Atlantic Association for Research in Mathematical Sciences
Fields Institute for Research in Mathematical Sciences
Memorial University of Newfoundland

Atlantic Algebra Centre
Network of Ontario Lie Theorists

Enveloping Algebras and Representation Theory

International Workshop

August 28 - September 1, 2014

Memorial University
St. John's, NL

Schedule

Abstracts of Talks

Thursday, August 28, 2014

9:00 - 9:30	**Registration**
9:30 - 10:20	**Victor Kac** *Massachusetts Institute of Technology, USA* Algebraic theory of integrable systems
10:30 - 11:00	**Coffee Break**
11:00 - 11:50	**Anthony Joseph** *Weizmann Institute, Israel* Zhelobenko invariants and the Kostant Clifford algebra conjecture. I
12:00 - 2:00	**Lunch Break**
2:00 - 2:50	**Vladislav Kharchenko** *Universidad Nacional Autónoma de México* Quantizations of Kac-Moody Algebras and Explicit Formula for Coproduct. I
3:00 - 3:50	**Vladimir Mazorchuk** *University of Uppsala, Sweden* Homological properties of the category $\mathcal{O}$, part 1: invariants of structural modules
4:00 - 4:30	**Coffee Break**
4:30 - 4:50	**Earl Taft** *Rutgers University, USA* Is there a left quantum group containing quantum $U_q(sl(2))$?
5:00 - 5:20	**Sara Madariaga** *University of Saskatchewan* Jordan quadruple systems
5:30 - 5:50	**María del Carmen Rodríguez Vallarte** *Universidad Autónoma de San Luis Potosí, Mexico* Contact Lie algebras

Friday, August 29, 2014

9:30	-	10:20	**Ivan Shestakov** *Unversity of São Paulo, Brazil* Multiplicative universal enveloping algebra
11:00	-	11:50	**Vladimir Mazorchuk** *University of Uppsala, Sweden* Homological properties of the category $\mathcal{O}$, part 2: Alexandru conjecture
12:00	-	2:00	**Lunch Break**
2:00	-	2:50	**Alberto Elduque** *Univeristy of Zaragoza, Spain* Graded modules over classical simple Lie algebras
3:00	-	3:50	**Vladislav Kharchenko** *Universidad Nacional Autónoma de México* Quantizations of Kac-Moody Algebras and Explicit Formula for Coproduct. II
4:00	-	4:30	**Coffee Break**
4:30	-	4:50	**Brendan Frisk Dubsky** *University of Uppsala, Sweden* Category $\mathcal{O}$ for the Schrödinger Algebra
5:00	-	5:20	**Jonathan Nilsson** *Uppsala University, Sweden* Simple Lie algebra modules which are free over $U(\mathfrak{h})$
5:30	-	5:50	**Changlong Zhong** *University of Alberta* Equivariant oriented cohomology theory and formal Demazure algebra

Sunday, August 31, 2014

9:30 - 10:20	**Alexander Premet** *University of Manchester, UK* Regular derivations of truncated polynomial rings
10:30 - 11:00	**Coffee break**
11:00 - 11:50	**Anthony Joseph** *Weizmann Institute, Israel* Zhelobenko invariants and the Kostant Clifford algebra conjecture. II
12:00 - 2:00	**Lunch Break**
2:00 - 2:50	**Vyacheslav Futorny** *University of São Paulo, Brazil* Representations of Weyl algebras and Affine Kac-Moody algebras
3:00 - 3:50	**Yuly Billig** *Carleton University* Classification of simple weight module for the Lie algebra of vector fields on a torus
4:00 - 4:30	**Coffee Break**
4:30 - 4:50	**Alexandr Kornev** *Federal University of ABC-São Paulo, Brazil* The imbedding of the alternative and Malcev algebras into associative algebras with involution
5:00 - 5:20	**Uladzimir Yahorau** *University of Ottawa* Conjugacy Theorem For Extended Affine Lie algebras
5:30 - 5:50	**Caroline Junkins** *Western Unversity* The Tits algebras of a linear algebraic group

Monday, September 01, 2014

9:30	-	10:20	**Ian Musson**
			University of Wisconsin-Milwakee, USA
			The primitive spectrum for $\mathfrak{gl}(m\|n)$
10:30	-	11:00	**Coffee Break**
11:00	-	11:50	**Erhard Neher**
			University of Ottawa
			Integrable representations of root-graded Lie algebras
12:00	-	2:00	**Lunch Break**
2:00	-	2:50	**José María Pérez Izquierdo**
			University of La Rioja, Spain
			Non-associative universal enveloping algebras
3:00	-	3:50	**Hamid Usefi**
			Memorial University
			The isomorphism problem for enveloping algebras
4:00	-	4:30	**Coffee Break**
4:30	-	4:50	**Marc-Antoine Leclerc**
			University of Ottawa
			A special elliptic Demazure algebra for a Kac-Moody root system
5:00	-	5:20	**Alexander Neshitov**
			University of Ottawa
			Invariants of degree 3 and torsion in the Chow ring of a versal flag variety

Yuly Billig

Carleton University

Classification of simple weight modules for the Lie algebra of vector fields on a torus

We establish the classification of all simple modules with finite-dimensional weight spaces over Lie algebra of vector fields on n-dimensional torus for any n. Every such module is either of a highest weight type or is a quotient of a module of tensor fields on a torus, which was conjectured by Eswara Rao. Our result generalizes the classical theorem of O.Mathieu (Kac's conjecture) on simple weight modules for the Virasoro algebra ($n = 1$).
This is a joint work with Slava Futorny.

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Brendan Frisk Dubsky

University of Uppsala, Sweden

Category $\mathcal{O}$ for the Schrödinger Algebra

In this talk we provide an overview of results on the category $\mathcal{O}$ for the (centrally extended) Schrödinger algebra, as developed by Dubsky, Lü, Mazorchuk and Zhao.

The category $\mathcal{O}$ of Bernstein-Gelfand-Gelfand is a particularly well-studied category in the representation theory of semisimple Lie algebras, where the modules are weight modules and subject to certain finiteness conditions. These conditions lend themselves well to modules over the Schrödinger algebra — which is the algebra of the group of symmetries of the Schrödinger equation, and indeed is roughly a semi-direct product of the simple $\mathfrak{sl}_2$ and its 2-dimensional simple representation — and several analogous results may be obtained.

We will in particular subdivide $\mathcal{O}$ into blocks, i. e. Serre subcategories generated by homologically related simple modules, and describe quivers of these. For blocks of nonzero central charge also the quiver relations have been found, whereas in the more difficult case of central charge zero they have only been found for the finite-dimensional part of $\mathcal{O}$.

These results may be applied to determine the center of the universal enveloping algebra, as well as annihilators of Verma modules.

Alberto Elduque

Univeristy of Zaragoza, Spain

Graded modules over classical simple Lie algebras

Simple graded modules over graded semisimple Lie algebras over an algebraically closed field of characteristic zero are studied. The invariants appearing in this classification are computed for the classical simple Lie algebras. In particular, some criteria are obtained to determine when a finite-dimensional irreducible module admits a compatible grading.

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Vyacheslav Futorny

University of São Paulo, Brazil

Representations of Weyl algebras and Affine Kac-Moody algebras

Weyl algebras are the simplest noncommutative deformations of polynomials relevant to many fields of Mathematics and Physics. We will discuss a classification of simple weight modules for the Weyl algebras of infinite rank and its application for the representation theory of affine Kac-Moody algebras. The talk is based on recent joint results with D. Grantcharov, V. Mazorchuk and I. Kashuba.

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Anthony Joseph

Weizmann Institute, Israel

Zhelobenko invariants and the Kostant Clifford algebra conjecture

The general theme is that there are some elementary open questions in semisimple Lie theory.

The first lecture will be an easy way to describe Zhelobenko invariants. This leads to a simply stated but very difficult problem of computing "base change". The determinant of base change is computed and described following [1].

The second lecture computes base change for the adjoint representation. Following [2], [3] it will be described how this solves a long-time open conjecture of Kostant concerning the Harish-Chandra map applied to the Clifford algebra of a semisimple Lie algebra which may be viewed as the missing Theorem 90 of [4].

References

[1] A. Joseph, A direct proof of a generalized Harish-Chandra isomorphism. Transform. Groups 17 (2012), no. 2, 513-521.

[2] A. Joseph, Zhelobenko invariants, Bernstein-Gelfand-Gelfand operators and the analogue Kostant Clifford algebra conjecture. Transform. Groups 17 (2012), no. 3, 781-821.

[3] A. Joseph, Analogue Zhelobenko invariants, Bernstein-Gelfand-Gelfand operators and the Kostant Clifford algebra conjecture. Transform. Groups 17 (2012), no. 3, 823-833.

[4] B. Kostant, Clifford algebra analogue of the Hopf-Koszul-Samelson theorem, the ρ-decomposition $C(\mathfrak{g}) = \operatorname{End} V_\rho \otimes C(P)$, and the $\mathfrak{g}$-module structure of $\wedge\mathfrak{g}$. Adv. Math. 125 (1997), no. 2, 275-350.

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Caroline Junkins

Western Unversity

The Tits algebras of a linear algebraic group

First defined by J. Tits in 1971 as an "algebra representation", a Tits algebra of a linear algebraic group G can be viewed as a generalization of an irreducible representation of G. In the case that G is non-split, the set of Tits algebras of G define a useful invariant of G. In this talk we relate the Tits algebras of G to the study of projective G-homogeneous varieties and algebras with orthogonal involution.

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Victor Kac

Massachusetts Institute of Technology, USA

Algebraic theory of integrable systems

I will explain how the recently introduced notions of local and non-local Poisson vertex algebras are used to establish integrability of Hamiltonian partial differential equations.

Vladislav Kharchenko

Universidad Nacional Autónoma de México

Quantizations of Kac-Moody Algebras and Explicit Formula for Coproduct

We analyze the extent to which a quantum universal enveloping algebra of a KacMoody Lie algebra L is defined by multi-degrees of its defining relations. To this end, we consider a class of character Hopf algebras defined by the same number of defining relations of the same degrees as the Lie algebra L. If the generalized Cartan matrix A of L is connected then the algebraic structure, up to a finite number of exceptional cases, is defined by just one continuous parameter q related to a symmetrization of A, and one discrete parameter m related to the modular symmetrizations of A. The Hopf algebra structure is defined by $\frac{n(n-1)}{2}$ additional continuous parameters. We also consider the exceptional cases for Cartan matrices of finite or affine types in more detail, establishing the number of exceptional parameter values in terms of the Fibonacci sequence.

We develop an explicit coproduct formula for PBW generators of quantum groups of infinite series. An inexplicit coproduct formula for PBW generators of Lusztig form appeared in [1]. Recently a similar inexplicit formula was proven within a more general context [2].

References

[1] S. Z. Levendorskii and Ya.S. Soibelman, Some applications of the quantum Weyl groups, J. Geom. Phys. 7 (1990), 221–254.

[2] I. Heckenberger and H.-J. Schneider, Right coideal subalgebras of Nichols algebras and the Duflo order on the Weyl groupoid, Israel Journal of Mathematics, 197 N1(2013), 139–187.

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Alexandr Kornev

Federal University of ABC-São Paulo, Brazil

The imbedding of the alternative and Malcev algebras into associative algebras with involution

Joint work with Ivan Shestakov. The famous Poincaré-Birkhoff-Witt theorem establishes the existence of universal enveloping algebra for every Lie algebra. In 1955 by A. I. Malcev posed the question of the speciality of Malcev algebras. We remind that a Malcev algebra is called special if it can be embedded in an alternative algebra with product given by the commutator. The problem of the speciality of any Malcev algebra is still open.

We prove that for any alternative algebra A there exists an imbedding into an associative algebra with involution (namely, into universal multiplicative enveloping algebra of A) with the product given by $x \cdot y = xy + 1/2[x^*, y] + 1/2[x, y^*]$ in such way that $Im(A)$ satisfies the identity $[x^*, x] = 0$ and this embedding is universal with respect to every homomorphism with the same properties into any associative algebra with involution.

We consider the important particular case of Cayley-Dickson algebra in which we prove the imbedding of Cayley-Dickson algebra into the algebra M_8 with the product given by $x \cdot y = xy + 1/2[x^*, y] + 1/2[x, y^*]$ with the involution $*$ defined for the matrix units $\varepsilon_{i,j}$ by

$$\varepsilon_{i,j}^* = \frac{e_j^2}{e_i^2}\varepsilon_{j,i}$$

for any $i, j \in I = \{1, 2, 3, 4, 5, 6, 7, 8\}$, where $\{e_j | i \in I\}$ is the standart basis of Cayley-Dikson algebra. Likewise, we prove that for any Malcev algebra M there exists an imbedding into an associative algebra with involution with the product given by $\langle x, y\rangle = [x, y] + [x^*, y] + [x, y^*]$ in such way that $Im(M)$ satisfies the identity $[x^*, x] = 0$ and this embedding is universal with respect to every homomorphism with the same properties into any associative algebra with involution. We present a new construction of alternative enveloping algebra for Malcev algebra and prove a criterion of the speciality for Malcev algebras.

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Marc-Antoine Leclerc

University of Ottawa

A special elliptic Demazure algebra for a Kac-Moody root system

In a recent paper in 2013, A. Hoffnung, J. Malagón-López, A. Savage and K. Zainoulline constructed a generalization of an Hecke algebra starting from a formal group law and a fnite root system. In this talk we discuss how to generalize their construction to a Kac-Moody root system in the case of a special elliptic formal group law. This is joint work with E. Neher and K. Zainoulline.

Sara Madariaga

University of Saskatchewan

Jordan quadruple systems

In this joint work with Prof. Bremner, we introduce Jordan quadruple systems. These structures are defined by the polynomial identities of degrees 4 and 7 satisfied by the Jordan tetrad $\{a, b, c, d\} = abcd + dcba$ as a quadrilinear operation on associative algebras. We also consider four infinite families of finite dimensional Jordan quadruple systems, and construct the universal associative envelope for the smallest system in each family. We give analogous definitions and results for the Jordan anti-tetrad $[a, b, c, d] = abcd - dcba$.

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Vladimir Mazorchuk

University of Uppsala, Sweden

Homological properties of the category $\mathcal{O}$, part 1: invariants of structural modules

In the first part of this talk I will try to recall basic definitions and properties related to the BGG category $\mathcal{O}$ associated with a semi-simple finite dimensional complex Lie algebra. The second part will address study of homological invariants for structural modules in the principal block of $\mathcal{O}$.

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Vladimir Mazorchuk

University of Uppsala, Sweden

Homological properties of the category $\mathcal{O}$, part 2: Alexandru conjecture

In this talks I will discuss Alexandru conjecture in the context of category $\mathcal{O}$ and some related questions. It turns out that the statement of Alexandru conjecture holds for the principal block of $\mathcal{O}$ but fails for singular blocks in general. A closely related question is the one addressing comparison of homological properties of objects in $\mathcal{O}$ inside $\mathcal{O}$ versus inside the category of all g-modules. This naturally extends to a more general setup of thick category $\mathcal{O}$. The talk is based on a joint work with Kevin Coulembier.

Ian M. Musson

University of Wisconsin-Milwakee, USA

The primitive spectrum for $\mathfrak{gl}(m|n)$

We study inclusions between primitive ideals for the general linear superalgebra $\mathfrak{g} = \mathfrak{gl}(m|n)$. If $\mathfrak{k}$ is a semisimple Lie algebra, then any primitive ideal in $U(\mathfrak{k})$ is the annihilator of a simple highest weight module, and the same is true for primitives in $U(\mathfrak{g})$. It therefore suffices to study the quasi-order on highest weights determined by the relation of inclusion between primitive ideals. For $\mathfrak{k}$ this quasi-order is the left Kazhdan-Lusztig partial order $\preceq_{KL}$, and we derive an alternative definition of $\preceq_{KL}$ which extends to $\mathfrak{g}$. For $\mathfrak{gl}(m|n)$ the new quasi-order is defined explicitly in terms of Brundan's Kazhdan-Lusztig theory. We prove that this quasi-order induces an actual partial order on the set of primitive ideals, which we conjecture is the inclusion order. We prove one direction of this conjecture for $\mathfrak{gl}(m|n)$, and the full conjecture for the case $\mathfrak{gl}(m|1)$. An important tool is a new translation principle for primitive ideals, based on a certain crystal structure. Finally we focus on an interesting explicit example; the poset of primitive ideals contained in the augmentation ideal for $\mathfrak{gl}(m|1)$.

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Erhard Neher

University of Ottawa

Integrable representations of root-graded Lie algebras

Let L be a Lie algebra over a field k of characteristic 0 which is graded by a finite reduced root system, e.g.,

(i) $L = \mathfrak{g} \otimes_k R$ where $\mathfrak{g}$ is a finite-dimensional split semisimple Lie algebra and R is a unital associative commutative k-algebra;

(ii) $L = \mathfrak{sl}_n(A) := [\mathfrak{gl}_n(A), \mathfrak{gl}_n(A)]$ for some unital associative k-algebra A;

(iii) a finite-dimensional central-simple isotropic Lie algebra;

(iv) a Tits-Kantor-Koecher algebra of some unital Jordan algebra;

(v) the centreless core of an extended affine Lie algebra of reduced type.

By definition, L contains a finite-dimensional split semisimple subalgebra $\mathfrak{g}$. An L-module is called integrable if it is integrable as $\mathfrak{g}$-module, i.e., a sum of finite-dimensional $\mathfrak{g}$-modules. In particular, we are considering the category of integrable representations of L whose weights are bounded above by some dominant (integral) weight λ of a splitting Cartan subalgebra of $\mathfrak{g}$. This category is closely related to the module category of a unital associative algebra S^λ (a quotient of some universal enveloping algebra), which in the context of the representation theory of Lie algebras of type (iii) was introduced and studied by Seligman.

Generalizing some of Seligman's work, we will describe the algebra S^λ for Lie algebras of types (i) and for some weights for Lie algebras of type (ii). In particular, we will be able to describe the global Weyl modules in these cases, generalizing recent work of Chari-Fourier-Khandai for Lie algebras of type (i). Time permitting, I will also talk about the fundamental representation of Lie algebras of type (iv).

The talk is based on work in progress with Nathan Manning.

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Alexander Neshitov

University of Ottawa

Invariants of degree 3 and torsion in the Chow ring of a versal flag variety

The talk is based on the joint project with Alexander Merkurjev and Kirill Zainoulline. We will discuss the connection between degree 3 cohomological invariants of a semisimple split group and the torsion in the Chow group of codimension two cycles of the corresponding versal flag variety. For a simple split group we prove that these two groups coincide. In general case we describe the difference in terms of the character lattice.

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Jonathan Nilsson

Uppsala University, Sweden

Simple Lie algebra modules which are free over $U(\mathfrak{h})$

Let $\mathfrak{g}$ be a simple complex Lie algebra with Cartan subalgebra $\mathfrak{h}$. Many classes of simple $\mathfrak{g}$-modules are known, for example; simple finite dimensional modules, simple highest weight modules, simple weight modules with finite dimensional weight spaces, Whittaker modules, and Gelfand-Zetlin modules.

In this talk I describe a class of $U(\mathfrak{h})$-free modules; the $U(\mathfrak{g})$-modules whose restriction to $U(\mathfrak{h})$ is free of finite rank. I give an explicit classification of the $U(\mathfrak{h})$-free modules of rank 1 in type A and C, and determine their Jordan-Hölder components. This leads to a new class of simple $\mathfrak{g}$-modules. I will also mention the connection between $U(\mathfrak{h})$-free modules and coherent families as was suggested by Olivier Mathieu. This leads to a proof that $U(\mathfrak{h})$-free modules exist only in type A and C, completing the classification of rank 1 $U(\mathfrak{h})$-free modules for simple complex Lie algebras.

José María Pérez Izquierdo

University of La Rioja, Spain

Non-associative universal enveloping algebras

Non-associative universal enveloping algebras are the non-associative counterpart of universal enveloping algebras of Lie algebras. These non-associative Hopf algebras have become one of the building blocks of the non-associative Lie Theory for loops. Groups form one of the infinitely many possible varieties of loops. Classical results such as Lie's theorems, Ado's theorem or the Baker-Campbell-Dynkin-Hausdorff formula are natural for these non-associative groups too. However, challenging problems such as an adequate Representation theory remain mostly open in this context. Based on the survey [1], I will discuss the development of non-associative universal enveloping algebras from their recent origin to our days.

References

[1] J. Mostovoy, J. M. Pérez-Izquierdo, I.P. Shestakov: Hopf algebras in non-associative Lie theory, *Bull. Math. Sci.* (2014) 4:129-173.

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Alexander Premet

University of Manchester, UK

Regular derivations of truncated polynomial rings

Let K be an algebraically closed field of characteristic $p > 2$ and let O be the ring of p-truncated polynomials in n variables over K. Let L be the derivation algebra of O, a simple Lie algebra of type $W(n)$. It is known that the ring of all regular functions on L invariant under the action of its automorphism group is freely generated by n elements and a version of Chevalley's restriction theorem holds for L. Furthermore, the related quotient morphism is faithfully flat and all its fibres are irreducible complete intersections.

An element x of L is called regular if the centraliser of x in L has the smallest possible dimension. In my talk I will give a description of regular elements of L and show that an analogue of Kostant's differential criterion for regularity holds in L. Normality of the fibres of the above mentioned quotient morphism will also be discussed.

María del Carmen Rodríguez Vallarte

Universidad Autónoma de San Luis Potosí, Mexico

Contact Lie algebras

A contact Lie algebra is a $2n+1$-dimensional Lie algebra for which there exists an 1-form α satisfying $\alpha \wedge (d\alpha)^n$ is not zero. It is well known that every real or complex 3-dimensional Lie algebra is a contact Lie algebra, except for the 3-dimensional abelian Lie algebra and $\mathfrak{q}_1(\mathbb{F})$. It is also known that applying the "Arnold suspension" to a symplectic Lie algebra, it is possible to construct a contact Lie algebra.

In this talk, we show that the construction known as "double extension" (introduced by V. Kac to construct quadratic Lie algebras) can be applied to any contact Lie algebra to produce a new contact Lie algebra. Furthermore, we can show examples of contact Lie algebras that cannot be obtained through a suspension of a symplectic Lie algebra (of codimension 1). As an application , we can list all the 5-dimensional contact Lie algebras.

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Earl Taft

Rutgers University, USA

Is there a left quantum group containing quantum $U_q(sl(2))$?

By modifiung the presentation of $SL_q(2)$, S. Rodriguez and E. Taft constructed a left quantum group H, i.e., H has a left antipode which is not a right antipode. H has $SL_q(2)$ as homomorphic image, so the continuous dual $SL_q(2)^\circ$, which contains $U_q(sl(2))$, embeds in H°. We hoped that H° would be a left quantum group, but we show that $H^\circ = SL_q(2))^\circ$, using the characterization of the $\circ$ functor as coordinate functions coming from finite-dimensional representations. Thus the search for a left quantum group containing $U_q(sl(2))$ remains open. (Joint with Uma Iyer)

Hamid Usefi

Memorial University

The isomorphism problem for enveloping algebras

Given Lie algebras L and H with isomorphic enveloping algebras, the isomorphism problem asks whether L and H are isomorphic. The answer to the isomorphism problem in positive characteristic is NO. In this talk, I will review the past and recent results and discuss a conjecture in characteristic zero and some recent evidence regarding the validity of the conjecture. In positive characteristic the isomorphism problem makes sense for restricted Lie algebras. I will also mention closely related problems such as cohomological dimension 1 conjecture.

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Uladzimir Yahorau

University of Ottawa

Conjugacy Theorem For Extended Affine Lie algebras

An extended affine Lie algebra (EALA) is a generalization of an affine Kac-Moody Lie algebra to higher nullity (in a sense that can be made precise). It is a pair consisting of a Lie algebra and its maximal adjointdiagonalizable subalgebra (MAD), satisfying certain axioms. It is natural to ask if a given Lie algebra admits a unique structure of an extended affine Lie algebra, i.e. if two MADs which are parts of two different structures are conjugate. In a joint work with V. Chernousov, E. Neher and A. Pianzola we proved that if the centreless core of an EALA (E,H) is a module of finite type over its centroid then such MADs are conjugate, thereby obtaining a positive answer to this question.

In this talk I will give the definition and construction of an EALA. I will then discuss the proof of the conjugacy theorem for EALAs.

Changlong Zhong

University of Alberta

Equivariant oriented cohomology theory and formal Demazure algebra

Oriented cohomology theories of algebraic varieties were introduced as generalizations of Chow groups and K_0, and the equivariant oriented ohomology theories share similar properties as that of equivariant Chow groups and equivariant K_0, the latter were previously studied by Demazure, Kostant–Kumar, Totaro, Edidin-Graham and Brion. On the other hand, formal Demazure algebra gave a pure algebraic construction of equivariant oriented cohomology of flag varieties. In this talk I will introduce this algebra and talk about its relation with equivariant cohomology theory. This is joint work with K. Zainoulline and B. Calmes.