Southern Regional Algebra Conference 2017

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Titles and Abstracts of the Talks

Ulrich Albrecht (Auburn University)

Valuated Baer-Groups

This talk discusses properties of a finite valuated p-group A which are determined by its endomorphism ring R. A pair of contra-variant functors between the categoy of finite valuated p-groups and the category of finite left R-modules is introduced to study the splitting of exact sequences $G \to A^n \to 0$ of valuated p-groups with $n < \omega$.

Irfan Bagci (University of North Georgia)

Weyl Modules and Weyl Functors for Lie Superalgebras

Given an algebraically closed field k of characteristic zero, a Lie superalgebra $\mathfrak{g}$ over k and an associative, commutative k-algebra A with unit, a Lie superalgebra of the form $\mathfrak{g} \otimes_k A$ is known as a map superalgebra. Recently, in joint work with L. Calixto and T. Macedo, we extended the definition of global and local Weyl modules for all map superalgebras where $\mathfrak{g}$ is either $\mathfrak{sl}(n, n)$ with $n \geq 2$, or a finite-dimensional simple Lie superalgebra not of type $\widetilde{S}(n)$ or $\mathfrak{q}(n)$. Under some mild assumptions, we proved that global and local Weyl modules satisfy certain universal, finiteness and tensor product decomposition properties. We also defined Weyl functors associated to $\mathfrak{g} \otimes_k A$ and proved that they satisfy some interesting homological properties.

Malik Bataineh (Jordan University of Science and Technology)

On Almost 2-Absorbing Primary Ideals in Commutative Rings

Let R be a commutative ring with $1 \neq 0$. Various generalizations of primary ideals have been studied. For example, a proper ideal I of R is 2-absorbing primary (resp., weakly 2-absorbing primary) if $a, b, c \in R$ with $abc \in I$ (resp., $0 \neq abc \in I$) implies $ab \in I$ or $ac \in \sqrt{I}$ or $bc \in \sqrt{I}$.

In this paper we introduce the concept of almost 2-absorbing primary ideal as a new generalization of primary ideals. A proper ideal I of R is called an almost 2-absorbing primary ideal of R whenever $a, b, c \in R$ and $abc \in I - I^2$, then $ab \in I$ or $ac \in \text{Rad}(I)$ or $bc \in \text{Rad}(I)$. A number of results concerning almost 2-absorbing primary ideals such as their properties and their relation to other primary ideals will be given. Also we will classify all rings for which every proper ideal is an almost 2-absorbing primary ideal.

Selvi Beyarslan (Tulane University)

Regularity of Powers of Unicyclic Graphs

Let G be a finite simple graph and let $I(G)$ denote the corresponding edge ideal. In this talk, we present that if G is a unicyclic graph, then for all $s \geq 1$ the regularity of $I(G)^s$ is exactly $2s + \text{reg}(I(G)) - 2$. We also provide the characterization of unicyclic graphs with regularity $\nu(G) + 1$ and $\nu(G) + 2$, where $\nu(G)$ denotes the induced matching number of G.

Gary Birkenmeier (University of Louisiana at Lafayette)

A Description of Indecomposable Quasi-Frobenius Rings

In this talk, we characterize a nilary QF-ring R in terms of the essentiality of the ideals ReR where e is a primitive idempotent of R. Recall that a ring R is nilary if $AB = 0$ implies either A or B is nilpotent for all ideals A and B of R. Note that nilary rings are indecomposable rings. This is a preliminary report on joint research with Omar A. Al-Mallah and Hafedh M. Al-Noghashi.

Mahir Can (Tulane University)

Geometry and Structure of Spherical Double Cones

Towards understanding tensor products of representations of algebraic groups, in the early 90's Littelmann initiated a study of spherical actions on products of Grassmannians. By the works of Magyar, Zelevinsky, Weyman for types A and C, and by Stembridge in all types, we now have a complete classification of all spherical diagonal actions on products of partial flag varieties. In particular, Stembridge completed the classification of multiplicity-free products. It turns out, understanding of such diagonal actions holds the key to understand all spherical subgroups of a given connected reductive group. Towards this lofty goal, in this talk, we are going to present our recent work on spherical double cones extending some results of Littelmann to arbitrary products of partial flag varieties.

Jon Carlson (University of Georgia)

Computing with Matrix and Basic Algebras

We discuss some problems in the computation of standard structures, such as a Wedderburn decomposition, for a matrix algebra. A basic algebra is a finite dimensional algebra for which all of the simple modules have dimension one. Every matrix algebra is Morita equivalent to a basic algebra, meaning that they have the same representation theory. We discuss what this means and the means for extracting the basic algebra from a matrix algebra. Several examples and some open problems are on display.

Tianran Chen (Auburn University at Montgomery)

The Root Counting Problem – Tropical Connections

The problem of computing or estimating the number of roots of a system of polynomial equations is an important problem in mathematics that has a wide range of applications. In this talk we briefly review the important algebraic results in this area and highlight recent developments that directly connect to tropical geometry.

Christopher Cyr (University of Florida)

Nilpotent Subgroups and Semipermutability in some Simple Groups

In recent years, many authors have explored several different generalizations of the idea of permutability of subgroups. One such concept, called S-semipermutability, requires a subgroup H of G to permute with every Sylow p-subgroup of G for every prime $p \in \pi(G) \setminus \pi(H)$. We show that a 2014 conjecture of Martin Isaacs on the normal closure of a nilpotent, S-semipermutable subgroup, while false in general, holds for several families of simple groups, including the alternating, sporadic, projective special linear, and symplectic groups. An important observation along the way is that solvable subgroups of these simple groups cannot have too many prime divisors compared to the group itself.

Jimmy Dillies (Georgia Southern University)

Example of an Automorphism of a K3 Surface

We explain a geometric and combinatorial way to construct projective models of K3 surfaces with given automorphisms. The ideas will be illustrated with the example of a K3 surface studied by Al Tabbaa et al. which had no known model.

Trung Hoa Dinh (Auburn University)

On the Characterization of Operator Monotone Functions

The theory of operator monotone functions was firstly studied and developed by Loewner in 1930. Nowadays, this theory plays an important role in quantum information theory as well as in operator theory. In this talk, I present a new characterization of operator monotone functions by using the reverse arithmetic-geometric mean inequality.

Christopher Drupieski (DePaul University)

Some $\mathbb{Z}/2\mathbb{Z}$-Graded Analogues of One-Parameter Subgroups and Applications to the Cohomology of $GL_{m|n(r)}$

In the late 1990's, Suslin, Friedlander, and Bendel showed, in analogy to Quillen's results for finite groups, that the cohomology variety of an infinitesimal group scheme G identifies with the variety of infinitesimal one-parameter subgroups $\nu : \mathbb{G}_{a(r)} \to G$. Here r denotes the height of G, and $\mathbb{G}_{a(r)}$ is the r-th infinitesimal Frobenius kernel of the additive group scheme $\mathbb{G}_a$. In this talk I will discuss joint work with Jonathan Kujawa in which we begin to extend these results to graded group schemes, or equivalently to finite-dimensional cocommutative Hopf superalgebras. In particular, I will discuss our progress toward describing the cohomology variety of $GL_{m|n(r)}$, the r-th Frobenius kernel of the general linear supergroup $GL_{m|n}$.

Jason Elsinger (Spring Hill College)

Representations of Lattice Vertex Algebras, Trace Functions, and Modular Transformations

A lattice vertex algebra is an algebraic structure associated to an even lattice. Any group of automorphisms of the lattice naturally extends to a group of automorphisms of the lattice vertex algebra. An important problem is to classify the irreducible modules for the subalgebra of fixed points, known as an orbifold. In this talk I will describe the classification of orbifold modules for the case of a general order two automorphism. I will then discuss an alternative approach to studying the representation theory of orbifold modules for higher order automorphisms using trace functions. It has been known that the set of irreducible characters for the orbifold is closed under modular transformations and I will discuss how these transformations relate to the representation theory. I will also showcase the general results using the A_3 root lattice and calculate the S-matrix for the corresponding orbifold.

Wei Gao (Auburn University)

Tree Sign Patterns that Require $\mathbb{H}_n$

A sign pattern (matrix) $\mathcal{A}$ is a matrix whose entries are from the set $\{+, -, 0\}$. The qualitative class of $\mathcal{A}$, denoted $Q(\mathcal{A})$, is defined as $Q(\mathcal{A}) = \{B \in M_n(\mathbb{R}) \mid \mathrm{sgn}(B) = \mathcal{A}\}$. The refined inertia of a square real matrix B, denoted $\mathrm{ri}(B)$, is the ordered 4-tuple $(n_+(B),\ n_-(B),\ n_z(B),\ 2n_p(B))$, where $n_+(B)$ (resp., $n_-(B)$) is the number of eigenvalues of B with positive (resp., negative) real part, $n_z(B)$ is the number of zero eigenvalues of B, and $2n_p(B)$ is the number of pure imaginary eigenvalues of B. For $n \geq 3$, the set of refined inertias $\mathbb{H}_n = \{(0, n, 0, 0), (0, n-2, 0, 2), (2, n-2, 0, 0)\}$ is important for the onset of Hopf bifurcation in dynamical systems. An $n \times n$ sign pattern $\mathcal{A}$ is said to require $\mathbb{H}_n$ if $\mathbb{H}_n = \{\mathrm{ri}(B) | B \in Q(\mathcal{A})\}$. Bodine et al. conjectured that no $n \times n$ irreducible sign pattern that requires $\mathbb{H}_n$ exists for n sufficiently large, possibly $n \geq 8$.

In this talk, we discuss the star and path sign patterns that require $\mathbb{H}_n$. It is shown that for each $n \geq 5$, a star sign pattern requires $\mathbb{H}_n$ if and only if it is equivalent to one of the five sign patterns identified in the talk. This resolves the above conjecture. It is also shown that no path sign pattern of order $n \geq 5$ requires $\mathbb{H}_n$.

Anthony Giovannitti (Clayton State University)

Quasi-Representing Graphs of Partially Ordered Sets

In 1987, D. Arnold and C. Vinsonhaler introduced the concept of a quasi-representing graph associated with co-rank one subgroups of finite rank completely decomposable torsionfree abelian groups. The author in 1989 showed that the projective dimension of the category of Λ-Butler groups (where Λ is a finite sub-lattice of the isomorphism classes of subgroups of the rationals, known as types) is less than or equal to 1 if and only if no crown can be embedded as a pseudo-convex sub-poset of the poset of join irreducible types of Λ. In this paper it was alluded that certain decompositions of these graphs will induce decompositions of the groups associated with them. In this talk we will prove why this is so and show how other graph properties imply properties of these classes of co-rank one models. We will also consider what needs to hold in order for these results to hold for Butler categories of modules over integral domains.

Daryl Granario (Auburn University)

Ballantine's Theorem on $\mathrm{Sp}(2n, \mathbb{C})$

In a series of papers, Ballantine studied products of positive definite matrices and showed that every matrix with positive determinant is a product of at most five positive definite matrices. In this talk, we consider products of symplectic positive definite matrices and look at analogs of Ballantine's results for the symplectic group $\mathrm{Sp}(2n, \mathbb{C})$.

Mark Greer (University of North Alabama)

Going to Loops from Groups through Baer

Given a group of odd order, Baer gave two binary operations, and depending on the nilpotency of the group, this gave rise to abelian groups. Our interest will be when these new structures become nonassociative loops. The first example using these constructions in a nonassociative setting is due to Glauberman, concerning Bruck and Moufang loops. Glauberman was able to prove, among many other things, an Odd Order Theorem for both varities. Recently, the same ideas have been used with automorphic loops, again giving an Odd Order Theorem. We will discuss these results as well as current research and open problems.

Lauren Grimley (Spring Hill College)

Group Extensions of Quantum Exterior Algebras

Quantum complete intersections are a non-commutative analog of truncated polynomial rings. The cohomology of these algebras is completely determined by the choice of non-commutative scalars, giving a large class of algebras with prescribed cohomological behavior. For example, quantum exterior algebras, the smallest dimensional quantum complete intersections, were used to disprove the conjecture that finite Hochschild cohomology implies finite global dimension. In this talk, we explore group extensions of quantum exterior algebras and their related algebras using Hochschild cohomology.

Zhuo-Heng He (Auburn University)

The Complete Equivalence Canonical Form of Four Matrices over an Arbitrary Division Ring

In this talk, we give the complete structure of the equivalence canonical form of four matrices over an arbitrary division ring $\mathcal{F}$ with compatible sizes: $A \in \mathcal{F}^{m\times p}$, $B \in \mathcal{F}^{m\times q}$, $C \in \mathcal{F}^{s\times p}$, and $D \in \mathcal{F}^{t\times p}$. As applications, we derive some practical necessary and sufficient conditions for the solvability to some systems of generalized Sylvester matrix equations using the ranks of their coefficient matrices. The results of this paper are new and available over the real number field, the complex number field, and the quaternion algebra.

Daniel Herden (Baylor University)

More on Local Automorphisms of FI(P)'s

In 2009, Khripchenko and Novikov introduced the finitary incidence algebra $FI(P)$ as an attempt at generalizing Stanley's classical definition of incidence algebras over a fixed commutative ring R with 1 from locally finite to arbitrary posets $(P, \leq)$. In this talk we will discuss some of our latest results on the local automorphisms of $FI(P)$'s, where we call an R-linear map $\eta : FI(P) \longrightarrow FI(P)$ a local automorphism if for every $f \in FI(P)$ there exists some $\varphi_f \in \mathrm{Aut}(FI(P))$ with $\eta(f) = \varphi_f(f)$. This is joint work with M. Dugas and J. Courtemanche.

Huajun Huang (Auburn University)

Upper Triangular Similarity of Upper Triangular Matrices

The upper triangular similarity class of an upper triangular matrix is determined by those of some strictly upper triangular matrices. This talk will survey the progress on classifying the upper triangular similarity classes of strictly upper triangular matrices. The canonical forms of these classes will be analyzed.

Kodithuwakku Indika (Auburn University)

Symmetry Classes and the Idempotent Property of a Symmetrizer

Certain relationships between symmetry classes of tensors associated with different types of characters of the dihedral group will be discussed, emphasising the importance of the idempotent property of certain symmetrizers in identifying some of these relationships. Furthermore, an orthogonality relation associated with p-blocks of a finite group, which is analogous to the generalized orthogonality relation for characters of a finite group will be discussed.

Michael Joyce (Tulane University)

Combinatorial Models for Complete Quadrics

The study of cellular decomposition and intersection theory on flag varieties has led to the development of rich ideas in combinatorics, algebra and representation theory. Flag varieties are the simplest examples of spherical varieties, and it is expected that this wider class of varieties also will lead to interesting connections with other areas of mathematics. In this talk, we will discuss one concrete example, the variety of complete quadrics. Studying a cellular decomposition leads to the combinatorial notion of barred permutations, while studying the Borel orbit structure leads to the combinatorial notion of degenerate involutions. We give some examples of how the geometry of complete quadrics can be described in combinatorial terms.

Zekeriya Karatas (Tuskegee University)

Metaquasihamiltonian Groups of Infinite Rank

The study of groups with certain conditions on their subgroups has a rich and long history. Recently, the structure of the groups whose subgroups have certain rank conditions have been studied by many famous mathematicians. In a recent paper, the authors determined the structure of a group with three conditions on its subgroups. This is the first example of a paper in which groups with three conditions on their subgroups were studied. In this talk, I will give some results about infinite rank $\mathfrak{X}$-groups in which every non-abelian subgroup is permutable or of finite rank, which will generalize some parts of that recent work. I will give the definitions, well-known results and some history about these type of problems as well.

This is joint work with Martyn R. Dixon.

Young Jo Kwak

Automorphisms of the Lie Algebra $\mathfrak{so}(n, \mathbb{K})$ that can not be seen

The outer automorphisms of a group G are defined as the quotient group $\mathrm{Aut}(G)/\mathrm{Inn}(G)$ where the inner automorphisms $\mathrm{Inn}(G)$ are the conjugations on G. Let $L_0 = L_0(n, \mathbb{K}) = \mathfrak{so}(n, \mathbb{K})$ be the Lie algebra of skew-symmetric matrices over an arbitrary field $\mathbb{K}$. The group of automorphisms of L_0 is defined as $\mathrm{Aut}(L_0) := \{\varphi \in \mathrm{GL}(L_0) : \varphi([x, y]) = [\varphi(x), \varphi(y)]\ \forall x, y \in L_0\}$. Steinberg replaced the classical theory over BC by BK using a Chevalley basis.

We can describe the inner automorphisms $\mathrm{Int}(L_0)$ over BK and then the automorphism $\mathrm{Aut}(L_0)$ over BK can be obtained from $\mathrm{Aut}(L_0) \cong \mathrm{Int}(L_0) \rtimes \mathfrak{S}_{\mathcal{P}}$. The group $\mathfrak{S}_{\mathcal{P}}$ is called the group of opposition automorphisms and is depending on n and $\mathbb{K}$. They are easy to determine from the Dynkin diagram of L_0. However, they cannot be seen without the root system of L_0.

Enkeleida Lakuriqi (Georgia Southern University)

Using Mirrors to Predict Symmetry

Since the work of Borcea and Voisin, we know how K3 surfaces with non-symplectic involutions come in mirror pairs. Studying automorphisms of higher order is often difficult as sub-lattices of the K3 lattice can be relatively large. Using mirror symmetry, we suggest a method for detecting potential K3 surfaces with given symmetry.

Richard LeBlanc (Saint Mary's Hall)

FI-Extending Hulls of Abelian Groups

Let G be an abelian group. Then G is an FI-extending group if every fully invariant subgroup is essential in a direct summand. In the paper *The Fully Invariant Extending Property For Abelian Groups* by Birkenmeier et al., a full characterization was obtained for torsion abelian groups with the FI-extending property. In this work, we investigate abelian groups G for which there is a group H which is "minimal" (in some sense) among FI-extending groups containing G. Here we say that G has an FI-extending hull, H, if

- H is FI-extending.
- If X is an FI-extending group such that $G \leq X \leq H$, then $X = H$.
- H is an essential extension of G.

In particular, for a torsion group G, we construct a hull $\overline{G}$ such that $\overline{G}$ is FI-extending and $G \hookrightarrow \overline{G}$ via a height preserving monomorphism. Examples will be provided to illustrate the main results of this work.

This is joint work with Gary F. Birkenmeier.

Enoch Lee (Auburn University at Montgomery)

On Right Intrinsic Ring Extensions

Faith and Utumi defined a ring extension R of S to be (right) intrinsic over S if $A \cap S \neq 0$ for each non-zero right ideal A of R. Essential extensions of modules and injective modules are important concepts in module theory. We study the basic properties of these ring extensions. In particular, we investigate if a maximal right intrinsic ring extension exists for a given ring.

Mark Lewis (Kent State University)

Ultraspecial p-Groups

A group G is a semiextraspecial p-group if it is a p-group, where when M is a maximal subgroup of $Z(G)$, then G/M is an extraspecial group. A group G is ultraspecial if G is semiextraspecial and $|G : Z(G)| = |Z(G)|^2$. We will survey results that show that the ultraspecial groups G with at least two abelian subgroups of order $|G : Z(G)|$ can be classified in terms of semifields. We will then show how this can used to construct all ultraspecial groups G with one abelian subgroup of order $|G : Z(G)|$.

Jianzhen Liu (Auburn University)

Star-Shapedness and Adjoint Orbits Associated with Semisimple Lie Algebras

Given an $n \times n$ matrix A, the celebrated Toeplitz-Hausdorff theorem asserts that the classical numerical range $\{x^*Ax : x \in \mathbb{C}^n : x^*x = 1\}$ is a compact convex set, where $\mathbb{C}^n$ is the vector space of complex n-tuples and x^* is the complex conjugate transpose of $x \in \mathbb{C}^n$. Among many interesting generalizations, we will focus our discussion on those in the context of Lie structure, more precisely, compact connected Lie groups and semisimple Lie algebras. We will present some interesting results and open problems on convexity and star-shapedness.

Klaus Lux (University of Arizona)

Basic Algorithms in the Representation Theory of Groups and Algebras

This talk will be a survey of the existing computational methods for studying representations of finite groups and finite dimensional algebras. The first part of the talk will be dedicated to the description of several algorithms that determine the character table of a given finite group. In the second part, we will discuss the algorithmic solutions to some fundamental questions about representations in finite characteristic.

Joshua Maglione (Colorado State University)

Computing New Isomorphism Invariants of Groups

We introduce a general method to make a series of isomorphism invariant subgroups, i.e., characteristic subgroups. Even in the extreme case where the only known characteristic subgroup is the commutator, this method can produce maximal characteristic series. We prove that this can be computed efficiently, which led to a test on a half billion 2-groups of class 2 – groups for which isomorphism invariants are least known. We succeeded in identifying new subgroups in about 97% of the groups we surveyed, and our approach can be adapted for further improvement. Our strategy uses techniques from multilinear algebra, module theory, and ring theory. We report on individual and joint work with J.B. Wilson.

Nham Ngo (University of North Georgia)

Rational Singularities of G-Saturation

Let G be a semisimple algebraic group defined over an algebraically closed field k of characteristic 0 and P a parabolic subgroup of G. Let M be a P-module and V a P-stable closed subvariety of M. In this talk, I will present some recent results on rational singularities of the G-saturation variety $G \cdot V$. In particular, if the varieties

V and $G \cdot M$ have rational singularities, and the induction functor $R^i\text{ind}_P^G(-)$ satisfies certain vanishing conditions, then the variety $G \cdot V$ has rational singularities. This generalizes a result of Kempf on the collapsing of homogeneous bundles.

Bach Nguyen (Louisiana State University)

Noncommutative Discriminants: Applications and Recent Progress

In a noncommutative setting, the concept of a discriminant has been applied to study orders and lattices of central simple algebras. With recent developments due to Bell, Ceken, Palmieri, Wang, and Zhang, new applications of noncommutative discriminants have been found in the quest of understanding automorphism groups of PI algebras and other related problems. In this talk, we will discuss these newfound applications and survey the recent progress in understanding discriminants of noncommutative algebras.

Venkata Pantangi (University of Florida)

Smith and Critical Groups of some Graphs Arising from Rank 3 Permutation Groups

The Smith and critical groups of a graph are interesting invariants. The Smith group of a graph is the abelian group whose cyclic decomposition is given by the Smith normal form of the adjacency matrix of the graph. The critical group is the finite part of the abelian group whose cyclic decomposition is given by the Smith normal form of the Laplacian matrix of a graph.

An active line of research has been to calculate the Smith and critical groups of families of strongly regular graphs. In this presentation, we shall find the elementary divisors of the strongly regular graph associated with the rank 3 permutation action of the symplectic group. This is joint work with Peter Sin.

John Perry (University of Southern Mississippi)

A Dynamic Buchberger Algorithm

Gröbner bases are a major tool in commutative algebra, typically computed using the Buchberger algorithm. This algorithm is "static" in that it works with a fixed term ordering, required as input along with the ideal's generators. In many cases, however, a "dynamic" Buchberger algorithm is more appropriate: it requires only the generators as input, and returns both a basis and an ordering that guarantees the Gröbner property. It computes the ordering by the guidance of a criterion inspired by an invariant of an ideal. This talk describes the algorithm, the traditional criterion to guide computation, and a new criterion.

Elena Poletaeva (University of Texas - Rio Grande Valley)

On Finite W-Algebras for Lie Algebras and Superalgebras in the Non-Regular Case

A finite W-algebra is a certain associative algebra attached to a pair $(\mathfrak{g}, e)$, where $\mathfrak{g}$ is a complex semisimple Lie algebra and $e \in \mathfrak{g}$ is a nilpotent element.

E. Ragoucy and P. Sorba described the finite W-algebra when $\mathfrak{g} = \mathfrak{gl}(n)$ and e consists of Jordan blocks of the same size. J. Brundan and A. Kleshchev generalized their result to an arbitrary nilpotent element.

We describe the finite W-algebra for the queer Lie superalgebra $Q(n)$ when e is an even nilpotent element whose Jordan blocks are of the same size. We discuss the case when e is an arbitrary nilpotent element.

This is joint work with Vera Serganova.

Basanti Poudyal (University of Texas at Arlington)

Existence of Totally Reflexive Modules in the Absence of Exact Zero Divisors

Let (A, m) be a Noetherian local graded ring whose Hilbert series is $1 + et + (e-1)t^2$. It is known that the existence of exact zero divisors implies the existence of non-free totally reflexive modules. We are interested in the existence of these modules in the absence of exact zero divisors. In a recent study, Vraciu and Atkins constructed an example of a ring of codimesion 8 that does not have exact zero divisors, but has non-free totally reflexive modules. In this talk, we will give a class of rings of codimension 5 and higher admitting totally reflexive modules, but without having exact zero divisors.

Matthew Ragland (Auburn University at Montgomery)

An Alternate Proof to Derek Robinson's 1968 Local Characterization Theorem on T-Groups

In 1968 Derek Robinson proved that G is a finite solvable T-group if and only if for every prime p every p-subgroup P of G is normalized by the normalizer of any Sylow p-subgroup of G containing P. The 1968 paper containing the result has been referenced at least 92 times according to Google Scholar. Derek Robinson's proof requires use of the transfer homomorphism and powerful transfer theorems such as Grün's First Theorem and Frobenius's Criterion for p-Nilpotence. I will present a proof that only relies on a simple induction argument and first principles of group theory.

Lucius Schoenbaum (University of South Alabama)

Categorical Semantics and the Lawvere-Tierney Theory of Toposes

Recently the notion of ideal topos was introduced based on an extension of the Curry-Howard correspondence. The observation motivating these abstractions is that topos theory has a wider purview than was previously known, i.e., several results generalize including the slice theorem (regarded by Freyd as the fundamental theorem of topos theory) and the Lawvere-Tierney theorem on elementary and Grothendieck toposes. In this talk, we will discuss aspects of these developments, in particular the motivation coming from categorical semantics for programming languages and type theory, also touching on higher category theory and synthetic differential geometry (topics that are related to topos theory and ideal toposes in ways we will explain).

Leonard Scott (The University of Virginia)

Computing Individual Kazhdan-Lusztig Basis Elements

I will first discuss some new ways of computing Kazhdan-Lusztig polynomials from "Computing individual Kazhdan-Lusztig basis elements," *Journal of Symbolic Computation* **73** (2016), 244–249, a paper coauthored by myself and a former undergraduate student, Tim Sprowl. The paper's main innovation is that it can compute a given desired Kazhdan-Lusztig polynomial, or, more accurately, the family of polynomials associated with a single given Kazhdan-Lusztig basis element, in a largely non-recursive way.

Next, as time permits, I will mention some of the applications of Kazhdan-Lusztig polynomials which interest me, and some open computational problems that might interest mathematicians in the audience and their students.

Tony Se (University of Mississippi)

The Cohen-Macaulay Property of Affine Semigroup Rings in Dimension 2

Let k be a field. We consider a subring $R = k[x^a, x^{p_1}y^{q_1}, \ldots, x^{p_t}y^{q_t}, y^b]$ of the polynomial ring $k[x, y]$. We will give simple numerical criteria for the ring R to be Cohen-Macaulay when $t = 2$. We will also give a simple algorithm that generates the monomial k-basis of $R/(x^a, y^b)$. This is joint work with Grant Serio.

Prasad Senesi (The Catholic University of America)

The Root System of a Linear Voting Method

In an election with ballots consisting of full rankings of n candidates, the Borda Count method of voting provides a full aggregate numerical ranking of the candidates. This method is naturally generalized by replacing the standard weights of the Borda Count by a weight vector in an n-dimensional vector space, yielding the so-called positional voting methods, or by replacing fully-ranked ballots with those in the shape of a composition of n, with multiple positions available for each 'place'.

Building upon a vector space of profiles introduced by Donald Saari in the 1990's, Michael Orrison and colleagues used methods from the representation theory of the symmetric group's action on compositions to study these positional and other voting methods. In this talk we will use the standard Euclidean inner product on this vector space to show how the neutrality of a positional voting method is combinatorially manifested by the appearance of a type A root system in this vector space of profiles, and conversely how this root system can be used to construct any neutral positional voting method.

Piyush Shroff (Texas State University)

Relationship between Color Lie Algebras and Quantum Drinfeld Orbifold Algebras

We examine PBW deformations of finite group extensions of skew polynomial rings, in particular, the quantum Drinfeld orbifold algebras defined by the first author. We give a homological interpretation, in terms of Gerstenhaber brackets, of the necessary and sufficient conditions on parameter functions to define a quantum Drinfeld orbifold algebra, thus clarifying the conditions. In case the acting group is trivial, we determine conditions under which such a PBW deformation is a generalized enveloping algebra of a color Lie algebra; our PBW deformations include these algebras as a special case.

This is joint work with Sarah Witherspoon.

Tin-Yau Tam (Auburn University)

Hyperbolic Geometry and Geometric Mean of Positive Definite Matrices

In this talk we will discuss the geometry and inequalities associated with the geometric mean of two $n \times n$ positive definite matrices, which was introduced by W. Pusz and S. L. Woronowicz. The space of $n \times n$ positive definite matrices of determinant 1 is a Riemannian manifold and its geometry is hyperbolic. We show that geodesic convexity emerges when a natural pre-order called log majorization is introduced to the manifold. We also derive several inequalities for the geometric mean and some inequalities reflecting the hyperbolic geometry of the manifold.

Simplice Tchamna-Kouna (Georgia College)

Kronecker Function Rings and Flat Epimorphic Ring Extensions

Knebusch and Kaiser develop a more general construction of the Kronecker function ring $\mathrm{Kr}_1(\star)$ of a ring extension $R \subseteq S$ with respect to a star operation $\star$. We characterize in several ways the Kronecker function ring as defined by Knebusch and Kaiser. In particular, we focus on the case where $R \subseteq S$ is a flat epimorphic extension or a Prüfer extension. We introduce a new class of rings which we denote $\mathrm{Kr}_2(\star)$. We construct examples of ring extensions for which $\mathrm{Kr}_1(\star) \neq \mathrm{Kr}_2(\star)$, and we give equivalent conditions under which the two rings $\mathrm{Kr}_1(\star)$ and $\mathrm{Kr}_2(\star)$ are equal.

This is joint work with Lokendra Paudel.

Kurt Trampel (Louisiana State University)

Computing Noncommutative Discriminants via Poisson Primes

We will present a general method for computing discriminants of noncommutative algebras obtained from specialization at roots of unity. This method builds a connection with Poisson geometry and will express the discriminants as products of Poisson primes. The method will be used to compute the discriminants of specializations at roots of unity of algebras of quantum square matrices, $R_\epsilon[M_n]$. We will also evaluate the more general case of specialization of any quantum Schubert cell algebra, $\mathcal{U}_\epsilon^-[w]$.

Robert Underwood (Auburn University at Montgomery)

The Structure of Hopf Algebras Acting on Galois Extensions

Let $K/\mathbb{Q}$ be a Galois extension with group G and let λ be the left regular representation of G in $\mathrm{Perm}(G)$. By Greither-Pareigis theory, there is a one-to-one correspondence between Hopf-Galois structures on $K/\mathbb{Q}$ and regular subgroups of $\mathrm{Perm}(G)$ normalized by $\lambda(G)$. The Hopf algebras constructed in this manner are finite dimensional algebras over $\mathbb{Q}$. In this talk, we discuss the Wedderburn-Malcev decomposition of these Hopf algebras.

Andrew Wang (Kishwaukee College)

An Alternative to the Exchange Condition in Coxeter Hypergroups

Hypergroups generated by involutions are Coxeter if they satisfy the constrained and exchange conditions. These conditions govern the multiplication of the hypergroup; in particular, the exchange condition generalizes the exchange condition for Coxeter groups.

In this talk we examine an alternate and weaker condition of the exchange condition for constrained hypergroups. We show in all but a few cases that our condition forces the exchange condition to be true. As hypergroups generalize association schemes, this result can be applied to constrained schemes as well.

Yong Yang (Texas State University)

On p-Parts of Character Degrees

Let G be a finite group and P be a Sylow p-subgroup of G, it is reasonable to expect that the degrees of irreducible characters of G somehow restrict the structure of P. The Ito-Michler theorem proves that each ordinary irreducible character degree is coprime to p if and only if G has a normal abelian Sylow p-subgroup. Of course, this implies that $|G : F(G)|_p = 1$ where $F(G)$ is the Fitting subgroup of G.

Let G be a finite group and $\mathrm{Irr}(G)$ the set of irreducible complex characters of G. Let $e_p(G)$ be the largest integer such that $p^{e_p(G)}$ divides $\chi(1)$ for some $\chi \in \mathrm{Irr}(G)$. In this talk, we show that $|G : F(G)|_p \leq p^{ke_p(G)}$ for a constant k. This settles a conjecture of A. Moretó. This is a joint work with Guohua Qian.

Pingping Zhang (Auburn University, Chongqing University)

A Further Extension of Rotfel'd Theorem

We prove an inequality for concave functions and partitioned matrices whose numerical ranges lie in a sector. This complements a theorem by E.Y. Lee concerning the positive semi-definite case.

Paul-Hermann Zieschang (University of Texas - Rio Grande Valley)

A Survey on Hypergroups

A hyperoperation on a set H is a map which assigns to any two elements of H a non-empty subset of H and satisfies three conditions which are similar to the defining conditions of a group. Hypergroups are sets endowed with a hyperoperation. They generalize association schemes (which generalize groups).

In my talk, I will first display the relationship between hypergroups and association schemes. After that, I will discuss the relationship between hypergroups and Tits buildings. Finally, I will exhibit several elementary structural results on hypergroups.