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CENTER FOR MATHEMATICS

UNIVERSITÄT BONN

"Representation Theory of Algebras and its Applications"

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organized by
Viktória Klász, Markus Kleinau, Rene Marczinzik

Abstracts

Azzurra Ciliberti (Ruhr University Bochum)

A Caldero-Chapoton map for the derived category of gentle algebras

Abstract: The derived category of a gentle algebra A can be described via the geometry of surface dissections, where indecomposable complexes of A-modules correspond to possibly infinite graded arcs on the surface, and morphisms between them are encoded by crossings between the associated arcs. Moreover, their mapping cones are given by the resolution of these crossings. We introduce a Caldero-Chapoton map in this setting. Specifically, we associate a Laurent polynomial to every finite indecomposable complex, and show that skein relations hold whenever the corresponding arcs cross in the interior. For each complex, its Caldero-Chapoton map specializes to the corresponding element of the Grothendieck group. Furthermore, if A is hereditary, the algebra generated by these functions is an ordinary cluster algebra. This is joint work in progress with Esther Banaian, Ilaria Di Dedda, Khrystyna Serhiyenko, Yadira Valdivieso-Díaz and Kayla Wright.

Johanne Haugland (Norwegian University of Science and Technology)

Koszul algebras in representation theory

Abstract: Koszul algebras were first defined by Priddy in 1970. These algebras have been extensively studied and arise naturally in various fields of mathematics, such as algebraic geometry, noncommutative geometry, topology and number theory. In this lecture series, we give an introduction to Koszul algebras and the role they play in representation theory. Many central classes of algebras in representation theory turn out to be Koszul. Examples include hereditary algebras, gentle algebras, quadratic monomial algebras, polynomial algebras and exterior algebras, as well as certain preprojective algebras and trivial extensions.
A main reason for the importance of Koszul algebras is their duality theory, as studied in the influential paper "Koszul duality patterns in representation theory" by Beilinson, Ginzburg and Soergel. To any Koszul algebra, there is an associated Koszul dual algebra. A key topic in the mini-course is the Koszul duality equivalence and how it reflects the strong connection between a Koszul algebra and its dual. As a motivating example, we look at how Koszul duality manifests in the geometric model for gentle algebras due to Opper, Plamondon and Schroll.
A core perspective in the lecture series is the notion of higher Koszul algebras, or n-T-Koszul algebras, which yields a natural connection to Iyama's higher Auslander–Reiten theory. This framework builds on a generalization of T-Koszul algebras, as introduced by Madsen and Green, Reiten and Solberg.

We discuss a higher version of classical Koszul duality and sketch some applications for n-hereditary algebras. This part of the lecture series builds on joint work with Mads H. Sandøy, who is also responsible for the exercise classes in the course.

Antonia Kekkou (University of Utah)

Regular Sequences in Triangulated Categories

Abstract: Regular sequences are a fundamental tool in commutative algebra. In this talk, we introduce regular sequences in R-linear triangulated categories, where R is a graded-commutative ring, and give some examples. As an application of this definition, we show that the length of regular sequences provides lower bounds on levels. This is joint work with Janina C. Letz and Marc Stephan.

Carlo Klapproth (University of Stuttgart)

Projectivisation and the strong no-loop conjecture (jt. work with Martin Kalck and Nebojsa Pavic)

Abstract: The strong no-loop conjecture says that a simple module of finite projective dimension over a finite-dimensional algebra has no degree 1 self-extensions. For algebras over algebraically closed fields k, this has been established by Igusa-Liu-Paquette and we explain how this result implies a similar result for arbitrary Hom-finite, k-linear categories with applications, for instance, in algebraic geometry.

Cyril Matoušek (Aarhus University)

Metric structures and continuity in derived representation theory

Abstract: Neeman's metric on a triangulated category is a collection of open neighbourhoods of the zero object. Such a structure allows us to construct a (*triangulated*) metric completion of the triangulated category and to consider continuous functors between triangulated categories. In this talk, we firstly describe all metric completions of the bounded derived category $D^b(mod - A)$ of a hereditary tame algebra A, and then also pass on this description to the bounded derived category $D^b(coh - X)$ of coherent sheaves on a weighted projective line X of tubular type by using tubular mutations as metric-related homeomorphisms.

Volodymyr Mazorchuk (Uppsala University)

Homological properties of category O

Abstract: In this series of lectures I will try to describe various homological properties of BGG category O and their relation to the Kazhdan-Lusztig combinatorics of Hecke algebras.
The plan is as follows: the first lecture will be about Hecke algebras and Kazhdan-Lusztig combinatorics. The second lecture will be about basics of category O and its connection with Hecke algebras. Finally, the third lecture will focus on various homological properties, in particular, on projective dimension of structural modules and Auslander regularity.
The excercise classes will treat small rank cases in detail, including $sl_2(typeA_1)$ and $sl_3(typeA_2)$.

Jonas Nehme (University of Bonn)

Categorification of the quantum electrical algebra

Abstract: We introduce the quantum electrical algebra, which is a quantum version of the electrical Lie algebra governing electrical networks. We will then provide a categorification of these algebras via electrical KLR algebras mimicking the classical construction of categorification of the positive half of quantum groups. In addition, this electrical KLR algebra bears close connections to the representation theory of the periplectic Lie superalgebra. (jt. with Catharina Stroppel)

Daniel Perniok (Paderborn University)

The domestic octopus is of finite type

Abstract: We introduce Coxeter-Dynkin algebras of canonical type (a.k.a. octopus algebras) and explain their role in the classification of Hom-finite hereditary categories with a tilting object. In the so-called domestic case they are known to be derived equivalent to tame hereditary algebras. Using a theorem of Ringel we prove that they are, at the same time, of finite representation type.

Marvin Plogmann (University of Cologne)

On extended hearts of t-structures

Abstract: For a finite-dimensional algebra A, the category mod(A) can be recovered inside the bounded derived category of A as the full subcategory of objects whose cohomology is concentrated in degree 0. A natural enlargement is obtained by considering, for a fixed n>0, those objects whose cohomology is concentrated in degrees 1-n,...,0. This subcategory is called the n-extended heart of the standard t-structure. For n=1, one recovers the abelian category mod(A), while for n>1 the extended heart is no longer abelian. Nevertheless, it retains many features reminiscent of module categories; for example, it admits Auslander–Reiten sequences. I will explain why extended hearts are useful for studying finite-dimensional algebras and their derived analogues.

Emily Poelders (University of Bonn)

The Reduced Incidence Algebra of of a Divisor Lattice

Abstract: We define a subalgebra of the incidenced algebra of a poset, called the reduced incidence algebra, and study some of its properties. With a particular focus on divisor lattices, we look at when a reduced incidence algebra is Frobenius.

Adina Veronica Remor (Federal University of Paraná)

A relative version of Kaplansky's Theorem for extension of local rings

Abstract: A classic result by Irving Kaplansky (1957) states that every projective module over a local ring is free. Motivated by the study of homological properties of extension of local rings $B \to A$, we investigate whether an analogous result applies to relative projective modules, that is, if they are

relatively free. In this talk, we will present the results obtained in pursuit of this question. This is a joint work with Kostiantyn Iusenko, Rosa Maria Miró-Roig, and Victor Pretti.

Annoy Sengupta (IIT Kanpur)

(Generalised) tree modules: Hom-sets and indecomposability

Abstract: Tree modules over zero-relation algebras have a rich history: in 1981, Gabriel established their indecomposability using universal covering techniques, and in 1989, Crawley-Boevey used "graph maps" to provide a combinatorial basis for their spaces of homomorphisms. But what happens when we loosen our definitions? In this talk, we introduce *generalised tree modules* by relaxing a core structural condition of tree modules. We will explore how—under certain conditions—we can generalise Crawley-Boevey's classical framework to construct a finite generating set of "generalised graph maps" for these hom-spaces, and discuss how this applies to the indecomposability of these modules.

Khrystyna Serhiyenko (University of Kentucky)

Syzygy categories over Iwanaga-Gorenstein algebras

Abstract: Syzygies are a fundamental topic of study in both commutative and non-commutative algebra. They are defined as submodules of projectives and appear as kernels of projective resolutions that are used to approximate every module. It is then natural to study the category of all syzygies, particularly when the entire module category cannot be explicitly understood.
In this series of talks, we will explore syzygy categories over Iwanaga-Gorenstein algebras of Gorenstein parameter 1, particularly focusing on the class of 2-Calabi-Yau tilted algebras. In this case, it is known that the syzygy category is triangulated and equivalent to the singularity category of an algebra as well as the category of maximal Cohen-Macauley modules. It is an open question to characterize algebras of finite CM type. As a first step in this direction, we will investigate the behavior of syzygy categories when passing from an algebra A to its quotient A/Ae_iA by an idempotent e_i, which corresponds to deleting a vertex from the quiver of A. Consequently, we describe various equivalent characterizations for these two algebras to have equivalent syzygy categories. We will then focus on the special class of Cohen-Macauley finite algebras, called dimer tree algebras and their skew group algebras, and provide a geometric model for their syzygy categories in terms of their associated checkerboard polygons.

Hugh Thomas (University of Québec at Montréal)

Representations of lattices, Auslander regularity, and Coxeter permutations

Abstract: In this minicourse, I will be focusing on the representation theory of lattices (that is to say, of their incidence algebras). This turns out to be an interesting setting in which to explore Auslander regularity and related notions, in part because they make contact with certain already studied notions within lattice theory, which I will also discuss. This minicourse assumes no prior knowledge of lattice theory, and the representation theory background required is fairly minimal.
I will explain the definition of Auslander regularity, and then present the result of Iyama and Marczinzik showing that a lattice is Auslander regular if and only if it is distributive. I will also explain how Auslander regularity (of incidence algebras of lattices) can be read off from the Coxeter matrix. This leads naturally to the notion of Coxeter permutation, and the rowmotion operation on distributive lattices. Finally, I will discuss the extension of rowmotion to semidistributive lattices, the way this manifests in terms of the Coxeter matrix, and how this can also be understood in representation-theoretic terms.
