

# Sophus Lie 2013 – Lyon – June, 27-29

## Program and Abstracts

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### Thursday 27th. (afternoon)

1:50 - 2:50 PM **Nicolas Perrin (Bonn)**

*Some properties of the cominuscule quantum K-theory*

**Abstract.** (Joint work with A. Buch, P.E. Chaput and L. Mihalcea) In this talk, I will recall some classical properties of the quantum cohomology of homogeneous spaces (finiteness of the product, positivity, existence of invertibles) and discuss their extensions to quantum K-theory.

3:00 - 4:00 PM **Peter Bürgisser (Paderborn)**

*The Challenges of Geometric Complexity Theory*

**Abstract.** It is a remarkable fact that two prominent problems of algebraic complexity theory, the permanent versus determinant problem and the tensor rank problem, can be restated as explicit orbit closure problems. This offers the potential for proving lower complexity bounds by relying on methods from algebraic geometry and representation theory. This basic idea for the tensor rank problem goes back to work by Volker Strassen from the mid eighties. It leads to challenging problems regarding the irreducible representations of symmetric groups over the complex numbers (tensor products and plethysms).

In the first part of the talk, we will present the general framework and explain some negative results. Then we will move on to outline some recent progress for proving lower bounds on the border rank of the matrix multiplication tensor. This is achieved by the explicit construction of highest weight vectors vanishing on the (higher secant) varieties of tensors of border rank at most  $r$ .

4:30 - 5:30 PM **Olivier Mathieu (CNRS, Lyon 1)**

*On the classification of  $\mathbf{Z}^N$ -graded Lie algebras (joint work with K. Iohara).*

**Abstract.** Set  $\Lambda = \mathbf{Z}^N$ . We consider  $\Lambda = \mathbf{Z}^N$ -graded Lie algebras  $\mathcal{L} = \bigoplus_{\lambda \in \Lambda} \mathcal{L}_\lambda$  such that each homogenous component  $\mathcal{L}_\lambda$  is one dimensional, and we assume that  $\mathcal{L}$  is graded simple.

Around 1978, V.G. Kac conjectured the classification of such Lie algebras in the case  $N = 1$  (proved by the author in 1983). In the 90's, I.M. Gelfand

and A. Kirillov raise the question of the classification of such Lie algebras in the case  $N \geq 2$ , but without providing an explicit list.

In this talk, we will explain how to solve Gelfand-Kirillov question. Although the setting of the question is very abstract, it turns out that the Lie algebras occurring in the list are very concrete. Most of them are connected with the Lie algebras of symbols of twisted PDO on the circle. The remaining Lie algebras are classified by using Jordan algebras theory.

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**Friday 28th. (morning session)**

8:50 - 9:50 AM **Andrei Jaikin-Zapirain (Madrid)**

*The action of the absolute Galois group on quasisplatonic curves and Beauville surfaces.*

**Abstract.** We prove that the absolute Galois group acts faithfully on quasisplatonic curves and on Beauville surfaces. We also show that for every automorphism  $\sigma$  of  $\overline{\mathbb{Q}}$  different from the identity and the complex conjugation, there exists a Beauville surface  $S$  such that the fundamental groups of  $S$  and  $S^\sigma$  are not isomorphic.

One of the main steps in the proof is to show that an automorphism of a profinite completion of a triangle group of hyperbolic type fixing all the open normal subgroups should be inner.

10:00 - 11:00 AM **Nikolay Nikolov (Imperial college, London)**

*Abstract quotients of compact groups I*

11:30 - 12:30 AM **Dan Segal (Oxford)**

*Abstract quotients of compact groups II*

**Abstract (for I and II).** Generalizing earlier work on subgroups of finite index in profinite groups, we show that a compact group cannot have an infinite finitely generated quotient (as abstract group). We will discuss some of the ideas leading up to this.

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**Friday 28th. (afternoon session)**

1:50 - 2:50 PM **Michela Varagnolo (Cergy)**

*Categorifications and cyclotomic rational double affine Hecke algebras*

**Abstract.** I will speak about an equivalence between the category  $\mathcal{O}$  for CRDAHA's and a subcategory of an affine parabolic category  $\mathcal{O}$  of

type A. I will discuss two applications, that is a proof of a conjecture of Rouquier on the dimension of simple modules of CRDAHA's and a proof of a conjecture of Chuang and Miyachi on the Koszulity of the category  $\mathcal{O}$  for CRDAHA. It is a joint work with Rouquier, Shan, Vasserot.

3:00 - 4:00 PM **Ghilain Fourier (Köln)**  
*Posets and Schur positivity*

**Abstract.** We introduce a partial order on tuples of dominant weights for classical simple Lie algebras. There are several conjectures on the modules corresponding to the weights, that come along with this partial order. We will report on their relation and on the process being made in proving them. The main target of this project, a conjecture on generators and relations for fusion products of current algebras, will be recalled and its implication to the conjectures about the partial order will be emphasized.

4:30 - 5:30 PM **Michel Brion (Grenoble)**  
*Associative structures on algebraic varieties.*

**Abstract.** The objects of this talk are the structures of algebraic semi-group on a given algebraic variety  $X$ . We will determine all such structures when  $X$  is complete, in terms of certain abelian varieties associated with  $X$ .  
**Reference:** M.B., On algebraic semigroups and monoids, arXiv:1208.0675 (v3)

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**Saturday 29th. (morning session)**

8:50 - 9:50 AM **Geordie Williamson (MPIM, Bonn)**  
*Hodge structures and Soergel bimodules*

**Abstract.** I will explain joint work with Ben Elias in which we use Soergel bimodules to give an algebraic proof of the Kazhdan-Lusztig conjecture, a character formula for simple highest weight modules over a semi-simple Lie algebra. In the proof ideas from higher algebra, categorification and Hodge theory (in particular work of de Cataldo and Migliorini) play a crucial role. If time permits I will explain how essentially everything that one expects from Hodge theory carries over to arbitrary Soergel bimodules, except for the existence of an integral lattice.

10:00 - 11:00 AM **Daniel Juteau (Caen)**  
*Generalized Springer correspondence modulo  $\ell$  for  $GL_n$*

**Abstract.** For a reductive group  $G$ , the Springer correspondence is an injection from irreducible representations of the Weyl group  $W$  to the simple

$G$ -equivariant perverse sheaves on the nilpotent cone of the Lie algebra. However, in general not all simple perverse sheaves in this way, which led Lusztig to define a generalized Springer correspondence, involving the process of inducing cuspidal perverse sheaves from Levi subgroups (the classical correspondence being the case of a maximal torus). In the case of  $GL_n$ , though, nothing new arises in this way.

In my thesis I studied a modular Springer correspondence, where one takes modular representations of the Weyl group and perverse sheaves with positive characteristic coefficients. In this talk I will explain the modular version of the generalized Springer correspondence in the case of  $GL_n$ . In the modular case there is something new, namely there is a cuspidal perverse sheaf supported by the regular nilpotent orbit when  $n$  is a power of  $\ell$ . This is joint work with Pramod Achar, Anthony Henderson and Simon Riche.

11:30 - 12:30 PM **Wolfgang Soergel (Freiburg)**  
*Motivic construction of graded representation categories*

**Abstract.** I want to explain how the motivic six-functor-formalism of Cisinsky and Deglise allows to construct some of these curious graded versions of representation theories in a very natural and geometric way.