Mathematics Seminar
of the
University of Luxembourg
in cooperation with the
Luxembourg Mathematical Society

January 2008

15 January 2008, at 4:30 pm **Room 3.04 bs**

Giuseppe Dito
University of Dijon

Star-exponentials and complex symplectic manifolds

Abstract

In the framework of formal deformation quantization, the notion of star-exponential is a rather singular object and does not admit a general definition. In this talk I will present a construction of a new sheaf of algebras W on the cotangent bundle of a complex manifold, in which the star-exponentials make sense. The algebra W is an analytic deformation extending the construction by M. Sato, M. Kashiwara, and T. Kawai of the sheaf of microlocal operators, and is obtained by imposing suitable growth conditions on the symbols.

Please note that this talk will be given at 4:30 and not as usually at 5 pm.

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February 2008

5 February 2008, at 5 pm **Room 3.04 bs**

Shizan Fang
University of Bourgogne - Dijon

Wasserstein space over the Wiener space

Abstract

We shall carry out the programme of Ambrosio-Gigli-Savaré on gradient flows to the Wiener space (X, H, μ). The suitable class of measures in this case is the one of measures having finite entropy, the notion of moments being not convenient.

19 February 2008, at 5 pm **Room 3.04 bs**

Salah Mehdi
University Paris 10

Harmonic spinors and representations of Lie groups

Abstract

In the 1970s it was shown that discrete series representations of non-compact semisimple Lie groups are realized on spaces of square integrable vector-valued harmonic spinors on non-compact Riemannian symmetric spaces. The introduction of the Dirac operator, replacing the usual Dolbeault operator, allows one to treat all non-compact semisimple Lie groups rather than just the ones whose symmetric space is hermitian. We define a product for harmonic spinors on reductive homogeneous spaces. We give also some examples where harmonic spinors with coefficients in a module are expressed as a linear combination of products of harmonic spinors with coefficients in two other modules. One such example involves discrete series representations. We will also explain how to construct explicit solutions of the cubic Dirac equation on reductive homogeneous spaces.

26 February 2008, at 5 pm **Room 3.04 bs**

Robert Wolak
Jagiellonian University of Krakow

Dynamics of pseudogroups and foliations

Abstract

The theory of smooth dynamical systems can be understood as a qualitative theory of systems of ordinary differential equations, and the theory of foliations as a qualitative theory of partial differential equations. It is to be expected that some methods of the theory of dynamical systems and ergodic theory can be transposed and usefully applied in the foliation theory.

Foliations can be understood as higher dimensional dynamical systems in which we have forgotten about the parametrization. Numerous topological properties of dynamical systems do not depend on parametrization, e.g. the minimality of the closures of trajectories or the so-called transverse properties. However, on a foliated manifold we can introduce a substitute of a parametrization (or "time") a covering by foliated charts, and it leads to the notion of holonomy pseudogroup, which provides us with a substitute of "discrete time". A Riemannian metric gives a substitute of continuous time.

In recent years classical methods of differential topology or geometry have not been very successful in solving problems in the theory of foliations. On the other hand, some applications of mathematical theories turned out to be of great importance. "Transverse" applications of methods of the ergodic theory and of topological dynamics have been particularly fruitful. By "transverse" we mean applied to the holonomy pseudogroup of a foliation.

We continue research into the dynamics of pseudogroup and their applications in the theory of foliations of any codimension. The central notion is "distality"; we study the properties of distal pseudogroup as well as transversely distal foliations, i.e. such foliations whose holonomy pseudogroup is distal.

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March 2008

4 March 2008, at 5 pm **Room 3.04 bs**

Mikolaj Rotkiewicz
Institute of Mathematics of the Polish Academy of Sciences

Double vector bundles revisited

Abstract

Double structures appear in geometry in many contexts. These objects carry two structures of the same kind, which satisfy some compatibility conditions. The most important examples for applications in mechanics are iterated tangent and cotangent bundles: T^*TM, TTM, T^*T^*M, etc. Each of these manifolds has two natural structures of a vector bundle. Following K. Mackenzie, the compatibility condition can be expressed by saying that all natural maps (additions, zero sections, etc.) are morphisms with respect to the other bundle structure. My talk is based on a joint work with J. Grabowski, in which we show that this condition can be much simplified in terms of Euler vector fields. Moreover, I am going to explain dualities of n-vector bundles ($n \geq 2$). It turns out that all duals of an n-vector bundle E live in T^*E which is an $(n+1)$-vector bundle.

11 March 2008, at 5 pm **Room 3.04 bs**

Miguel Couceiro
University of Luxembourg

Join-irreducible Boolean functions

Abstract

Throughout this presentation we only consider the simplest interesting case of multivariate functions, the so-called Boolean functions. Mainly, we shall be interested in a quasi-ordering

of functions which is know as the simple minor relation. This quasi-order can be described as follows: an m-ary function g is said to be *simple minor* of an n-ary function f, denoted $g \leq f$, if g can be obtained from f by identification of variables, permutation of variables or addition of dummy variables.

The importance of the simple minor relation $\leq$ in the equational approach to specify properties of Boolean functions was made apparent by Ekin, Foldes, Hammer and Hellerstein who showed that the classes (or properties) of Boolean functions definable by functional equations coincide exactly with the initial segments of this quasi-order. This correspondence to function class definability led to several studies of the simple minor relation. As any quasi-order, the simple minor relation $\leq$ on the set Ω of all Boolean functions induces a partial order on the set $\tilde{\Omega}$ made of equivalence classes, where properties of $\leq$ are easier to express. Several results concerning the structure of this partially ordered set (poset) have been established and connections to hypergraph theory have been recently revealed.

In this talk we shall survey these and other results concerning the poset $\tilde{\Omega}$. We start by presenting some properties of this poset and establish connections to the equational approach to function class definability. Then we will present a classification of $\tilde{\Omega}$ showing that it is universal among countable posets, and address some open problems. In particular, we shall consider the question of determining the join-irreducible elements of this poset, i.e., elements having a unique lower cover in $\tilde{\Omega}$. By establishing a complete correspondence between Boolean functions and hypergraphs, join-irreducibility translates into combinatorial properties of hypergraphs such as set-transitivity. As a partiular case, we explicitly describe those graphs which correspond to join-irreducible members of $\tilde{\Omega}$. We will discuss some results obtained jointly with Stephan Foldes, Maurice Pouzet, Erkko Lehtonen and Moncef Bouaziz.

18 March 2008, at 5 pm **Room 3.04 bs**

Giovanni Peccati
University Paris 6

High-frequency asymptotics on the sphere and Clebsch-Gordan random walks

Abstract

We discuss high-frequency central limit theorems on homogeneous spaces, and how they can be expressed in terms of convolutions of Clebsch-Gordan coefficients. These coefficients appear in unitary matrices connecting reducible representations of SO(3). This allows reinterpreting part of our results in terms of coupling of angular momenta in a quantum mechanical system. An important motivation for our research comes from the probabilistic representation and the statistical analysis of the Cosmic Microwave Background (CMB) radiation.

This is based on joint works with D. Marinucci (Rome).

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April 2008

8 April 2008, at 3:30 pm **Room 3.04 bs**

Nikita Ratanov
Universidad del Rosario, Bogota, Colombia

Jump telegraph processes and a volatility smile

Abstract

We develop a class of financial market models based on inhomogeneous telegraph processes, i.e. random motions with alternating velocities and jumps occurring when the velocities are switching. While such markets may admit an arbitrage opportunity, the model under consideration is arbitrage-free and complete if directions of jumps in stock prices are in a certain correspondence with their current velocity and interest rate behaviour. Diffusion rescaling in this model gives a natural representation of volatility. Explicit formulae for prices of standard European options are obtained, which permits to calculate directly implied volatilities with respect to various moneyness of the option.

8 April 2008, at 5 pm **Room 3.04 bs**

Janusz Grabowski
Institute of Mathematics of the Polish Academy of Sciences

The Lagrange and Hamilton formalisms on Lie algebroids

Abstract

I will present a geometric approach to formalisms of Analytical Mechanics, alternative to the variational one, explaining the generation of the Euler-Lagrange and the Hamilton equations on one diagram. We recognize the structure responsible for the whole picture as the canonical symplectic structure on the cotangent bundle of the configuration space (phase space). The advantage of this approach is that it can be easily generalized to the case of Lie algebroids, i.e. to linear Poisson structures instead of the symplectic one.

29 April 2008, at ~~5 pm~~ 16:15 pm **Room 3.04 bs**

Bernard Beauzamy
Professor, University of Lyon, 1979-1995
Chairman, Société de Calcul Mathématique, Paris, 1995 -

Mathematical methods for handling uncertainties

Abstract

In real life problems, many difficulties often occur: lack of data, conflicting aims, and so on, so the use of academic tools (for instance optimisation tools) is rarely possible. In this talk, we will present a "robust" approach, which takes all difficulties into account from the very beginning. We will also show that this approach requires sophisticated mathematical tools, mostly of probabilistic nature. In particular, we will present a brief description of the "Experimental Probabilistic Hypersurfac", the construction of which is based upon entropy principles (Bernard Beauzamy and Olga Zeydina).

6 May 2008, at 6:30 pm **Bâtiment de Recherche B, ground floor, seminar room**

Annual meeting of the Luxembourg Mathematical Society

Mathematics Seminar
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May 2008

6 May 2008, at 5 pm **Room 3.04 bs**

Dorin Chepta
Romanian Academy of Sciences, Institute of Mathematics

Lagrangian cobordisms and finite type invariants

Abstract

Cobordisms between parametrized surfaces naturally determine closed 3-dimensional manifolds. Lagrangian cobordisms preserve under composition the property that this closed manifold is a homology sphere. This makes their category a suitable domain for a functorial extension of the universal finite-type invariant of 3-dimensional manifolds of Le, Murakami, and Ohtsuki. Such functors, which take values in spaces of Jacobi diagrams (of certain type), can be constructed in the case of closed surfaces and in the case of surfaces with one boundary component. The former is independent of the Drinfeld associator used, the latter admits a simple combinatorial description of the operation on Jacobi diagrams corresponding to the composition of cobordisms. Universality properties for finite-type invariants of cobordisms hold. Degree truncations of the internal part of the latter functor induce finite-dimensional representations of the Torelli group and of homology cylinders, which are further explored.

13 May 2008, at 5 pm **Room 3.04 bs**

Alexander Zuevsky
National University of Ireland, Galway

Torus n-Point Functions for $\mathbb{R}$-graded Vertex Operator Superalgebras as an Origin of Twisted Elliptic Functions

Abstract

We consider n-point functions for free fermion conformal field theories/twisted modules of real graded vertex operator superalgebras on genus one and genus two (sewed from two genus one) Riemann surfaces.

In the rank two case we show how twisted elliptic functions arrise as coefficients in recursive formulae. The modular properties of these orbifold n-point functions are given and we describe a generalization of Fay's trisecant identity for elliptic functions.

(Joint work with Geoffrey Mason (Santa Cruz) and Michael P. Tuite (Galway))

27 May 2008, at 5 pm **Room 3.04 bs**

Lauri Hella
University of Tampere, Finland

Title and abstract: tba

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June 2008

3 June 2008, at 5 pm **Room 3.04 bs**

Mathieu Stienon
Penn State University, USA

Gerbes, principal 2-group bundles and characteristic classes

Abstract

It is well known that a principal G-bundle P over a manifold M determines a homotopy class of maps f from M to the classifying space BG of the group G. Pulling back the generators of $H^*(BG)$ through f, one obtains characteristic classes of the principal bundle P over M. It is a classical theorem of Chern and many others that these characteristic classes coincide with those obtained from the Chern-Weil construction using connections and curvatures. Gerbes are higher order analogues of principal bundles. We will discuss an analogue of Chern's theorem for gerbes. The idea is to relate Gerbes to 2-group principal bundles, and to study characteristic classes of these principal 2-group bundles. Recently, physicists motivated by string theory have been increasingly interested in 2-group bundles.

10 June 2008, at 3.15 pm **Room 3.04 bs**

Friedrich Wagemann
University of Nantes

Deformations of Lie algebras induced by families of curves

Talk in the frame of the Mini-Workshop "Krichever-Novikov type algebras and related subjects"

Abstract

It is well-known that the moduli space $M_{g,n}$ of projective curves of genus g with n marked points is an algebraic stack. We introduce another stack Def, the stack of deformations of Lie algebras, with the goal to formalise the construction of deformations of Lie algebras of vector field by families of curves as given by Fialowski and Schlichenmaier. This gives a morphism of stacks which is nearly a monomorphism. We develop the role of Kac-Moody algebras in this framework.

10 June 2008, at 5 pm **Room 3.04 bs**

Nicolas Juillet
Universities of Grenoble and Bonn

Synthetic Ricci curvature for the Heisenberg group

Abstract

Lott and Villani and simultaneously Sturm recently introduced a property for geodesic metric measure spaces (X, d, m) that has to be understood as an uniform lower bound for Ricci curvature (which usually only make sense for Riemannian manifolds). This property called "curvature-dimension" involves mass transportation and especially the behaviour of entropy functionals on the space of probability measures of X. We will investigate what happens when X is the sub-Riemannian Heisenberg group. The property does not hold but surprisingly the weaker "measure contraction property" does.

17 June 2008, at 5 pm **Room 3.04 bs**

Tom Schmitz
MPI Leibzig

Title: TBA

24 June 2008, at 5 pm **Room 3.04 bs**

Benjamin Enriquez
University of Strasbourg

Quantization of quasi-Lie bialgebras

Abstract

The classical limit of a quasi-Hopf algebra deforming an enveloping algebra is a quasi-Lie bialgebra (Drinfeld). The problem of inverting this map is called the quantization

problem of quasi-Lie bialgebras. We explain the solution of this problem, which we recently obtained with G. Halbout. It relies on the deformational approach to quantization problems (Gerstenhaber-Schack, Shnider-Sternberg), the study of a suitable prop, the vanishing of certain cohomology groups, and the existence of quantization functors for Lie bialgebras (Etingof-Kazhdan).

Transformations of measures: analytic and geometric problems

Vladimir Bogachev

Moscow State University, Russia

The talk gives a survey of recent results on three types of transformations of measures on $\mathbb{R}^n$ related to some basic analytic and geometric problems such as change of variables formulas and isoperimetric inequalities.

First we discuss the so called traingular transformations, which have the form

$$T = (T_1, \ldots, T_n),$$

where each component T_k depends only on the variables $x_1, \ldots, x_k$. The second type of transformations concern the Monge–Kantorovich problem of optimal mass transportation. Finally, yet another type of transformations is connected with geometric flows.

All necessary concepts will be explained in the talk; no special knowledge is assumed.

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September 2008

16 September 2008, at 4 pm **Room 3.04 bs**

Anne Pichereau
Centre de Recerca Matemàtica, Barcelona

Formal deformations of Poisson structures in low dimensions

Abstract

As in the classical cases of associative or Lie brackets, there is a cohomology that governs the existence of formal deformations and the existence of extensions of deformations of Poisson structures. This cohomology is the so-called Poisson cohomology. In this talk, we consider a family of Poisson structures on the affine space of dimension 3, F^3, and a family of singular Poisson surfaces in F^3, both families being associated to weight-homogeneous polynomials that admit an isolated singularity. We then obtain a classification of all formal deformations of these Poisson structures, using some results of Poisson cohomology.

16 September 2008, at 5 pm **Room 3.04 bs**

Artem Pulemotov
Cornell University

The Li-Yau-Hamilton estimate and the Yang-Mills heat equation

Abstract

The talk will focus on two connected subjects. First, we will discuss the Li-Yau-Hamilton estimate for the heat equation on a manifold M with nonempty boundary. Results of this kind play a significant part in the study of geometric flows. Second, we will talk about the Yang-Mills heat equation in a vector bundle over M. Our interest is mainly in the long-time existence of solutions.

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October 2008

14 October 2008, at 5 pm **Room 3.04 bs**

Julien Roth
Université de Marne-la-Vallée

Spinorial characterization of surfaces into 3-homogeneous manifolds

Abstract

We give a spinorial characterization of isometrically immersed surfaces into 3-dimensional homogeneous manifolds with 4-dimensional isometry group in terms of existence of a particular spinor field, called generalized Killing spinor. This extends works by T. Friedrich for R3 and B. Morel for S3 and H3. The main argument is the interpretation of the energy-momentum tensor of a genralized Killing spinor as the second fondamental form of the immersion up to a tensor depending on the structure of the ambient space.

21 October 2008, at 5 pm **Room 2.04 bs**

Léonard Todjihounde
National University of Benin

Harmonic nets in metric spaces

Abstract

We investigate harmonic maps from weighted graphs into metric spaces that locally admit centers of gravity, like Alexandrov spaces with upper curvature bounds, and we prove an existence result by constructing an iterative geometric process that converges to such maps, called harmonic nets.

28 October 2008, at 5 pm **Room 2.04 bs**

Oleg K. Sheinman
Steklov Mathematical Institute, Moscow

Hamiltonian properties of Lax equations on Riemann surfaces

Abstract

We will define the universal Krichever-Phong symplectic structure related to Lax equations, construct (following I.Krichever) corresponding integrable hierarchies and Hamiltonians for the equations of those. We will outline the generalizaion of the theory related to an arbitrary Lax operator algebra.

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November 2008

4 November 2008, at 5 pm **Room 3.04 bs**

Christian Mauduit
Institut de Mathématiques de Luminy

Q-adic properties of prime numbers

Abstract

We will present recent results concerning the q-adic representation of prime numbers. In particular we proved that, under some trivial necessary conditions, the sum of digits function of prime numbers is well distributed in arithmetic progressions (joint work with Joël Rivat), thus solving a conjecture due to Alexander Gelfond (1967). The technics we use to estimate the associated exponential sums can also be applied to give precise estimates for the number of prime numbers with an average sum of digits (joint work with Michael Drmota and Joël Rivat).

11 November 2008, at 5 pm **Room 3.04 bs**

TBA

18 November 2008, at 5 pm **Room 3.04 bs**

Pierre Schapira
University Paris VI, Jussieu

Sheaves and $\mathscr{D}$-modules: a microlocal approach

Abstract

Microlocal analysis, which emerged in the 70's, enhances our ability to localize different objects of analysis and geometry by moving the main arena of action from an underlying manifold to its cotangent bundle.

I shall give an introduction to sheaf theory and $\mathscr{D}$-modules theory from a microlocal point of view. In particular, I will explain the definition of the characteristic variety of a coherent $\mathscr{D}$-module on a complex manifold, that of the micro-support of a sheaf on a real manifold and their relation. I will also briefly discuss the functorial properties of the characteristic variety and of the micro-support, and the link between constructible sheaves and holonomic $\mathscr{D}$-modules.

25 November 2008, at 5 pm **Room 3.04 bs**

Dragan Mašulović
University of Novi Sad, Serbia

On a new kind of homogeneity

Abstract

A structure is called homogeneous if every isomorphism between finite substructures of the structure extends to an automorphism of the structure. Recently, P. J. Cameron and J. Nešetřil introduced a relaxed version of homogeneity: we say that a structure is homomorphism-homogeneous if every homomorphism between finite substructures of the structure extends to an endomorphism of the structure.

Not much is known about homomorphism-homogeneous structures. Homomorphism-homogeneous posets were characterized in 2007 by D. Mašulović and the characterization of countable posets with respect to various types of morphisms can be found in a recent paper by P. J. Cameron and D. Lockett. Moreover, finite homomorphism-homogeneous tournaments (with loops) were characterized in 2008 by A. Ilić, D. Mašulović and U. Rajković.

In this talk we shall survey some of these results and discuss possibilities for further investigations.

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December 2008

9 December 2008, at 5 pm **Room 3.04 bs**

Robert O. Bauer
University of Illinois at Urbana-Champaign

Random self-avoiding loops in Riemann surface—a direct construction of Werner's measure

Abstract

In 1999, Oded Schramm introduced the Stochastic Loewner Evolution (SLE) to describe the scaling limit of loop-erased random walk and other random simple curves that arise as the scaling limit of interfaces in various 2 dimensional models of statistical mechanics at criticality, such as the boundaries of clusters in percolation or the Ising model. Since then, our understanding of such random simple curves has advanced significantly—rigorous convergence results linking various discrete models with continuous scaling limits, computation of critical exponents (e.g. Mandelbrot's conjecture), and a probabilistic explanation of (some of the) concepts, constructions, and results in Conformal Field Theory. For his contribution to these advances Wendelin Werner was awarded the Fields medal in 2006.

One of Werner's results is the construction of the unique conformally invariant restriction measure on self-avoiding loops in Riemann surfaces. In this talk I will give a direct construction of this measure based on chordal SLE(8/3). Our construction highlights some of the basic techniques for SLE-type curves—deriving uniqueness from very general properties, and obtaining invariant measures by integrating covariant measures. Throughout this talk, I will emphasize the topological and geometric aspects of the theory.

16 December 2008, at 5 pm **Room 3.04 bs**

Mikołaj Rotkiewicz, University of Warsaw

Geometry of affine values

Abstract

In standard Differential Geometry many constructions are based on the algebra $C^\infty(M)$ of smooth functions of a manifold M. In the geometry of affine values, AV-Geometry for short, we replace $C^\infty(M)$ by the space of sections of an affine bundle modelled on $M \times \mathbb{R}$. AV-Geometry turned out to be the proper language for the geometric description of many problems in Theoretical Mechanics. In my talk, I will describe basic objects of AV-Geometry and present new results on "double affine bundles" (joint work with J. Grabowski and P. Urbañski).