** 14:40 - 15:10

  Piecewise Hereditary Algebras

  (Joint with Tanise Carnieri Pierin and Patrick Le Meur)

  Some of the homological properties of the algebras A, such that the bounded derived category $\mathcal{D}^b(mod\ A)$ is derived equivalent to the bounded derived category of a hereditary category (known as Piecewise Hereditary Algebras), are well known. In this talk we give sufficient homological conditions on an algebra to be Piecewise Hereditary.

- **Asmae Ben Yassine (Charles University, Prague)** 15:10 - 15:40

  f-projective and relative flat Mittag-Leffler modules

  (Joint with Jan Trlifaj)

The classes $\mathcal{D}_{\mathcal{Q}}$ of relative flat Mittag-Leffler modules are sandwiched between the class $\mathcal{FM}$ of all (absolute) flat Mittag-Leffler modules, and the class $\mathcal{F}$ of all flat modules. Building on the works of Angeleri-Hügel, Herbera, and Šaroch, we give a characterization of relative flat Mittag-Leffler modules in terms of their local structure, and also show that Enochs' Conjecture holds for all the classes $\mathcal{D}_{\mathcal{Q}}$. Finally, we apply these results to the particular case of f-projective modules.

- **Viktor Chust (Institute of Mathematics and Statistics, U. São Paulo)** `16:10 - 16:40`

  On generalized path algebras

  (Joint with Flávio Ulhoa Coelho)

  The generalized path algebras were introduced in (Coelho, Liu, 2000), in order to generalize the well-known concept of path algebras over a quiver. In order to construct a generalized path algebra, we associate an algebra to each vertex of a quiver (instead of only the base field as it happens with ordinary path algebras), and we consider paths intercalated by elements from the algebras to form a vector space basis of the generalized path algebra. Multiplication is then naturally defined by concatenation of paths and using the multiplications of the algebras in each vertex.

  The aim of this talk is to briefly introduce the generalized path algebras and to discuss some ideas which appear in two recent works by the authors, which relate representation-theoretical properties of a given generalized path algebra with those of the algebras used in its construction.

  This work was produced under supervision by Dr. Flávio Ulhoa Coelho (IME-USP) and the authors acknowledge financial support by São Paulo Research Foundation (grant FAPESP #2018/18123-5 and #2020/13925-6).

- **Gabriella D'Este (University of Milano)** `16:40 - 17:10`

  A bijection between the indecomposable summands of two basic tilting modules

  (Joint with H. Melis Tekin Akcin - Hacettepe University, Ankara)

  We will describe a bijection between the n indecomposable summands of two basic "classical" tilting modules, that is finite dimensional tilting modules of projective dimension at most one. As we shall see, a similar bijection does exist if we replace tilting modules by tau tilting modules.

Tuesday - August 9th

Session 1 - Pabellón Cero+Infinito, Room 1204

- **Mindy Y. Huerta (Universidad Nacional Autónoma de México)** `14:40 - 15:10`

  m-Periodic Gorenstein objects I: properties under orthogonality conditions

  (Joint with O. Mendoza and Marco A. Pérez)

  We present the notion of m-periodic $(\mathcal{A}, \mathcal{B})$-Gorenstein projective (injective) objects where m is a positive integer and $\mathcal{A}, \mathcal{B}$ are classes of objects in an abelian category $\mathcal{C}$, as a generalization of m-strongly Gorenstein projective modules introduced by Bennis and Mahdou. This relativization follows the ideas proposed by Becerril, Mendoza and Santiago for $(\mathcal{A}, \mathcal{B})$-Gorenstein projective (injective) objects and it shows that several well known properties, existing for m-strongly Gorenstein projective modules, can be extended. In this work, we study the behaviour of m-periodic $(\mathcal{A}, \mathcal{B})$-Gorenstein projective (injective) objects under orthogonality assumptions on the classes $\mathcal{A}$ and $\mathcal{B}$. For instance, when the pair is hereditary (that is, the projective dimension between the classes is zero) or by considering the pair $(\mathcal{D}, \mathcal{D})$ where $\mathcal{D}$ is an n-cluster tilting subcategory of $\mathcal{C}$.

- **Karin M. Jacobsen (Aarhus University and NTNU)** `15:10 - 15:40`

  Higher analogues of correspondences from tilting theory

  (Joint with August, Haugland, Kvamme, Palu and Treffinger)

  Homological algebra has been a very active field in recent years, and one line of research has investigated higher analogues of τ-tilting, torsion classes and wide subcategories. In classical tilting theory, there are well-known correspondences between support τ-tilting pairs, functorially finite torsion classes, and wide subcategories. I will review the higher homological versions of these objects, and then discuss what is known about their connections in the higher case.

- **Fiorela Rossi Bertone (Universidad Nacional del Sur)** `16:10 - 16:40`

  The Ext-algebra for infinitesimal deformations

  (Joint with María Julia Redondo and Lucrecia Román)

  Let f be a Hochschild 2-cocycle and A_f an infinitesimal deformation of a finite-dimensional $\mathbb{K}$-algebra A. We describe, under some conditions on f, the algebra structure of the Ext-algebra of A_f in terms of the Ext-algebra of A. We achieve this description by getting an explicit construction of minimal projective resolutions.

- **Marco A. Pérez (Universidad de la República)** `16:40 - 17:10`

  m-Periodic Gorenstein objects II: applications to relative Gorenstein dimensions

  (Joint with Mindy Huerta and Octavio Mendoza)

We present and study the concept of m-periodic Gorenstein objects (where m is a positive integer) relative to a GP-admissible pair $(\mathcal{A}, \mathcal{B})$ of classes of objects in an abelian category, as a generalization of m-strongly Gorenstein projective modules over associative rings. Some important results for the latter notion carry over to our proposed generalization. For example, an object will be Gorenstein projective relative to $(\mathcal{A}, \mathcal{B})$ if, and only if, it is a direct summand of a 1-periodic Gorenstein projective object relative to $(\mathcal{A}, \mathcal{B})$. We use this equivalence to show some outcomes regarding relative global Gorenstein dimension. In particular, we can recover a result of Bennis and Mahdou from 2010 that asserts that the global Gorenstein projective and Gorenstein injective dimensions of any ring coincide. Moreover, similar conclusions are valid for Ding and AC-Gorenstein global dimensions of rings.

Session 2 - Pabellón Cero+Infinito, Room 1205

- **Ivon Dorado (Universidad Nacional de Colombia)** `14:40 - 15:10`

  p-equipped posets through Drozd's ditalgebra and bocses

  A p-equipped poset is an ordered set in which the order relation splits into p disjoint relations. Its incidence algebra is an algebra over a non-algebraically closed field, with a unique simple projective ideal, and a socle isomorphic to a direct sum of finite copies of it.

  The category of representations of these posets is non-abelian and it has been studied through different approaches as submodule categories, or categories of morphisms between projective modules over its incidence algebra. In this talk, our aim is to relate all of this work to bocses, using differential tensor algebras (ditalgebras). In particular, we have proven that there is an equivalence from the category of representations of a p-equipped poset to a subcategory of representations of a Drozd's ditalgebra.

- **Didrik Fosse (NTNU)** `15:10 - 15:40`

  Towards a classification of linear A_n-quivers with relations

  Linearly ordered A_n-quivers with different sets of relations give rise to a seemingly simple family of path algebras, but for large n the derived equivalence classes of such algebras become surprisingly complex.

  In this talk we will show how we can use tilting mutation to explicitly construct sequences of derived equivalent algebras, and we will illustrate how such sequences can be useful for investigating derived equivalence classes of linear A_n-quivers with relations.

- **Giovanna Le Gros (Università di Padova)** `16:10 - 16:40`

  Generalisations of Bass' Theorem P over commutative rings

  Perfect rings were introduced and characterised by Bass in his pivotal 1960 paper [Bass]. In Theorem P of this paper, Bass gives both a homological and ring-theoretic characterisation of these rings, moreover finding a connection between approximation theory in the module category over the ring and the finitistic dimensions of a ring. In particular, for a commutative ring R, R is perfect (that is, every R-module has a projective cover) if and only if the big finitistic dimension of R is zero.

In this talk we will discuss some natural generalisations of this theory, in particular considering the rings over which the class of modules of projective dimension at most one is covering, and some partial results in this direction in the case of commutative rings. This study is related to Enochs' Conjecture, that is that a covering class is necessarily closed under direct limits, in the specific case of the class of modules of projective dimension at most one.

– [Bass] Bass, Hyman, "Finitistic dimension and a homological generalization of semi-primary rings," *Trans. Amer. Math. Soc.*, pp. 466–488, 1960.

- **Jan-Paul Lerch (Universität Bielefeld)** `16:40 - 17:10`

The spectrum of the real line

Motivated by the study of persistence modules we investigate the linear representation of the real line and, more generally, of totally ordered sets. We provide a classification of isoclasses of indecomposable injective representations. The set of these forms a topological space called the spectrum, which refines the topology induced by the interleaving distance.

Session 3 - Pabellón Cero+Infinito, Room 1206

- **Marc Stephan (Universität Bielefeld)** `14:40 - 15:10`

Perfect complexes for extensions by $\mathbb{Z}/2 \times \mathbb{Z}/2$

(Joint with Henrik Rüping and Ergün Yalçın)

Let G be an extension of a group of odd order by an elementary abelian 2-group of rank 2. It is known that the total homology of an arbitrary perfect complex over $\mathbb{F}_2[G]$ is either zero or at least four-dimensional. I will explain how to classify the perfect complexes with four-dimensional total homology. As an application, I will provide restrictions for the existence of free A_4-actions on a product of two spheres. Taking the topology into account, our strongest restrictions come from a classification of Steenrod closed parameter ideals in the group cohomology of the alternating group A_4.

- **Amit Shah (Aarhus University)** `15:10 - 15:40`

The index with respect to a rigid subcategory of a triangulated category

(Joint with Peter Jørgensen)

Motivated by the study of minimal projective presentations of modules over a suitable ring, the index with respect to a cluster tilting subcategory $\mathcal{T}$ in a good 2-Calabi–Yau triangulated category $\mathcal{C}$ has been used by several authors to e.g. understand the Caldero-Chapoton map and categorify $\mathbf{g}$-vectors. This classical index takes values in the split Grothendieck group $K_0^{\mathrm{split}}(\mathcal{T})$ of $\mathcal{T}$. Recently, it has been shown that this group is isomorphic to the Grothendieck group of an extriangulated category coming from $\mathcal{C}$. In this talk I will explain how we can exploit this perspective to establish an index with respect to a rigid subcategory of $\mathcal{C}$. Moreover, this index is again additive on triangles up to an error term, generalising an important property of the classical index.

- **Matthew Pressland (University of Glasgow)** `16:10 - 16:40`
  On categorification of g-vectors

  (Joint with Xin Fang, Mikhail Gorsky, Yann Palu and Pierre-Guy Plamondon)

  First arising in a combinatorial form in Fomin and Zelevinsky's theory of cluster algebras, g-vectors have two closely related representation-theoretic incarnations. The first of these is the notion of an index (or coindex) in a 2-Calabi–Yau triangulated category, whereas the second involves projective presentations of modules over finite-dimensional algebras. In this talk I will explain some joint work in progress with Xin Fang, Mikhail Gorsky, Yann Palu and Pierre-Guy Plamondon, in which we show how to lift the relationship between these two computations to an equivalence of categories. The categories in question will be extriangulated, and part of the talk will serve as an introduction to such categories, via well-behaved examples. I will also explain how our results extend beyond the triangulated setting, to indices in more general stably 2-Calabi–Yau categories.

- **Job Daisie Rock (Ghent University)** `16:40 - 17:10`
  Stability Conditions for Continuous Representations of Type $\mathbb{A}$

  (Joint with Kiyoshi Igusa)

  Stability conditions of finite quivers are connected to cluster algebras, Calabi–Yau manifolds, D-branes, and moduli spaces. We generalize the notion to continuous representations using non-standard analysis. Then we connect our new stability conditions to continuous clusters and laminations of the hyperbolic plane. This generalizes the connection to clusters and triangulations, respectively.

Session 4 - Pabellón Cero+Infinito, Room 1207 (online talks)

- **Norihiro Hanihara (Kavli Institute, The University of Tokyo)** `14:40 - 15:10`
  Higher representation infinite algebras arising from and quotient singularities

  (Joint with Osamu Iyama)

  Higher representation infinite algebras form a distinguished class of finite dimensional algebras which are important in higher dimensional Auslander-Reiten theory, cluster theory, (commutative or non-commutative) algebraic geometry, and so on.

  One of peculiar features is their relationship between Calabi-Yau algebras. Let Γ be a positively graded (twisted) m-Calabi-Yau algebra of Gorenstein parameter a. Then by Minamoto–Mori's theorem, the algebra $A := \mathrm{End}_{\Gamma}^{\mathbb{Z}}(T)$ for $T = \Gamma \oplus \Gamma(1) \oplus \cdots \oplus \Gamma(a-1)$ is $(m-1)$-representation infinite. This is in fact a consequences of the triangle equivalence

  $$\mathrm{D}^{\mathrm{b}}(\mathrm{qgr}\,\Gamma) \simeq \mathrm{D}^{\mathrm{b}}(\mathrm{mod}\,A)$$

  given by a tilting obejct $T \in \mathrm{D}^{\mathrm{b}}(\mathrm{qgr}\,\Gamma)$. Notice that this higher representation infinite algebra A has a "$\mathbb{Z}/a\mathbb{Z}$-symmetry" given by the degree shift functor (1).

Our main result is that such higher representation infinite algebras "with symmetries" arise from some graded singularity categories. Let d be an integer ≥ 2 and $S = k[x_1, \ldots, x_d]$ the polynomial ring over an arbitrary field k. Pick any positive integer n dividing d and let

$$R = k[x_1, \ldots, x_d]^{(n)}$$

be the Veronese subring. We view it as a graded ring whose degree i part consists of homogeneous polynomials of degree ni. Then R is a Gorenstein ring with Gorenstein parameter $a := d/n$. We denote by Ω the syzygy functor on the graded singularity category $\underline{\mathrm{CM}}^{\mathbb{Z}} R$.

Theorem:

1. The object $T = S \oplus \Omega S(1) \oplus \cdots \oplus \Omega^{a-1} S(a-1) \in \underline{\mathrm{CM}}^{\mathbb{Z}} R$ is tilting.
2. The endomorphism ring $A = \underline{\mathrm{End}}_R^{\mathbb{Z}}(T)$ is $(d-a-1)$-representation infinite.
3. The algebra $\Gamma = \bigoplus_{i \geq 0} \underline{\mathrm{Hom}}_R(S, \Omega^i S)$ is twisted $(d-a)$-Calabi-Yau of Gorenstein parameter a.

Consequently, there are triangle equivalences $\underline{\mathrm{CM}}^{\mathbb{Z}} R \simeq \mathrm{D^b}(\mathrm{mod}\, A) \simeq \mathrm{D^b}(\mathrm{qgr}\, \Gamma)$, and importantly, the higher hereditary algebra A has a "$\mathbb{Z}/a\mathbb{Z}$-symmetry" by $\Omega(1)$, as in Minamoto–Mori's theorem. We can also show that for the ungraded singularity category one has

$$\underline{\mathrm{CM}}\, R \simeq \mathrm{C}_{d-1}^{(1/a)}(A)$$

for a "$\mathbb{Z}/a\mathbb{Z}$-quotient" of the $(d-1)$-cluster category $\mathrm{C}_{d-1}(A)$ of A. This extends established results by Keller–Reiten for $d = n = 3$ (thus $a = 1$) and by Keller–Murfet–Van den Bergh for $d = 4$ and $n = 2$ (thus $a = 2$) to arbitrary Veronese subrings.

- **Lutz Hille (WWU Münster)** `15:10 - 15:40`

Polynomial Invariants for Triangulated Categories with Full Exceptional Sequences

We consider triangulated categories over an algebraically closed field admitting full exceptional sequences and admit an Euler characteristic. The bounded derived category of finite dimensional modules over a quasi-hereditary algebra satisfies this condition. For any full exceptional sequence of length n we obtain the Euler characteristics $x_{i,j} = \langle E_i, E_j \rangle$ for any two members E_i and E_j with $i < j$.

It is natural to ask, whether these natural numbers $x_{i,j}$ satisfy any condition, in particular any polynomial identity, depending only on the triangulated category and not on the chosen full exceptional sequence. Such a polynomial we call a polynomial invariant, its value is an invariant of the triangulated category. It can, by definition, computed using any full exceptional sequence.

There is one well known such polynomial invariant for $n = 3$, the Markov equation, it was used for cluster algebras with three vertices in joint work with Brüstle and Beineke and appears first for full exceptional sequences of vector bundles on the projective plane.

The aim of this talk is to construct polynomial invariants for any natural number n. Moreover, we show a completeness result for such invariants. If time permits we relate this to the action of the braid group on the polynomial ring in the variables $x_{i,j}$. This allows to determine some invariants recursively.

- **Yuta Kimura (Osaka Metropolitan University)** `16:10 - 16:40`

  Tilting ideals of deformed preprojective algebras

  (Joint with William Crawley-Boevey)

  For a quiver Q and a weight λ, the deformed preprojective algebra $\Pi^\lambda(Q)$ was introduced by Crawley-Boevey and Holland to study deformations of Kleinian singularities. Among interesting properties of a preprojective algebra $\Pi^0(Q)$, the classification of tilting ideals by a Coxeter group of Q, shown by Buan-Iyama-Reiten-Scott, is fundamental and important.

  In this talk, when Q is non-Dynkin, we see that $\Pi^\lambda(Q)$ is a 2-Calabi-Yau algebra, and show that there exists a bijection between tilting ideals of a 2-Calabi-Yau algebra and a certain Coxeter group.

- **Yuta Kozakai (Tokyo University of Science)** `16:40 - 17:10`

  Tilting-connected blocks covering cyclic blocks

  Let p be a prime number, k an algebraically field of characteristic p, $\tilde{G}$ a finite group, and G a normal subgroup of $\tilde{G}$ having a p-power index in $\tilde{G}$. Moreover let B be a block of kG and $\tilde{B}$ the unique block of $k\tilde{G}$ covering B. For $\Lambda \in \{B, \tilde{B}\}$, we denote by 2-tilt Λ the set of isomorphism classes of basic 2-term tilting complexes over Λ, and by tilt Λ the set of isomorphism classes of basic tilting complexes over Λ. In [Kozakai1], it is shown that the set tilt Λ has a structure of partially ordered set, and the classification of tilting complexes by using this partial order is one of the themes of the representation theory of finite dimensional algebras.

  On the other hand, in [Kozakai2] R. Koshio and the author proved that if B satisfies the following conditions, then the induction functor $\mathrm{Ind}_G^{\tilde{G}}(-) := k\tilde{G} \otimes_{kG} - : K^b(\mathrm{proj}\, B) \to K^b(\mathrm{proj}\, \tilde{B})$ induces an isomorphism between 2-tilt B and 2-tilt $\tilde{B}$:

  - any indecomposable B-module is $I_{\tilde{G}}(B)$-invariant,
  - the block B is τ-tilting finite.

  We can naturally expect that the induction functor $\mathrm{Ind}_G^{\tilde{G}}(-) := k\tilde{G} \otimes_{kG} - : K^b(\mathrm{proj}\, B) \to K^b(\mathrm{proj}\, \tilde{B})$ induces an isomorphism between tilt B and tilt $\tilde{B}$ as partially ordered sets under some assumptions.

  In this talk, we give a condition for the functor to induce the isomorphism between tilt B and tilt $\tilde{B}$. Moreover, we focus on the case of B having a cyclic defect group.

  - [Kozakai1] T. Aihara, O. Iyama, *Silting mutation in triangulated categories.* J. Lond. Math. Soc. (2) **85** (2012), no. 3, 633–668.
  - [Kozakai2] R. Koshio, Y. Kozakai, *On support τ-tilting modules over blocks covering cyclic blocks.* J. Algebra **580** (2021), 84–103.

Thursday - August 11th

Session 1 - Pabellón Cero+Infinito, Room 1204

- **Josh Pollitz (University of Utah)** `14:40 - 15:10`

  Cohomological jump loci in local algebra

  (Joint with Benjamin Briggs and Daniel McCormick)

  Support varieties defined over a (commutative) complete intersection ring have found numerous applications in local algebra. In this talk I will discuss joint work with Ben Briggs and Daniel McCormick introducing a higher order support theory, called cohomological jump loci, generalizing support varieties. This theory is applied to reveal symmetries in resolutions over a complete intersection ring. Namely, for a finitely generated module over a complete intersection ring, its sequences of Bass and Betti numbers are each eventually modeled by quasi-polynomials of period two. I will show how cohomological jump loci can be applied to establish the leading terms of these two quasi-polynomials must coincide.

- **Marcelo Lanzilotta (Universidad de la República)** `15:10 - 15:40`

  IT/LIT/GLIT algebras

  (Joint with Diego Bravo, Octavio Mendoza, José A. Vivero)

  Since M. Auslander proposed the concept of repdim, (classifying Artin algebras of finite representation type), passing through the statement (with the level of conjecture until 2004) that every Artin algebra has repdim less than or equal to three, arriving at the homological tools defined by Igusa and Todorov in 2005 (IT functions), and later the definition of Igusa-Todorov algebras defined by J. Wei in 2009 (IT-algebras), we define the LIT (2021) and GLIT algebras (work in progress), generalising the previous concepts.

- **Colin Lawson (University of North Texas)** `16:10 - 16:40`

  Deformation cohomology for cyclic group actions on polynomial rings

  (Joint with my thesis advisor, Dr. Anne V. Shepler)

  Hochschild cohomology records information about the deformations of the algebra. In this talk, we highlight the Hochschild cohomology governing the graded deformations of skew group algebras for cyclic groups acting on polynomial rings. For skew group algebras, a description of the Hochschild cohomology is known in the nonmodular setting (i.e. when the characteristic of the field and the order of the group are coprime), but much less is know in the modular setting (i.e. when the characteristic of the field divides the order of the group).

- **Valente Santiago Vargas (Universidad Nacional Autónoma de México)** `16:40 - 17:10`

  Homological Theory of Idempotent Ideals in Dualizing Varieties

In this talk, we will develop the theory of k-idempotent ideals in the setting of dualizing varieties. Several results given previously by M. Auslander, M. I. Platzeck, and G. Todorov are extended to this context. Given an ideal I (which is the trace of a projective module), we construct a canonical recollement which is the analogous to a well-known recollement in categories of modules over artin algebras. Moreover, we study the homological properties of the categories involved in such a recollement.

Session 2 - Pabellón Cero+Infinito, Room 1205

- **Pamela Suárez (Universidad Nacional de Mar del Plata)** `14:40 - 15:10`

  On the nilpotency index of the radical of the module category

  (Joint with Claudia Chaio and Victoria Guazzelli)

  Let A be a finite dimensional algebra over an algebraically closed field and $\operatorname{mod} A$ be the category of finitely generated A-modules. The radical of $\operatorname{mod} A$ is the ideal generated by all non-isomorphisms between indecomposable A-modules. For $n \geq 2$, the powers of the radical are defined inductively.

  An important research direction towards understanding the structure of a module category is the study of the compositions of irreducible morphisms in relation with the powers of the radical of their module categories.

  In case we deal with a representation finite algebra, it is well-known by a result of M. Auslander that the radical of the module category is nilpotent. Moreover, it is also known that such a bound is the length of the longest non-zero path from the projective in a vertex a to the injective in the same vertex going through the simple in a.

  The aim of this talk is to determine which vertices of Q_A are sufficient to be consider in order to determine the nilpotency index of the radical of the module category of an algebra. Furthermore, we compute the nilpotency index of the radical of some representation-finite tree algebras with zero-relations not overlapped.

  References

  – C. Chaio, V. Guazzellli, P. Suarez. On the nilpotency index of the radical of a module category. preprint arXiv: 2003.04189.(2020).

- **Aran Tattar (University of Cologne)** `15:10 - 15:40`

  Chains of torsion classes and weak stability conditions

  (Joint with Hipolito Treffinger)

  Joyce introduced the concept of weak stability conditions for an abelian category as a generalisation of Rudakov's stability conditions. In this talk, we show an explicit relation between chains of torsion classes and weak stability conditions over an abelian category.

Consequently, we give a new characterisation of torsion classes, discuss the structure of the space of chains of torsion classes and its relation to the stability manifold. Based on work-in-progress.

- **Jan Trlifaj (Charles University, Prague)** 16:10 - 16:40

Closure properties of $\varinjlim \mathcal{C}$

(Leonid Positselski and Pavel Příhoda)

Let $\mathcal{C}$ be a class of modules. If $\mathcal{C}$ consists of finitely presented modules, then the class $\varinjlim \mathcal{C}$ of all direct limits of modules from $\mathcal{C}$ is well-known to enjoy a number of closure properties. Moreover, if $R \in \mathcal{C}$, $\mathcal{C}$ consists of FP_2-modules, and $\mathcal{C}$ is closed under extensions and direct summands, then $\varinjlim \mathcal{C}$ can be described homologically: $\varinjlim \mathcal{C}$ is just the double perp of $\mathcal{C}$ with respect to the Tor_1^R bifunctor.

The picture changes completely when $\mathcal{C}$ is allowed to contain infinitely generated modules: $\varinjlim \mathcal{C}$ then need not even be closed under direct limits. After presenting some general results on $\varinjlim \mathcal{C}$, we will concentrate on two particular cases, when $\mathcal{C} = \mathrm{add}(M)$ and $\mathcal{C} = \mathrm{Add}(M)$ for an arbitrary module M. We will prove that if $S = \mathrm{End}(M)$ and $\mathcal{F}$ is the class of all flat right S-modules, then $\varinjlim \mathrm{add}(M) = \{F \otimes_S M \mid F \in \mathcal{F}\}$. For $\varinjlim \mathrm{Add}(M)$, we will have a similar formula, involving the contratensor product $\odot_S$ and direct limits of projective right S-contramodules, for S endowed with the finite topology. We will then show that for various particular classes of modules $\mathcal{D}$, $\varinjlim \mathrm{add}(\mathcal{D}) = \varinjlim \mathrm{Add}(\mathcal{D})$. Notably, this is true when $\mathcal{D}$ consists of pure projective modules. However, the equality remains open in general.

Based on the paper L. Positelski, P. Příhoda, J. Trlifaj: *Closure properties of* $\varinjlim \mathcal{C}$, J. Algebra (2022), pp. 1-74, https://doi.org/10.1016/j.jalgebra.2022.04.029.

Session 4 - Pabellón Cero+Infinito, Room 1207 (online talks)

- **Sefi Ladkani (University of Haifa)** 14:40 - 15:10

Non-degenerate potentials on the quiver X_7

The quiver X_7 is an exceptional quiver of finite mutation type discovered by Derksen and Owen. We construct two inequivalent non-degenerate potentials on X_7, thus confirming a conjecture of Geiss, Labardini and Schröer.

A peculiar feature of these potentials is that fundamental properties of their Jacobian algebras (e.g. finite-dimensionality) depend heavily on the characteristic of the ground field. This seems to be the first instance of a non-degenerate potential exhibiting such phenomenon.

As a consequence, we draw some conclusions on the associated cluster categories and deduce the non-existence of a reddening mutation sequence for the quiver X_7, a result which was previously obtained using combinatorial arguments.

In most cases, the Jacobian algebras associated with one of these potentials show many similarities to those arising from triangulations of closed oriented surfaces with punctures. Time permits, I will explain how to view this potential as arising from a suitable dimer model on a *non-orientable* surface.

- **Junyang Liu (Université Paris Cité)** `15:10 - 15:40`

  Relative Calabi-Yau structures and ice quivers with potential

  Van den Bergh showed that complete Calabi-Yau algebras are weakly equivalent to deformed dg preprojective algebras. For example, in dimension 3, they are given by quivers with potential. We generalize his theorem to the relative case: under suitable assumptions, relative Calabi-Yau morphisms between complete dg algebras are weakly equivalent to Ginzburg morphisms as introduced by Yeung. For example, in dimension 3, they are given by ice quivers with potential.

- **Intan Muchtadi-Alamsyah (Insititut Teknologi Bandung, Indonesia)** `16:10 - 16:40`

  The Relation between τ_n-Tilting Modules and n-term Silting Complexes

  (Joint with Yann Palu)

  In this paper, we define support τ_n-tilting modules over a finite dimensional k-algebra A. We establish a bijection between support τ_n-tilting modules and n-term silting complexes in the bounded homotopy category of finitely generated projective A-modules, generalizing the result of Adachi, Iyama and Reiten for support τ-tilting modules and two-term silting complexes.

- **Shantanu Sardar (Indian Institute of Science Education and Research)** `16:40 - 17:10`

  Combinatorics of the bridge quiver and the stable rank of a string algebra

  (Joint with A. Kuber and E. Gupta)

  String algebras are a class of tame representation type finite-dimensional algebras whose Auslander-Reiten (AR) quivers, i.e., the classification of their finite-dimensional representations and maps between them is completely known, thanks to Gelfand-Ponomarev and Butler-Ringel, in terms of certain walks on the quivers known as “strings” and “bands”.

  The bridge quiver associated with a string algebra comprises bands as vertices and some special strings called bridges as arrows and encodes useful information about certain algebraic invariants. Domestic string algebras are characterized by their acyclic bridge quivers and are well-studied, whereas there is a lot to explore on the non-domestic side.

  After explaining the basics of string algebras in the talk, I will explain a new combinatorial technique of “terms” that helps to capture the geometry of the AR quiver. This technique allows us to connect graph-theoretic properties of the bridge quivers of non-domestic string algebras with the study of their category-theoretic radical.

Friday - August 12th

Session 1 - Pabellón Cero+Infinito, Room 1204

- **Wassilij Gnedin (Ruhr Universität Bochum)** `14:40 - 15:10`

  Weak lifting problems and tilting bijections

  In [Yoshino], Yoshino studied the problem to lift complexes in the context of a commutative complete local ring R and its quotient $R/(x)$ by a regular sequence x. In particular, he proved that a perfect complex P of the quotient $R/(x)$ has a *weak lift*, that is, P lifts to a perfect complex of the ring R up to direct summands, if and only if a certain second self-extension of P, its so-called *Eisenbud class*, vanishes. A central tool in his work was an explicit resolution of the restriction of the complex P to the ring R by projective R-modules.

  The first part of my talk is concerned with a categorical interpretation of the Eisenbud class. It turns out that there is a generalization of Yoshino's results to the non-commutative setup of a Noetherian R-algebra Λ and its quotient Λ/I by any two-sided subideal I of $\operatorname{rad}\Lambda$.

  In the second part of my talk, I will use the preceding findings to establish a bijection between tilting complexes of a Brauer graph algebra and those of its associated ribbon graph order. These studies form a continuation of [Gnedin].

  - [Gnedin] W. Gnedin, Silting theory under change of rings, preprint 2022, `arXiv:2204.00608`
  - [Yoshino] Y. Yoshino. The theory of L-complexes and weak liftings of complexes. J. Algebra 188 (1997), no. 1, 144–183.

- **Geoffrey Janssens (Vrije Universiteit Brussel)** `15:10 - 15:40`

  On the number of n-term silting complexes

  In this talk we will discuss instances of the general question of when two finite dimensional algebras A and B have the same 'number' of n-term silting complexes. In the first half, this equality will be in a strong sense, namely given by an explicit order-preserving bijection. The starting point will the reduction theorem modulo $\mathcal{Z}(A) \cap J(A)$ of [EJR] for 2-term silting complexes (equivalently τ-tilting modules). Thereafter we survey the recent more general results of Eisele [Eisele] and Gnedin [Gnedin] concerning the full $\operatorname{Silt}(A)$ (via specialisations of a formal extension of A). If time permits, in the last part of the talk, the 'number' will refer to representation types and hereby B will be a deformation of A. After recalling the geometric approach in the classical context, we will open the conversation for the case of τ-tilting theory with an emphasize on the 2nd Brauer-Thrall conjecture for bricks [SchTre] and the notion of tameness [BST,AY].

  - [AY] T. Aoki, T. Yurikusa, *Complete gentle algebras are g-tame*, arXiv: 2003.09797
  - [BST] T. Brüstle, D. Smith, H. Treffinger, *Wall and Chamber structure for finite-dimensional algebras*, Adv. Math. **354** (2019), no. 2, 572–618
  - [Eisele] F. Eisele, *Bijections of silting complexes and derived Picard groups*, J. Lond. Math. Soc., (2022)

- [EJR] F. Eisele, G. Janssens and T. Raedschelders, *A reduction theorem for τ-rigid modules*, Math. Z. **290** (2018), no. 3-4, 1377–1413
- [Gnedin] W. Gnedin, *Stability theory under change of rings*, arXiv: 2204. 00608
- [SchTre] H. Treffinger, S. Schroll, *A τ-tilting approach on the first Brauer-Thrall conjecture*, arXiv: 2004. 14221 (to appear in PAMS)

- **Laertis Vaso (Norges Teknisk-Naturvitenskapelige Universitet)** `16:10 - 16:40`

  n-cluster tilting subcategories for truncated path algebras

  (Joint with Steffen Oppermann)

  n-cluster tilting subcategories play a central role in higher dimensional Auslander-Reiten theory. However, finding examples of n-cluster tilting subcategories is not an easy task. The aim of this talk is to present many new examples via a classification of n-cluster tilting subcategories for truncated path algebras, that is, bound quiver algebras of the form KQ/J^L where Q is a quiver and J is the ideal generated by the arrows of Q.

- **Bernhard Keller (Université Paris Cité)** `16:40 - 17:10`

  Braid subgroup actions on Higgs categories and cluster categories

  We will recall mutation at frozen (blue) vertices (due to Fraser–Sherman-Bennett) and its categorification (due to Yilin Wu). We will present the blue vs. red game and show how its combinatorics lift to actions of subgroups of braid groups on Higgs categories, cluster categories and the associated varieties. These actions generalize Fraser's braid group action on the Grassmannian.

Session 2 - Pabellón Cero+Infinito, Room 1205

- **Zachery Peterson (University of Kentucky)** `14:40 - 15:10`

  Triangulations of Flow Polytopes, Ample Framings, and Gentle Algebras

  (Joint with Matias von Bell, Benjamin Braun, Kaitlin Bruegge, Derek Hanely, Khrystyna Serhiyenko, Martha Yip)

  We study directed acyclic graphs together with an ordering on the edges at each vertex called a framing. A result by Danilov, Karzanov, and Koshevoy shows a relation between framings and triangulations of flow polytopes coming from a graph. By placing some additional restrictions on the graphs we establish a connection between flow polytopes and representation theory of gentle algebras. Then we apply results about tau-tilting posets to derive a shelling of these triangulations. Furthermore, in this case we prove that the flow polytopes are Gorenstein and h^*-unimodal.

- **Benjamin Dequêne (Université du Quebec à Montréal)** `15:10 - 15:40`

  Jordan recoverability of some subcategories of modules over gentle algebras

  (Joint with Hugh R. Thomas)

Gentle algebras form a class of finite dimensional algebras introduced by Assem and Skowroński in the 80's. Modules of such an algebra can be described by string and band combinatorics, which are some kind of walk in the associated gentle quiver, thanks to works of Butler and Ringel. Jordan recoverability of a subcategory $\mathscr{C}$ of modules is the fact that we are able to recover (up to isomorphism) a module $X \in \mathscr{C}$ just by knowing the generic form of nilpotent endomorphism over it. This data is encoded as a tuple of integer partitions.

After we introduced some definitions and set the context, the main aim of the talk is to explain what is the notion of Jordan recoverability throughout various examples, and to highlight a combinatoric characterization of that property for some special kind of subcategories of modules − a result which extend the work of Garver, Patrias and Thomas done in Dynkin cases −. If time allows it, we could discuss about some open questions related to this result and, in particular, we could exhibit new ideas to characterize all the subcategories of modules that are Jordan recoverable in A_n case.

- **Raphael Bennett-Tennenhaus (University of Bielefeld)** `16:40 - 17:10`

Semilinear clannish algebras

(Joint with William Crawley-Boevey)

Indecomposable modules over string algebras were classified by Butler and Ringel, and take exactly one of two forms: string modules, defined by walks in the quiver; or band modules, given by cyclic walks together with a representation of the Laurent polynomial ring. Clannish algebras, introduced by Crawley-Boevey, are a generalisation of string algebras – where one specifies a set of special loops, each bounded by some quadratic polynomial. An analogue of Butler and Ringel's result was given where the class of string (or band) modules splits into so-called asymmetric and symmetric subclasses. Said symmetry is given by reflecting the walk about a special loop, and symmetric strings and bands are parameterised using appropriate replacements for the Laurent polynomial ring.

Both string algebras and clannish algebras were defined over a field, and the quadratics bounding special loops were assumed to have distinct roots in this field. This talk will be about ongoing joint work with Bill Crawley-Boevey, where we generalise the classification for clannish algebras. For the rings we consider we replace this field with a division ring equipped with a set of automorphisms, indexed by arrows of the quiver, and we allow irreducible quadratics to bound the special loops. The resulting notion of a semilinear clannish algebra recovers a generalisation of string algebras considered by Ringel, where one allows the map associated to an arrow to be semilinear with respect to its automorphism.

Session 4 - Pabellón Cero+Infinito, Room 1207 (online talks)

- **Satoshi Usui (Tokyo University of Science)** `14:40 - 15:10`

Characterization of eventually periodic modules and its applications

The *singularity category* $\mathcal{D}_{\rm sg}(R)$ of a left Noetherian ring R is defined to be the Verdier quotient of the bounded derived category of R-modules by the full subcategory consisting of complexes that are quasi-isomorphic to bounded complexes of projective R-modules. It is known that an R-module M has finite projective dimension if and only if $M \cong 0$ in $\mathcal{D}_{\rm sg}(R)$.

Thus it is natural to study R-modules with infinite projective dimension in $\mathcal{D}_{\mathrm{sg}}(R)$. Recall that a module over a left artin ring is *eventually periodic* if its minimal projective resolution has infinite length and eventually becomes periodic. Recently, it was proved by the speaker that, when R is a finite dimensional Gorenstein algebra, an R-module is eventually periodic if and only if its Tate cohomology ring has a non-zero invertible homogeneous element of positive degree.

In this talk, we first extend the above result to the case of left artin rings. Then, as applications, we show that eventual periodicity of finite dimensional algebras is preserved under singular equivalence of Morita type with level, introduced by Wang (2015). Moreover, we give a necessary and sufficient condition for a finite dimensional connected Nakayama algebra to be eventually periodic.

- **Nicholas Williams (University of Tokyo)** `15:10 - 15:40`

  Algebraic interpretation of the higher Stasheff–Tamari orders

  Oppermann and Thomas show how the representation theory of Iyama's higher Auslander algebras of type A (A_n^d) was related to triangulations of even-dimensional cyclic polytopes. We show how two natural partial orders on the set of triangulations of a cyclic polytope, the higher Stasheff–Tamari orders, can be interpreted on the representation-theoretic side as well-known orders on silting complexes introduced by Aihara and Iyama. This allows one to interpret triangulations of odd-dimensional cyclic polytopes within the representation theory of A_n^d, namely, as equivalence classes of d-maximal green sequences. This allows the higher Stasheff–Tamari orders to be interpreted algebraically in odd dimensions too. Using intricate arguments on the combinatorial side, we are able to prove new results about the representation theory of A_n^d.