General Mathematics Seminar

Of the

University of Luxembourg

In cooperation with the

Luxembourg Mathematical Society

January 2011

Tuesday, January 4, 2011, at 17:00 **Campus Kirchberg, room A02**

Walter van Suijlekom

(Radboud University, Nijmegen)

Gauge theories and noncommutative manifolds

Abstract:
In this talk, we will discuss some aspects of the intrinsic gauge theoretical nature of noncommutative manifolds. Following Connes, we describe a noncommutative (Riemannian, spin) manifold by its fundamental class in K-homology. Among other functional analytical data, such a K-cycle consists of a (noncommutative) C*-algebra. As a consequence of noncommutativity, there might exist non-trivial inner automorphisms; these will be referred to as gauge transformations.

The key example that motivates this terminology from physics is when one replaces the algebra of functions on a manifold by matrix-valued functions. The resulting Morita equivalence describes ordinary Yang-Mills theory as formulated in terms of vector bundles and connections thereon. If time permits, we will consider a second class of examples, so-called toric noncommutative manifolds.

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January 2011

Tuesday, January 25, 2011, at 17:00 **Campus Kirchberg, room A02**

Arkady Onishchik
(Yaroslavl University, Russia)

Homogeneous complex supermanifolds associated to compact Hermitian symmetric spaces

Abstract:

I would like to discuss the following classification problem: given a complex flag homogeneous space $M = G/P$ (G is a semi-simple complex Lie group, P its parabolic subgroup), to describe all homogeneous complex supermanifolds $(M;\mathscr{O})$ with reduction M. In the case when $M = Gr_{4;2}$ is the Grassmann manifold of 2-planes in $\mathbb{C}^4$ this problem was formulated by Yu.I. Manin; it was motivated by certain physical models. He also gave an example of a non-split homogeneous complex supermanifold with this reduction; this is the so-called Π- symmetric supergrassmannian $\Pi Gr_{4|4;2|2}$. My goal is to discuss certain general approaches to this classification problem and to formulate certain results in the case when M is an irreducible compact Hermitian symmetric space.

First, I consider the case when the supermanifold $(M;\mathscr{O})$ is split and $\mathscr{O}$ is determined by the homogeneous vector bundle over M induced by a representation ϕ of P. If ϕ is completely reducible, then homogeneous supermanifolds of this sort may be described in terms of the highest weights of ϕ.

The most difficult is the case of a non-split supermanifold $(M;\mathscr{O})$. There is the following conjecture: if, in our situation, the retract of this supermanifold is determined by an irreducible representation of P, then this retract is isomorphic to $(M;\Omega)$, where Ω is the sheaf of holomorphic differential forms on M. It is also possible to describe non- split homogeneous supermanifolds with this retract. The conjecture is proved for the following symmetric spaces:$M = Gr_{n;k}, 3 \leq k \leq n-k; Gr_{2n+1;2}, n \geq 2$; $Gr_{4;2}, Gr_{6;2}; Sp_{2n}/U_n, n \geq 2; E_6/D_5 \times T; E_7/E_6 \times T$.

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February 2011

Tuesday, February 8, 2011, at 17:00 **Campus Kirchberg, room A02**

Katarzyna Grabowska
(University of Warsaw, Poland)

Dirac Algebroids

Abstract:

I will present the concept of a Dirac algebroid which is a linear almost Dirac structure on the dual E^* to a vector bundle $\tau : E \to M$. The linearity of the structure is expressed in the language of double vector bundles. Dirac algebroids provide a general setting for Lagrangian and Hamiltonian systems in mechanics including systems described by singular Lagrangians, system with nonholonomic constraints and systems on Lie algebroids.

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February 2011

Tuesday, February 22, 2011, at 17:00 **Campus Kirchberg, room B02**

Robert Philipowski
(University of Bonn, Germany)

Ricci flow, coupling of Brownian motions and Perelman's L-functional

Abstract:

In this talk I will show that on a manifold whose Riemannian metric evolves under backwards Ricci flow two Brownian motions can be coupled in such a way that their normalized L-distance is a supermartingale. As a corollary, one obtains a new proof and a generalization of a recent result of Peter Topping concerning L-optimal transport. This is joint work with Kazumasa Kuwada.

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March 2011

Tuesday, March 08, 2011, at 17:00 **Campus Kirchberg, room B02**

Elizaveta Vishnyakova
(Tver'-Bochum)

Non-split supermanifolds

Abstract:

It is well known that the category of real Lie supergroups is equivalent to the category of the so called Harish-Chandra pairs. That means that a Lie supergroup depends only on the underlying Lie group and its Lie superalgebra with certain compatibility conditions. More precisely, the structure sheaf of a Lie group and the group morphisms can be explicitly described in terms of the corresponding Lie superalgebra. Hence, some geometric properties of homogeneous supermanifolds can be characterized in terms of Lie superalgebras. We will discuss necessary and sufficient conditions for a complex homogeneous supermanifold to be split, i.e. its structure sheaf is not isomorphic to $\bigwedge \mathscr{E}$, where $\mathscr{E}$ is a locally free sheaf. More precisely, the following theorem is proved (2010).

Theorem *Let $(G, \mathscr{O}_G)$ be a complex Lie supergroup with the Lie superalgebra $\mathfrak{g} = \mathfrak{g}_{\bar{0}} \oplus \mathfrak{g}_{\bar{1}}$. If $[\mathfrak{g}_{\bar{1}}, \mathfrak{g}_{\bar{1}}] = 0$, then all $(G, \mathscr{O}_G)$-homogeneous supermanifolds $(M, \mathscr{O}_M)$ are split.*

Conversely, if a complex homogeneous supermanifold $(M, \mathscr{O}_M)$ is split, then there is a Lie supergroup $(G, \mathscr{O}_G)$ with $[\mathfrak{g}_{\bar{1}}, \mathfrak{g}_{\bar{1}}] = 0$, where $\mathfrak{g} = \mathfrak{g}_{\bar{0}} \oplus \mathfrak{g}_{\bar{1}} = \mathrm{Lie}(G, \mathscr{O}_G)$ such that $(G, \mathscr{O}_G)$ acts on $(M, \mathscr{O}_M)$ transitively.

The second question, which we are going to discuss, is

How to find out, whether a complex supermanifold is split or non-split?

A method, suggested by A.L.Onishchik, is to study grading operators on the structure sheaf of a supermanifold. We are going to use this method for the flag supermanifolds introduced by Yu.I. Manin. Here we need the description of Lie superalgebra of vector fields on flag supermanifolds, given by A.L. Onishchik, A.A. Serov, E. Vishnyakova, V. Bunegina and others.

Note that from the results of a paper written by I. Penkov and I. Skornyakov (1983) it follows, that certain flag supermanifolds are non-split.

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March 2011

Tuesday, March 15, 2011, at 17:00 **Campus Kirchberg, Room- B02**

Pierre Bieliavsky
(UCLouvain, Belgium)

Rankin-Cohen brackets and $\mathfrak{sl}_2$-equivariant quantizations

Abstract:

Rankin-Cohen brackets are $\mathfrak{sl}_2$-equivariant bilinear maps on holomorphic modular forms. Twenty years ago, Zagier gave a combinatorial formula for a bilinear formal product in terms of Rankin-Cohen brackets that turns the space of modular forms into a formal noncommutative associative $\mathfrak{sl}_2$-module algebra. We will present a geometric approach to Zagier's product and some of its extensions in the context of (non-formal) quantization of $\mathfrak{sl}_2$-surfaces.

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April, 2011

Tuesday, April 05, 2011, at 17:00 **Campus Kirchberg, Room B02**

Alexei Daletskii
(University of York, UK)

Cluster Point Processes via Configuration Space Analysis: integration by parts, stochastic dynamics and Poincaré inequalities

Abstract:

The distribution μ_{cl} of a cluster point process in a Riemannian manifold X, with i.i.d. clusters attached to points of a random (e.g. Poisson or Gibbs) configuration in X, is studied via the projection of an auxiliary measure on a marked configuration space of X. We prove an integration by parts formula for μ_{cl} and discuss properties of the corresponding Laplacian.

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April, 2011

Tuesday, April 12, 2011, at 17:00 **Campus Kirchberg, Room B02**

Özgür Ceyhan
(University of Amsterdam)

Geometric, topological and number theoretical problems around quantum field theory.

Abstract:

Many aspects of quantum field theory (QFT) remain puzzling for mathematicians, in particular renormalization techniques which magically produces finite results out of divergent Feynman integrals. In this talk, I will to try give an overview of the symmetries of QFTs arising from renormalizations and related problems in geometry, topology and number theory.

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April, 2011

Tuesday, April 26, 2011, at 17:00 **Campus Kirchberg, Room B02**

Ajay Ramadoss
(ETH, Zürich)

A variant of the Mukai pairing via deformation quantization

Abstract:

We use an algebraic index theorem of P. Bressler, R. Nest and B. Tsygan to give a relatively short computation of a certain pairing on the Hochschild homology of a smooth projective variety. This pairing is closely related to the Mukai pairing constructed by A. Caldararu.

MATHEMATICS SEMINAR
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May 2011

Tuesday, 10 May 2011, at 5:30 pm **Lecture Hall B.02, Campus Kirchberg**
(6, rue R. Coudenhove-Kalergi)

Pedro Pérez Carreras
Universidad Politécnica de Valencia

What is Mathematical Education and why is it relevant?

Abstract

A glimpse in what Mathematical Education is will be provided. After a short incursion in its young history, we shall deal with the shift in paradigm which has occurred in the last thirty years and some of the topics of research generated. Special emphasis will be placed in how computed oriented strategies can help students to understand Calculus, as well as in considerations on whether formal proofs of theorems are the only alternative to gain mathematical insight.

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Pedro Pérez Carreras received his Ph.D. in Mathematical Sciences (1973) from the University of Valencia (Spain) under the supervision of Prof. Manuel Valdivia. His main research area was Functional Analysis and is now Mathematical Education. Dr Pedro Pérez Carreras was a Full Professor of Mathematics at the Universities of Sevilla and Valencia, as well as an Invited Professor at the Universities of Maryland and Kent State (USA). He is currently retired from the Universidad Politécnica de Valencia, where he served as Head of the Department of Applied Mathematics, Head of the Institute of Educational Sciences, and Head of the Institute of Advanced Technologies (CETA, Havana, Cuba).

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May, 2011

Tuesday, May 24, 2011, at 17:00 **Campus Kirchberg, Room B02**

Prof. Eugenio Regazzini
(Pavia University)

STUDY OF ASYMPTOTICAL PROPERTIES OF SOLUTIONS OF KINETIC EQUATIONS VIA CENTRAL LIMIT THEOREMS

Abstract:

In the last years it has been shown that classical methods, pertaining to the study of the central limit problem of probability theory, can be used to analyze the convergence to equilibrium of the solutions of relevant kinetic equations. In particular, these methods turn out to be effective in determining sharp evaluations of the speed of convergence. The present seminar aims at giving a systematic account of methods and results in the field.

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June, 2011

Tuesday, June 07, 2011, at 15:30 **Campus Kirchberg, Room B02**

Frederi G. Viens
(Purdue University, West Lafayette, USA)

Malliavin calculus for expectation, density, and tail estimates, with applications

Abstract:

I. Nourdin and G. Peccati introduced the functional $X \mapsto G := < DX, DMX >$ where D is the Malliavin derivative, and M is pseudo-inverse of the generator of the Ornstein-Uhlenbeck semigroup. A detailed analysis of G yields a number of comparison estimates with the normal distribution and other benchmark laws. Applications to stochastic PDEs and polymer models are also outlined. This covers work with the above two authors, plus H. Airault, R. Eden, P. Malliavin, D. Nualart, and Ll. Quer.

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June, 2011

Tuesday, June 07, 2011, at 17:00 **Campus Kirchberg, Room B02**

Samy Tindel
(Institut Elie Cartan − Nancy, France)

On Malliavin derivatives for rough differential equations

Abstract:

Integrability properties for linear differential equations driven by general Gaussian processes (in particular fractional Brownian motion with Hurst parameter smaller than $\frac{1}{2}$) are still an important open problem in rough paths analysis. This kind of equation governs for instance Malliavin derivatives, but also differentials of flows or convergence rates for numerical schemes. After recalling this general problem, we shall give some nontrivial examples of equations for which Malliavin derivatives are integrable and Gaussian bounds for the density are available, in the case of rough equations driven by fractional Brownian motion. If time allows it, we shall then give a general strategy in order to bound accurately the Malliavin derivative.

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September, 2011

Tuesday, September 13, 2011, at 17:00 **Campus Kirchberg, Room B02**

Melchior Grützmann
(Sun Yat- Sen University, China)

Matched pairs of Courant algebroids

Abstract:

Matched pairs of Lie algebroids were introduced by Lu in 1997 and studied by Mokri. We will generalize their idea to Courant algebroids, i.e. two Courant algebroids over the same base together with some additional structure such that their direct sum is a Courant algebroid. We will give numerous examples from complex geometry, such as the twisted standard complex Courant algebroid, a construction from a holomorphic Courant algebroid. Another example from Chen, Stiénon, and Xu's classification of regular Courant algebroids. Finally, we also describe the construction in the language of dg-symplectic supermanifolds. This is joint work with M. Stiénon.

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September, 2011

Tuesday, September 20, 2011, at 17:00 **Campus Kirchberg, Room B02**

Loïc Foissy
(University of Reims)

Free and cofree combinatorial Hopf algebras

Abstract:

In the theory of combinatorial Hopf algebras, a certain number of free and cofree objects are studied, for example:
- The Hopf algebra of permutations (Malvenuto-Reutenauer),
- The Hopf algebras of (decorated) plane trees (Connes-Kreimer),
- The free dendriform Hopf algebra of binary trees (Loday-Ronco). -...

They all satisfy certain common properties, such as the self-duality, or the freeness of the Lie algebra of their primitive elements. We here answer the following questions:

1) Is a free and cofree Hopf algebra always self-dual?
2) What can be said about the Lie algebra of the primitive elements of a free and cofree Hopf algebra?
3) When are two free and cofree Hopf algebras isomorphic?

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September, 2011

Tuesday, September 27, 2011, at 15:30 **Campus Kirchberg, Room B02**

Zdzislaw Brzezniak
(University of York, UK)

Stochastic geometric heat equations

Abstract:

I will show that an approach from the paper Brzeźniak and Ondreját (2007) can be applied to the stochastic heat flow equation in the case when the domain is one dimensional. The one dimensionality of the domain allows us to work with the energy space, i.e. the Hilbert space $H^{1,2}(\mathbb{S}^1,\mathbb{R}^d)$ as a state space since in this case the embedding of the energy space into the Banach space $C(\mathbb{S}^1,\mathbb{R}^d)$ of continuous functions holds. Some techniques that have been developed by the speaker in collaboration with Goldys and Jegaraj (2010) are essential. Let us point out a difference between our proof of the global existence and the one in the deterministic case by Eells-Sampson (1964) and Hamilton (1975). While in the latter papers the crucial step is to prove that the energy density solves certain scalar parabolic equation, in our case the crucial step is to prove an inequality for the L^2-norm of the gradient of the solution which is based on certain geometric property of the target manifold M. Based on a joint work of the speaker with B. Goldys and M. Ondrejat.

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September, 2011

Tuesday, September 27, 2011 **Campus Kirchberg, Room B02**

Igor Wigman
(Cardiff University)

Nodal length fluctuations for arithmetic random wave

Abstract:

Using the spectral multiplicities of the standard torus, we endow the Laplace eigenspace with Gaussian probability measure. This induces a notion of random Gaussian Laplace eigenfunctions on the torus ("arithmetic random wave"). We study the distribution of the nodal length of random Laplace eigenfunctions for high eigenvalues.

It is standard to compute that the expected length is commensurable with the square root of the eigenvalue. Our primary find is that the asymptotics for the variance is intimately related to arithmetics of lattice points lying on the circle with radius corresponding to the energy.

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October, 2011

Tuesday, October 04, 2011, at 17:00 **Campus Kirchberg, Room B02**

Dr. Anton Khoroshkin
(ETH Zurich)

On generating functions of finitely presented operads

Abstract:

It is well known that the Hilbert series of a generic finitely presented graded algebra is rational. The purpose of this talk is to suggest an answer to a similar question in the case of operads. Namely I shall show that the generating series of a generic nonsymmetric operad is an algebraic function, and the generating series of a generic symmetric operad is differentially algebraic. All results are based on the combinatorics of trees/monomials and are accompanied with algorithms that might be useful in particular computations. Despite the motivation coming from the operad theory, the main part of the talk will only deal with the combinatorics of tree monomials and hence will be accessible to nonspecialists. (Joint work with D.Piontkovski)

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October, 2011

Tuesday, October 25, 2011, at 17:00 **Campus Kirchberg, Room B02**

Jacques Franchi
(Universit*é* de Strasbourg)

Non-explosion criteria for relativistic diffusions

Abstract:

Relativistic diffusions live on the unit tangent bundle of a given Lorentz manifold, and have their law invariant with respect to the isometries of this Lorentz manifold. In the Riemanniann setting a big amount of work has been made to find out nice conditions ensuring the non-explosion of Brownian motion, that is, the so-called stochastic completeness. The aim is here to provide analogous criteria in the Lorentzian case, which is really more difficult to handle.

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November 2011

Tuesday, November 08, 2011, at 17:00 **Campus Kirchberg, room B02**

Lara Thomas
(ENS Lyon)

Formal group exponentials and ramified Witt vectors to solve Galois module questions in Lubin-Tate extensions

Abstract:

In this talk, we shall give explicit descriptions of integral normal basis generators for some modules in abelian totally, weakly and wildly ramified extensions of any p-adic field. Our construction comes from the combination of several tools : formal group exponentials, Lubin-Tate theory, and the theory of ramified Witt vectors. In this manner, we shall generalise two recent works : Pickett's construction of some local integral Galois module generators which extends that of Erez, as well as the theory of Pulita's formal power series for the study of rank one solvable p-adic differential equations.

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November, 2011

Tuesday, November 15, 2011, at 17:00 **Campus Kirchberg, Room B02**

Jacques Franchi
(Universit*é* de Strasbourg)

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November, 2011

Tuesday, November 22, 2011, at 17:00 **Campus Kirchberg, Room B02**

Mario Maican
(Institute of Mathematics of the Romanian Academy, Bucharest, Romania)

On some moduli spaces of sheaves supported on plane curves

Abstract:

We will classify the Gieseker semi-stable plane sheaves supported on curves of degree four, five and, in some cases, six. We will give natural stratifications for their moduli spaces. The strata are defined by means of cohomological conditions and have concrete geometric descriptions.

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December, 2011

Tuesday, December 13, 2011, at 17:00 **Campus Kirchberg, Room B02**

Marco Zambon
(Universidad Autonoma de Madrid and ICMAT)

Moment maps up to homotopy

Abstract:

We start reviewing a few notions in symplectic geometry (manifolds endowed with certain 2-forms), in particular we review moment maps. The aim of the talk is to propose an extension of this notion to the case of closed 3-forms invariant under a Lie group action. We show that such moment maps exist for actions satisfying very reasonable assumptions, and give an interpretation in terms of equivariant cohomology.