ABSTRACTS

Maurice Auslander Distinguished Lectures

Ragnar Buchweitz

Maximal Cohen-Macaulay Modules over Complete Intersection Rings.

We explain the structure theory of maximal Cohen-Macaulay modules over the rings in the title and show how that structure can be revealed using the representation theory of the differential graded algebra provided by the Koszul complex on the defining equations. We will discuss applications and remaining challenges.

The Orlov Octahedron on a Graded Gorenstein Algebra.

One of the deepest results in the theory of maximal Cohen-Macaulay modules surely is Orlov’s theorem from 2005 that relates the stable category of graded such modules over a not necessarily commutative graded Gorenstein ring $A$ to the derived category of coherent sheaves on the underlying (virtual) projective scheme. We explain how this result defines for any graded $A$-module an octahedron of complexes of such modules that connects projective geometry and maximal Cohen-Macaulay approximations. Time permitting we will discuss in some detail the case of graded matrix factorizations, or graded maximal Cohen-Macaulay modules, over (quasi-)homogeneous hypersurface rings.

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Maurice Auslander Distinguished Lectures\textsuperscript{3} and International Conference\textsuperscript{4}  
April 25-30, 2012  
All talks at Clark 507,  
Woods Hole Oceanographic Institute, Woods Hole, Massachusetts, USA  

Expository Lectures  

Aslak Buan: \textit{Rigid objects and torsion pairs in tubes.}  
Abstract: This is based on joint work with Baur and Marsh.  
We study certain uniserial abelian categories, called tubes, and extensions of such containing Pr"ufer and adic objects. We describe rigid objects in the extended tubes, and the relationship to torsion pairs. We also discuss a combinatorial model.  

Yuri Berest: \textit{Derived representation schemes and cyclic homology.}  
Abstract: Many important varieties in algebra, geometry and physics can be realized as moduli spaces of finite-dimensional representations of associative algebras and groups. The simplest and most commonly used are the classical representation scheme $\text{Rep}_n(A)$ parametrizing the $n$-dimensional representations of a f.g. algebra $A$ over a field $k$ and its affine categorical quotient $\text{Rep}_n(A)//\text{GL}_n(k)$ parametrizing the isomorphism classes of semisimple representations. For a fixed $n$, each of these schemes defines a (contravariant) functor on the category of algebras. In this talk, I will explain how to construct the corresponding derived functors in the category of DG schemes and compute their stable homology as $n$ goes to infinity. Time permitting, I will discuss some applications of the derived representation schemes in knot theory and low-dimensional topology. (The talk is based on joint work with A. Ramadoss.)  

Lutz Hille: \textit{Full exceptional sequences and tilting modules over the Auslander algebra of $k[T]/T^d$.}  
Abstract: We classify all exceptional and all spherical modules over the Auslander algebra of $k[T]/T^d$. This module category contains many spherical objects defining non-standard equivalences of the derived category. There is a close connection between spherical and exceptional objects that we can explain in detail for this example. Its importance came originally from tilting bundles on rational surfaces. Any chain of (-2)-curves on a rational surface defines a subcategory of coherent sheaves that is equivalent to the category of modules over the Auslander algebra of $k[T]/T^d$. The main result in the talk gives a complete classification of all full exceptional sequences for the Auslander algebra of $k[T]/T^d$. We use this construction and universal extensions to obtain tilting modules. Tilting modules of projective dimension at most one have been classified in a joint work with Br"ustle, Ringel and R"ohrle. We extend this classification to all tilting modules. Moreover, the Auslander algebra of $k[T]/T^d$ seems to appear in various applications, we also give some overview. This is joint work with David Ploog.  

\textsuperscript{3}Sponsored by Bernice Auslander.  
\textsuperscript{4}Sponsored by NSF/DMS-1162304.
Abstract: We will begin with the concepts of fine/coarse moduli spaces. After a brief history and some classical examples, we will discuss two fundamentally different lines of approach in applying these notions to classification problems in the representation theory of finite dimensional algebras. The juxtaposition will highlight differences in goals and methodology. Both viewpoints will be illustrated with prototypical results.

Otto Kerner: *Wild hereditary algebras.*
Abstract: Otto Kerner, Wild hereditary algebras. The category of finite dimensional modules for a finite dimensional wild hereditary algebra $H$ (over an algebraically closed field) is considered in my talk.
Spectral properties of the Coxeter transformation can be used to describe the asymptotic behavior of modules under Auslander-Reiten translations, maps between regular modules and the shape of regular Auslander-Reiten components.
In the second part, I will speak about perpendicular categories $X^\perp$ of regular indecomposable modules without self extensions and the relation of these categories $X^\perp$ with the original module category $H$-mod.

Henning Krause: *Koszul, Ringel, and Serre duality for strict polynomial functors.*
Abstract: Strict polynomial functors were introduced by Friedlander and Suslin in their work on the cohomology of finite group schemes. This category admits a Koszul duality by recent work of Chalupnik and Touze. In my talk I will give a gentle introduction to strict polynomial functors (via representations of divided powers) and will explain the Koszul duality, making explicit the underlying monoidal structure which seems to be of independent interest. Then I connect this to Ringel duality for Schur algebras and describe Serre duality for strict polynomial functors.

Graham Leuschke: *The MCM McKay Correspondence.*
Abstract: The McKay correspondence is a collection of correspondences and equivalences which encompasses representation theory, commutative algebra, algebraic geometry, and mathematical physics. I will give an informal introduction to the McKay correspondence from the point of maximal Cohen-Macaulay modules over fixed rings of group actions.
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Conference Talks 

Vladimir Bavula: \textit{The largest left quotient ring of a ring.} 
Abstract: The left quotient ring (i.e. the left classical ring of fractions) of a ring does not always exist and still, in general, there is no good understanding of the reason why this happens. Recently, for an arbitrary ring I proved existence of its largest left quotient ring. A criterion is given of when the largest left quotient ring of a ring is semi-simple (generalizing Goldie's Theorem). We extend slightly Ore's method of localization to localizable left Ore sets, give a criterion of when a left Ore set is localizable, and prove that all left and right Ore sets of an arbitrary ring are localizable (not just denominator sets as in Ore's method of localization). Applications are given for certain classes of rings (semi-prime Goldie rings, Noetherian commutative rings, the algebra of polynomial integro-differential operators).

Frauke Bleher: \textit{Brauer's generalized decomposition numbers and universal deformation rings.} 
Abstract: In this talk, I will study the problem of lifting to local rings certain mod 2 representations $V$ of a finite group $G$ which belong to a 2-modular tame block $B$ of $G$ having at least two isomorphism classes of simple modules. Green's lifting theorem determines when such a $V$ may be lifted to the ring of infinite Witt vectors. I will generalize this result by determining the full universal deformation ring $R(G,V)$ of such $V$ using Brauer's generalized decomposition numbers. The isomorphism type of $R(G,V)$ will depend on whether the stable Auslander-Reiten quiver of $B$ contains 3-tubes.

Thomas Bruestle: \textit{Poset structures on the cluster exchange graph.} 
Abstract: Cluster mutation is an involution, so the cluster exchange graph comes a priori without any orientation. However, fixing an initial cluster allows to turn it into an oriented graph with a unique source and a unique sink. We discuss this order relation from various points of view and indicate relations to other areas: it contains the Happel-Unger poset of tilting modules. Moreover, maximal paths in the oriented graph give rise to quantum dilogarithm identities, and they allow to compute the complete spectrum of a BPS particle.

\textsuperscript{5}Sponsored by Bernice Auslander. 
\textsuperscript{6}Sponsored by NSF/DMS-1162304.
Giovanni Cerulli Irelli: *On linear independence of cluster monomials and application to positivity in cluster algebras.*

Abstract: In a recent preprint in collaboration with B. Keller, D.Labardini-Fragoso and P.-G. Plamondon, we prove that the cluster monomials of a skew-symmetric cluster algebra are linearly independent over the ground ring. From the proof of this result we also deduce that exchange graph of the cluster algebra is independent on the system of coefficients. I will present this results and if time permits I will also provide some applications to positivity.

Claudia Chiao: *Degrees of irreducible morphisms.*

Abstract: The concept of degree of an irreducible morphism was introduced by S. Liu, in 1992. This notion has shown to be a very useful tool to solve many problems. In particular, we are able to determine if a finite dimensional algebra over an algebraically closed field is of finite representation type by computing the degree of a finite number of irreducible morphisms. It is well known that $A$ is an artin algebra of finite representation type if and only if there exists a positive integer $n$ such that $R^n(X,Y) = 0$ for all $A$-module $X,Y$. In this case, by the Harada and Sai Lemma we can consider $n = 2m \pm 1$ where $m$ is the maximum length of all the indecomposable $A$-modules. In this talk, for a finite dimensional algebra over an algebraically closed field of finite representation type $A$, we are going to show a new bound $n$ such that $R^n \neq 0$ but $R^{n+1}(X,Y) = 0$ for all $X,Y \in \text{mod } A$. This bound is given in terms of degrees of irreducible morphisms. We are also going to present some recent developments on degrees of irreducible morphisms.

Miodrag Iovanov: *Quiver and monomial algebras, coalgebras, and rational representations.*

Abstract: Given a quiver $Q$, besides the quiver algebra $K[Q]$, there is another less well known but equally important associated object, the quiver coalgebra $KQ$. A natural question is: what are the connections between the two, is there any (bialgebra) compatibility between them, and what kind of bialgebra structures can be found on a quiver (co)algebra. We first give an account of algebras, coalgebras, rational modules, and duality. We show that the path coalgebra can be obtained from the quiver algebra as a certain type of graded finite dual; also, it is the classical finite dual of the quiver algebra (i.e. the coalgebra of representative functions) if and only if the quiver is acyclic and only finitely many arrows exist between any two vertices. We also give some results about recovering the quiver algebra from the path coalgebra, and we mention the interpretation in categorical terms of representations and rational modules of quivers. Time permitting, we briefly discuss bialgebra structures on monomial (co)algebras, and new categorical characterizations of monomial algebras.

Finally, we look at a particular class of quivers, which produce the linear categories whose finite objects are all serial. We show how a theory that parallels that of infinite abelian groups can be developed for this situation; as a main application, we give an example of an algebra all of whose rational (i.e. locally finite) left modules are direct sums of indecomposables but not all right locally finite modules decompose this way. This provides an interesting contrast to the finite dimensional algebra case, where one of the main open questions asks whether decomposability into indecomposables of all modules on one side implies the analogue complete decomposability on the other.
Gabriella D’Este: **Cancellations, additions and Lego-type constructions.**

Abstract: The first part of my talk will deal with “non classical” partial tilting modules, that is partial tilting modules $T$ of projective dimension at most 2, with the following property: if $\text{Hom}(T, X) = 0$ and $\text{Ext}^m(T, X) = 0$ for every $m > 0$, then $X = 0$.

The second part of my talk will deal with partial tilting complexes $T^\circ$ which are projective resolutions of partial tilting (but not tilting) modules $T$ with the above property. As we shall see, there seems to be a weak relationship between the complexes $T^\circ$ and the indecomposable complexes orthogonal to them. For instance, some of these complexes look like mutations of direct summands of the complexes $T^\circ$, while other are completely different.

Sachin Gautam: **Geometry of quiver varieties.**

Abstract: For a Dynkin graph $\Gamma = (I, E)$ of A, D, E type and a pair of dimension vectors $v, w \in \mathbb{N}^I$, Nakajima has constructed a smooth, quasiprojective, symplectic variety $\mathcal{M}(v, w)$ which comes equipped with an action of $GL(w) \times \mathbb{C}^\times$ (called Nakajima quiver variety). The equivariant $K$-theory of the Nakajima quiver variety $\mathcal{M}(w) = \sqcup_v \mathcal{M}(v, w)$ admits an action of an infinite-dimensional quantum group, namely the quantum loop algebra $U_q(L\mathfrak{g})$ of simple Lie algebra $\mathfrak{g}$ associated with $\Gamma$. Similarly the equivariant cohomology of $\mathcal{M}(w)$ admits an action of the Yangian $Y_{\hbar}(\mathfrak{g})$ of $\mathfrak{g}$. These symmetries of the quiver varieties were constructed by Nakajima and Varagnolo respectively. Motivated by the geometric representation theory of Nakajima quiver varieties, we have constructed several homomorphisms of geometric type $U_q(L\mathfrak{g}) \to Y_{\hbar}(\mathfrak{g})$. In this talk, I will discuss the compatibility between the homomorphisms of geometric type and (certain variants of) the equivariant Chern character relating equivariant $K$-theory and cohomology of Nakajima quiver varieties. This talk is based on a joint work with V. Toledano Laredo.

Ed Green: **The symmetric special biserial algebras that are $K_2$**

Abstract: Let $\Lambda$ be a finite dimensional $K$-algebra where $K$ is a field. The algebra is said to a $K_2$ algebra if the Ext-algebra $\text{Ext}^*_\Lambda(\Lambda/\mathfrak{r}\Lambda/\mathfrak{r})$ can be generated in degrees 1 and 2, where $\mathfrak{r}$ is the Jacobson radical of $\Lambda$. In joint work with Sibylle Schroll, Nicole Snashall, and Rachell Taillefer, we classify the symmetric special biserial algebras that are $K_2$.

Ivo Herzog: **An introduction to ideal approximation theory.**

Abstract: An introduction to the theory of ideal approximations in the context of an exact category (joint with X. Fu, P.A. Guil Asensio and B. Torrecillas). The main highlights are a 3-dimensional version of Salce’s Lemma, and the characterization of special precovering ideals as ideals of phantom morphisms with respect to certain subfunctors of $\text{Ext}$. Some applications to the powers of the phantom ideal will be given (joint with X. Fu).

Tom Howard: **Upper bounds on complexity over representation-finite algebras.**

Abstract: We will look into the question of whether there is some exponential bound on the complexity of a module over a representation-finite algebra, i.e. on the dimension growth of the module’s syzygies. In particular, we will show that for a truncated path algebra, $2n$ is a sufficient upper bound. Since these complexities are preserved under derived equivalences, our upper bounds also apply to modules over derived equivalent algebras.
David Jorgensen: *On products in negative cohomology for $n$-Calabi-Yau categories.*

Abstract: We investigate the structure of the $\mathbb{Z}$-graded cohomology rings of objects in $n$-Calabi-Yau triangulated categories. Almost by definition these cohomology rings possess a natural duality. In particular, the stable endomorphism ring of a finitely generated module over a finite dimensional symmetric $k$-algebra is a $\mathbb{Z}$-graded $k$-algebra that possesses a natural duality between its positive and negative sides. A consequence of this is that if the non-negative part of the endomorphism ring has a regular sequence of central elements of length 2, then all products between elements of negative degree are trivial. As a corollary we show this holds for the Tate-Hochschild cohomology ring of a symmetric $k$-algebra. We’ll also show the same results hold over a commutative zero-dimensional Gorenstein ring. This is based on joint work with Petter Bergh and Steffen Oppermann.


Abstract: 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 characterize various properties of an algebra $A$ in terms of its module varieties. For example, if $A$ is assumed to have global dimension one, then it is not difficult to show that $A$ has finitely many indecomposable modules (up to isomorphism) 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 (with modification) to higher global dimension. After explaining the background, we present counterexamples to the naive generalizations, along with plausible modifications and cases where these modifications are correct. (Joint work with Calin Chindris and Jerzy Weyman.)

Daniel Labardini-Fragoso: *Tagged triangulations, potentials and cluster monomials.*

Abstract: Linear independence of cluster monomials in skew-symmetric cluster algebras with arbitrary coefficients has been proved recently by Cerulli-Keller-LF-Plamondon. One of the main ideas in the proof had been used before by Cerulli and myself to show the alluded linear independence in the context of (possibly punctured) surfaces with marked points and non-empty boundary. In this talk I will explain this idea and some results on QPs of tagged triangulations that we showed in order to apply it.

Liping Li: *A generalized Koszul theory and its relation to the classical theory.*

Abstract: Koszul theory plays an important role in the representation theory of graded algebras. However, there are a lot of structures (algebras, categories, etc) having natural gradings with non-semisimple degree 0 parts. Particular examples include tensor algebras generated by non-semisimple algebras $A_0$ and $(A_0, A_0)$-bimodules $A_1$, and extension algebras of standard modules of standardly stratified algebras. In this talk we introduce a generalized theory which preserves many classical results and can be applied to the above examples. We also describe its applications to directed $k$-linear categories and a close relation to the classical theory.
Shiping Liu: *Almost split sequences and approximations.*
Abstract: Let $\mathcal{A}$ be an exact category, that is, an extension-closed full subcategory of an abelian category. Firstly, we give a new characterization of almost split sequences in $\mathcal{A}$, which yields some necessary and sufficient conditions for $\mathcal{A}$ to have almost split sequences. In case $\mathcal{A}$ has almost split sequences, we shall provide a necessary and sufficient condition for an exact subcategory of $\mathcal{A}$ to have almost split sequences. Finally, we show two applications of these results.

Ivan Losev: *Crystal for $\text{Rep}(GL_n)$ revisited.*
Abstract: Consider the category $\text{Rep}(GL_n)$ of rational representations of $GL_n$ over an algebraically closed field of positive characteristic. On this category one has two distinguished endo-functors – tensor products with the tautological module and its dual. Each of them decomposes into the direct sum of $p$ endofunctors that leads to a categorical action of the affine algebra $\hat{sl}_p$. This gives rise to a canonical crystal structure on the set of simple $GL_n$-modules. In this talk we will describe this crystal combinatorially. This was done previously by Brundan and Kleshchev. A new feature of our approach is that it works for every categorical Kac-Moody action on a highest weight category modulo some compatibility conditions between the action and the highest weight structure.

František Marko: *Simple modules for Schur superalgebra $S(2|2)$.*
Abstract: We will describe explicitly simple modules for Schur superalgebra $S(2|2)$ over an algebraically closed field $K$ of positive characteristic $p > 2$. Additionally, we determine all decomposition numbers in the process of modular reduction of simple $S(2|2)$-modules of restricted highest weight.

Roberto Martínez Villa: *Dualities in Koszul AS Gorenstein algebras.*
Abstract: The main result in the talk is that for Koszul algebras $\Lambda$ with Yoneda algebra $\Gamma$, such that both $\Lambda$ and $\Gamma$ are graded AS Gorenstein noetherian of finite local cohomology dimension on both sides, there are dualities of triangulated categories: $gr_{\Lambda}[\Omega^{-1}] \simeq D^b(Qgr_{\Gamma})$ and $gr_{\Gamma}[\Omega^{-1}] \simeq D^b(Qgr_{\Lambda})$.

Puiman Ng: *Quotients of the finite derived category $D^b(modkD_5)$ as derived categories.*
Abstract: Let $\mathcal{D}$ be the finite derived category $D^b(modkD_5)$ and consider a certain quotient of $\mathcal{D}$. This quotient category is pretriangulated and is furthermore triangulated. Then by the extensive use of the octahedral axiom of a triangulated category, we are able to describe explicitly the action of the translation functor of the quotient category, and to compare the distinguished triangles between the two categories. Finally, we briefly describe the theorem which shows that this quotient category can also be seen as a derived category.
Steffen Oppermann: *n-Representation infinite algebras.*
Abstract: This talk is based on joint work with Martin Herschend and Osamu Iyama. Iyama introduced a higher version of Auslander-Reiten theory, in which (compared to classic AR-theory) all short exact sequences are replaced by longer exact sequences. In joint work we introduced the notion of n-representation finite algebras as a setup in which his higher AR-theory applies as nicely as possible. It turns out that many statements about representation finite hereditary algebras can be generalized to this setup. In my talk I will first recall the notion of n-representation finiteness, and give some idea what the natural generalization of AR-translation is in this setup. Then I will focus on the question what an appropriate analog of representation infinite hereditary algebras is. I will suggest a definition of n-representation infiniteness, explain some basic properties of n-representation infinite algebras, and finally illustrate how preprojective algebras can be used to get a better picture at least in some (“tame”) cases.

Charles Paquette: *Semi-stable categories for Euclidean quivers.*
Abstract: Let \( k \) be an algebraically closed field and \( Q \) a finite quiver of Euclidean type. The semi-stable subcategories of \( \text{rep}(Q) \) are important objects coming from geometric invariant theory. In the Euclidean case, they are easy to describe. In this talk, I will show what are the possible subcategories arising as intersection of semi-stable categories of \( \text{rep}(Q) \). Contrary to the Dynkin case, these categories are not necessarily semi-stable and do not cover all the thick subcategories of \( \text{rep}(Q) \). This is joint work with C. Ingalls and H. Thomas.

Alice Pavarin: *Recollements from partial tilting complexes.*
Abstract: Joint work with Silvana Bazzoni. From [DG], [Mi] and [J] it is known that every compact object \( Q \) of the derived category \( D(B) \) of a dg-algebra gives rise to a recollement of triangulated categories of the form

\[
\begin{array}{ccc}
\mathbb{L} & \\
Q \otimes \quad & D(B) & \mathbb{L} \\
\mathbb{R} \text{Hom}_B(Q, ?) \quad & \cong \quad & P \otimes_B - \\
\mathbb{R} \text{Hom}_D(P, -) & \longrightarrow & D(D) \\
\end{array}
\]

with \( P = \mathbb{R} \text{Hom}_B(Q, B) \). Following [NS] we show that the left hand term of the recollement above is equivalent to the derived category of a dg algebra \( C \) linked to \( B \) by a homological epimorphism and we study the TTF triple associated to the recollement. A particular case of (?) gives a generalization of the Morita-type theorem proved by Rickard in [R]. As an application we obtain the same result as in [BMT] but with much weaker assumptions. Moreover, our setting generalizes to the case of infinitely generated \( n \)-tilting modules, the results proved recently by [CX] for 1-tilting modules. Finally we characterize when the left hand term of (?) is exactly a ring, introducing the concept of “generalized universal localization”.

[BMT] S. Bazzoni, F. Mantese, and A. Tonolo. *Derived equivalence induced by infinitely*


María Inés Platzeck: Fundamental domains of cluster categories inside module categories.
Abstract: Let $H$ be a finite dimensional hereditary algebra over an algebraically closed field, and let $\mathbb{C}H$ be the corresponding cluster category. In this talk I will give a description of the (standard) fundamental domain of $\mathbb{C}H$ in the bounded derived category $D^b(H)$, and of the cluster-tilting objects, in terms of the category $\text{mod} B$ of finitely generated modules over a suitable tilted algebra $B$. Furthermore, I will explain how this description can be used to obtain (the quiver of) an arbitrary cluster-tilted algebra. This talk reports joint work with Juan A. Cappa and Idun Reiten.

Marju Purin: The generalized Auslander-Reiten condition.
Abstract: A ring $R$ is said to satisfy the Generalized Auslander-Reiten Condition (GARC) if for each $R$-module $M$ with $\text{Ext}_i^R(M; M \otimes R) = 0$ 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 open conjecture, asserts that all Artin algebras satisfy ARC. Examples of rings which do not satisfy GARC have been produced. In this talk we show that GARC is a homological property of a ring that depends only on its derived category. This is joint work with Kosmas Diveris.

Jeremy Russell: A Functorial Approach to Linkage.
Abstract: Martsinkovsky and Strooker generalized the notion of linkage of algebraic varieties to linkage of finitely generated modules over semiperfect noetherian rings. In an unpublished work, Martsinkovsky generalized this definition even further to linkage on the stable module category. This definition works over arbitrary noetherian rings. Using the satellites and injective resolutions, I will explain how to extend the definition of linkage on the stable module category to linkage of finitely presented functors and discuss the relationship between these two notions.
Peter Samuelson: *Skein modules and the quantum torus.*
Abstract: Skein modules are vector spaces associated to 3-manifolds which are functorial with respect to embeddings of manifolds. We review this construction and a result of Frohman and Gelca which shows that the skein module of a knot complement is a module over the $\mathbb{Z}_2$-invariant subalgebra of the quantum torus (where $\mathbb{Z}_2$ acts by inverting $x$ and $y$). We discuss some new results and conjectures about the structure of these modules. If time permits, we may discuss the question of deforming these modules to modules over the double affine Hecke algebra of type $A_1$.

Ralf Schiffler: *On the first Hochschild cohomology of a cluster-tilted algebra.*
Abstract: This is joint work with Ibrahim Assem and Maria Julia Redondo. If $B$ is a cluster-tilted algebra, then there exists a tilted algebra $C$ such that $B$ is the relation extension of $C$. We study the relation between the first Hochschild cohomology of $B$ and $C$. If $B$ is tame or $C$ is constrained we show that this relation is given by an invariant $n\{B, C\}$ which is defined in terms of the bound quivers of $B$ and $C$.

Markus Schmidmeier: *Operations on arc diagrams and degenerations for invariant subspaces of linear operators.*
Abstract: 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 Justyna Kosakowska from Torun.

Salvatore Stella: *Polyhedral models for generalized associahedra via Coxeter elements.*
Abstract: Motivated by the theory of cluster algebras, S. Fomin and A. Zelevinsky have associated to each finite type root system a simple convex polytope called generalized associahedron. It turns out that this purely combinatorial gadget encodes many informations on the associated cluster algebra making it an interesting object to study.
I will describe, after recalling the basic definitions, a family of geometric realizations of these polytopes, parametrized by orientations of the corresponding Dynkin diagram. I will also show that this construction agrees with the one given by C. Hohlweg, C. Lange and H. Thomas in the setup of Cambrian fans developed by N. Reading and D. Speyer.

Hugh Thomas: *Quotient-closed subcategories of the representations of a quiver.*
Abstract: Let $Q$ be a quiver without oriented cycles. We show that the quotient-closed full subcategories of $\text{rep } Q$ 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.
Peter Tingley: Some musings on preprojective algebras.
Abstract: Preprojective algebras play an important role in geometric representation theory of Kac-Moody algebras. However, the notion of a preprojective algebra is older than this work. Here I will describe preprojective algebras as they are typically defined in geometric representation theory, I will explain why these are in fact preprojective algebras according to older definitions, and then I will discuss some interplay between these points of view. I am interested in this because the early work of Dlab-Ringel included preprojective algebras for non-symmetric types, which are usually not considered by the geometric representation theory community. I will finish by mentioning some very recent work with Vinoth Nandakumar showing that some (but not all) of the geometric representation theory results remain true in at least some non-symmetric cases.

Valerio Toledano-Laredo: Stability conditions and Stokes factors.
Abstract: This talk will be concerned with wall-crossing in an abelian category \( \mathcal{A} \), that is the (dis)appearance of semistable objects when varying a stability or slope condition on \( \mathcal{A} \). D. Joyce gave a remarkable construction of a generating function which counts semistable objects in \( \mathcal{A} \) and, unlike the objects themselves, is continuous (in fact, holomorphic) with respect to a change of the stability condition.
I will explain how wall-crossing in \( \mathcal{A} \) is governed by an ODE in the complex plane with an irregular singularity at the origin, and the jumps of semistable objects by the Stokes phenomena of that ODE, that is the discontinuous changes in asymptotics as one crosses the Stokes rays of that ODE. This gives in particular a conceptual explanation of Joyce’s construction, and realizes it as the solution of an appropriate Riemann-Hilbert problem. This is joint work with Tom Bridgeland.

Helene Tyler: The Auslander-Reiten components in the rhombic picture.
Abstract: For an indecomposable module \( M \) over a path algebra of a quiver of type \( \tilde{\mathbb{A}}_n \), 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.

José Vélez-Marulanda: Universal deformations rings of modules over a certain symmetric special biserial algebra.
Abstract: Let \( k \) be an algebraically closed field, let \( \Lambda \) be a finite dimensional \( k \)-algebra and let \( V \) a \( \Lambda \)-module with stable endomorphism ring isomorphic to \( k \). If \( \Lambda \) is self-injective \( V \) has a universal deformation ring \( R(\Lambda, V) \), which is a complete local commutative Noetherian \( k \)-algebra with residue field \( k \). Moreover, if \( \Lambda \) is also a Frobenius \( k \)-algebra then \( R(\Lambda, V) \) is stable under syzygies. We use these facts to determine the universal deformation rings of \( \Lambda(s, t, u, k) \)-modules with stable endomorphism ring isomorphic to \( k \), where \( \Lambda(s, t, u, k) \) is a symmetric special biserial \( k \)-algebra that has quiver with relations depending on the four parameters \( s, t, u \geq 3 \) and \( k \geq 2 \). Our goal is to explain how universal deformation rings change when inflating modules from \( \Lambda(s, t, u, k) \) to \( \Lambda(s', t', u', k') \), where \( \Lambda(s', t', u', k') \) surjects onto \( \Lambda(s, t, u, k) \) when \( s' \geq s, t' \geq t, u' \geq u, k' \geq k \).
Ben Webster: *Category \mathcal{O} for a quiver variety.*
Abstract: One of the best-beloved playgrounds of infinite-dimensional representation theory is the category \mathcal{O} of Bernstein, Gelfand and Gelfand. I’ll show how this is actually a special case of a much more general construction arising naturally in symplectic algebraic geometry, and discuss recent advances of understanding in the quiver variety case with connections to categorical representations of Lie algebras.

Kunio Yamagata: *Morita theory revisited.*
Abstract: In his paper on dualities of module categories (1958), K. Morita gave a characterization for a finite dimensional algebra to be the endomorphism algebra of a faithful module over a finite dimensional self-injective algebra. These endomorphism algebras form a class of algebras properly containing all finite dimensional self-injective algebras. From a joint work with O. Kerner I will introduce a new characterization of the endomorphism algebra, and other related results.

Gufang Zhao: *Noncommutative desingularization of orbit closures for some GL_n-representations.*
Abstract: A noncommutative desingularization of determinantal varieties defined by maximal minors of generic matrices has been studied by Buchweitz, Leuschke, and van den Bergh. In this talk, we generalize their results to the orbit closures of other GL_n-representations. We describe a method to calculate the quiver with relations for any non-commutative desingularizations coming from exceptional collections over partial flag varieties. I will study non-commutative desingularizations of generic determinantal varieties, determinantal varieties defined by minors of generic symmetric matrices, and pfaffian varieties defined by pfaffians of generic skew-symmetric matrices. We introduce the language of equivariant quivers to describe these noncommutative desingularizations more explicitly. For maximal minors of square matrices and symmetric matrices, this gives a non-commutative crepant resolution. This talk is based on my joint work with Jerzy Weyman.