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Abstracts

Contents

Workshop Abstracts

Lidia Angeleri Hügel (University of Verona, Verona, Italy)
Infinite dimensional tilting theory

Infinite dimensional tilting modules are abundant in representation theory. They occur when studying torsion pairs in module categories, when looking for complements to partial tilting modules of projective dimension greater than one, or in connection with the Homological Conjectures. They share many properties with classical tilting modules, but they also give rise to interesting new phenomena. For example, they induce localizations of derived categories rather than derived equivalences. Moreover, they often correspond to localizations of module categories or of categories of quasi-coherent sheaves.

In my talks, I will review the main features of infinite dimensional tilting modules. I will discuss the relationship with approximation theory and with localization. Finally, I will focus on some classification results.

Dave Benson (University of Aberdeen, Aberdeen, United Kingdom)
Modules for elementary abelian p-groups, and vector bundles on projective space

The concept of a module of constant Jordan type was introduced in a 2008 paper of Carlson, Friedlander and Pevtsova. In the case of a finite elementary abelian p-group, these modules are closely connected with algebraic vector bundles on projective space. My plan for these talks is to introduce this class of modules, explain some of their elementary and less elementary properties, and then explain how representation theoretic information comes from algebraic geometry. In particular, the theory of Chern classes and the Hirzebruch-Riemann-Roch theorem play a major role. An extensive set of notes on this subject can be found on my home page.

Jonathan Brundan (University of Oregon, Eugene, United States)
Quiver Hecke algebras and categorification

I will explain how to realize some algebraic structures—quantized enveloping algebras and their canonical bases—via a certain tensor category—representations of the quiver Hecke algebras of Khovanov, Lauda and Rouquier. I expect to focus mainly on finite type and discuss the categorification of (dual) PBW bases via (proper) standard modules over these algebras. This has some interesting homological consequences for quiver Hecke algebras in finite type.

Osamu Iyama (Nagoya University, Nagoya, Japan)
n-hereditary algebras

Generalizing classical hereditary algebras, we introduce a class of finite dimensional algebras of global dimension n which we call n-hereditary. They consists of two disjoint classes: n-representation finite (n-RF) algebras and n-representation infinite (n-RI) algebras. n-RF algebras are defined by existence of n-cluster tilting modules, while n-RI algebras are closely related to n-Fano algebras of Minamoto and Mori in noncommutative algebraic geometry. We discuss their basic properties and examples: n-AR translations, preprojective algebras, n-APR tilting, connection with cluster categories, n-regular modules, representation dimension and so on. This series of lectures is based on joint work with Herschend and Oppermann motivated by higher dimensional Auslander-Reiten theory.

Sergey Mozgovoy (University of Oxford, Oxford, United Kingdom)
Donaldson-Thomas invariants

Refined Donaldson-Thomas invariants were introduced by Kontsevich and Soibelman for 3-Calabi-Yau A_∞-categories. The goal of this lecture is to introduce these invariants in the special case of derived categories over the DG algebras associated with quivers with potentials (Ginzburg DG algebras). We will define refined Donaldson-Thomas invariants and compute them in some simple cases. Then we will discuss their basic properties including integrality, positivity, and wall-crossing phenomena.

Dmitri Orlov (Steklov Mathematical Institute, Moscow, Russia)
Landau-Ginzburg Models, D-branes, and Mirror Symmetry – mathematical approach

I am going to give a few lectures on Homological Mirror Symmetry. I plan to talk on categories of D-branes of type B in sigma-models and Landau-Ginzburg models. These categories are directly related to derived categories of coherent sheaves and triangulated categories of singularities. We will describe some different properties of such categories and relations between them, many of which are coming from physics. Useful notions of exceptional collections, classical and strong generators will be discussed.

I am also going to describe a procedure of constructing mirror symmetric models (known as Batyrev-Givental-Hori-Vafa procedure) and will describe mirror symmetry for weighted projective spaces, Del Pezzo surfaces and their non-commutative deformations. Categorical generalization of Strange Arnold Duality will be introduced and some results and conjectures will be given in the last lecture.

Conference Abstracts

Takahide Adachi (Nagoya University, Nagoya, Japan)
τ-tilting modules for Nakayama algebras

Let Λ be a basic connected finite dimensional algebra over an algebraically closed field with n simple modules. We call a module $M \in \mathrm{mod}\Lambda$ (1) *τ-tilting* if $\mathrm{Hom}_\Lambda(M, \tau M) = 0$ and the number of non-isomorphic indecomposable direct summands of M is equal to n, and (2) *support τ-tilting* if there exists an idempotent $e \in \Lambda$ such that M is a τ-tilting $\Lambda/\langle e\rangle$-module, where τ is the Auslander-Reiten translation of Λ.

In this talk, we study a connection between τ-tilting modules and proper support τ-tilting modules for self-injective Nakayama algebras. As an application of this result, we give how to obtain all support τ-tilting modules for self-injective Nakayama algebras from tilting modules for path algebras of Dynkin type A.

Claire Amiot (Université de Strasbourg, Strasbourg, France)
Algebraic Mckay correspondence and cluster-tilting

This is a joint work with Osamu Iyama and Idun Reiten. Algebraic Mckay correspondence is result due to Auslander in 1986. It gives a link between the irreducible representations of finite subgroups G of $SL_2(\mathbb{C})$ and the Cohen-Macaulay modules of the invariant ring $\mathbb{C}[x,y]^G$. In this talk, I will show how it is possible to generalize this result using cluster-tilting theory. It will give an interpretation of certain stable categories of Cohen-Macaulay modules over Gorenstein singularities in terms of derived and cluster categories.

Zvi Arad (Netanya Academic College and Bar Ilan University, Netanya and Ramat Gan, Israel)
On Normalized Integral Table Algebras (Fusion Rings) generated by a faithful non-real element of degree 3

My lecture is based on a recent research book of the above title by Z. Arad, Xu Bangteng, G. Chen, E. Cohen, A. Haj Ihia Hussam and M. Muzychuk ([1]).

The theory of table algebras was introduced in 1991 by Z. Arad and H. Blau in order to treat, in a uniform way, products of conjugacy classes and irreducible characters of finite groups. Today, table algebra theory is a well-established branch of algebra with various applications including the representation theory of finite groups, algebraic combinatorics and fusion rules algebras.

The main goal of my lecture is to state a classification theorem of the normalized integral table algebras (fusion rings) generated by a faithful non-real element of degree 3.

References

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Tokuji Araya (Tokuyama College of Technology, Yamaguchi, Japan)
Dimensions of triangulated categories with respect to subcategories

This is a joint work with T. Aihara, O. Iyama, R. Takahashi and M. Yoshiwaki. We will introduce the concept of the dimension of a triangulated category with respect to a fixed full subcategory. For the bounded derived category of an abelian category, upper bounds of the dimension with respect to a contravariantly finite subcategory and a resolving subcategory are given. Our methods not only recover some known results on the dimensions of derived categories in the sense of Rouquier, but also apply to various commutative and non-commutative noetherian rings.

Javad Asadollahi (IPM and University of Isfahan, Isfahan, Iran)
On the derived dimension of abelian categories

The notion of the dimension of a triangulated category has been introduced and studied by Rouquier [Rq]. Roughly speaking, it measures the minimum steps one requires to build the whole triangulated category $\mathcal{T}$ out of a single object M.

In this talk, we give an upper bound on the dimension of the bounded derived category of an abelian category. We show that if $\mathcal{X}$ is a sufficiently nice subcategory of an abelian category, then the derived dimension of $\mathcal{A}$ is at most $\mathcal{X}$-dim$\mathcal{A}$, provided $\mathcal{X}$-dim$\mathcal{A}$ is greater than one. As application, we obtain some generalizations of the known results and provide an upper bound on the derived dimension of n-torsionless-finite algebras.

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Hideto Asashiba (Shizuoka University, Shizuoka, Japan)
Induced pseudofunctors and gluing of derived equivalences

We fix a commutative ring $\Bbbk$ and a small category I, and denote by $\Bbbk$-**Cat** ($\Bbbk$-**Tri**) the 2-category of small (resp. small triangulated) $\Bbbk$-categories. As a generalization of (co)lax actions of a group we consider (co)lax functors $X : I \to \Bbbk\text{-}\mathbf{Cat}$, for which (the $\Bbbk$-linear version of) the Grothendieck construction $\mathrm{Gr}(X)$ is defined that is a category obtained from the categories $X(i)$ ($i \in I_0$) by "gluing" them together with the functors $X(a)$ ($a \in I_1$). We can define a colax functor $\mathcal{D}(\mathrm{ModX}) : I \to \Bbbk\text{-}\mathbf{Tri}$ on the collection of derived categories of $X(i)$ ($i \in I_0$) by applying the following.

Theorem 1. *Let* $\mathbf{B}, \mathbf{C}$ *and* $\mathbf{D}$ *be 2-categories. Then a pseudofunctor* $V : \mathbf{C} \to \mathbf{D}$ *induces a pseudofunctor*

$$\overleftarrow{\mathrm{Colax}}(\mathbf{B}, V) : \overleftarrow{\mathrm{Colax}}(\mathbf{B}, \mathbf{C}) \to \overleftarrow{\mathrm{Colax}}(\mathbf{B}, \mathbf{D}), \quad X \mapsto V \circ X.$$

In the above $\overleftarrow{\mathrm{Colax}}(\mathbf{B}, \mathbf{C})$ is a suitably defined 2-category consisting of colax functors $\mathbf{B} \to \mathbf{C}$. Two colax functors X, X' are said to be *derived equivalent* if $\mathcal{D}(\mathrm{Mod}\, X)$ and $\mathcal{D}(\mathrm{Mod}\, X')$ are equivalent in the 2-category $\overleftarrow{\mathrm{Colax}}(I, \Bbbk\text{-}\mathbf{Tri})$. The proof of the following uses the correspondence on 1-morphisms in Theorem 1.

Theorem 2. *If* X *and* X' *are derived equivalent, then so are their Grothendieck constructions* $\mathrm{Gr}(X)$ *and* $\mathrm{Gr}(X')$.

By Theorem 2 we can "glue" derived equivalences between $X(i)$ and $X'(i)$ ($i \in I_0$) together to have a derived equivalence between $\mathrm{Gr}(X)$ and $\mathrm{Gr}(X')$. We will present an example of gluing of derived equivalences between Brauer tree algebras.

Vladimir Bavula (University of Sheffield, Sheffield, United Kingdom)
An analogue of the Conjecture of Dixmier is true for the algebra of polynomial integro-differential operators

In 1968, Dixmier posed six problems for the algebra of polynomial differential operators, i.e. the Weyl algebra. In 1975, Joseph solved the third and sixth problems and, in 2005, I solved the fifth problem and gave a positive solution to the fourth problem but only for homogeneous differential operators. The remaining three problems are still open. The first problem/conjecture of Dixmier (which is equivalent to the Jacobian Conjecture as was shown in 2005-07 by Tsuchimito, Belov and Kontsevich) claims that the Weyl algebra 'behaves' as a finite field extension. In more detail, the first problem/conjecture of Dixmier asks: is it true that an algebra endomorphism of the Weyl algebra an automorphism? In 2010, I proved that this question has an affirmative answer for the algebra of polynomial integro-differential operators. In my talk, I will explain the main ideas, the structure of the proof and recent progress on the first problem/conjecture of Dixmier.

Charlie Beil (Stony Brook University, Stony Brook, NY, United States)
Categorical equivalences from higgsing toric superpotential algebras

Let A and A' be superpotential algebras of brane tiling quivers, with A' cancellative and A non-cancellative, and suppose A' is obtained from A by contracting, or 'higgsing', a set of arrows to vertices while preserving a certain associated commutative ring. A' is then a Calabi-Yau algebra and a noncommutative crepant resolution of its prime noetherian center, whereas A is not a finitely generated module over its center, and its center is not prime or noetherian. I will present some categorical equivalences that relate the representation theory of A with that of A'.

Petter Andreas Bergh (NTNU, Trondheim, Norway)
The Krull dimension of a triangulated category

A thick subcategory of a triangulated category is called irreducible if, roughly speaking, it cannot be generated by two proper thick subcategories. The supremum of the lengths of chains of such irreducible thick subcategories is the Krull dimension of the category. Understanding the thick subcategories gives structural knowledge of the category, and the Krull dimension is a numerical measure of relations among building blocks.

For some triangulated categories the thick subcategories have been completely classified, and for these we determine the precise value of the Krull dimension. Such a classification was done for perfect complexes over commutative Noetherian rings by Hopkins and Neeman, and for stable module categories of group algebras of p-groups by Benson, Carlson and Rickard. The recent extensive work by Benson, Iyengar and Krause on stratification for triangulated categories has resulted in a unified classification approach, and includes many new classes of triangulated categories.

However, for triangulated categories where the thick subcategories have not been classified, very little is known in general about the Krull dimension. For example, it is unclear how it relates to the (ordinary) dimension, or even when it is finite. For the stable module category of a group algebra we determine a lower bound, which takes into account the nucleus of the group.

Jerzy Bialkowski (Nicolaus Copernicus University, Torun, Poland)
Tame algebras of semiregular tubular type

This is report on a joint work with A. Skowroński.

From Drozd's Tame and Wild Theorem the finite dimensional algebras over an algebraically closed field K may be divided into two disjoint classes (tame and wild dichotomy). One class consists of the *tame algebras* for which the indecomposable modules occur, in each dimension d, in a finite number of discrete and a finite number of one-parameter families. The second class is formed by the *wild algebras* whose representation theory comprises the representation theories of all finite dimensional algebras over K. A finite dimensional algebra A over K is said to be of *semiregular tubular type* if all components in the Auslander-Reiten quiver Γ_A of A are semiregular tubes (ray tubes or coray tubes). Moreover, A is said to be *standard* if A is basic, connected, and admits a simply connected Galois covering.

The aim of the talk is to present a complete description of all tame standard finite dimensional algebras over an algebraically closed field of semiregular tubular type. A prominent role in this description will be played by periodic sequences of tame quasitilted algebras of canonical type.

Marta Blaszkiewicz (Nicolaus Copernicus University, Torun, Poland)
On selfinjective algebras of finite representation type

This is a report on joint work with A. Skowroński.

We are concerned with the problem of describing the Morita equivalence classes of finite dimensional selfinjective algebras of finite representation type over a field K. For K algebraically closed, the problem was solved in the early 1980's by Riedtmann via the combinatorial classification of the Auslander-Reiten quivers of selfinjective algebras of finite representation type over K. For K an arbitrary field, it was conjectured by Skowroński and Yamagata that a nonsimple, basic, indecomposable, finite dimensional, selfinjective algebra A over K is of finite representation type if and only if A is a socle deformation of an orbit algebra $\widehat{B}/G$, where $\widehat{B}$ is the repetitive algebra of a tilted algebra B of Dynkin type $\mathbb{A}_n(n \geq 1)$, $\mathbb{B}_n(n \geq 2)$, $\mathbb{C}_n(n \geq 3)$, $\mathbb{D}_n(n \geq 4)$, $\mathbb{E}_6$, $\mathbb{E}_7$, $\mathbb{E}_8$, $\mathbb{F}_4$ or $\mathbb{G}_2$. We will describe the structure of all nonsimple, basic, indecomposable, finite dimensional, selfinjective algebras A of finite representation type over an arbitrary field K whose stable Auslander-Reiten quiver has a sectional module which is not the middle of a short chain.

Frauke Bleher (University of Iowa, Iowa City, United States)
Large universal deformation rings

Let k be an algebraically closed field of positive characteristic p and let $\mathcal{O}$ be a complete discrete valuation ring of characteristic 0 with residue field k. Suppose G is a finite group and V is a finitely generated kG-module. An important question in the representation theory of G is whether V can be lifted to an $\mathcal{O}$-free $\mathcal{O}G$-module. Green's lifting theorem gives a sufficient criterion for this to be possible. However, to answer this question more systematically, one needs to determine the (uni-)versal deformation ring of V, as introduced by B. Mazur, which encompasses all complete local commutative noetherian $\mathcal{O}$-algebras with residue field k to which V can be lifted.

In this talk, we will consider the case when V is indecomposable and the stable endomorphism ring of V is isomorphic to k, which ensures that V has a well-defined universal deformation ring $R(G,V)$. We will study the question of how large $R(G,V)$ can be. We will show that if V belongs to a certain class of blocks of kG, then the size of $R(G,V)$ is bounded by the group ring over $\mathcal{O}$ of a defect group of the block. We will also provide examples when $R(G,V)$ is large in the sense that $R(G,V)/pR(G,V)$ is isomorphic to the power series algebra $k[[t]]$.

Grzegorz Bobiński (Nicolaus Copernicus University, Toruń, Poland)
Normality of maximal orbit closures for Euclidean quivers

Given a quiver Q and a dimension vector $\mathbf{d}$ one studies singularities appearing in the orbit closures with respect to the action of a product $\mathrm{GL}(\mathbf{d})$ of general linear groups on the space of representations with dimension vector $\mathbf{d}$. We have shown in a joint paper with Zwara [1] that these closures are normal Cohen–Macaulay varieties if Q is of Dynkin type $\mathbb{A}/\mathbb{D}$ (the case of type $\mathbb{E}$ is not settled yet). On the other hand, Zwara [2] gave an example showing that there exist orbit closures which are neither normal nor Cohen–Macaulay for quivers of infinite type. His example is of very special form and in my talk I will present the result stating that the closures of maximal orbits over the Euclidean quivers are still normal and Cohen–Macaulay. I will also indicate a possible generalization of this result to the case of tame concealed-canonical algebras.

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Klaus Bongartz (Bergische Universität Wuppertal, Wuppertal, Germany)
Indecomposables live in all smaller lengths

The title means the basic fact that there are no gaps in the lengths of the indecomposable objects in an abelian k-linear length category provided all simple objects have trivial endomorphism algebra k. My proof depends on the theory developed 25 years ago for representation-finite algebras and a slight generalization thereof.

Clinton Boys (University of Sydney, Sydney, Australia)
A graded isomorphism theorem for alternating Iwahori-Hecke algebras

We prove that the alternating Hecke algebra, which is the subalgebra of the Iwahori-Hecke algebra consisting of points fixed by the hash involution, is isomorphic to the graded subalgebra of the quiver Hecke algebra $\mathcal{R}_n^{\Lambda_0}$ of points fixed by the graded involution sgn. In particular this gives an explicit grading on the alternating Hecke algebras, as well as the group algebras of the alternating groups in positive characteristic $p > 2$.

Ragnar-Olaf Buchweitz (University of Toronto, Toronto, Canada)

The Fundamental Group of a Morphism in a Triangulated Category

We introduce the fundamental group of a morphism in a triangulated category. This encodes the ambiguity of completing that morphism to a distinguished triangle, the often bemoaned lack of uniqueness when forming “mapping cones” in triangulated categories.

As a concrete application, we show that the groupoid of distinguished triangles in a derived category that contains a given extension of objects from the abelian category is equivalent to the Quillen groupoid of the corresponding extension category as studied by V. Retakh, Neeman-Retakh, and Schwede.

We will explain how this work should relate to the question of the existence of Gerstenhaber algebra structures on the Yoneda Ext-algebra of the identity object in a monoidal category, taking earlier results of Schwede as a guide.

Igor Burban (University of Cologne, Cologne, Germany)

Matrix problems, vector bundles on curves of genus one and Yang–Baxter equation

Let $E = V(zy^2 - 4x^3 - g_2xz^2 - g_3z^3) \subset \mathbb{P}^2 \times \mathbb{A}^2$ be the Weierstraß fibration, $\mathcal{P}$ a relatively simple sheaf on E and $\mathcal{A} = Ad(\mathcal{P})$ the sheaf of traceless endomorphisms of $\mathcal{P}$. We construct a *canonical* meromorphic section $r \in \Gamma\big(E \times_{\mathbb{A}^2} E, \pi_1^*(\mathcal{A}) \otimes \pi_2^*(\mathcal{A})\big)$ satisfying the Yang–Baxter identity $[r^{12}, r^{13}] + [r^{13}, r^{23}] + [r^{12}, r^{23}] = 0$. This construction allows to find explicit solutions (called *r–matrices* in the physics literature) of the classical Yang–Baxter equation (CYBE) with spectral parameters.

1. For the elliptic fibers E_{g_2,g_3} (those with $\Delta := g_2^3 + 27g_3^2 \neq 0$) this construction gives *all elliptic* solutions of CYBE (the so–called Belavin's elliptic r–matrices).

2. The nodal fibers (with $\Delta = 0, (g_2, g_3) \neq (0,0)$) resp. the cuspidal fiber ($(g_2, g_3) = (0,0)$) give certain *distinguished trigonometric* resp. *rational* solutions of CYBE.

In the second case, our computations essentially use the technique of bocses as well as the matrix problem approach to the study of vector bundles on singular curves. A generalization of the described geometric construction of solutions of CYBE to other degenerations of elliptic curves (like the Kodaira type III fiber $V(y^2z - x^2y) \subset \mathbb{P}^2$) leads to new results in the theory of Frobenius Lie algebras.

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Ilke Canakci (University of Connecticut, Storrs, Connecticut, United States)
On surface cluster algebras: Combinatorial Formulas

Recall from [MSW] that there is a positive combinatorial formula for the Laurent expansion of any cluster variable in a cluster algebra arising from a surface [FST] given by the perfect matchings of snake graphs associated to arcs in the surface, that is $x_\gamma = \frac{1}{x(\mathcal{G})} \sum_{P \in \mathrm{Match}\, \mathcal{G}_\gamma} x(P)y(P)$. In this work, joint with Ralf Schiffler, we introduce the notion of abstract snake graphs and develop a graphical calculus for surface cluster algebras. Moreover, we give a new proof of Skein relations.

Giovanni Cerulli Irelli (University of Bonn, Bonn, Germany)
Desingularization of Quiver Grassmannians

In [FF] the authors construct a desingularization $\pi : \tilde{X} \to X$ of the degenerate flag variety $X = \mathcal{F}l^a_{n+1}$, introduced by Feigin in [Fe]. In [CFR] we noticed that X is actually a quiver Grassmannian $Gr_{\mathbf{e}}(M)$ associated with a representation M of the equioriented quiver Q of type A_n. Moreover the variety $\tilde{X}$ is also a quiver Grassmannian, and it has the form $Gr_{\hat{\mathbf{e}}}(\hat{M})$ for a representation $\hat{M}$ of the AR–quiver of Q (notice that $\hat{M}$ is *not* a representation of the Auslander algebra of Q). Motivated by these results, for every Dynkin quiver Q we construct an algebra B (related to the Auslander algebra of Q) such that for every finite dimensional Q-representation M there is a B–module $\hat{M}$ and an explicit surjective map of the form $\pi : \cup_{\hat{e}} Gr_{\hat{\mathbf{e}}}(\hat{M}) \to Gr_{\mathbf{e}}(M)$. We show that the map π is a desingularization, so it is one to one on the smooth locus of $Gr_{\mathbf{e}}(M)$. In this talk I will explain the construction of B, of $\hat{M}$ and some of the properties of the map π.

This is joint work with Evgeny Feigin and Markus Reineke.

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Bo Chen (University of Stuttgart, Stuttgart, Germany)
Characterization of representation type of quivers, using the Gabriel-Roiter measures

From the pioneering work of Ringel, it is known that the Gabriel-Roiter measure provides a discrete invariant of the module category of an Artin algebra. They form a totally ordered set and also form so-called GR segments, which are just the connected components of this ordering. The number (finite or infinite) of GR segments relates to the representation types of hereditary algebras. More precisely, a finite connected acyclic quiver is wild if and only if its path algebra admits infinitely many GR segments.

Jianmin Chen (Xiamen University, Xiamen, China)
Some observations on quasi-coherent sheaves on a weighted projective line

This is joint work with Jinjing Chen, Yanan Lin, Pin Liu and Shiquan Ruan. We describe the relationship between Prüfer sheaves and generic sheaves in the category of quasi-coherent sheaves on weighted projective lines of genus one, and construct tilting objects for the stable category of vector bundles on the weighted projective line of type $(2, 2, 2, 2; \lambda)$. Moreover, we show that there is a correspondence between tilting objects in the stable category of vector bundles on the weighted projective line of type $(2, 2, 2, 2; \lambda)$ and cluster-tilting objects in its cluster category.

Xiao-Wu Chen (University of Science and Technology of China, Hefei, China)
Retractions and Gorenstein Homological Properties

To a localizable module, one may associate a homomorphism of algebras, which is called a left retraction of algebras. It is a homological ring epimorphism that preserves singularity categories in the sense of Buchweitz and Orlov. Left retractions are related to Gorenstein homological properties. We apply the results to Nakayama algebras: any connected Nakayama algebra is linked to a self-injective one via a sequence of left retractions. In particular, the singularity category of a Nakayama algebra is known. Moreover, following the ideal of Gustafson, Gorenstein projective modules over Nakayama algebras are related to perfect elements. This work is related to some results by Nagase, and is based on joint investigation with Yu Ye in USTC.

Flávio U. Coelho (Universidade de São Paulo, São Paulo, Brazil)
Trisections in module categories

In this talk, we will introduce and study a special type of trisections in a module category, namely the compact trisections, which characterize quasi-directed components. Recall that a component of the Auslander-Reiten quiver of an artin algebra is *quasi-directed* provided it is generalized standard and contains at most finitely many modules lying on oriented cycles. We apply this notion to the study of laura algebras and we use it do define a class of algebras with predictable Auslander-Reiten components. *This is a joint work with Alvares, Assem, Peña and Trepode.*

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Raquel Coelho Simoes (University of Leeds/Universitaet Bielefeld, Leeds/Bielefeld, United Kingdom/Germany)
Hom-configurations and noncrossing partitions

Let Q be a Dynkin quiver and $D^b(Q)$ the bounded derived category of the path algebra associated to Q. We will give a bijection between maximal Hom-free sets of indecomposable objects (the Hom-configurations in the title) in a certain orbit category of $D^b(Q)$ and noncrossing partitions in the Weyl group associated to Q which are not contained in any proper standard parabolic subgroup. This bijection generalizes a result of C. Riedtmann arising in her work classifying the representation-finite selfinjective algebras of tree class A_n.

Septimiu Crivei (Babes-Bolyai University, Cluj-Napoca, Romania)
One-sided exact categories

One-sided exact categories appear naturally as instances of Grothendieck pretopologies. In an additive setting they are given by considering the one-sided part of Keller's axioms defining Quillen's exact categories. We study one-sided exact additive categories and a stronger version defined by adding the one-sided part of Quillen's "obscure axiom". We show that some homological results, such as the Short Five Lemma and the 3×3 Lemma, can be proved in our context. This is a joint work with Silvana Bazzoni.

Kálmán Cziszter (Central European University, Budapest, Hungary)
The Noether number for the polynomial invariants of finite groups

The Noether number $\beta(G)$ of a finite group G gives for a fixed field $\mathbb{F}$ the maximal degree of the generators in the ring of polynomial invariants $\mathbb{F}[V]^G$ for any G-module V over $\mathbb{F}$. Despite the longstandig interest in this number its precise value is still widely unknown except for very few particular groups. By a classic result of Noether and some newer developments $\beta(G)$ is bounded by the order of the group $|G|$ whenever $\mathrm{char}(\mathbb{F})$ does not divide $|G|$. Even more, it is known that this bound is sharp only if G is cyclic. This gives the relevance of our main result which states that —apart from four particular groups of small order— the inequality $\beta(G) \geq \frac{1}{2}|G|$ holds only for those groups which contain a cyclic subgroup of index at most two. Moreover the constant 1/2 is special here in the sense that the set of rational numbers $\beta(G)/|G|$ has no other limit points between 1/2 and 1; this follows from our second main result, according to which the difference $\beta(G) - \frac{1}{2}|G|$ equals 1 or 2 for every non-cyclic group with a cyclic subgroup of index 2. Our method is based on a generalization of the Noether number and a series of related reduction lemmata which proved to be a useful technical tool in this domain.

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Gabriella D'Este (Universita' degli Studi di Milano, Milano, Italy)
Partial tilting complexes and beyond

Some "proper" non classical partial tilting modules T have the following property: even though their projective resolution $T^\bullet$ is not a tilting complex, for every non-zero module M there is a morphism from $T^\bullet$ to the projective resolution of M which is not homotopic to zero. On the other hand, a characterization of tilting complexes given by Miyachi [M] guarantees the existence of non-zero right bounded complexes $C^\bullet$ (with projective components) with the property that any morphism from $T^\bullet$ to any shift of $C^\bullet$ is homotopic to zero.

Confining ourselves to indecomposable complexes $C^\bullet$ with a "combinatorial" structure, suggested by Shaps and Zachay-Illouz [S-ZI] (i.e. with the property that every non-zero component of $C^\bullet$ is an indecomposable projective module), we will show that there is no restriction on the cardinality of a representative system (up to shift) of the indecomposable complexes $C^\bullet$ as above. We will also see that complexes with injective (more precisely, with projective-injective) components play a big role.

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Erik Darpö (Nagoya University, Nagoya, Japan)
The Loewy length of a tensor product of modules of a dihedral two-group

While the finite-dimensional modules of the dihedral 2-groups over fields of characteristic 2 were classified over 30 years ago, not much is known about tensor products of such modules. In this talk, I shall present a formula for the Loewy length of the tensor product of any two modules of a dihedral 2-group.

This is joint work with C. C. Gill.

José A. de la Peña (CIMAT, Guanajuato, Mexico)
Algebras whose Coxeter polynomials are products of cyclotomic polynomials

Let A be a finite dimensional algebra over an algebraically closed field k. Assume A is basic connected with n pairwise non-isomorphic simple modules. We consider the *Coxeter transformation* ϕ_A as the automorphism of the Grothendieck group $K_0(A)$ induced by the Auslander-Reiten translation τ in the derived category $\mathrm{Der}(\mathrm{mod}_A)$ of the module category mod_A of finite dimensional left A-modules. We say that A is an algebra of *cyclotomic type* if the characteristic polynomial χ_A of ϕ_A is a product of cyclotomic polynomials. There are many examples of algebras of cyclotomic type in the representaton theory literature: hereditary algebras of Dynkin and extended Dynkin types, canonical algebras, some supercanonical and extended canonical algebras. Algebras satisfying the fractional Calabi-Yau property have periodic Coxeter transformation and are, therefore, of cyclotomic type. In this talk we describe general properties of algebras A of cyclotomic type. In particular, we describe the shape of the Auslander-Reiten components of $\mathrm{Der}(\mathrm{mod}_A)$.

Laurent Demonet (Nagoya University, Nagoya, Japan)
Mutation of quiver with potential at several vertices

Derksen, Weyman and Zelevinsky introduced mutations of quivers with potentials in [DWZ]. These mutations have been proved to categorify cluster algebras mutations, which permitted to reach a better understanding of cluster algebras by solving several open conjectures. On the other hand, the Jacobian algebras of mutated quivers with potentials are canonically derived equivalent [KY].

In both of these cases, the mutation of Jacobian algebras behaves as the mutation of endomorphism rings of cluster tilting objects in well behaved triangulated categories. Moreover, it these triangulated categories, it makes sense to mutate several indecomposable summands of cluster tilting objects at the same time.

The aim of this talk is to introduce a conjectural formula of mutation of quiver with potential at several vertices. Thus, we will give some lemmas and propositions supporting the conjecture. For example, the fact that it numerically behaves has expected (*c.f.* green sequences) when the subquiver we mutate at belongs to some specified families of quivers (including the family of acyclic quivers).

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Bangming Deng (Beijing Normal University, Beijing, China)
Identification of simple representations for affine q-Schur algebras

We will explain how to identify simple representations of affine q-Schur algebras arising from simple polynomial representations of quantum affine $\mathfrak{gl}_n$ with those arising from simple modules of affine Hecke algebras of type A. This is based on joint work with Jie Du.

Matyas Domokos (Renyi Institute of Mathematics, Hungarian Academy of Sciences, Budapest, Hungary)
On subdiscriminants of matrices

Representation theory of the orthogonal group and classical invariant theory are applied to some computational problems, related to the real algebraic variety consisting of real symmetric matrices with a bounded number of distinct eigenvalues. Recall that the *k-subdiscriminant* of an $n \times n$ real symmetric matrix is a polynomial function of the entries that vanishes if and only if the matrix has at most $n-k-1$ distinct eigenvalues. Note that it is a non-negative form on the space of matrices. In the special case $k = 0$ we recover the *discriminant*. Using the Kleitman-Lovász theorem on the vanishing ideal of certain subspace arrangements an invariant theoretic characterization of subdiscriminants is given. Developing further ideas of P. Lax, this is used to study sum of squares presentations of (sub)discriminants, a topic going back to Kummer and Borchardt. Covariants of a binary quartic form are used to compute the coordinate ring of the variety of third order degenerate real symmetric matrices.

Ivon Andrea Dorado Correa (Universidad Nacional de Colombia, Bogotá, Colombia)
One parameter 3-equipped posets

This work follows the research line proposed by Alexander Zavadskij (1946 - 2012) who studied, from the 90s, representation theory of *equipped posets* and more recently, of *generalized equipped posets.*

A 3-equipped poset is a partially ordered set with two kinds of points, and an order relation of three kinds. By choosing a cubic field extension $F \subset G$, each 3-equipped poset determines two artinian schurian algebras. Their socle projective modules are called respectively, the representations and the corepresentations of the choosen 3-equipped poset. We study the case char $F = 3$, and G is a pure inseparable extension over F.

We define matrix problems of mixed type over the pair (F, G) which correspond to classifications of indecomposable representations and corepresentations. Through them, we describe the one-parameter 3-equipped posets, establish the respective list of sincere posets, and completely classify, in evident matrix form, their indecomposable representations and corepresentations.

Piotr Dowbor (Nicolaus Copernicus University, Torun, Poland)

On parametrizing bimodules for homogeneous modules over tubular canonical algebras

In the talk we will discuss the problem of constructing matrix presentations of indecomposable Λ-modules from all homogeneous tubes (in non integral slopes), for tubular canonical algebras $\Lambda = \Lambda(\mathbf{p}, \boldsymbol{\lambda})$ introduced and studied by C.M. Ringel. We give an effective recursive algorithm, creating for each slope $q \in \bar{\mathbb{Q}}' := \mathbb{Q}_{\leq 0} \cup \mathbb{Q}_{\geq p} \cup \{\infty\}$ a matrix bimodule ${}_{k[t]_f}B_\Lambda$ $(= {}_{k[t]_f}B_{\Lambda}(q))$, which yields a parametrization (in the form of the tensor products $N \otimes_{k[t]_f} B$) of all indecomposable Λ-modules in homogeneous tubes from the $\mathbb{P}^1(k)$-family $\widetilde{\mathcal{T}}^{(q)}$ by indecomposable finite dimensional $k[t]_f$-modules N, where $k[t]_f$ is a localization of the polynomial algebra $k[t]$ in one variable t, with respect to the polynomial $f = f_{\mathbf{p}} \in k[t]$. The bottom of this recursion is the list of bimodules $B(q) := B^{(q)}$, for $q \in \bar{\mathbb{Q}}' \cap \mathbb{Z}$, given in [1] and presented by Andrzej Mróz in his talk.

The construction of the algorithm is mainly based on nice properties of universal extensions for bimodules. It also uses Geigle-Lenzing approach of studying the category $\operatorname{mod}\Lambda$ in terms of coherent sheaves over the weighted projective line associated to Λ and the technique of tubular mutations. The presented result is a joint work with A. Mróz and H. Meltzer (see [2]). Note that it definitely closes the problem of positive verification of tameness (in the sense of the classical definition) for tubular canonical algebras.

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Jie Du (University of New South Wales, Sydney, Australia)

Realization of quantum and affine quantum $\mathfrak{gl}_n$

One important breakthrough in the theory of quantum groups is Ringel's Hall algebra realization of the positive part of a quantum enveloping algebra. However, the realization problem for the entire quantum enveloping algebra seems interesting and is far from completion. By generalizing the work of Beilinson, Lusztig and MacPherson for quantum $\mathfrak{gl}_n$ to the affine case, we have seen a hope for solving the realization problem for affine quantum $\mathfrak{gl}_n$. I will talk about a conjecture and its proof in the classical $(v = 1)$ case.

This is joint work with Bangming Deng and Qiang Fu.

Alex Dugas (University of the Pacific, Stockton CA, United States)
Mutations of simple-minded systems in triangulated categories

Let $\mathcal{T}$ be a Hom-finite triangulated Krull-Schmidt category over a field k. Inspired by a definition of Koenig and Liu, we say that a family $\mathcal{S} \subseteq \mathcal{T}$ of pairwise orthogonal objects with trivial endomorphism rings is a simple-minded system if its closure under extensions is all of $\mathcal{T}$. We construct torsion pairs in $\mathcal{T}$ associated to any subset $\mathcal{X}$ of a simple-minded system $\mathcal{S}$, and use these to define left and right mutations of $\mathcal{S}$ relative to $\mathcal{X}$. When $\mathcal{T}$ has a Serre functor ν and $\mathcal{S}$ and $\mathcal{X}$ are invariant under $\nu \circ [1]$, we show that these mutations are again simple-minded systems. We are particularly interested in the case where $\mathcal{T} = \underline{\text{mod}}\text{-}\Lambda$ for a self-injective algebra Λ. In this case, our mutation procedure parallels that introduced by Koenig and Yang for simple-minded collections in $D^b(\text{mod-}\Lambda)$. It follows that the mutation of the set of simple Λ-modules relative to $\mathcal{X}$ yields the images of the simple Γ-modules under a stable equivalence $\underline{\text{mod}}\text{-}\Gamma \to \underline{\text{mod}}\text{-}\Lambda$, where Γ is the endomorphism ring of the Okuyama tilting complex corresponding to $\mathcal{X}$. We will give some examples and discuss applications to the problem of lifting a stable equivalence of Morita type (between self-injective algebras) to a derived equivalence.

Karin Erdmann (University of Oxford, Oxford, United Kingdom)
On Hochschild cohomology and support varieties for special biserial selfinjective algebras

Let A be a finite-dimensional selfinjective algebra over a field K, and let $\text{HH}^*(A)$ be the Hochschild cohomology algebra of A; this acts on $\text{Ext}^*_A(M, M)$ for any A-module M. One would like to know when the Hochschild cohomology satisfies suitable finite generation properties. If so, then A-modules have supports defined via this action, and these supports share many properties of supports defined via group cohomology.

This lecture will present recent results for special biserial selfinjective algebras on the additive structure of Hochschild cohomology. In particular we show that many such algebras do not have such supports. We also give a new proof for the result of [BGMS], showing that Hochschild cohomology of a selfinjective algebra can be finite-dimensional.

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Stanislav Fedotov (Moscow State University, Moscow, Russia)
Framed moduli spaces, Grassmannians and tuples of operators

Consider a quiver L_q with one vertex and q loops. Classifications of representations of L_q with dimension vector (m) is equivalent to classification of tuples of q operators on an m-dimensional vector space. It is well known that this problem is "wild" even for $q = 2$, that is we are not supposed to make any considerable progress in it. To make things easier we first have to make them worse. Add a new vertex to the quiver and k arrows from the initial one to the one added. Denote the quiver obtained by $L_{q,k}$ and consider an extended dimension vector $(m, 1)$. We are thus dealing now with the problem of classifying tuples of q operators and k linear functions on a vector space. It turns out that on a Zariski open subset of $\mathrm{Rep}(L_{q,k}, (m, 1))$ given by some stability condition there is a complete classification of the tuples up to the action of $\mathrm{GL}_m(\Bbbk)$. This means that not only we have a moduli space, but to each tuple we may associate a finite number of normal forms.

The above trick is in fact a particular case of a more general construction of framed representations. Framed representation spaces are very convenient since they contain a Zariski open subset allowing a geometric quotient. For quivers without oriented cycles the moduli space was described by M. Reineke as a quiver Grassmannian. In the talk I am going to discuss how his construction may be generalized for finite dimensional algebras and quivers with oriented cycles and how the normal forms may be obtained.

Sergey Fomin (University of Michigan, Ann Arbor, United States)
Cluster structures in rings of SL_3 *invariants*

The rings of polynomial $\mathrm{SL}(V)$-invariants of configurations of vectors and linear forms in a k-dimensional complex vector space V have been explicitly described by Hermann Weyl in the 1930s. Each such ring conjecturally carries a natural cluster algebra structure (typically, many of them) whose cluster variables include Weyl's generators. In joint work with Pavlo Pylyavskyy, we describe and explore these cluster structures in the case $k = 3$.

Tore Forbregd (NTNU, Trondheim, Norway)
Partial Orders on Representations of Algebras

Joint work with N. M. Nornes and S. O. Smalø.

Let k be a commutative artin ring and let Λ be an artin k-algebra. For each natural number d let $\operatorname{rep}_d \Lambda$ be the set of isomorphism classes of Λ-modules with k-length equal to d. For each natural number n, a $n \times n$-matrix with entries in Λ, can be considered as a k-endomorphism of M^n, where M^n denotes the direct sum of n copies of the Λ-module M. The quasi-order $\leq_n$ on $\operatorname{rep}_d \Lambda$ is defined by $M \leq_n N$ if for every $n \times n$-matrix φ, with entries in Λ, we have that $\ell_k(M^n/\varphi M^n) \leq \ell_k(N^n/\varphi N^n)$.

We show that the quasiorder $\leq_n$ is a partial order on $\operatorname{rep}_d \Lambda$ for $n \geq d^3$.

Ghislain Fourier (Universität zu Köln, Cologne, Germany)
Weyl modules for generalized current algebras

Fixing a associative commutative algebra A, a simple finite-dimensional Lie algebra $\mathfrak{g}$, both defined over the complex numbers, the generalized current algebra $\mathfrak{g} \otimes A$, which might be seen as regular maps on $\operatorname{MaxSpec} A$ with values in $\mathfrak{g}$, is subject to a lot of research in the past decades. In this talk we will focus on the global Weyl module $W(\lambda)$, that is the maximal integrable quotient with weights bounded by λ of the induced module of $\mathbb{C}_\lambda$, a one-dimensional module for the Borel subalgebra of $\mathfrak{g}$.

We will analyze this module for certain algebras A, for instance $A = \mathbb{C}$, $A = \mathbb{C}[t]$, A semisimple, A finitely generated, and $A = \mathbb{C}[t]/(t^N)$ and see what is known in the several cases. For this we will study the highest weight space and the local "counterparts", furthermore relate this study to Demazure modules, fusion products and to the combinatorics of Schur functions.

Changjian Fu (Sichuan University, Chengdu, China)
On root categories of finite dimensional algebras

We investigate the generalized root category of a finite-dimensional k-algebra of finite global dimension as the triangulated hull of its 2-periodic orbit category via Keller's construction. This is motivated by the Ringel-Hall Lie algebra associated to 2-periodic triangulated category in the sense of Peng-Xiao.

Takahiko Furuya (Tokyo University of Science, Tokyo, Japan)
Hochschild cohomology of cluster-tilted algebras of Dynkin types $\mathbb{A}_n$ and $\mathbb{D}_n$

In this talk we show that all cluster-tilted algebras of Dynkin type $\mathbb{A}_n$ are (D, A)-stacked monomial algebras (with $D = 2$ and $A = 1$), and then study their Hochschild cohomology rings modulo nilpotence. We also describe the structures of the Hochschild cohomology rings modulo nilpotence for several cluster-tilted algebras of Dynkin type $\mathbb{D}_n$. This talk is based on joint work with Takao Hayami [4].

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Wassilij Gnedin (University of Cologne, Cologne, Germany)

Maximal Cohen-Macaulay Modules over certain tame non-reduced Curve Singularities

The study of maximal Cohen–Macaulay modules (MCM) over Gorenstein rings (in particular, matrix factorizations) drew out a lot of attention in the last ten years. On the other hand, not much is known about an *explicit* description of those even in the tame cases like $T_{p,q}(\lambda) = \mathrm{k}[|x,y|]/(x^p + y^q + \lambda x^2y^2)$. Using methods of [3, 1, 2] we show the following results.

- The *non-reduced* curve singularities $P_{p\infty} = \mathrm{k}[|x,y,z|]/(xy, x^p + z^2)$, $p \in \mathbb{N}^{\geq 2} \cup \{\infty\}$, are CM-tame for any algebraically closed base field k of characteristic $\neq 2$.
- Next, we give an explicit description of all indecomposable MCMs over the ring $P_{\infty\infty} = \mathrm{k}[|x,y,z|]/(xy, z^2)$. The answer is given in terms of "gluing" of MCMs over the partial normalization $\mathrm{k}[|x,z|]/(z^2) \times \mathrm{k}[|y,z|]/(z^2)$.
- The last result is used to get explicit families of indecomposable matrix factorizations of $w = x^2y^2 \in \mathrm{k}[|x,y|]$.

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Mikhail Gorsky (Université Paris 7, Paris, France)
Semi-derived Hall algebras

Inspired by recent work of Bridgeland, from the category $\mathcal{C}^b(\mathcal{E})$ of bounded complexes over an exact category $\mathcal{E}$ satisfying certain finiteness conditions, we construct an associative unital *"semi-derived Hall algebra"* $\mathcal{SDH}(\mathcal{E})$. This algebra is an object sitting, in some sense, between the usual Hall algebra $\mathcal{H}(\mathcal{C}^b(\mathcal{E}))$ and the Hall algebra of the bounded derived category $\mathcal{D}^b(\mathcal{E})$, introduced by Töen and further generalized by Xiao and Xu. It has the structure of a free module over a properly defined quantum torus of acyclic complexes, with a basis given by the isomorphism classes of objects in the bounded derived category $\mathcal{D}^b(\mathcal{E})$. We prove the invariance of $\mathcal{SDH}(\mathcal{E})$ under derived equivalences induced by exact functors between exact categories.

When $\mathcal{E}$ has enough projectives and is of finite global dimension, $\mathcal{SDH}(\mathcal{E})$ is isomorphic to the Hall algebra of the category of complexes with projective components (localized at the classes of contractibles). The $\mathbb{Z}/2$ version of this algebra, for $\mathcal{E}$ being the category of representations of a quiver, was related by Bridgeland in [B] to the corresponding quantum group.

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Jan Grabowski (Lancaster University, Lancaster, United Kingdom)
A quantum analogue of a dihedral group action on Grassmannians

In recent work, Launois and Lenagan [1] have shown how to construct a cocycle twisting of the quantum Grassmannian and an isomorphism of the twisted and untwisted algebras that sends a given quantum minor to the minor whose index set is permuted according to the n-cycle $c = (1\ 2\ \dots\ n)$, up to a power of q. This twisting is needed because c does not induce an automorphism of the quantum Grassmannian, as it does classically and semi-classically.

With Allman [2], we have described an extension of this construction to give a quantum analogue of the action on the Grassmannian of the dihedral subgroup of S_n generated by c and w_0, the longest element, and this analogue takes the form of a groupoid. We see that this dihedral subgroup action exists classically, semi-classically (by Poisson automorphisms and anti-automorphisms, a result of Yakimov) and in the quantum and nonnegative settings.

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Joseph Grant (University of Leeds, Leeds, United Kingdom)
Periodic algebras and derived equivalences

Autoequivalences of Calabi-Yau derived categories, known as spherical twists, were introduced independently by Seidel-Thomas and, in a special case, Rouquier-Zimmermann. For derived categories of symmetric algebras, I will outline the construction of autoequivalences which generalize the spherical twists, as well as the $\mathbb{P}^n$-twists of Huybrechts-Thomas, using periodic algebras. I will present some properties and examples of these functors.

Anna-Louise Grensing (Universität Bielefeld, Bielefeld, Germany)
Monoids of projection functors and Hecke-Kiselman monoids

The Hecke-Kiselman monoid associated with a finite acyclic quiver Q was introduced by Ganyushkin and Mazorchuk. It is given by generators corresponding to the vertices and relations depending on the arrows.

We define the monoid of projection functors attached to the simple modules of the path algebra kQ and construct an epimorphism of the Hecke-Kiselman monoid onto this monoid of functors. We present a method to detect when this epimorphism is actually an isomorphism.

Yvonne Grimeland (NTNU, Trondheim, Norway)
Special Biserial Cluster-tilted Algebras

This is joint work with Fedra Babaei. In my talk I will describe the class of special biserial cluster-tilted algebras. We use that for any special biserial algebra A the number of non-projective middle terms in any AR-sequence is less than or equal to 2, and for A of finite representation type then this is less than or equal to 2 if and only if A is special biserial. If H is a hereditary finite dimensional algebra over an algebraically closed field K and $\mathcal{C}$ the cluster category of H, then for any cluster-tilting object T in $\mathcal{C}$ the AR-sequences of the module category of the cluster-tilted algebra $\Gamma = \mathrm{End}_{\mathcal{C}}(T)^{\mathrm{op}}$ is inherited from the AR-triangles of $\mathcal{C}$ through the equivalence

$$F = \mathrm{Hom}_{\mathcal{C}}(T, -) : \mathcal{C}/\,\mathrm{add}(\tau T) \to \mathrm{mod}\,\Gamma.$$

Rasool Hafezi (University of Isfahan, Isfahan, Iran)
PHI-dimension and relative Igusa-Todorov function

Let R be a right artinian ring. In this talk we study the ϕ-dimension of modules over right artinian ring, which was first defined in [HL], where ϕ is the function defined by Igusa and Todorov. Our results, in particular, imply that for any Gorenstein projective module M, $\phi(M) = 0$. We show that $\phi.\mathrm{dim}(R) \leq \mathcal{G}\mathrm{-gldim}(R)$, with equality where the latter one is finite. This will have some applications. Then we introduce a relative version of the function ϕ and prove that if M is a resolving module over an algebra Λ with $\mathrm{rep.dim}\Lambda \leq 3$, then $\Gamma = \mathrm{End}_\Lambda(M)^{op}$ is of finite finitistic dimension. Let Λ be an arbitrary artin algebra. Finally, we show that the finitistic dimension of Γ is finite, provided Γ is the endomorphism ring of a self-orthogonal Λ-module of finite injective dimension which is a generator for $\mathrm{mod}\Lambda$.

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Adam Hajduk (Nicolaus Copernicus Uniwersity, Torun, Poland)
Partial order induced by the generalized CB-degeneration on alg_k

Let k be an algebraically closed field. Recall that the classical degeneration of a d-dimensional k-algebra A ($d \geq 0$) is, by definition, expressed in terms of structure constants $c(A) \in \mathrm{alg}_d(k)$ of A and the orbit-closure inclusions in $\mathrm{alg}_d(k)$, with respect to the natural action of full linear group $\mathrm{Gl}_d(k)$. There is also another concept for algebra degeneration introduced by W. W. Crawley-Boevey: instead of modifying the multiplication structure in A, one can represent A as the factor algebra B/I of some finite dimensional k-algebra B modulo relations generating the ideal $I \lhd B$, and modify, in some restrictive sense, just the relations. We call this type of algebra degeneration the CB-degeneration.

We briefly introduce the definition of GCB-degeneration ("generalized CB-degeneration"), which is some common generalization of the classical notion, and the notion of CB-degeneration. Firstly, we show, that GCB-degenerations induces the partial order relation on the disjoint sum of isoclasses of d-dimensional k-algebras ($d \geq 1$). Secondly, we present the analysis of the GCB-degeneration partial order structure.

Anne Henke (University of Oxford, Oxford, United Kingdom)
Symmetric Powers, Brauer Algebras and Schur Algebras

Classical Schur-Weyl duality relates Schur algebras of infinite general linear groups with finite symmetric groups via commuting actions on tensor space. Similarly, Schur algebras of symplectic or orthgonal groups are related with Brauer algebras. Now replace the tensor space by a direct sum of tensor products of symmetric powers. For general linear groups, the endomorphism ring is the classical Schur algebra. For orthogonal and symplectic groups, however, the endomorphism ring is a new algebra, which at the same time plays the role of a Schur algebra for Brauer algebras. This is joint work with Steffen Koenig.

Dolors Herbera (Universitat Autònoma de Barcelona, Bellaterra (Barcelona), Spain)
Effective construction of nonfinitely generated projective modules

The aim of this talk is to discuss concrete constructions of countably generated projective modules that are not finitely generated done in joint work with P. Příhoda.

If R is a left noetherian ring then any idempotent ideal is the trace ideal of a countably generated projective right module. We shall show how such a projective module can be constructed. We will apply our methods to enveloping algebras of finite dimensional semisimple Lie algebras over a field of characteristic zero.

By a result of Quillen, all finitely generated projective modules over an enveloping algebra of a finite dimension Lie algebra are stably free, this implies that its trace ideal is always R. On the other hand, in characteristic zero, the enveloping algebra of a semisimple Lie algebra is an FCR algebra, then it has a countable descending chain of ideals of finite codimension (hence, idempotent) with zero intersection. We show that, for such a ring R and any ideal I of R of finite codimension there are uncountably many non-isomorphic countably generated projective right R-modules such that its trace ideal is contained in I.

Reiner Hermann (Bielefeld University, Bielefeld, Germany)
A bracket for monoidal categories

Fix an exact category which admits a (semi-exact) monoidal structure and which is closed under kernels of epimorphisms. Following the ideas of Stefan Schwede, we will explain how to construct a bilinear operation on the Ext-algebra of the tensor unit. This involves results by Retakh and Retakh-Neeman relating homotopy groups of extension categories. It is unknown if the obtained map yields a Gerstenhaber bracket. We will provide examples of categories where this is the case.

Martin Herschend (Nagoya University, Nagoya, Japan)
2-hereditary algebras and quivers with potential

This talk is based on joint work with Osamu Iyama and Steffen Oppermann [HIO]. From the viewpoint of higher dimensional Auslander-Reiten theory there is a natural analogue of hereditary algebras, called 2-hereditary, which are algebras of global dimension at most two satisfying a certain homological condition. The 2-hereditary algebras consist of two disjoint classes called 2-representation finite and 2-representation infinite. These algebras can be characterized by their higher preprojective algebras, which are selfinjective and 3-Calabi-Yau respectively.

By describing higher preprojective algebras using quivers with potential and cuts we obtain a structure theorem for 2-hereditary algebras. For the finite case several examples are constructed using this structure theorem in [HI]. To similarly treat the infinite case I will show how examples can be constructed from consistent dimer models, which give rise to 3-Calabi-Yau quivers with potential.

Finally I will show how the action of 2-APR tilting, which preserves 2-hereditary algebras, can be interpreted as a change of cut called cut mutation.

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Estanislao Herscovich (Université Grenoble, Grenoble, France)
On a definition of multi-Koszul algebras

In this talk we will introduce the notion of *multi-Koszul algebra* for the case of a nonnegatively graded connected algebra with a finite number of generators of degree 1 and with a finite number of relations, as a generalization of the notion of (generalized) Koszul algebras defined by R. Berger for homogeneous algebras, which were in turn an extension of Koszul algebras introduced by S. Priddy. Our definition is in some sense as closest as possible to the one given in the homogeneous case. Moreover, the new definition may seem however to be too restrictive, and despite the fact that it is probably not the most general possible and reasonable extension of the Koszul property for such algebras, all the nice properties satisfied by it make us believe that any sensible such general definition of *Koszul-like* algebra in the general context of graded algebras, if it exists, should necessarily include our definition as a special case. In fact this is part of an on-going work and it can be considered as the first step in the attempt to obtain such a general definition.

We shall present an equivalent description of the (new) definition in terms of the Tor (or Ext) groups, similar to the existing one for homogeneous algebras, and also a complete characterization of the multi-Koszul property, which derives from the study of some associated homogeneous algebras, providing a very strong link between the new definition and the generalized Koszul property for the associated homogeneous algebras mentioned before. We will further provide an explicit description of the Yoneda algebra of a multi-Koszul algebra. As a consequence, we get that the Yoneda algebra of a multi-Koszul algebra is generated in degrees 1 and 2, so a $\mathcal{K}_2$ algebra in the sense of T. Cassidy and B. Shelton.

This is joint work with Andrea Rey.

Lutz Hille (Universität Münster/Universität Bielefeld, Münster/Bielefeld, Germany)
Tilting Modules over the Auslander Algebra of the Truncated Polynomial Ring and Spherical Twists

The Auslander algebra $\mathcal{A}_t$ of the truncated polynomial ring $k[T]/T^t$ plays an important role for parabolic group actions, generic $k[T]$–module homomorphisms, and for spherical twists on an algebraic surface. The tilting modules of projective dimension at most one are realated to Richardson's dense orbit theorem. They have been classified ten years ago in a joint work with Brüstle, Ringel and Röhrle.

In this talk we classify all tilting modules using universal extensions of full exceptional sequences. The full exceptional sequences of $\mathcal{A}_t$–modules correspond to certain diagrams, called *worm diagrams*. They are in bijection to elements of the symmetric group. Moreover, we classify all exceptional and all spherical modules. Then, using spherical twists, we also classify all indecomposable superrigid modules and, eventually, also all tilting modules.

The talk starts with some elementary combinatorics, the worm diagrams. In a second part we consider the Auslander algebra $\mathcal{A}_t$ and certain modules over this algebra. In a third part we present the results and in the last part we give a short overview on applications.

This is joint work with David Ploog (Hannover).

Kazuki Hiroe (RIMS Kyoto University, Kyoto, Japan)
Linear ordinary differential equations with irregular singular points and representations of quivers

The Deligne-Simpson problem asks to determine the existence of irreducible monodromy representations of the Riemann sphere minus n-points which have required local monodromies. Its additive analogue also exists and asks for the existence of irreducible linear ordinary differential equations with regular singular points which have required conjugacy classes of their residue matrices.

This additive analogue was solved by W. Crawley-Boevey. He found a correspondence between differential equations with regular singular points and representations of quivers with certain relations. Then he applied the existence of irreducible representations of quivers to that of irreducible differential equations.

Also a generalization of this result to differential equations with one irregular singular point was obtained by P. Boalch.

As a generalization of these results, we will consider differential equations with arbitrary numbers of unramified irregular singular points and associate it to representations of quivers. As an application of this correspondence, we will discuss the existence of irreducible differential equations with generic characteristic exponents.

Andreas Hochenegger (Universität zu Köln, Cologne, Germany)
Spherelike Twist Functors

I will report on a ongoing joint work with Martin Kalck and David Ploog.

We call an object F in a triangulated category d-spherelike, if its endomorphism algebra is isomorphic to the cohomology of a d-sphere. If we would also ask for F to be a d-Calabi-Yau object, we would arrive at the well-known notion of a d-spherical object. For such an object, P. Seidel and R. Thomas defined a functor, the so-called spherical twist, which is an auto-equivalence (see [ST]).

Without this CY-condition, we define analogously a spherelike twist functor which still incorporates interesting properties. The aim of this talk is to demonstrate these, by presenting examples from representation theory of finite dimensional algebras.

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Andrew Hubery (University of Leeds, Leeds, United Kingdom)
Irreducible Components of Quiver Grassmannians

We generalise a result of Crawley-Boevey and Schroër on irreducible components of module varieties to more general schemes, including those given by fixing the dimensions of various homomorphism spaces, as well as quiver grassmannians, or more generally quiver flag varieties. We remark that our method is based around constructing tangent spaces, rather than the deformation theory used in the earlier paper. This is joint work with Julia Sauter.

Kiyoshi Igusa (Brandeis University, Boston, MA, United States)
Categories of representations of cyclic posets

(joint with G. Todorov) We consider representations of any "connected" cyclic poset X over a discrete valuation ring R. Using an automorphism of the cyclic poset (which can be the identity), we construct a Frobenius category. The objects are projective representations of X together with endomorphisms whose squares are multiplication by the uniformizer t of R. Recall that the stable category of a Frobenius category is a triangulated category. The continuous cluster categories and m-cluster categories of type A_∞ $(m \neq 2)$ are (contained as triangulated subcategories of) examples of this simple construction.

Alexander Ivanov (Saint-Petersburg State University, Saint-Petersburg, Russia)
Hochschild cohomology of algebras of quaternion type of the family $Q(2B)_1(k, s, a, c)$

Hochschild cohomology of algebras of quaternion type of the family $Q(2B)_1(k, s, a, c)$ is investigated over fields of various characteristics. Calculations are made using a bimodule resolution. The resolution was constructed independently by K. Erdmann and A. Skowronski, but it was published in [2] with a little inaccuracy.

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Sergey Ivanov (Saint Petersburg State University, Saint Petersburg, Russia)
Selfinjective algebras of small stable Calabi-Yau dimension

We introduce the natural class of bounded quiver algebras, which allows the so-called DTI-family of relations. With few exceptions, the stable Calabi-Yau dimension of these algebras is equal to three. We prove that all algebras of quaternion type and some other algebras are contained in this class.

Moreover, we prove that if characteristic of the base field is not equal to 2 the stable Calabi-Yau dimension of the preprojective algebra of type $\mathbf{L}_n$ is equal to 5. It corrects an inaccuracy occurred in the description of selfinjective algebras of stable Calabi-Yau dimension 2 introduced by Karin Erdmann and Andrzej Skowroński (see [1, Proposition 3.4.]).

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Osamu Iyama (Nagoya University, Nagoya, Japan)
Tilting and cluster tilting for Cohen-Macaulay modules

Cohen-Macaulay modules is one of major subjects in representation theory. The approximation theory due to Auslander, Buchweitz and Reiten shows that Cohen-Macaulay modules appear in the context of cotilting theory with respect to the canonical modules. Moreover, for Gorenstein rings, the stable categories of Cohen-Macaulay modules describe the singular derived categories, which are studied also by people motivated by mirror symmetry. I will discuss equivalences between the stable categories of Cohen-Macaulay modules and the derived/cluster categories of finite dimensional algebras in the context of tilting/cluster tilting theory.

Gustavo Jasso (Nagoya University, Nagoya, Japan)
τ-Tilting Reduction

Let k be an algebraically closed field and let A be a finite dimensional k-algebra. Recently, O. Iyama and I. Reiten proposed a class of modules which are module-theoretic analogs of 2-cluster-tilting objects in (Hom-finite Krull-Schmidt) 2-Calabi-Yau triangulated categories, the so-called support τ-tilting modules: An A-module M is *τ-rigid* if $\mathrm{Hom}_A(M, \tau M) = 0$. If moreover M is basic and $|M| = |A|$ (where $|M|$ is the number of non-isomorphic indecomposable summands of M), then M is called a *τ-tilting module*. If there exist an idempotent e in A such that M is an A/e-module and $|M| = |A/e|$, then M is called a *support τ-tilting module*.

We note that there is a bijective correspondence between the set of functorially finite torsion classes in $\mathrm{mod}\, A$ and the set of isomorphism classes of support τ-tilting A-modules. In particular, τ-tilting modules are a generalization of tilting modules.

In this talk I will introduce an analog of 2-Calabi-Yau reduction in terms of support τ-tilting modules: Given a τ-rigid A-module U, it is known that U has a Bongartz-type completion, *i.e.* there exist a τ-tilting module T which has U as a direct summand. Then, there is a bijection between the set of isomorphism classes of support τ-tilting A-modules which have U as a direct summand and the set of isomorphism classes of all support τ-tilting modules over the factor τ-tilted algebra $\mathrm{End}_A(T)/e_U$, where e_U is the idempotent in $\mathrm{End}_A(T)$ corresponding to U.

The content of this talk is part of my ongoing doctoral research under the advise of Prof. O. Iyama.

Alicja Jaworska (Nicolaus Copernicus University, Toruń, Poland)
Tilted algebras and short chains of modules

This is a report on a joint work with P. Malicki and A. Skowroński.

Let A be an artin algebra over a commutative artin ring R, $\operatorname{mod} A$ the category of finitely generated right A-modules and $\tau_A = \mathrm{DTr}$ the Auslander-Reiten translation in $\operatorname{mod} A$. Recall that a short chain of A-modules is a sequence $X \to M \to \tau_A X$ of nonzero homomorphisms in $\operatorname{mod} A$ with X being indecomposable, and then M is called the middle of this short chain.

The question if a tilted artin algebra can be characterized by the existence of a sincere finitely generated module which is not the middle of a short chain was raised nearly twenty years ago by I. Reiten, A. Skowroński and S. O. Smalø. We will show that the answer for this question is affirmative. Moreover, using injective and tilting modules over hereditary artin algebras, we will give a complete description of all finitely generated modules which are not the middle of a short chain in a module category $\operatorname{mod} A$.

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Yong Jiang (Universität Bielefeld, Bielefeld, Germany)
The crystal structure on MV-polytopes and representations of preprojective algebras

The set of Mirković-Vilonen polytopes can be endowed with a crystal structure isomorphic to that of the crystal basis of quantum groups. However, the action of Kashiwara operators has not been explicitly described. Anderson and Mirković gave a conjectural description, known as the AM-conjecture. Kamnitzer has proved the conjecture in type A. He also gave a counterexample in type C. Later a modified version of the conjecture in types B and C was proved by Naito and Sagaki. Up to now not much is known for other types.

We study this problem via the connections between MV-polytopes and representations of preprojective algebras, which was developed by Baumann and Kamnitzer. For types ADE we can show that part of the AM-conjecture is always true. answering an open problem of Kamnitzer in 2007. Moreover, for any polytope which is sufficiently far away from the extremal point in a j-string, the full part of the AM-conjecture holds.

Daniel Joo (Central European University, Budapest, Hungary)
Toric moduli spaces of quivers

Representations of a quiver with a fixed dimension vector are parametrized by a vector space on which we have the action of a product of general linear groups, such that orbits consist of isomorphic representations. It has been the aim of several works to describe the cases when the affine quotient variety under this action has certain good properties (for ex. smoothness, complete intersection). If we fix the dimension vector to be $(1, ..., 1)$ the affine quotients are toric varieties. I will present my results from [2] which mainly concern this special case. I will show an algorithmic method to decide if a quiver setting (with dimension vector $(1, ..., 1)$) has the complete intersection property. I will show that this class can be also described in a fashion similar to forbidden minors from graph theory. Furthermore it turns out that this second approach can be used to describe smooth quiver settings with arbitrary dimension vectors as well.

I will also present some combinatorial problems that arise from studying the GIT moduli spaces of quivers with dimension vector $(1, ..., 1)$. I will show an important conjecture towards understanding these moduli spaces which turn out to be equivalent to a conjecture of Diaconis and Erikkson [1].

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David Jorgensen (University of Texas at Arlington, Arlington, Texas, United States)
Triangulated defect categories

Inspired by the work of Buchweitz, we define for any additive category $\mathcal{P}$ a fully faithful triangle functor from the homotopy category of “totally acyclic” complexes in $\mathcal{P}$ to an analogue of the stable derived category, namely the Verdier quotient of the homotopy category of the right bounded “eventually acyclic” complexes in $\mathcal{P}$ modulo the homotopy category of bounded complexes in $\mathcal{P}$. Given a triangulated subcategory $\mathcal{C}$ of the homotopy category of totally acyclic complexes in $\mathcal{P}$, we consider the thick closure of the image of $\mathcal{C}$, and call the corresponding Verdier quotient the *defect category* of $\mathcal{C}$.

One application is where $\mathcal{P}$ is the category of finitely generated projective modules over a commutative local ring, or a finite dimensional algebra. In this case the defect category of the full homotopy category of totally acyclic complexes in $\mathcal{P}$ we call the *Gorenstein defect category*; it’s triviality is a triangulated categorical reformulation of the Auslander-Bridger characterization of Gorenstein rings as those rings over which all finitely generated modules have finite Gorenstein dimension.

Another application is when $\mathcal{C}$ is the subcategory consisting of totally acyclic complexes of finitely generated free modules and of finite complexity over a commutative local ring A. Here the defect category describes the failure of A to be a complete intersection.

The dimension (in the sense of Rouquier) of the defect category thus gives a measure of how close the ring is to being Gorenstein, respectively, a complete intersection.

This is based on joint work with Petter Bergh and Steffen Oppermann.

Martin Kalck (Bonn University, Bonn, Germany)
Relative Singularity Categories

In [1], we studied the *relative singularity category* $\Delta_S(A) := \mathcal{D}^b(\mathsf{mod}\,A)/K^b(\mathsf{proj}\,S)$ associated with a non-commutative resolution $A = \mathsf{End}_S(S \oplus M)$ (i.e. $\mathsf{gldim}(A) < \infty$ and $M \in \mathsf{MCM}(S)$) of a (complete isolated) Gorenstein singularity S. This category has a lot of interesting properties, e.g. it admits a dg description [Thanhoffer de Völcsey & Van den Bergh, 2], it is a Hom-finite category [TV, 2], it yields a generalized cluster category description of $\underline{\mathsf{MCM}}(T)$, where T is a 3-dimensional Gorenstein quotient singularity [TV]. Moreover, it is related to the classical singularity category of Buchweitz and Orlov:

Theorem ([2]) The *singularity category* $\mathcal{D}_{sg}(S) := \mathcal{D}^b(\mathsf{mod}\,S)/\mathsf{Perf}(S)$ of S is uniquely determined by the relative singularity category $\Delta_S(A)$. Conversely, $\mathcal{D}_{sg}(S)$ determines $\Delta_S(A)$ if S is MCM-finite and $A = \mathsf{Aus}(\mathsf{MCM}(S))$ denotes the *Auslander algebra*.

The technique developed in [2], led to the following "purely commutative" result:

Theorem (Iyama–Kalck–Wemyss–Yang) Let R be a complete rational surface singularity and $\mathsf{SCM}(R)$ be the Frobenius category of special Cohen–Macaulay modules defined by Iyama & Wemyss. Then $\underline{\underline{\mathsf{SCM}}}(R) \xrightarrow{\cong} \mathcal{D}_{sg}(X) \cong \bigoplus_{x \in \mathsf{Sing}(X)} \underline{\mathsf{MCM}}(\widehat{\mathcal{O}}_x)$, where X is the rational double point resolution of $\mathsf{Spec}(R)$ studied by Artin and Lipman.

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Noritsugu Kameyama (Shinshu, Nagano, Japan)
Constructions of Auslander-Gorenstein local rings

Auslander-Gorenstein rings appear in various areas of current research. For instance, regular 3-dimensional algebras of type A in the sense of Artin and Schelter, Weyl algebras over fields of characteristic zero, enveloping algebras of finite dimensional Lie algebras and Sklyanin algebras are Auslander-Gorenstein rings (see [1]). However, little is known about constructions of Auslander-Gorenstein rings. It was shown in [2] that a left and right noetherian ring is an Auslander-Gorenstein ring if it admits an Auslander-Gorenstein resolution over another Auslander-Gorenstein ring. In this note, generalizing the notion of crossed product, we will provide systematic constructions of Auslander-Gorenstein local rings starting from an arbitrary Auslander-Gorenstein local ring.

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Ryo Kanda (Nagoya University, Nagoya, Japan)

Classifying Serre subcategories via atom spectrum

A full subcategory of an abelian category is called a *Serre subcategory* if it is closed under subobjects, quotient objects, and extensions. The following theorem is a basic result on classifying Serre subcategories:

Theorem 1 (Gabriel [G62]) *Let R be a commutative noetherian ring. Then there exists a one-to-one correspondence between Serre subcategories of the category* $\operatorname{mod} R$ *of finitely generated right R-modules and specialization-closed subsets of* $\operatorname{Spec} R$.

We introduce the atom spectrum of an abelian category as a topological space consisting of all the equivalence classes of monoform objects. In terms of the atom spectrum, we give a classification of Serre subcategories of an arbitrary noetherian abelian category:

Theorem 2 ([K]) *Let $\mathcal{A}$ be a noetherian abelian category. Then there exists a one-to-one correspondence between Serre subcategories of $\mathcal{A}$ and open subsets of the atom spectrum of $\mathcal{A}$.*

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Maciej Karpicz (Nicolaus Copernicus University, Toruń, Poland)

On selfinjective artin algebras without short cycles in the component quiver

Let A be a selfinjective artin algebra of infinite representation type, $\operatorname{mod} A$ the category of finitely generated right A-modules and Γ_A the Auslander-Reiten quiver of A. Recall that a component $\mathcal{C}$ of Γ_A is called *generalized standard* if $\operatorname{rad}_A^\infty(X, Y) = 0$ for all modules X and Y in $\mathcal{C}$. Following [3], the *component quiver* Σ_A of an algebra A has the components of Γ_A as the vertices and two components $\mathcal{C}$ and $\mathcal{D}$ are linked in Σ_A by an arrow $\mathcal{C} \to \mathcal{D}$ if $\operatorname{rad}_A^\infty(X, Y) \neq 0$ for some modules X in $\mathcal{C}$ and Y in $\mathcal{D}$. In particular, a component $\mathcal{C}$ in Γ_A is generalized standard if Σ_A has no loop in $\mathcal{C}$.

The aim of the talk is to present a complete description of the basic, connected selfinjective artin algebras of infinite representation type without short cycles in the component quiver in terms of orbit algebras of repetitive algebras of tilted algebras of Euclidean type or tubular algebras.

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Stanisław Kasjan (Nicolaus Copernicus University, Toruń, Poland)
Representation-finite algebras over algebraically closed fields form open $\mathbb{Z}$-schemes

Let V be a valuation ring in an algebraically closed field K with the residue field R. Given a V-order A we denote by $\overline{A}$ the R-algebra obtained from A by reduction modulo the radical of V and $KA = A \otimes_V K$. We prove that if the R-algebra $\overline{A}$ is representation-finite then the K-algebra KA is representation-finite. An application of van den Dries's test yields that the representation-finite algebras of fixed dimension d over algebraically closed fields form an open $\mathbb{Z}$-subscheme of the scheme of the d-dimensional associative algebras.

Dawid Kedzierski (Szczecin Uniwersity, Szczecin, Poland)
Matrix factorisation for domestic singularities

This is a report on joint work with Helmut Lenzing and Hagen Meltzer. In the last years stabilized vector bundle categories are more and more important in modern algebra.

Let k be a field and $R = k[X, Y, Z]/\langle f\rangle$ a canonical algebra of domestic type. We consider the category $\operatorname{vect}\mathbb{X}$ where $\mathbb{X}$ is the weighted projective line associated to R. In this situation the stabilized category $\underline{\operatorname{vect}}\,\mathbb{X}$ is equivalent to the stabilized category of Cohen-Macaulay modules over R and to the derived category of the singularity R. We describe matrix factorisations for all indecomposable objects Z in $\underline{\operatorname{vect}}\,\mathbb{X}$. For this we calculate injective hulls and projective covers for these Z.

Bernhard Keller (Institut de mathématiques de Jussieu, Paris, France)
On tropical friezes (after Lingyan Guo)

Tropical friezes are certain integer-valued functions on cluster categories. They are related to (but different from) the cluster-additive functions introduced by C. M. Ringel. They can also be interpreted as points of Fock-Goncharov's tropical A-variety, which is conjectured to parametrize a basis in the space of functions on the (non tropical) Y-variety. In her thesis, Lingyan Guo has obtained a representation-theoretic construction of all tropical friezes on the cluster category of a Dynkin quiver and proved a conjecture by Ringel on cluster-additive functions. I will report on her work.

Otto Kerner (Heinrich-Heine-Universitaet, Düsseldorf, Germany)
Regular modules over wild hereditary algebras

Let K be some field and $H = KQ$ a finite dimensional connected wild hereditary path algebra. If $\mathcal{C}$ is a component in the Auslander-Reiten quiver $\Gamma(H)$ of H and $U \in \mathcal{C}$ is indecomposable, $(\to U)$ denotes the set of predecessors of U in $\mathcal{C}$. The Auslander-Reiten translation is denoted by τ.

Theorem. *Let U be a quasisimple regular H-module. If Y is an indecomposable regular H-module, then $\tau^{-m}Y$ generates $(\to U)$ for $m \gg 0$.*

This answers a question of Claus Ringel, motivated by properties of the Gabriel-Roiter measure.

Mayumi Kimura (Shizuoka University, Shizuoka, Japan)
Derived equivalence classification of generalized multifold extensions of piecewise hereditary algebras of tree type

This is a joint work with H. Asashiba. Let $\Bbbk$ be an algebraically closed field. All algebras are assumed to be basic finite-dimensional $\Bbbk$-algebras. An algebra A is called piecewise hereditary of tree type if it is derived equivalent to a hereditary algebra whose quiver is an oriented tree. A generalized multifold extension of A is a category of the form $\hat{A}/\langle\phi\rangle$ for some automorphism ϕ of the repetitive category $\hat{A}$ having a *jump* $n \in \mathbb{Z}$,i.e., ϕ sends the 0-part $A^{[0]}$ to n-part $A^{[n]}$. We give a derived equivalence classification of generalized multifold extensions of piecewise hereditary algebras of tree type. This generalizes the main result of [Asashiba, H.: Derived and stable equivalence classification of twisted multifold extensions of piecewise hereditary algebras of tree type, J. Algebra 249 (2002), no. 2, 345–376.] Our results are summerized as follows.

Theorem 1. *Let A be a piecewise hereditary algebra of tree type and $n \in \mathbb{Z}$. Then any generalized n-fold extension $\hat{A}/\langle\phi\rangle$ of A (ϕ an automorphism of $\hat{A}$ having a jump n) is derived equivalent to a twisted n-fold extension $T^n_{\phi_0}(A)$ of A.*

Theorem 2. *Let Λ, Λ' be generalized multifold extensions of piecewise hereditary algebras of tree type. Then the following are equivalent.*

(1) Λ *and* Λ' *are derived equivalent;*
(2) Λ *and* Λ' *are stably equivalent;*
(3) $\mathrm{type}(\Lambda) = \mathrm{type}(\Lambda')$.

Yoshiyuki Kimura (Osaka City University, Osaka, Japan)
Graded quiver varieties and dual canonical basis

This is a joint work with Fan Qin (Jussieu, Paris, France). Let $A_v(\mathfrak{n}(w))$ be the quantum coordinate ring of unipotent subgroup associated with a Weyl group element w of symmetric Kac-Moody Lie algebra $\mathfrak{g}$. It is shown that $A_v(\mathfrak{n}(w))$ has the dual canonical basis which is compatible with Kashiwara-Lusztig's dual canonical basis in [2]. Geiss-Leclerc-Schröer [1] have shown that $A_v(\mathfrak{n}(w))$ has a structure of quantum cluster algebra which is induced by the preprojective algebra Λ. It is conjectured that the dual canonical basis of $A_v(\mathfrak{n}(w))$ contains the quantum cluster monomial of that. Let Q be an acyclic quiver, c_Q be the corresponding acyclic Coxeter word and $w = c_Q^2$ with $\ell(w) = 2|Q_0|$. In [3], we identify the (twisted) quantum Grothendieck ring of the corresponding graded quiver variety and $A_v(\mathfrak{n}(c_Q^2))$ and identify the basis of simple perverse sheaves with the dual canonical basis. Using this isomorphism, it can be shown that the set of quantum cluster monomials is contained in the dual canonical basis of $A_v(\mathfrak{n}(c_Q^2))$.

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Ryan Kinser (Northeastern University, Boston, MA, United States)
Module varieties with dense orbits in every component

Given a finite-dimensional algebra A, the set of A-modules of a fixed dimension d can be viewed as a variety. This variety carries a group action whose orbits correspond to isomorphism classes of A-modules. A natural problem is to relate representation theoretic properties of an algebra to its module varieties.

Our work is motivated by a straightforward observation for algebras of global dimension one: such an A is of finite representation type if and only if all of its module varieties have a dense orbit, which is also if and only if all weight spaces of semi-invariants in the coordinate rings of its module varieties have dimension one. Our goal is to generalize these statements to higher global dimension.

In the talk we present counterexamples to the naive generalizations, along with plausible modifications and a summary of cases where the modified conjectures are proven correct. This leads to a new class of algebras that are representation infinite but still admit classification of "generic" modules by geometric methods. This is joint work with Calin Chindris and Jerzy Weyman.

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Mark Kleiner (Syracuse University, Syracuse, New York, United States)
Adjoint functors in representation theory of partially ordered sets

Let S be a finite partially ordered set (poset) consisting of n elements, let k be a field, and let kS be the incidence algebra. We denote by S-sp the category of S-spaces over k introduced by Gabriel; an S-space is a homomorphism of the poset S into the poset of subspaces of a finite dimensional k-vector space V. If R is a subposet of S, the natural restriction functor $\mathrm{res}_R^S : S\text{-sp} \to R\text{-sp}$ has both a left adjoint ind_R^S and a right adjoint coind_R^S. In a recent joint paper with Markus Reitenbach we expressed several differentiation algorithms for the categories of S-spaces as composites of some of the above functors with two other, very simple, functors.

Let $\mathrm{rep}\, S$ be the category of representations of S over k originally introduced by Nazarova and Roiter. If S^ω is the enlargement of S by a unique maximal element ω, denote by kS^ω-mod the category of finitely generated left kS^ω-modules. Let Λ be the path algebra over k of the star quiver with one sink and n sources; Λ is a subalgebra of kS^ω. Then $\mathrm{rep}\, S$ is equivalent to the full subcategory of kS^ω-mod determined by the induced modules of the form $kS^\omega \otimes_\Lambda X,\ X \in \Lambda\text{-mod}$.

The category $\mathrm{rep}\, S$ contains S-sp as a full subcategory. Although the definition of $\mathrm{rep}\, S$ is not as elegant as that of S-sp, the former category has several advantages versus the latter. In particular, since the category of induced modules makes sense for any algebra with a subalgebra, one hopes to extend properties of $\mathrm{rep}\, S$ to more general settings. We show how to construct the adjoint functors res_R^S, ind_R^S, and coind_R^S for the categories $\mathrm{rep}\, S$ and how to use them to express the relevant differentiation algorithms.

Hirotaka Koga (University of Tsukuba, Ibaraki, Japan)
Semi-tilting modules and mutation

In this talk, based on [1], we introduce the notion of semi-tilting modules and show that the class of basic semi-tilting modules is closed under mutation. Using this, we provide a partial answer to the Wakamatsu tilting conjecture. Let R be a commutative noetherian complete local ring and A a noetherian R-algebra. A module

$T \in \text{mod-}A$ is said to be a semi-tilting module if the following conditions are satisfied: (1) $\text{Ext}^i_A(T,T) = 0$ for $i \neq 0$; (2) A admits a right resolution $A \to T^\bullet$ in mod-A with $T^\bullet \in \mathcal{K}^{\text{b}}(\text{add}(T))$. We show that for a basic semi-tilting module $T = U \oplus X \in \text{mod-}A$ with X indecomposable, if X is generated by U then there exists a non-split exact sequence $0 \to Y \to E \to X \to 0$ in mod-A with Y indecomposable, $E \in \text{add}(U)$ and $\mu_X(T) = U \oplus Y$ a semi-tilting module. We define a quiver K as follows: The vertices of K are isomorphism classes of basic semi-tilting modules and there is an arrow $V \to W$ if W and V are represented by basic semi-tilting modules T' and $\mu_{X'}(T')$ with X' a non-projective indecomposable direct summand of T', respectively. We show that if the connected component of K including a semi-tilting module T contains a tilting module then T itself is a tilting module.

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Masahide Konishi (Nagoya Univ., Nagoya, Japan)
Level 1 cyclotomic KLR algebras of cyclic quivers

This talk is based on my master thesis. A Khovanov-Lauda-Rouquier algebra is defined by a quiver Γ and a weight α on its vertices. We fix Γ cyclic quiver with n vertices and give an another weight Λ on its vertices, then we get a cyclotomic quiver Hecke algebra as a quotiont of the KLR algebra by an ideal which is determined by Λ. In this talk, we fix both α and Λ, then we can see systematic changes of structures of cyclotomic quiver Hecke algebras for n from diagrammatic approach.

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Justyna Kosakowska (Nicolaus Copernicus University, Torun, Poland)
Operations on arc diagrams and degenerations for invariant subspaces of linear operators

We study geometric properties of varieties associated with invariant subspaces of nilpotent operators. There are reductive algebraic groups acting on these varieties. We give dimensions of orbits of these actions. Moreover, a combinatorial characterization of the partial order given by degenerations is described. This is a report about a joint project with Markus Schmidmeier from FAU.

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Matthias Krebs (University of East Anglia, Norwich, United Kingdom)
Auslander-Reiten-quivers of functorially finite resolving subcategories

Let $K = \overline{K}$ and let A be a finite-dimensional associative K-algebra with an identity element 1_A. Since Auslander-Reiten-quivers of A-mod have been introduced in [1] the natural question arose if there are criteria on the Auslander-Reiten-quiver of A-mod for A to be representation finite. It has been shown that the Auslander-Reiten-quiver of an indecomposable algebra contains a finite component if and only if A is representation finite [2]. Another answer was given for selfinjective algebras which are representation finite if and only if the tree types of the stable components are Dynkin Diagrams [3].

I will present similar results for the Auslander-Reiten-quiver of a functorially finite resolving subcategory Ω. We will see that Brauer-Thrall 1 and Brauer-Thrall 1.5 can be proved for these categories with only little extra effort. Moreover, a connection between sectional paths in A-mod and irreducible morphisms in Ω will be given. Finally, I will show how one can generalize Riedtmann's result to all Auslander-Reiten-quivers of A-mod or Ω with a notion similar to the tree type that coincides in a finite stable component.

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Julian Külshammer (University of Kiel, Kiel, Germany)
Representation type and Auslander-Reiten theory of Frobenius-Lusztig kernels

Let G be a reductive algebraic group over an algebraically closed field of positive characteristic. Frobenius-Lusztig kernels are a class of finite-dimensional non-commutative, non-cocommutative Hopf algebras. They have the small quantum group, a quantum analogue of the restricted enveloping algebra, as a normal Hopf subalgebra with quotient the algebra of distributions of G_r. In this talk we determine the representation type of and obtain results about the Auslander-Reiten theory of Frobenius-Lusztig kernels. Our Methods involve support varieties, quivers and special properties of the extensions mentioned above. We prove:

Theorem. Representation-finite blocks are simple and tame blocks only occur for small r if $\mathfrak{g} = \mathfrak{sl}_2$. The Auslander-Reiten components arise from infinite Dynkin diagrams.

As an application, we obtain information on the shape of the projective modules.

Dirk Kussin (University of Verona, Verona, Italy)
Large tilting modules over tubular algebras

This is on joint work with Lidia Angeleri Hügel. We consider the problem of classifying the large (infinite-dimensional) tilting modules over a canonical algebra. This is strongly related to solving the analogous problem for quasicoherent sheaves over the corresponding weighted projective line. The focus of the presentation will be on the *tubular* case. Here we show that

- there exists a large tilting object of every given slope $w \in \mathbb{R} \cup \{\infty\}$;
- there is a classification of all large tilting objects T of a given slope (up to their tilting classes $\mathrm{Gen}(T)$).

Daniel Labardini (Universität Bonn, Bonn, Germany)
Potentials from triangulations of surfaces: Old and new

The quivers with potentials associated to triangulations of surfaces have had important, if surprising, appearances in Mathematics and in Physics, with the compatibility between flips and QP-mutations playing a central role. In this talk I will give an overview of recent and not-so-recent results concerning the alluded QPs, with an emphasis in the very recently proved “Popping Theorem”, a useful tool for dealing with empty-boundary surfaces.

Magdalini Lada (NTNU, Trondheim, Norway)
A finite set of equations for Bongartz resolutions

Let $\Lambda = kQ/I$, where kQ is the path algebra of a finite quiver Q, over a field k, and I an admissible ideal. We show that there is a finite set of equations involving the right Gröbner basis of I which, starting with a projective presentation over kQ, algorithmically determine the projective (Bongartz) resolution for any finitely generated Λ-module. As an application we sketch a new proof of the finitistic conjecture for monomial algebras.

Sefi Ladkani (University of Bonn, Bonn, Germany)
On Jacobian algebras from closed surfaces

Labardini-Fragoso associated a quiver with potential to any ideal triangulation of a surface with marked points in such a way that flips of triangulations correspond to mutations of the associated quivers with potentials, thus providing a link between the work of Fomin, Shapiro and Thurston on cluster algebras arising from marked surfaces and the theory of quivers with potentials initiated by Derksen, Weyman and Zelevinsky.

We show that the quivers with potentials associated to ideal triangulations of marked surfaces with empty boundary are not rigid, and their (completed) Jacobian algebras are finite-dimensional and symmetric. This settles a question that has been open for some time and also provides an explicit construction of infinitely many families of symmetric, finite-dimensional Jacobian algebras. As a consequence we can associate a Hom-finite cluster category to any marked surface with empty boundary in a similar way to the case of non-empty boundary. Our proofs are based on a combinatorial model for the quivers with potentials.

In addition, we prove in a more general setting that for any mutation of a quiver with potential (without 2-cycles) whose Jacobian algebra is (weakly) symmetric, the resulting Jacobian algebra is always derived equivalent to the original one. As an application, we deduce that all the Jacobian algebras associated to the ideal triangulations of a given surface with marked points and empty boundary are derived equivalent. Further applications will be presented in the talk.

Part of the talk is based on `arXiv:1207.3778`.

Philipp Lampe (University of Bielefeld, Bielefeld, Germany)
Cluster algebras from a ring theoretic point of view

A very important role in the representation theory of finite dimensional algebras is played by *cluster algebras.* The talk gives a ring theoretic perspective on cluster algebras. Geiß-Leclerc-Schröer prove that all cluster variables in a cluster algebra are irreducible elements. Furthermore, they provide two necessary conditions for a cluster algebra to be a unique factorization domain, namely the irreducibility and the coprimality of the initial exchange polynomials.

We present a sufficient condition for a cluster algebra to be a unique factorization domain in terms of primary decompositions of certain ideals generated by initial cluster variables and initial exchange polynomials. As an application, the criterion enables us to decide which coefficient-free cluster algebras of Dynkin type are unique factorization domains. Moreover, it yields a normal form for irreducible elements in cluster algebras that satisfy the condition. The talk also sketches our proof which uses Gröbner basis arguments.

In addition, we state a conjecture about the range of application of the criterion.

Helmut Lenzing (Universität Paderborn, Paderborn, Germany)
The E-series, Happel-Seidel symmetry, and Orlov's theorem

This talk is on joint work with de J.A. de la Peña. Let $A_n(r)$ be the Nakayama algebra obtained by endowing the equioriented A_n-quiver with all nilpotency relations of degree r, and let $\mathcal{T}_n(r)$ denote the bounded derived category of $A_n(r)$. For fixed r, the categories $\mathcal{T}_n(r)$ form a tower of triangulated categories while there is no good relationship between the $\mathcal{T}_n(r)$ for fixed n. As was first observed by Happel and Seidel, the system of categories $\mathcal{T}_n(r)$ satisfies an interesting 'symmetry', if one restricts to the piecewise hereditary ones. Based on work with Kussin and Meltzer we establish this 'symmetry' in general, by relating it to singularity theory.

Of particular interest is the case $r = 3$, yielding the E-series, or E-tower, specializing for $n = 6, 7, 8$ to the derived categories of the Dynkin quivers of type E_6, E_7 and E_8. We provide a complete spectral analysis for the members of this series, showing in particular, that their Coxeter polynomials always factor into cyclotomics. We determine — if finite — their Coxeter numbers (=period of the Coxeter transformation) and identify, whenever possible, related graded singularities having $\mathcal{T}_n(r)$ as its singularity category.

Fang Li (Zhejiang University, Hangzhou, Zhejiang, China)
Topological study of cluster quivers of finite mutation type

We study the distribution of the genuses of cluster quivers of finite mutation type. First, we prove that in the 11 exceptional cases, the distribution of genuses is 0 or 1. Next, we consider the relationship between the genus of an oriented surface and that of cluster quivers from this surface. It is verified that the genus of an oriented surface is an upper bound for the genuses of cluster quivers from this surface. Furthermore, for any non-negative integer n, we show that there always exists an oriented surface with genus n and an ideal triangulation of the surface with punctures such that the corresponding cluster quiver from this triangulation is just of genus n. Finally, we give a complete classification of reduced skeleton quivers of K_5 and $K_{3,3}$ types, which implies the analogue of Kuratowski's theorem for cluster quivers from surface.

This is joint work with Jichun Liu and Yichao Yang.

Kay Jin Lim (National University of Singapore, Singapore, Singapore)
Lie powers and Lie modules

We discuss some properties of Lie powers and Lie modules. For Lie powers, we present the decomposition formula due to Bryant and Schocker. For Lie modules in the modular case, we explain their block components and complexities.

Yu Liu (Nagoya University, Nagoya, Japan)
Quotients of exact categories by cluster tilting subcategories as module categories

The quotient category of a Frobenius category by a cluster tilting subcategory is abelian by a result of Koenig-Zhu and a classical result by Happel.

We generalize this result to non necessarily Frobenius exact categories by an n-cluster tilting subcategory $\mathcal{M}$. More precisely,

Theorem 1 *Let $\mathcal{B}$ be an exact category with enough projectives and injectives.*

1. *If $\mathcal{M}$ is a 2-cluster tilting subcategory of $\mathcal{B}$, then $\mathcal{B}/[\mathcal{M}] \simeq \operatorname{mod} \underline{\mathcal{M}}$.*
2. *If $\mathcal{M}$ is an n-cluster tilting subcategory of $\mathcal{B}$, then ${}^{\perp_{n-2}}\mathcal{M}/[\mathcal{M}] \simeq \operatorname{mod} \underline{\mathcal{M}}$ where ${}^{\perp_{n-2}}\mathcal{M} = \{X \in \mathcal{B} \,|\, \forall i \in \{1, \ldots, n-2\}, \operatorname{Ext}^i_{\mathcal{B}}(X, \mathcal{M}) = 0\}$.*
3. *If $\mathcal{M}$ is a rigid subcategory of $\mathcal{B}$, then $\mathcal{M}_L \simeq \operatorname{mod} \underline{\mathcal{M}}$ where $\mathcal{M}_L = \{X \in \mathcal{B} \,|\, X$ admits a left 2-resolution by $\mathcal{M}\}$.*

Moreover, if $\mathcal{B}$ admits a $(n-1)$-AR translation τ_{n-1}, we can embed the second equivalence in a commutative diagram of equivalences of categories

$$\begin{array}{ccc} {}^{\perp_{n-2}}\mathcal{M}/[\mathcal{M}] & \longrightarrow & \operatorname{mod} \underline{\mathcal{M}} \\ \downarrow{\scriptstyle \tau_{n-1}} & & \downarrow \\ \mathcal{M}^{\perp_{n-2}}/[\Omega' \mathcal{M}] & \longrightarrow & \operatorname{mod} \overline{\mathcal{M}} \end{array}$$

where Ω' is the cosyzygy.

Xueyu Luo (Nagoya University, Nagoya, Japan)
Realizing Cluster Categories of Dynkin type A_n as Stable Categories of Lattices

We have already known that the cluster category $\mathcal{C}$ of Dynkin type A_n has some tight connections with triangulations of a regular polygon P with $n+3$ vertices by non-crossing diagonals. Given a triangulation of P, we associate a quiver with potential such that the associated Jacobian algebra has the structure of a $K[\![x]\!]$-order denoted as Λ_{n+3}, where $K[\![x]\!]$ is a formal power series ring over a field K. Then we show that $\mathcal{C}$ is equivalent to the stable category of the category of Λ_{n+3}-lattices.

This is my recent research under the guidance of my supervisor Prof. Iyama for my ongoing PhD program.

Dag Oskar Madsen (University of Nordland, Bodø, Norway)
On the category of modules with Δ-filtration

Let B be a quasi-hereditary algebra and let $\mathcal{F}(\Delta)$ denote the category of B-modules with filtration in standard modules. According to the references below, there is a finite dimensional algebra A and an exact functor $F\colon \operatorname{mod} A \to \operatorname{mod} B$ sending simple A-modules to standard B-modules and with the additional property that $F\colon \operatorname{mod} A \to \mathcal{F}(\Delta)$ is dense. In ongoing work with Vanessa Miemietz our aim is to find a concrete description of such an algebra A and functor F. The talk will mainly be based on examples.

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Nils Mahrt (Universitaet Bielefeld, Bielefeld, Germany)
Exceptional components of wild hereditary algebras

For a wild acyclic quiver Q, Kerner introduced the notion of exceptional components for the Auslander-Reiten quiver of Q over an algebraically closed field k. He then defined two invariants of these exceptional components and asked whether these two invariants coincide. Each exceptional component is related to a hereditary factor algebra B of the path algebra kQ. He then proved that B is tame or representation finite and asked whether the representation finite case does occur at all. We will answer both of Kerner's questions.

Piotr Malicki (Nicolaus Copernicus University, Toruń, Poland)
Module categories with heart

This is report on joint work with A. Jaworska and A. Skowroński.

Let A be an artin algebra, Γ_A the Auslander-Reiten quiver of A, $\operatorname{mod} A$ the category of finite generated right A-modules and $\operatorname{ind} A$ the full subcategory of $\operatorname{mod} A$ consisting

of indecomposable modules. Recall that a family $\mathcal{C} = (\mathcal{C}_i)_{i\in I}$ of components in Γ_A is called *generalized standard* if the restriction of the infinite Jacobson radical of mod A to $\mathcal{C}$ is zero. Moreover, a family $\mathcal{C}$ is called *sincere* if every simple module in mod A occurs as a composition factor of a module in $\mathcal{C}$.
A family $\mathcal{H} = (\mathcal{H}_i)_{i\in I}$ of components in Γ_A is said to be a *heart* of mod A if the following conditions are satisfied:

(H1) $\mathcal{H}$ is sincere and generalized standard;

(H2) $\mathcal{H}$ has no external short paths in ind A.

A short path $X \to Y \to Z$ in ind A is *external* for $\mathcal{H}$ if $X, Z \in \mathcal{H}$ but $Y \notin \mathcal{H}$.
The aim of the talk is to describe the structure and homological properties of module categories having hearts.

Andrei Marcus (Babes-Bolyai University, Cluj-Napoca, Romania)
Brauer-Clifford groups and equivariant derived equivalences

Let G be a finite group, Z a commutative simple G-ring, and let K be the field Z^G of G-invariant elements of Z. Turull [4] introduced an equivalence relation between central simple G-algebras with fixed center Z (refining a previous notion of equivalence over K), and showed that the set of equivalence classes form a group $\mathrm{BrCliff}(G, Z)$. Moreover, if χ is an irreducible character of G and N is a normal subgroup of G then Turull associates to χ a commutative G-ring Z and a class $[[\chi]] \in \mathrm{BrCliff}(G/N, Z)$.

In this talk we discuss Brauer-Clifford classes in terms of graded Morita equivalences. We then show that characters corresponding under certain graded derived equivalences have the same Brauer-Clifford classes. Such equivalences occur in the context of blocks with cyclic defect groups or of the Glauberman correspondence.

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Alex Martsinkovsky (Northeastern University, Boston, MA, United States)
Is there stable homology?

Tate cohomology was defined around 1950. While the original definition was intended for group cohomology only, it soon became clear that it can be generalized to wider classes of algebras. In the mid-1980s, Pierre Vogel gave a definition that worked over any ring. Around the same time, Buchweitz came up with another generalization that also worked over any ring and produced a cohomology theory isomorphic to that of Vogel. Finally, in 1994, Mislin gave yet another construction, which, in a sense, was even more general.

A natural question related to these developments is whether there are homological (vs cohomological) counterparts to these constructions. In the case of Vogel cohomology there is also Vogel homology. In a sense, the two constructions are very similar. For the Mislin approach to cohomology, it is easy to produce a homological counterpart. But there has been no counterpart for the Buchweitz construction, and the purpose of this talk is to propose one. This is done by constructing what we call the asymptotic stabilization of the tensor product.

This is joint work with Jeremy Russell.

Vanessa Miemietz (University of East Anglia, Norwich, United Kingdom)
Cell 2-representations of fiat 2-categories

Motivated by recent success of actions of 2-categories in representation theory (in instances of *categorification*), we define certain 2-categories with good finiteness properties, which we call fiat, and study their 2-representations. In particular, we will discuss cell 2-representations, which satisfy various natural conditions analogous to simpicity for representations of algebras. These are

- the kernel of the cell 2-representation being in some sense maximal;
- under good conditions, the (abelian) cell 2-representation being generated by any simple object;
- under good conditions, the (abelian) cell 2-representation having semi-simple endomorphism category (analogous to Schur's Lemma).

This is joint work with Volodymyr Mazorchuk.

Hiroyuki Minamoto (Nagoya University, Nagoya, Japan)
Derived Gabriel topology, localization and completion of dg-algebras

Gabriel topology is a special class of linear topology on rings, which plays an important role in the theory of localization of (not necessary commutative) rings. Several evidences have suggested that there should be a corresponding notion for dg-algebras. In this talk we will introduce a notion of Gabriel topology on dg-algebras called derived Gabriel topology, and show its basic properties.

We also introduce a notion of derived topological dg-modules over a dg-algebra with a derived Gabriel topology. An important example of derived topology on dg-module is the finite topology on the bi-dual module $\mathbb{R}\mathrm{Hom}_E(\mathbb{R}\mathrm{Hom}_A(M, J), J)$. We show that the bi-dual module is a completion of the module M with respect to J-adic topology. This result is inspired by the result of J. Lambek. However we give a new formulation: the derived bi-duality module is quasi-isomorphic to the homotopy limit of a certain tautological diagram. This is a simple observation, which seems to be true in wider context. However this provide us a fundamental understanding of the derived bi-duality functor.

We give applications. 1. we give a generalization and an intuitive proof of Efimov-Dwyer-Greenlees-Iyenger Theorem which asserts that the completion of commutative ring satisfying some conditions is obtained as a derived bi-commutator. 2. We prove that every smashing localization of dg-category is obtained as a derived bi-commutator of some pure injective module. This is a derived version of the classical results in localization theory of rings.

Yuya Mizuno (Nagoya University, Nagoya, Japan)
A Gabriel-type theorem for cluster tilting

In this talk, we explain Gabriel's theorem [1] from the viewpoint of higher dimensional Auslander-Reiten theory. We call an algebra *n-representation-finite* if its global dimension is at most n and it has an n-cluster tilting module, and we call a Λ-module *cluster-indecomposable* if it is isomorphic to an indecomposable direct summand of an n-cluster tilting module. Then we obtain the following results.

Theorem 1 *Let Λ be an n-representation-finite algebra and q_Λ be the Euler form of Λ.*

(1) For any cluster-indecomposable Λ-module X, the dimension vector $\underline{\dim} X$ is a positive root of q_Λ.

(2) The map $X \mapsto \underline{\dim} X$ gives a injection between the isomorphism classes of cluster-indecomposable Λ-modules and the positive roots of q_Λ.

Note that 1-representation-finite algebras are classified by path algebras of Dynkin quivers and any indecomposable module is cluster-indecomposable in this case. Thus, when $n = 1$, we obtain a part of Gabriel's Theorem. We call the above positive roots *cluster-roots* and investigate the characterization of cluster-roots.

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Izuru Mori (Shizuoka University, Shizuoka, Japan)
McKay type correspondence for AS-regular algebras

The classical McKay correspondence claims that if G is a finite subgroup of $\mathrm{SL}(2,k)$ naturally acting on the polynomial algebra $S = k[x,y]$ in two variables, then the endomorphism algebra $\mathrm{End}_{SG} S$, the skew group algebra $S * G$, and the preprojective algebra ΠQ_G of the McKay quiver Q_G of G are all Morita equivalent, and they are derived equivalent to the minimal resolution of the Kleinian singularity $\mathrm{Spec}\, S^G$. In this talk, we will show that similar statements hold in the noncommutative graded setting if G is a finite cyclic subgroup of $\mathrm{GL}(n,k)$ acting on an AS-regular algebra S, which is a noncommutative analogue of the polynomial algebra in n variables. In this new McKay correspondence, the McKay quiver Q_G is typically not extended Dynkin.

Andrzej Mróz (Nicolaus Copernicus University, Toruń, Poland)
Parametrizatons for integral slope homogeneous modules over tubular canonical algebras

Let Λ be a *tubular canonical algebra* (this class of algebras was introduced and studied by C.M. Ringel). Recall that the direct description of indecomposable Λ-modules in terms of matrix forms is not known up to now and it remains one of the very last important open questions concerning representation theory of Λ. It is known that almost all indecomposables of fixed dimension vector lie in *homogeneous tubes* and the description of modules from these tubes seems to be the most challenging task.

In this talk we give a concrete list of matrix $k[t]-\Lambda$-bimodules parametrizing (by means of a tensor product) all families of indecomposable Λ-modules from homogeneous tubes with a fixed integral *slope* over Λ, for all possible integers. This is joint work with P. Dowbor and H. Meltzer. In the construction we use Geigle-Lenzing approach of studying the category $\mathrm{mod}\,\Lambda$ in terms of *graded coherent sheaves* over the *weighted projective line* $\mathbb{X}$ associated to Λ.

Moreover, these bimodules are used in an algorithm for computing parametrizing bimodules for all homogeneous families of indecomposable Λ-modules (not only for those of integral slope). This algorithm will be presented in Piotr Dowbor's talk.

Intan Muchtadi-Alamsyah (Institut Teknologi Bandung, Bandung, Indonesia)
The p-regular subspaces of symmetric Nakayama algebras and algebras of dihedral and semidihedral type

In this paper we define and determine the p-regular subspace of symmetric Nakayama algebras. We also determine the 2-regular subspaces of algebras of dihedral and semidihedral type with two simple modules. The importance of these calculations is that any block with cyclic defect group is derived equivalent with a symmetric Nakayama algebra and any block with dihedral or semidihedral defect group and two simple modules is derived equivalent to some algebra of dihedral type and semidihedral type respectively.

Alfredo Nájera Chávez (Paris Diderot - Paris 7, Paris, France)
The **c***-vectors of the cluster algebra associated to an acyclic quiver*

In the theory of cluster algebras, a prominent role is played by two families of integer vectors, namely the **c**- and the **g**-vectors. They were first introduced in [2] in order to parameterize (respectively) the coefficients and the cluster variables of a (geometric) cluster algebra. In [3] the authors showed that both families were closely related provided that the **c**-vectors satisfy the *sign-coherence* property, i.e. each **c**-vector has either all its entries nonnegative or all its entries nonpositive. The sign-coherence of the **c**-vectors was proved in [1] for the case of skew- symmetric exchange matrices, using decorated representations of quivers with potentials and for acyclic quivers, the clusters of **c**-vectors were characterized in [4]. We show that the set of positive **c**-vectors associated to an acyclic quiver Q coincides with the set of real Schur roots in the root system associated to Q.

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Hiraku Nakajima (Kyoto University, Kyoto, Japan)
Monoidal categorification, revisited

In my previous 'monoidal categorification of cluster algebras' via perverse sheaves on graded quiver varieties, the definition of a coproduct is missing, except finite type cases. Thus the construction does not give a true monoidal category, though it gives a well-defined multiplication on the quantum Grothendieck group. I explain how to define the true monoidal category.

Kazunori Nakamoto (University of Yamanashi, Yamanashi, Japan)
The moduli of absolutely thick representations

This is a joint work with Y. Omoda (Akashi College of Technology).

Let G be a group. Let V be an n-dimensional vector space over a field k. We say that a representation $\rho : G \to \mathrm{GL}(V)$ is *m-thick* if for any subspaces V_1, V_2 of V with $\dim V_1 = m$ and $\dim V_2 = n - m$ there exists $g \in G$ such that $\rho(g)V_1 \oplus V_2 = V$.

We also say that a representation $\rho : G \to \mathrm{GL}(V)$ is *thick* if ρ is m-thick for each $0 < m < n$. Let $\overline{k}$ be an algebraic closure of k. We say that ρ is *absolutely thick* if $\rho \otimes_k \overline{k}$ is thick.

We show that there exists a moduli scheme over $\mathbb{Z}$ of equivalence classes of absolutely thick representations of any group G.

Hiroyuki Nakaoka (Kagoshima University, Kagoshima, Japan)
Construction of a (pre-)abelian category from a pair of torsion pairs on a triangulated category

Previously, we constructed an abelian category from any torsion pair on a triangulated category, which generalizes the heart of a t-structure and the ideal quotient by a cluster tilting subcategory.

Recently, generalizing the quotient by a cluster tilting subcategory, Buan and Marsh showed that an integral preabelian category can be constructed as a quotient, from a rigid object in a triangulated category with some conditions.

In this time, by considering a pair of torsion pairs, I attempt to make a simultaneous generalization of these two constructions.

Pedro Nicolas (Universidad de Murcia, Murcia, Spain)
Generalized tilting theory

By results of Happel and Rickard in the case of bounded derived categories and the Morita theory of unbounded derived categories developed by Keller, we know that if A is an ordinary algebra, T is a right A-module and $B = \mathrm{End}(T_A)$, then T is a (classical) tilting A-module if, and only if, the functor $? \otimes^L_B T : \mathcal{D}(B) \longrightarrow \mathcal{D}(A)$ (resp. $\mathrm{RHom}_A(T, ?) : \mathcal{D}(A) \longrightarrow \mathcal{D}(B)$) is an equivalence of categories.

It seems natural to weaken the hypotheses on the functors, by requiring only that they be fully faithful, and try to see what sort of modules we do get. Another natural question arises also, namely, the connection of these fully faithful hypotheses with the concept of (infinitely generated) tilting module. A recent result by Bazzoni-Mantese-Tonolo points in this direction and shows that the so-called good tilting modules provide an example where the functors $\mathrm{RHom}_A(T, ?) : \mathcal{D}(\mathcal{A}) \longrightarrow \mathcal{D}(B)$ and $T \otimes^L_A ? : \mathcal{D}(A^{\mathrm{op}}) \longrightarrow \mathcal{D}(B^{\mathrm{op}})$ are fully faithful.

In this series of two talks we tackle the above questions in a much more general setting. We consider the situation where $\mathcal{A}$ and $\mathcal{B}$ are small dg categories and T is a dg $\mathcal{B} - \mathcal{A}-$bimodule and study necessary and sufficient conditions for each of the canonical total derived functors $? \otimes^L_{\mathcal{B}} T : \mathcal{DB} \longrightarrow \mathcal{DA}$ and $\mathrm{RHom}_{\mathcal{A}}(T, ?) : \mathcal{DA} \longrightarrow \mathcal{DB}$ to be fully faithful.

When applied to ordinary algebras, our results will show several nontilting situations where the fully faithful condition holds. This is applied to the study of recollement situations and its connection with recent results in this direction by Yang, Chen-Xi and Bazzoni-Pavarin.

Nils Nornes (NTNU, Trondheim, Norway)
Degenerations of submodules.

Let Λ be a finite-dimensional algebra and let M and N be d-dimensional Λ-modules. Degeneration and virtual degeneration are partial orders on the set of isoclasses of d-dimensional modules. They are defined geometrically, but due to results of Riedtmann and Zwara they can be described algebraically as follows: M *degenerates* to N if and only if there is a short exact sequence

$$0 \to X \to X \oplus M \to N \to 0$$

in $\operatorname{mod}\Lambda$. M *virtually degenerates* to N if there exists $Y \in \operatorname{mod}\Lambda$ such that $M \oplus Y$ degenerates to $N \oplus Y$.

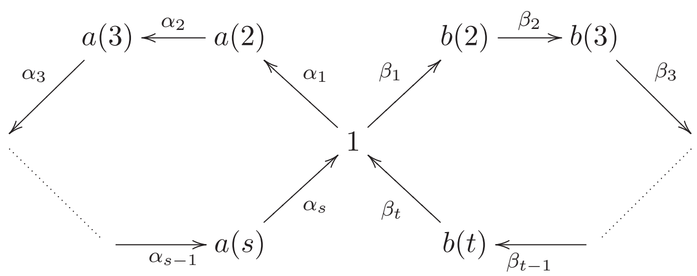
I will show that if M (virtually) degenerates to N, then any submodule $M' \subseteq M$ (virtually) degenerates to a submodule of N.

This is a joint work with Steffen Oppermann.

Daiki Obara (Tokyo University of Science, Tokyo, Japan)
Hochschild cohomology of quiver algebras defined by two cycles and a quantum-like relation

In this talk, we consider the algebra A_q over a field k defined by two cycles and a quantum-like relation depending on a nonzero element q in k.

Let k be a field. For $s, t \geq 1$, let Q be the quiver with $s + t - 1$ vertices $1 = a(1) = b(1), a(2), \dots, a(s), b(2), \dots, b(t)$ and $s + t$ arrows as follows:



Let $a, b \geq 2$, q be a nonzero element in k and let $A_q = kQ/I_q$ where I_q is the ideal of kQ generated by

$$X^{sa}, X^sY^t - qY^tX^s, Y^{tb}$$

for $X := \alpha_1 + \alpha_2 + \cdots + \alpha_s$ and $Y := \beta_1 + \beta_2 + \cdots + \beta_t$.

Gabriela Olteanu (Babes-Bolyai University, Cluj-Napoca, Romania)
Constructing idempotents in group algebras

We present an explicit and character-free construction of a complete set of orthogonal primitive idempotents for a semisimple group algebra of a finite nilpotent group. In all the constructions dealt with, pairs of subgroups (H, K), called strong Shoda pairs (see [OdRS]), and explicit constructed central elements denoted by $e(G, H, K)$ play a crucial role. For arbitrary finite groups we prove that the primitive central idempotents of the rational group algebras are rational linear combinations of such $e(G, H, K)$, with (H, K) strong Shoda pairs in subgroups of G. As an application, we obtain that the unit group of the integral group ring $\mathbb{Z}G$ of a finite nilpotent group G has a subgroup of finite index that is generated by three nilpotent groups for which we have an explicit description of their generators. Another application is a new construction of free subgroups in the unit group.

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Yasuhiro Omoda (Akashi National College of Technology, Akashi, Japan)
On the classification of irreducible representations of special class

This is a report on joint work with K. Nakamoto (University of Yamanashi).

Let G be a group. Let V be a finite dimensional vector space over a field k. A finite dimensional representation $\rho : G \to \mathrm{GL}(V)$ over a field k is irreducible if and only if for any subspaces V_1, V_2 of V with $\dim V_1 = 1$ and $\dim V_2 = \dim V - 1$ there exists $g \in G$ such that $\rho(g)V_1 \oplus V_2 = V$.

Then following definitions are natural. We say that a representation $\rho : G \to \mathrm{GL}(V)$ is *m-thick* if for any subspaces V_1, V_2 of V with $\dim V_1 = m$ and $\dim V_2 = \dim V - m$ there exists $g \in G$ such that $\rho(g)V_1 \oplus V_2 = V$. We also say that a representation $\rho : G \to \mathrm{GL}(V)$ is *thick* if ρ is m-thick for each $0 < m < \dim V$.

Generally it is very hard to say that a given representation is thick or not. But the next definitions help to find thick representations. We say that a representation V is *m-dense* if the induced representation $\Lambda^m V$ of G is irreducible. We also say that a representation V of G is *dense* if ρ is m-dense for each $0 < m < \dim V$. Then we have following properties.

$$m\text{-dense} \Longrightarrow m\text{-thick} \Longrightarrow 1\text{-dense} \Longleftrightarrow 1\text{-thick} \Longleftrightarrow \text{irreducible.}$$

These properties show that standard representations of symmetric groups are thick.

Moreover we have a certain criterion of thickness. Using this criterion we will show the complete classification of thick representations over complex number field of complex simple Lie groups.

Steffen Oppermann (NTNU, Trondheim, Norway)
Higher preprojective algebras and stable Calabi-Yau properties

Based on joint work with Claire Amiot

Given a finite dimensional algebra Λ of global dimension at most $d-1$, one defines its *d-preprojective algebra* as the tensor algebra of the Λ-bimodule $\mathrm{Ext}^{d-1}_{\Lambda}(\mathrm{D}\Lambda, \Lambda)$.

For $d = 2$ this recovers the classical notion of preprojective algebra of a hereditary algebra. One may note that these d-preprojective algebras are the zeroth cohomology of Keller's derived preprojective algebras. They have recently appeared as endomorphism rings of the canonical cluster tilting object in the $(d-1)$-Amiot cluster category associated to Λ, and also proven to be useful is the study of higher AR-theory and $(d-1)$-representation finite algebras by and with Iyama.

The aim of this work is to give homological conditions under which a given graded algebra is the d-preprojective algebra of its degree zero part. By a result of Keller and Reiten, finite dimensional d-preprojective algebras are Gorenstein, and the stable category of Cohen-Macaulay modules is d-Calabi-Yau. Our result shows that if we slightly strengthen the condition that the stable category is d-Calabi-Yau (by replacing it by a suitable bimodule condition), then the converse holds. For $d \in \{2, 3\}$ it is not hard to see that d-preprojective algebras are also bimodule stably Calabi-Yau, so that we obtain a precise criterion for an algebra being d-preprojective in these cases.

Charles Paquette (University of New Brunswick, Fredericton, NB, Canada)
The Strong No Loop Conjecture

The Strong No Loop Conjecture states that a simple module of finite projective dimension over an artin algebra has no non-zero self-extension. In this talk, I will explain how to prove this conjecture in the algebraically closed case and give some results that generalize this conjecture. One of them is the following. Let Λ be a finite dimensional algebra over an algebraically closed field and S be a simple Λ-module with $\mathrm{Ext}^1_{\Lambda}(S, S) \neq 0$. Then S is a composition factor of all of the syzygies and co-syzygies of S. This is joint work with K. Igusa and S. Liu.

Grzegorz Pastuszak (Nicolaus Copernicus University, Toruń, Poland)
Super-decomposable pure-injective modules over strongly simply connected algebras of non-polynomial growth

This is a report on the joint work with S. Kasjan. Let R be a ring with a unit. An R-module is called *super-decomposable* if it has no indecomposable direct summand. For the concept of *pure-injectivity* we refer to [1]. The problem of the existence of super-decomposable pure-injective modules over rings was first studied by M. Ziegler. Later on M. Prest considers the problem for finite-dimensional algebras and he proves that such modules do exist for algebras of wild representation type. In 2003 G. Puninski proved that every string algebra of non-polynomial growth admits a super-decomposable pure-injective module. In our talk we will sketch a proof of the following theorem.

Theorem. *Let K be a countable algebraically closed field of characteristic different from 2. If Λ is a finite-dimensional strongly simply connected tame K-algebra of non-polynomial growth, then there is a super-decomposable pure-injective Λ-module.*

The proof uses main results of our recent work with S. Kasjan and a characterization of strongly simply connected algebras of non-polynomial growth due to Skowroński.

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David Pauksztello (Leibniz Universität Hannover, Hannover, Germany)
Co-stability conditions on triangulated categories

Stability conditions on triangulated categories were introduced by Bridgeland, and from a homological perspective, can be thought of as a 'continuous' generalisation of bounded t-structures. The set of stability conditions carries a natural topological structure making it a manifold, which has a rich structure.

Co-t-structures are a 'mirror image' of t-structures, and as such it is natural to introduce the corresponding notion of a co-stability condition on a triangulated category. Further motivation comes from the fact that there are naturally occurring triangulated categories that have no non-trivial bounded t-structures but do have non-trivial bounded co-t-structures. In this case, the stability manifold is trivial, whereas the analogous concept of the co-stability manifold is not.

In this talk, we compare and contrast the two notions and show that the set of co-stability conditions satisfying a certain technical separation condition form a topological manifold. We shall also discuss some examples. This is a report on joint work with Peter Jørgensen (University of Newcastle-upon-Tyne, United Kingdom).

Julia Pevtsova (University of Washington, Seattle, United States)
Elementary subalgebras of modular Lie algebras and vector bundles on projective varieties

Let g be a p-restricted Lie algebra. We call a subalgebra E of g "elementary" of rank r if it is an abelian Lie algebra with trivial p-restriction of dimension r. For a fixed r we consider a projective variety $E_r(g)$ that parameterizes all elementary subalgebras of g of rank r. This variety is a natural generalization of the rank variety introduced by Carlson for elementary abelian p-groups and the support variety for Lie algebras of Friedlander and Parshall.

I'll identify this projective variety in various classical cases. I'll also show how representations of g with special properties lead to constructions of families of vector bundles on $E_r(g)$, thereby extending the study of "modules of constant Jordan type" and their geometric applications to this more general context.

This is a joint work with Jon Carlson and Eric Friedlander.

Pierre-Guy Plamondon (Université de Caen, Caen, France)
Quiver varieties and repetitive algebras

We will show that specific instances of Nakajima's graded quiver varieties can be viewed as spaces of representations of repetitive algebras of the same Dynkin type. (This is joint work with Bernard Leclerc).

David Ploog (Leibniz Universität Hannover, Hannover, Germany)
Averaging t-structures

In this talk, we present joint work with Nathan Broomhead and David Pauksztello, centering around the following questions: Can a finite set of t-structures be averaged into a new t-structure? Is the extension closure of aisles again an aisle? One might expect an abstract positive answer, and this is indeed the case for big categories. However, we give examples of bounded derived categories of tame hereditary algebras where the answer is negative. But such averaging is often possible, and we have an explicit solution to the above questions in the tame case.

Mike Prest (University of Manchester, Manchester, United Kingdom)
Superdecomposable pure-injective modules over tubular algebras

I report some results from the doctoral thesis of my student Richard Harland (this can be found at `http://www.maths.manchester.ac.uk/~mprest/publications.html`, a preprint is in preparation).

Suppose that A is a tubular algebra and let r be a positive irrational. It has been known for a long time that the A-modules of slope r form a nonzero definable subcategory $\mathcal{D}_r$ of mod-A, in particular there are nonzero indecomposable pure-injective modules of slope r. However, nothing seems to have been known about the complexity of $\mathcal{D}_r$. Harland proved that the width, in the sense of Ziegler, of the lattice of pp formulas for $\mathcal{D}_r$ is undefined. It follows, at least if we assume the underlying field to be countable, that there are uncountably many indecomposable pure-injectives of slope r and also that there are superdecomposable pure-injectives in $\mathcal{D}_r$.

An important theme in the proof is the behaviour of pp-pairs in finite-dimensional modules with slopes in neighbourhoods of r.

Chrysostomos Psaroudakis (University of Ioannina, Ioannina, Greece)
Homological Theory of Recollements of Abelian Categories

Our aim in this talk is to present how certain homological properties of the categories involved in a recollement situation $(\mathcal{A}, \mathcal{B}, \mathcal{C})$ are related. In particular we are interested in the behavior of global, finitistic and representation dimension in this context. We also discuss recollements of triangulated categories $(\mathcal{U}, \mathcal{T}, \mathcal{V})$ and we provide bounds for the Rouquier dimension of $\mathcal{T}$ in terms of the corresponding dimensions of $\mathcal{U}$ and $\mathcal{V}$. Finally we give applications for the derived dimension of triangular matrix rings.

Daiva Pučinskaitė (University of Kiel, Kiel, Germany)
Quiver and relations of $\mathcal{O}_0(\mathfrak{sl}_{n+1})$ induced from $\mathcal{O}_0(\mathfrak{sl}_n)$

Any block $\mathcal{O}_\lambda(\mathfrak{g})$ of BGG-category $\mathcal{O}(\mathfrak{g})$ of a complex semisimple Lie algebra $\mathfrak{g}$ is equivalent to the category of modules over a finite dimensional $\mathbb{C}$-algebra $A_\lambda(\mathfrak{g})$. The quiver of $A_\lambda(\mathfrak{g})$ is related to certain coefficients of the Kazhdan-Lusztig polynomials. However, the relations are known just for small rank cases.

This presentation deals with the connection between the quivers and relations of algebras $A(n)$ and $A(n+1)$, where $A(n)$ describes a regular integral block of Lie-algebra $\mathfrak{sl}_n(\mathbb{C})$.

Marju Purin (St. Olaf College, Minnesota, United States)
The Generalized Auslander-Reiten Condition for Symmetric Algebras

This is joint work with Kosmas Diveris.

A ring R is said to satisfy the Generalized Auslander-Reiten Condition (GARC) if for each R-module M with $\mathrm{Ext}^i(M, M \oplus R) = 0$ for all $i > n$, the projective dimension of M is at most n. In the special case when $n = 0$, we obtain the Auslander-Reiten Condition (ARC) for a ring R. The Auslander-Reiten Conjecture, a long-standing conjecture, asserts that all Artin algebras satisfy ARC. In this talk we provide a reduction criterion for checking whether a symmetric algebra satisfies GARC– a result parallel to what Hoshino showed for ARC. Moreover, we describe the extension degree of all modules over a symmetric algebra.

Fan Qin (University Paris 7, Paris, France)
Bases of acyclic quantum cluster algebras

In this talk, we discuss bases of acyclic quantum cluster algebras for any choice of coefficients and quantization. We first recall graded quiver varieties and t-analogue of q-characters associated with acyclic quivers. Then we present recent results on generic characters, which are obtained in a joint paper [3] with Yoshiyuki Kimura via Fourier-Deligne-Sato transforms. In general, the deformed Grothendieck ring associated with graded quiver varieties fails to be isomorphic to the acyclic quantum cluster algebra. Nevertheless, we can measure the failure and obtain a generic basis, a dual PBW basis, and a dual canonical basis with positive structure constants. We shall see how the basis data depend on the coefficients and the quantization.

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Yu Qiu (Université de Sherbrooke, Sherbrooke, Canada)
Colored quivers for higher clusters via Ext-quivers of hearts

For an acyclic quiver Q and any integer $N \geq 2$, we study Buan-Thomas' coloured quivers of the clusters in the higher cluster category $\mathcal{C}_{N-1}(Q)$. First, we show that any such clusters can be realized as the projectives of a heart in the bounded derived category $\mathcal{D}(Q)$. Then we prove that the augmented coloured quiver of such a cluster is the Calabi-Yau-N double of the Ext-quiver of the corresponding heart. Next, we consider the finite-dimensional derived category $\mathcal{D}(\Gamma_N Q)$ of the Calabi-Yau-N Ginzburg algebra associated to Q. We show that any heart $\mathcal{H}$ in $\mathcal{D}(\Gamma_N Q)$ is induced from some heart in $\mathcal{D}(Q)$ while the Ext-quiver of $\mathcal{H}$ can be obtained by Calabi-Yau-N doubling the corresponding Ext-quiver. Thus, the augmented coloured quiver of a $(N-1)$-cluster is exactly the Ext-quiver of the corresponding heart in $\mathcal{D}(\Gamma_N Q)$.

Claus Michael Ringel (Universität Bielefeld, Bielefeld, Germany)
How modules determine morphisms: The Auslander bijections as a frame for the representation theory of artin algebras.

Let A be an artin algebra. The lecture will report on the work of M. Auslander in his seminal Philadelphia Notes (published already in 1978). Auslander was very passionate about these investigations (they also form part of the final chapter of the Auslander-Reiten-Smalø book and could and should be seen as its culmination) — but the feedback until now is really meager. The theory presented by Auslander has to be considered as an exciting frame for working with the category of A-modules, incorporating all what is known about irreducible maps (the usual Auslander-Reiten theory), but Auslander's frame is much wider and allows for example to take into account families of modules — an important feature of module categories. What Auslander has achieved (but even he himself may not have realized it fully) was a clear description of the poset structure of the category of A-modules as well as a blueprint for interrelating individual modules and families of modules.

Auslander has subsumed his considerations under the heading of morphisms being determined by modules. Unfortunately, the wording in itself seems to be somewhat misleading, and the basic definition looks quite technical and unattractive, at least at first sight. This may be the reason that for over 30 years, Auslander's powerful results did not gain the attention they deserve.

Claudio Rodríguez (Universidad del Rosario, Bogotá, Colombia)
One-parameter 2-equipped posets and classification of their corepresentations

A *2-equipped poset* is a triple $(\mathbf{P}, \leq, \lhd)$ where $(\mathbf{P}, \leq)$ is an ordinary poset and $\lhd$ is an additional binary relation over $\mathbf{P}$, called *strong*, and satisfies the following condition:

$$x \leq y \lhd z \quad \textit{or} \quad x \lhd y \leq z \qquad \text{implies} \qquad x \lhd z.$$

Whether $x \leq y$ and $x \ntriangleleft y$, we write $x \prec y$ and the relation $\prec$ is called *weak*. A point $x \in \mathbf{P}$ is called *strong* (resp. *weak*) if $x \lhd x$ (resp. $x \prec x$).

Let $\mathbb{F} \subset \mathbb{G} = \mathbb{F}(\xi)$ be an arbitrary quadratic field extension. A corepresentation of a 2-equipped poset $\mathbf{P}$ over the pair $(\mathbb{F}, \mathbb{G})$ is a collection $U = (U_0, U_x : x \in \mathbf{P})$ where U_0 is a finite dimensional $\mathbb{G}$-space, U_x is $\mathbb{F}$-subspace for each $x \in \mathbf{P}$, and $U_x \subset U_y$ if $x \leq y$, additionally U_x is also a $\mathbb{G}$-subspace if x is a strong point. Corepresentations are objects of the category *corep* $\mathbf{P}$ with morphisms $U \overset{\varphi}{\to} V$ being $\mathbb{G}$-linear maps $\varphi : U_0 \longmapsto V_0$ such that $\varphi(U_x) \subset V_x$ for each $x \in \mathbf{P}$.

The classification of indecomposable objects in *corep* $\mathbf{P}$ is reduced to a matrix problem of mixed type over the pair $(\mathbb{F}, \mathbb{G})$.

In this talk is presented, a criterion of one-parameter type for 2-equipped posets with respect to corepresentations, the list of all sincere one-parameter 2-equipped posets as well as a complete matrix classification of all indecomposable corepresentations of that posets over an arbitrary quadratic field extension.

Raphaël Rouquier (University of Oxford/UCLA, Oxford/Los Angeles, United States)
2-Hopf algebras

We will give a definition of tensor categories with a coproduct, and construct such structures for 2-Kac-Moody algebras. This is done in the A-infinity setting. As a consequence, the 2-category of A-infinity 2-representations of Kac-Moody algebras is equipped with a closed monoidal structure.

Shokrollah Salarian (University of Isfahan and Institute for Research in Fundamental Science (IPM), Isfahan, Iran)
Almost Split Sequences for Complexes of Maximal Cohen-Macaulay modules

In this talk we investigate an analogue of the existence of almost split sequences in the category of maximal Cohen-Macaulay modules for the category of complexes of maximal Cohen-Macaulay modules. Let R be a Henselian Cohen-Macaulay local ring with a canonical module. We prove that every complex of maximal Cohen-Macaulay modules with local endomorphism ring which is locally free on the puncture spectrum admits almost split sequence in the category of maximal Cohen-Macaulay complexes. As an application, we show that the isolated singularity subcategory of $K^{\mathrm{c}}(\mathrm{PrjR})$ admits almost split triangle.

Manuel Saorín (Universidad de Murcia, Murcia, Spain)
Generalized tilting theory

By results of Happel and Rickard in the case of bounded derived categories and the Morita theory of unbounded derived categories developed by Keller, we know that if A is an ordinary algebra, T is a right A-module and $B = \mathrm{End}(T_A)$, then T is a (classical) tilting A-module if, and only if, the functor $? \otimes_B^L T : \mathcal{D}(B) \longrightarrow \mathcal{D}(A)$ (resp. $\mathrm{RHom}_A(T, ?) : \mathcal{D}(A) \longrightarrow \mathcal{D}(B)$) is an equivalence of categories.

It seems natural to weaken the hypotheses on the functors, by requiring only that they be fully faithful, and try to see what sort of modules we do get. Another natural question arises also, namely, the connection of these fully faithful hypotheses with the concept of (infinitely generated) tilting module. A recent result by Bazzoni-Mantese-Tonolo points in this direction and shows that the so-called good tilting modules provide an example where the functors $\mathrm{RHom}_A(T, ?) : \mathcal{D}(\mathcal{A}) \longrightarrow \mathcal{D}(B)$ and $T \otimes_A^L ? : \mathcal{D}(A^{\mathrm{op}}) \longrightarrow \mathcal{D}(B^{\mathrm{op}})$ are fully faithful.

In this series of two talks we tackle the above questions in a much more general setting. We consider the situation where $\mathcal{A}$ and $\mathcal{B}$ are small dg categories and T is a dg $\mathcal{B} - \mathcal{A}-$bimodule and study necessary and sufficient conditions for each of the canonical total derived functors $? \otimes_{\mathcal{B}}^L T : \mathcal{DB} \longrightarrow \mathcal{DA}$ and $\mathrm{RHom}_{\mathcal{A}}(T, ?) : \mathcal{DA} \longrightarrow \mathcal{DB}$ to be fully faithful.

When applied to ordinary algebras, our results will show several nontilting situations where the fully faithful condition holds. This is applied to the study of recollement situations and its connection with recent results in this direction by Yang, Chen-Xi and Bazzoni-Pavarin.

Julia Sauter (University of Leeds, Leeds, United Kingdom)
Introducing generalized quiver-graded Springer Theory

Lusztig's quiver-graded Springer Theory starts with a family of collapsings of homogeneous vector bundles into the representation spaces of a quiver parametrized by the different dimension vectors. He associated a category of perverse sheaves to it which categorifies the positive half of the quantum group of the quiver (see [L]). A second categorification comes as projective modules over the KLR-algebra, which can also be constructed geometrically from Lusztig's maps (work of Khovanov,Lauda, Rouquier and [VV]). Derksen and Weyman (in [DW]) introduced generalized quiver representation spaces. With their definition we can construct families of collapsings of homogeneous vector bundles into the generalized quiver representation spaces which we call (construction data) of *generalized quiver-graded Springer Theory*. Using methods of [VV] we can calculate the generalized quiver Hecke algebra. Also, we give some ideas for the convolution product for the associated category of perverse sheaves.

This is part of my phd under the supervision of Andrew Hubery in Leeds.

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Ralf Schiffler (University of Connecticut, Storrs, United States)
Positivity for cluster algebras of rank 3

The cluster variables in a cluster algebra are known to be Laurent polynomials with integer coefficients, and the positivity conjecture states that these coefficients are nonnegative. In this talk, I will present a joint work with Kyungyong Lee in which we prove the positivity conjecture for skew-symmetric coefficient-free cluster algebras of rank 3.

Markus Schmidmeier (Florida Atlantic University, Boca Raton, Florida, United States)
ADE Posets

We consider a family of double-infinite posets of width at most three such that the categories of representations are naturally contained in each other and grow slowly in complexity.

Symmetries of the posets give rise to endofunctors on the categories of representations: The reflection at the center to the duality; the rotation to the square of the AR-translation; and the shift to the graded shift.

The categories are equivalent to lattices over tiled orders studied by W. Rump and — modulo the projectives on one orbit under the graded shift — to invariant subspaces of nilpotent linear operators.

Note that D. Kussin, H. Lenzing and H. Meltzer have shown that invariant subspaces occur also as factors of singularity categories, but while they factor out four orbits of "fading" line bundles, we loose only one orbit.

Chelliah Selvaraj (Periyar University, Salem, India)
Signed Brauer's algebras are cellularly stratified and quasi-hereditary

We prove that the Signed Brauer's algebra $\vec{D}_f(\delta)$ is an iterated inflation of the group algebra of the wreath product of a hyper-octahedral group by symmetric group and that it is cellularly stratified. We also prove that the induction functor G sends the cell modules of $k(\mathbb{Z}_2 \wr S_{f-2\ell})$ to cell modules of $\vec{D}_f(\delta)$. Finally we prove that the Signed Brauer's algebra $\vec{D}_f(\delta)$ is quasi-hereditary and stratified with a stratification. This is joint work with T.Geetha.

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Ahmet Seven (Middle East Technical University, Ankara, Turkey)
Cluster algebras and symmetric matrices

In the structural theory of cluster algebras, a crucial role is played by a family of integer vectors, called **c**-vectors, which parametrize the coefficients. Each **c**-vector with respect to an acyclic initial seed is a real root of the corresponding root system. In this talk, we will discuss an interpretation of this result in terms of symmetric matrices. In particular, we will show that, for skew-symmetric cluster algebras, the **c**-vectors associated with any seed (with respect to an acyclic initial seed) form a companion basis and establish some basic combinatorial properties.

Markus Severitt (Universität Bielefeld, Bielefeld, Germany)
Vector bundles induced by the geometric Frobenius

The geometric Frobenius morphism on smooth curves is an fppf-fiber bundle with fibers the first Frobenius kernel of the additive group. Each representation of the automorphism group scheme of the fiber induces a vector bundle over the Frobenius twist of the curve by twisting. We will compute all vector bundles obtained in this way in terms of Grothendieck groups. That is, we compute them in K-Theory. This heavily involves representations of the multiplicative group.

Armin Shalile (University of Stuttgart, Stuttgart, Germany)
Decomposition numbers of Brauer algebras via Jucys-Murphy elements

Brauer algebras were introduced by Richard Brauer in 1937 and are closely related to the representation theory of orthogonal, symplectic and symmetric groups. They are also a prototypical example of a cellular algebra in the sense of Graham and Lehrer. Decomposition numbers for Brauer algebras are defined by the multiplicities of the simple modules in the cell modules. In 2009, Paul Martin determined the decomposition numbers of Brauer algebras over the complex numbers and shortly afterwards Cox and De Visscher gave a diagrammatic calculus in terms of so called cup-cap diagrams to compute these.

In this talk, we will relate decomposition numbers over the complex numbers to analogues of Jucys–Murphy elements as defined for Brauer algebras by Nazarov in 1996. In the representation theory of the symmetric groups, the classical Jucys–Murphy elements play a crucial role. For example, their operation on a Specht module determines to which block the Specht module belongs over a field of positive characteristic p. We will give a description of when a simple module occurs as a composition factor of a cell module in terms of the action of Jucys-Murphy elements. This will give a natural interpretation of the cup-cap diagram calculus introduced by Cox and De Visscher.

Kenichi Shimizu (Nagoya University, Nagoya, Japan)
Frobenius-Schur theorem for a class of $*$-algebras

For a finite-dimensional representation V of a compact group G, the Frobenius-Schur indicator $\nu(V)$ is defined by using the Haar measure on G. The Frobenius-Schur theorem states that if V is irreducible, then $\nu(V)$ is equal to $+1$, 0 or -1 according as V is real, complex or quaternionic. I plan to talk about a generalization of this theorem for a class of $*$-algebras, which I call *pivotal $*$-algebras*.

A pivotal $*$-algebra [S2] is a $*$-algebra A endowed with an anti-algebra map $S : A \to A$ and an invertible positive element $g \in A$ such that $S(g) = g^{-1}$, $S^2(a) = gag^{-1}$ and $S(S(a)^*)^* = a$ for all $a \in A$. For a pivotal $*$-algebra A, the notions of real, complex and quaternionic irreducible $*$-representations of A are defined in terms of the real subalgebra $A_{\mathbb{R}} = \{a \in A \mid S(a)^* = a\}$. If V is an irreducible $*$-representation of A, then the Frobenius-Schur indicator of V, introduced in [S1] in a category-thereotic way, is equal to $+1$, 0 or -1 according as V is real, complex or quaternionic.

There are some applications of this result to finite-dimensional weak Hopf C^*-algebras and Doi's group-like algebras.

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Adam Skowyrski (Nicolaus Copernicus University, Toruń, Poland)
On a homological problem for cycle-finite algebras

This is report on a joint work with A. Skowroński

Let A be an artin algebra over a commutative artin ring K, modA the category of finitely generated right A-modules, and indA the full subcategory of modA formed by the indecomposable modules. Recall that a cycle in modA is a sequence

$$X_0 \xrightarrow{f_1} X_1 \xrightarrow{f_2} \cdots \longrightarrow X_{r-1} \xrightarrow{f_r} X_r = X_0$$

of nonzero nonisomorphisms in indA, and the cycle is called finite if the homomorphisms $f_1, ..., f_r$ do not belong to the infinite Jacobson radical rad_A^∞ of modA. Following Assem and Skowroński, an artin algebra is called cycle-finite if all cycles in modA are finite.

The following homological problem was raised 10 years ago by Skowroński:

Let A be a connected artin algebra such that for all but finitely many isomorphism classes of modules X in indA we have $\mathrm{pd}_A X \leqslant 1$ *or* $\mathrm{id}_A X \leqslant 1$*. Is then A a quasitilted algebra or a generalized double tilted algebra?*

The aim of the talk is to present solution of this problem for cycle-finite algebras.

Oeyvind Solberg (NTNU, Trondheim, Norway)
Quivers and Path Algebras – QPA

The QPA-project is a project for developing a GAP package for doing computations with finite dimensional quotients of path algebras, and finitely generated modules over such algebras. We present the QPA-project by describing some of the background, aims and goals, current status, design and algorithms and main future projects. A short demonstration of the current features of the program will be given.

Johan Steen (NTNU, Trondheim, Norway)
The Orlov spectrum for $D^b(kD_n)$

Let $\mathcal{T}$ be a triangulated category and G an object of it. Let $\langle G\rangle_1 = \langle G\rangle$ be the full subcategory of $\mathcal{T}$ consisting of the objects $\mathrm{add}\{G[m] \mid m \in \mathbb{Z}\}$. Inductively define

$$\langle G\rangle_{n+1} := \big\langle \{\mathrm{cone}(f) \mid f\colon X \to Y,\ X \in \langle G\rangle,\ Y \in \langle G\rangle_n\}\big\rangle.$$

If G is a strong generator, we say that the *generation time of* G, $\mathrm{gt}\, G = n$, if n is the least integer such that $\langle G\rangle_{n+1} = \mathcal{T}$.

The set of integers $\{\mathrm{gt}\, G \mid G \text{ is a strong generator}\}$, now called the Orlov spectrum, was first studied by Orlov, and later by Ballard–Favero–Katzarkov. The latter authors compute the Orlov spectrum for $D^b(kA_n)$. We will discuss what happens in type D.

Jan Stovicek (Charles University, Prague, Czech Republic)
Cluster categories associated to thread quivers

This is a report on joint work with Adam-Christian van Roosmalen. We introduce a class of examples of 2-Calabi-Yau categories with a cluster tilting subcategory, where the example of Dynkin type A_∞ given by Holm and Jørgensen is the simplest "infinite" representative. The construction goes along the same lines as the construction of usual cluster categories as orbit categories, only acyclic quivers are replaced by so-called thread quivers. In some cases, the categories admit a combinatorial description in terms of triangulations.

Csaba Szanto (Babes-Bolyai University, Cluj-Napoca, Romania)
On Ringel-Hall products and extensions in tame cases

Let k be a field and consider the finite dimensional path algebra kQ where Q is a quiver of tame type, i.e. of type $\tilde{A}_n$(non-cyclic),$\tilde{D}_n, \tilde{E}_6, \tilde{E}_7, \tilde{E}_8$. Modules are considered to be finite dimensional right modules over kQ. For k finite we define the rational Ringel-Hall algebra $\mathcal{H}(kQ)$ as follows: its $\mathbb{Q}$-basis is formed by the isomorphism classes $[M]$ of modules and the multiplication is given by $[N_1][N_2] = \sum_{[M]} F^M_{N_1 N_2}[M]$, where the structure constants $F^M_{N_1 N_2} = |\{U \subseteq M |\ U \cong N_2,\ M/U \cong N_1\}|$ are called Ringel-Hall numbers. It is well known that Ringel-Hall algebras play an important role in linking representation theory with the theory of quantum groups. They also appear in cluster theory.

In the first part of the talk we give an explicit description for every Ringel-Hall product involving indecomposable preprojective modules of defect -1, indecomposable preinjective modules of defect 1 and arbitrary regular modules. These results can be extended to determine extensions of specific modules over kQ, where k is an arbitrary field.

The second part of the talk will focus on the applications of the results above. The knowledge of specific Ringel-Hall numbers (when k is finite) and extensions (when k is arbitrary) leads us to results on cardinalities of quiver Grassmannians and matrix pencil problems.

Ryo Takahashi (Nagoya University/University of Nebraska, Nagoya/Lincoln, Japan/ United States)
Classifying resolving subcategories by grade consistent functions

For the past fifty years, various classifications of subcategories have been given in ring theory, stable homotopy theory, algebraic geometry and modular representation theory. More precisely, classifying full subcategories such as Serre, thick and localizing subcategories has been studied for:

- module categories of commutative rings by Gabriel, Garkusha-Prest, Hovey, Krause, Krause-Stevenson, Stanley-Wang and Takahashi,
- stable homotopy categories by Devinatz-Hopkins-Smith and Hopkins-Smith,
- derived categories of commutative rings and schemes by Hopkins, Neeman and Thomason,

- stable and derived categories of finite groups and group schemes by Benson-Carlson-Rickard, Benson-Iyengar-Krause and Friedlander-Pevtsova,
- singularity categories of complete intersections by Stevenson and Takahashi.

Let R be a commutative noetherian ring, and denote by $\operatorname{mod} R$ the category of finitely generated R-modules. A resolving subcategory of $\operatorname{mod} R$ defined by Auslander-Bridger is a full subcategory that contains the projective modules and is closed under direct summands, extensions and syzygies. In this talk we consider classifying resolving subcategories by using certain integer-valued functions on $\operatorname{Spec} R$ which we call *grade consistent functions*. This talk is based on joint work with Hailong Dao.

Hugh Thomas (University of New Brunswick, Fredericton, Canada)
Quotient-closed subcategories of the representations of a quiver

Let Q be a quiver without oriented cycles. We show that the quotient-closed full subcategories of rep Q which are cofinite (i.e. contain all but finitely many indecomposable representations of Q) are naturally in bijection with the elements of the Weyl group W associated to Q, and that the inclusion order on the subcategories corresponds to the "sorting order" on W introduced by Armstrong. In the Dynkin case, cofiniteness is trivially satisfied, and we obtain a bijection between the quotient-closed subcategories and the elements of W. Even the fact that these sets have the same cardinality seems to be new. The representation theory of preprojective algebras plays an important role in our analysis. This is joint work with Steffen Oppermann and Idun Reiten, based on arXiv:1205.3268.

Gordana Todorov (Northeastern University, Boston, Mass, United States)
Morphisms determined by objects in Continuous Cluster Categories

The notion of Morphism Determined by Object was introduced by Maurice Auslander in order to construct and classify morphisms, mostly in module categories. There is a renewed interest in this notion by C.M.Ringel in module categories, and by H. Krause in triangulated categories.

It is known that the existence of determinators of morphisms is equivalent to the existence of Serre functor. We consider continuous cluster categories, which are triangulated, however the morphisms are not determined by objects, there is no Serre functor, the cokernel functors induced by morphisms do not have socle and there are no almost split maps. We extend the continuous cluster category to a larger category which contains pro-objects and ind-objects and discuss the above notions in the extended category. (joint work with Kiyoshi Igusa)

Jan Trlifaj (Univerzita Karlova, Prague, Czech Republic)
Trees and locally free modules

We present recent results on the global structure of locally free modules. In particular, we investigate a construction of locally free modules $L(T_\kappa, N)$ from two sorts of input data: the trees T_κ of finite sequences of ordinals $< \kappa$, and countably presented Bass modules N. This construction is general enough to show that the class $\mathcal{L}$ of all flat Mittag-Leffler modules over any non-perfect ring R is not deconstructible, and moreover, $\mathcal{L}$ is not precovering in case R is countable.

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Helene Tyler (Manhattan College, Bronx, NY, United States)
The Auslander-Reiten Components in the Rhombic Picture

For an indecomposable module M over a path algebra of a quiver of type $\widetilde{\mathbb{A}}_n$, the Gabriel-Roiter measure gives rise to four new numerical invariants; we call them the multiplicity, and the initial, periodic and final parts. We describe how these invariants for M and for its dual specify the position of M in the Auslander-Reiten quiver of the algebra. This talk is based on joint work with Markus Schmidmeier.

Ramalingam Udhayakumar (Periyar University, Salem, TamilNadu, India)
n-flat covers over n-coherent rings

In this paper we show that all pure injective left R-modules over right n-coherent ring R have n-flat cover and also we show that every left R-modules of finite flat dimension over right n-coherent ring R has n-flat cover.

Kenta Ueyama (Shizuoka University, Shizuoka, Japan)
Graded maximal Cohen-Macaulay modules over noncommutative graded Gorenstein isolated singularities

Gorenstein isolated singularities play an essential role in representation theory of Cohen-Macaulay modules ([2], etc.). Furthermore, AS-Gorenstein algebras are the important class of algebras studied in noncommutative algebraic geometry ([3], etc.). In this talk, we define a notion of noncommutative graded isolated singularity by the smoothness of the noncommutative projective scheme defined in [1] (see also [4]), and study AS-Gorenstein isolated singularities and the categories of graded maximal Cohen-Macaulay modules over them. For an AS-Gorenstein algebra A of dimension $d \geq 2$, we show that A is a graded isolated singularity if and only if the stable category of graded maximal Cohen-Macaulay modules over A has the Serre functor. Using this result, we also show the existence of cluster tilting modules in the categories of graded maximal Cohen-Macaulay modules over Veronese subalgebras of certain AS-regular algebras. This gives examples of cluster tilting modules over non-orders.

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Razieh Vahed (University of Isfahan, Isfahan, Iran)
Almost split sequences in the category of complexes of modules

Let Λ be an artin algebra. By letting the Nakayama functor act degree-wise, we define a translation τ in the category of complexes of finitely generated Λ-modules. Then we investigate the existence of almost split sequences in this category. As applications of our results, we show that every compact object of the homotopy categories $\mathbf{K}(\operatorname{Proj}\Lambda)$ and $\mathbf{K}(\operatorname{Inj}\Lambda)$ with local endomorphism ring admits an almost split sequence in $\mathbf{K}(\operatorname{mod}\Lambda)$. Moreover, the translation τ provides a bijection between the class of compact objects of $\mathbf{K}(\operatorname{Proj}\Lambda)$ with local endomorphism ring and the class of compact objects of $\mathbf{K}(\operatorname{Inj}\Lambda)$ with the same property.

Michel Van den Bergh (Hasselt University, Hasselt, Belgium)
Non-commutative resolutions of determinantal varieties

During the lecture I will discuss joint work with Ragnar Buchweitz and Graham Leuschke on the non-commutative resolution of determinantal varieties. We will show that such resolutions can be constructed in a characteristic free manner and we will discuss their properties. In particular we will give a explicit presentation by generators and relations.

Adam-Christiaan van Roosmalen (University of Regina, Regina, Canada)
Hall algebras and locally finite Lie algebras

Let Q be a finite Dynkin quiver and $\mathbb{F}_q$ be a finite field with q elements. It is well-known that the Hall algebra of the category of finite dimenional $\mathbb{F}_q$ representations of Q is isomorphic to the positive part of the quantized enveloping algebra of the semi-simple Lie algebra associated to Q. In this talk, I will replace the quiver Q with an infinite version and show that the associated Hall algebra is a topological bialgebra in the sense of Burban-Schiffmann. This topological bialgebra can be seen as the positive part of the quantized enveloping algebra of a so-called locally finite Lie algebra.

Jorge Vitória (University of Stuttgart, Stuttgart, Germany)
Glueing silting or how two hearts become one

The natural question of which module categories embed "nicely" in a fixed bounded derived category of a finite dimensional algebra can be approached by looking at endomorphism algebras of silting objects. In general, not much is known about these "silted" algebras. There are, however, methods to glue silting objects via recollements of derived categories. In this talk we discuss these methods and observe that, for piecewise hereditary algebras, they may help solving this problem. This is joint work with Qunhua Liu and Dong Yang.

Denys Voloshyn (Institut of Mathematics, NAS of Ukraine, Kyiv, Ukraine)
Derived categories and vector bundles over noncommutative nodal curves

A noncommutative curve is called *nodal* if all localizations of its structure sheaf are nodal in the sense of [2]. We consider nodal curves of *string type* and nodal curves of *almost string types* [3]. We describe vector bundles and derived categories of coherent sheaves over these noncommutative nodal curves [3, 4]. Our works uses the technique of "matrix problems" more exactly representations of bunches of semi-chains [1]. We also study when categories of vector bundles and derived categories of coherent sheaves over noncommutative curves are wild.

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Heily Wagner (Universidade de São Paulo, São Paulo, Brazil)
Pullback of finite dimensional algebras

Given two epimorphisms of algebras $f\colon A \to B$ and $g\colon C \to B$ the pullback R is the subalgebra of $A \times C$ defined by $\{(a, c) \in A \times C \mid f(a) = g(c)\}$. For basic finite dimensional k-algebras (k an algebraically closed field), which can be determined by bounded quivers, the ordinary quiver of the pullback R can be determined by those of A, B and C. We study a more specific case, the Dynkin oriented pullback, whose main feature is the ordinary quiver of B being Dynkin with a single sink. In this case, there is also a close relation between the category of indecomposable modules of this algebras. This leads us to obtain relations between the classes of these algebras.

Matthias Warkentin (TU Chemnitz, Chemnitz, Germany)
On mutation graphs of quivers

Let Q be an acyclic quiver and K an algebraically closed field. We are interested in the simplicial complex of tilting modules over KQ. The exchange graph of tilting modules introduced by Riedtmann and Schofield as a tool for understanding this complex has been studied extensively by Happel and Unger. After the introduction of cluster algebras and cluster categories it has been shown that this exchange graph can be seen as a part of the exchange graph of the cluster algebra given by Q, which is governed by the combinatorics of quiver mutations. We show (generalizing work of Assem, Blais, Brüstle and Samson) that elementary considerations about quiver mutations yield new results about the corresponding exchange graphs and simplicial complexes. In particular we show that an exchange graph (of a cluster algebra) contains a cycle if and only if there are two vertices in Q that are not connected by more than one arrow. Furthermore we can classify all exchange graphs for quivers with three vertices, answering a question by Happel in this case.

Sven-Ake Wegner (Bergische Universität Wuppertal, Wuppertal, Germany)
Exact Structures on Categories of Locally Convex Spaces

The class of all locally convex spaces constitutes an example of a category which is not abelian but allows for the use of homological methods in an intuitive way, see e.g. Wengenroth (2003). This is due to the fact that the collection of all its kernel cokernel pairs forms an exact structure in the sense of Quillen (1973). Indeed, the latter category is quasi-abelian, a notion which is strongly connected to tilting theory by a result of Bondal, van den Bergh (2003).

Unfortunately, many subcategories of the locally convex spaces are not quasi-abelian. In order to make such a subcategory accessible for homological methods it is necessary to determine an appropriate exact structure. In particular, this structure should fit into the framework of the analytic problem under consideration.

In this talk we review some recent results on the hierarchy of pre-abelian categories as well as on the existence of exact structures. We illustrate these results by examples arising from functional analysis.

Thorsten Weist (Bergische Universität Wuppertal, Wuppertal, Germany)
Tree modules

We state several tools which can be used to construct indecomposable tree modules for quivers without oriented cycles. These methods can be used to construct indecomposable tree modules for every imaginary Schur root. We also give an idea for the construction of tree modules for arbitrary roots.

Paweł Wiśniewski (Nicolaus Copernicus University, Toruń, Poland)
Artin algebras having all Auslander-Reiten components semiregular and without external short paths

This is report on a joint work with A. Skowroński.

Let A be an artin algebra over a commutative artin ring K, mod A the category of finitely generated right A-modules, and Γ_A the Auslander-Reiten quiver of A. A component $\mathcal{C}$ of Γ_A is called semiregular if $\mathcal{C}$ does not contain both projective module or an injective module. Fallowing Reiten and Skowroński by an external short path of a component $\mathcal{C}$ of Γ_A we mean a sequence $X \to Y \to Z$ of nonzero nonisomorphism between indecomposable modules in mod A with X and Z in $\mathcal{C}$, but Y not in $\mathcal{C}$. The structure of semiregular components without external short paths of an Auslander-Reiten quiver Γ_A has been described in a recent paper by Jaworska, Malicki and Skowroński.

The aim of the talk is to present a complete description of all basic indecomposable artin algebras A for which all components of Γ_A are semiregular and without external short paths. A crucial role in this description will be played by sequences of (generically) tame quasitilted algebras of canonical type.

Julia Worch (University of Kiel, Kiel, Germany)

Module categories for elementary abelian p-groups and generalized Beilinson algebras

We approach the study of modules of constant rank and equal images modules over elementary abelian p-groups E_r of rank $r \geq 2$ by exploiting a functor from the module category of a generalized Beilinson algebra $B(n, r)$, $n \leq p$, to $\operatorname{mod} E_r$.
We define analogs of the above mentioned properties in $\operatorname{mod} B(n, r)$ and give a homological characterization of the resulting subcategories via a $\mathbb{P}^{r-1}$-family of $B(n, r)$-modules of projective dimension one. This enables us to apply general methods from Auslander-Reiten theory and thereby arrive at results that, in particular, contrast the findings for equal images modules of Loewy length two over E_2 [CFS11] with the case $r > 2$.

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Changchang Xi (Capital Normal University, Beijing, China)

Infinitely generated tilting modules, homological subcategories and recollements

In this talk, I shall report some of our recent investigations (see [1]-[4]) on the derived categories of the endomorphism rings of infinitely generated tilting modules which involve many classical and modern subjects: Ring epimorphisms, coproducts, universal localizations, stratifications and recollements. This general tilting theory has completely different features. For example, Bazzoni shows that Happel's theorem is no longer true. What should be an analogue of Happel's theorem for infinitely generated tilting modules? The contents of this talk will focus on this problem and its related topics, and are mainly taken from the following joint works with H. X. Chen.

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Jie Xiao (Tsinghua University, Beijing, China)
Hall type algebras associated to triangulated categories

By a detailed investigation of the proof in the paper [2], we give the explicit relations among several versions of derived Hall algebras in Toen [1], and Kontsevich and Soibelman [3].

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Kunio Yamagata (Tokyo University of Agriculture and Technology, Tokyo, Japan)
Morita algebras and the double centralizer property of a bimodule

This is joint work with Otto Kerner. Let K be a field. K. Morita [2] gave a characterization of the endomorphism algebra A of a faithful module over a *self-injective* algebra B: we call such an algebra A a *Morita algebra* over B. Recently, M. Fang and S. König [1] studied Morita algebras over a symmetric algebra, and they showed: an algebra A is a Morita algebra over a symmetric algebra if and only if $\mathrm{Hom}_A({}_AD(A), {}_AA) \cong A$ as (A, A)-bimodules, where $D = \mathrm{Hom}_K(-, K)$. In this talk I will show some properties of $\mathrm{Hom}_A(D(A), A)$ for a finite dimensional algebra A and some Frobenius subalgebras of A, and give a new characterization of the Morita algebra as an algebra A with the property that the A-bimodule $\mathrm{Hom}_A({}_AD(A), {}_AA)$ has the double centralizer property. As an application, we consider the case when $\mathrm{Hom}_A({}_AD(A), {}_AA) \cong A$ as one-sided A-modules.

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Kota Yamaura (Nagoya University, Nagoya, Japan)
Realizing stable categories as derived categories

In my talk, we discuss a relationship between representation theory of graded self-injective algebras and that of algebras of finite global dimension. For a positively graded self-injective algebra A whose 0-th subring has finite global dimension, we construct two types of triangle-equivalences. First we show that there exists a triangle-equivalence between the stable category of $\mathbb{Z}$-graded A-modules and the derived category of a certain algebra Γ of finite global dimension [Y, Theorem 1.3]. This triangle-equivalence is a generalization of D. Happel's equivalence [H, Theorem 2.3]. Secondly we show that if A has Gorenstein parameter ℓ, then there exists a triangle-equivalence between the stable category of $\mathbb{Z}/\ell\mathbb{Z}$-graded A-modules and a derived-orbit category of Γ [Y, Theorem 1.6], which is a triangulated hull of the orbit category of the derived category introduced by B. Keller [K].

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Dong Yang (University Stuttgart, Stuttgart, Germany)

Silting objects, t-structures, cluster-tilting objects and their mutations

As an analogue of the classical tilting theory where BGP reflections of quivers induce derived equivalences of path algebras, for quivers with potential (QPs) we have

Theorem (Keller–Y). *Let (Q,W) be a QP without 2-cycles or loops and i be a vertex. Let μ_i denote the mutation at i, $\hat{\Gamma}$ denote the Ginzburg dg algebra and $\mathcal{D}$ denote the derived category. Then there is a triangle equivalence $\mathcal{D}(\hat{\Gamma}(\mu_i(Q,W))) \longrightarrow \mathcal{D}(\hat{\Gamma}(Q,W))$.*

Let $\Gamma = \hat{\Gamma}(Q,W)$. The above equivalence induces a mutation of: (i) silting objects in the perfect derived category $\mathrm{per}(\Gamma)$, (ii) simple-minded collections in the finite-dimensional derived category $\mathcal{D}_{fd}(\Gamma)$, (iii) bounded t-structures on $\mathcal{D}_{fd}(\Gamma)$ with length heart, (iv) bounded co-t-structures on $\mathrm{per}(\Gamma)$, (v) 'cluster-tilting objects' in the generalised cluster category $\mathrm{per}(\Gamma)/\mathcal{D}_{fd}(\Gamma)$. This motivates the following

Theorem (Keller–Nicolás, Koenig–Y). *Replacing Γ by a finite-dimensional algebra or a homologically smooth non-positive dg algebra with finite-dimensional* 0*-th cohomology, we have bijections between* (i)–(iv) *which commute with mutations.*

Assume that $\mathsf{H}^0(\Gamma)$ is finite-dimensional. Restricted to certain regions, the bijections in the preceding theorem for Γ and those for $\mathsf{H}^0(\Gamma)$ are related by the push-out and pull-back functors along the projection $\Gamma \to \mathsf{H}^0(\Gamma)$. This yields a commutative diagram of bijections. Collecting known results in cluster theory we can extend it to a larger diagram involving support τ-tilting modules, functorially finite torsion classes, cluster-tilting objects, clusters, c-matrices and g-matrices.

Lingling Yao (Southeast University, Nanjing, China)
The torsionless modules over cluster-tilted algebras of type A_n

The class of cluster-tilted algebras has been introduced by Buan, Marsh and Reiten. The cluster-tilted algebras are the endomorphism rings of the cluster tilting objects in a cluster category. We consider the torsionless modules over the cluster-tilted algebras of type A_n. For this type of algebras we deduced some properties and characterizations of the torsionless modules. Moreover, it is nicely showed that all the indecomposable torsionless modules are the indecomposable projective modules and the L(α)'s where α is a cyclic arrow. In the end, the Auslander-Reiten structure of all the indecomposable torsionless modules is also investigated.

Dan Zacharia (Syracuse University, Syracuse, United States)
On rigid sheaves on the projective n-space

Let X be a projective variety. Recall that an *exceptional sheaf* on X is a coherent sheaf E such that $\operatorname{Ext}^i(E,E) = 0$ for all $i \geq 1$ and $\operatorname{End} E \cong \mathbb{C}$. Drézet proved in [1] that if E is an indecomposable sheaf over $\mathbf{P}^2$ such that $\operatorname{Ext}^1(E,E) = 0$ then then its endomorphism ring is automatically trivial, and also that $\operatorname{Ext}^2(E,E) = 0$. Moreover, he proved that E is a vector bundle. The same result was proved for del Pezzo surfaces by Kuleshov and Orlov [2]. We will look at rigid sheaves over $\mathbb{P}^n$ that is sheaves having no self-extensions. We prove that every indecomposable rigid sheaf has a trivial endomorphism ring. The proof uses properties of Koszul algebras and reduction to finite dimensional modules having no self-extensions. This is joint work with Dieter Happel.

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Pu Zhang (Shanghai Jiao Tong University, Shanghai, China)
The category of monic representations

Given a finite quiver Q and a k-algebra A, the category $\operatorname{Mon}(Q, A)$ of the monic representations of Q over A is a full subcategory of $(kQ \otimes_k A)$-mod. This is a generalization of the submodule category (in the sense of C. M. Ringel and M. Schmidmeier) and the filtered chain category (in the sense of D. M. Arnold and D. Simson). It has been used by D. Kussin, H. Lenzing, H. Meltzer, X. W. Chen, O. Iyama, K. Kato and J.

I. Miyachi in different settings. I'll talk about a relation between Mon(Q, A) and the category of Gorenstein-projective $(kQ \otimes_k A)$-modules, the relative Auslander-Reiten theory of Mon(Q, A), and a symmetric recollement involved.

This is a joint work with Xiuhua Luo, Baolin Xiong and Yuehui Zhang.

Yingbo Zhang (Beijing Normal University, Beijing, China)
Bi-module Problems

The concept of Bi-module problems is defined by Crawley-Boevey over some trivial algebras mod$k \times \cdots \times$ mod$k$ for a perfect field k. In the present talk, we will extend the notion of Bi-module problems over some minimal algebras over an algebraically closed field, and give its representation categories, which is completely as the same as that given by Crawley-Boevey for R being trivial. Then we define the dual structure, so called Bi-co-module problems and their representation categories. This is joint work with Xu Yunge from Hubei University.

Yuehui Zhang (Shanghai Jiao Tong University, Shanghai, China)
Monomorphism Categories Associated to Symmetric Groups and Parity in Finite Groups

Monomorphism categories of the symmetric and alternating groups are studied via Cayley's Embedding Theorem. It is shown that the parity is well-defined in such categories. As an application, the parity in a finite group G is classified. It is proved that any element in a group of odd order is always even and such a group can be embedded into some alternating group (instead of some symmetric group in the Cayley's theorem). It is also proved that the parity in an abelian group of even order is always balanced and the parity in an nonabelian group is independent of its order.

Minghui Zhao (Tsinghua University, Beijing, China)
A parameterization of the canonical basis of affine modified quantized enveloping algebras

Let U^+ be the positive part of the quantized enveloping algebra U. Then Lusztig introduce a canonical basis of U^+. In the case of finite type, Lusztig gives a quiver approach of the canonical basis with the help of a PBW-type basis. Then Lin, Xiao and Zhang give a similar construction in the case of affine type. Lusztig also introduce the modified quantized enveloping algebra and its canonical basis. In this paper, we define a set which depend only on the root category and prove that there is a bijection between the set and the canonical basis of the modified quantized enveloping algebra using the the PBW-basis defined by Lin, Xiao and Zhang.

Guodong Zhou (Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland)
Comparison morphisms and Hochschild cohomology

We explain a general recursive method to construct comparison morphisms between two projective resolutions of a module. We shall give applications to monomial algebras, the additive decomposition of the Hochschild cohomology of a group algebra and the Hochschild cohomology of the Heisenberg algebra.

Yu Zhou (Tsinghua University, Beijing, China)
Mutation of cotorsion pairs and its geometric realization arising from marked surfaces

My talk is on joint work with Jie Zhang and Bin Zhu. By generalizing mutation of rigid subcategories, maximal rigid subcategories and cluster tilting subcategories, we introduce the notion of mutation of cotorsion pairs in triangulated categories. It is proved that the mutation of cotorsion pairs in triangulated categories are cotorsion pairs. As an application we classify cotorsion pairs in the cluster category of a marked surface and give a geometric realization of mutation of cotorsion pairs in this case.

Bin Zhu (Tsinghua University, Beijing, China)
t- structures in 2- Calabi-Yau triangulated catgeories with cluster tilting objects

Let $\mathcal{C}$ be a $2-$CY triangulated category (not necessary connected) with a cluster tilting object T. It is proved that $\mathcal{C}$ decomposes as the direct sum of connected triangulated subcategories $\mathcal{C}_i, i = 1, \cdots m$, i.e $\mathcal{C} = \oplus_{i=1}^m \mathcal{C}_i$ if and only if T decomposes as the direct sum of $T_i, i = 1, \cdots m$, such that the quiver of any $\mathrm{End}_{\mathcal{C}} T_i$ is connected. Under the condition that $\mathcal{C}$ is connected, it is proved that the $t-$ctructures in $\mathcal{C}$ are only trivial ones, i.e. $(\mathcal{C}, 0)$ or $(0, \mathcal{C})$. As an application, a classification of cotorsion pairs in $\mathcal{C}$ is given.

This is a joint work with Yu Zhou.

Alexander Zimmermann (Université de Picardie, Amiens, France)
On singular equivalences of Morita type

This is joint work with Guodong Zhou. Xiao-Wu Chen and Long-Gang Sun defined singular equivalences of Morita type in analogy to stable equivalences of Morita type, and showed various properties. We shall prove that under some mild hypothesis such a singular equivalences of Morita type is induced by a pair of adjoint functors in the module category, and that Hochschild homology is invariant under singular equivalences of Morita type.

Alexandra Zvonareva (Saint Petersburg State University, Saint Petersburg, Russia)
Two-term tilting complexes over Brauer tree algebras

Various subgroups of the derived Picard group of the Brauer tree algebra are known, but the whole group is computed only in the case of an algebra with two simple modules. On the other hand, Abe and Hoshino proved that for a representation-finite selfinjective Artin algebra any tilting complex P such that $add(P) = add(\nu P)$, where ν is the Nakayama functor, can be presented as a product of tilting complexes of length ≤ 1. In other words, the derived Picard groupoid of the Brauer tree algebra is generated by one-term and two-term tilting complexes. In my talk I will describe all two-term tilting complexes over any Brauer tree algebra and provide some information on the endomorphism ring of such tilting complexes.

Grzegorz Zwara (Nicolaus Copernicus University, Toruń, Poland)
Transversal slices to orbits in varieties of quiver representations

Let k be an algebraically closed field, $Q = (Q_0, Q_1, s, t)$ be a quiver and $\mathbf{d} = (d_i) \in \mathbb{N}^{Q_0}$ be a dimension vector. The representations $M = (M_i, M_\alpha)_{i \in Q_0, \alpha \in Q_1}$ of Q with fixed vector spaces $M_i = k^{d_i}$, $i \in Q_0$, form an affine space denoted by $\text{rep}_Q(\mathbf{d})$. The product $\text{GL}(\mathbf{d}) = \prod_{i \in Q_0} \text{GL}_{d_i}(k)$ of general linear groups acts on $\text{rep}_Q(\mathbf{d})$ by

$$(g_i)_{i \in Q_0} \star (M_\alpha)_{\alpha \in Q_1} = (g_{t(\alpha)} \cdot M_\alpha \cdot g_{s(\alpha)}^{-1})_{\alpha \in Q_1}.$$

Then the orbits correspond to isomorphism classes of representations. We shall denote by $\mathcal{O}_N$ the orbit corresponding to a representation N.

Let M and N be two representations in $\text{rep}_Q(\mathbf{d})$ such that N belongs to the (Zariski) closure $\overline{\mathcal{O}}_M$ of the orbit $\mathcal{O}_M$. An interesting problem is to describe the type of singularity of $\overline{\mathcal{O}}_M$ at N. In order to achieve that, one can investigate transversal slices in $\overline{\mathcal{O}}_M$ to the orbit $\mathcal{O}_N$ at the point N; some results in this direction will be presented.

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