Geometry and Physics 2012 - Anogia, August 6-10, 2012

Monday, August 6

09:30-10:30 **Georges Skandalis** *Foliations, groupoids and index theorems I*

10:30-11:30 **Mathai Varghese** *T-duality: A basic introduction*

11:30-12:00 **coffee break**

12:00-13:00 **Romeo Brunetti** *Perturbative algebraic quantum field theories and deformation quantization I*

16:00-17:00 **Xiaobo Liu** *On Genus-1 Virasoro conjecture for Gromov-Witten invariants*

17:00-17:30 **coffee break**

17:30-18:30 **Siye Wu** *Index gerbe and differential K-theory*

18:30-19:30 **Hisham Sati** *TBA*

Tuesday, August 7

09:30-10:30 **Mathai Varghese** *T-duality: part 2*

10:30-11:30 **Romeo Brunetti** *Perturbative algebraic quantum field theories and deformation quantization II*

11:30-12:00 **coffee break**

12:00-13:00 **Georges Skandalis** *Foliations, groupoids and index theorems II*

16:00-17:00 **Jean-Marie Lescure** *A pseudodifferential calculus adapted to stratified pseudomanifolds and Poincaré duality in K-theory*

17:00-17:40 **Cyril Levy** *Spectral shift function and non-compact spectral action*

17:40-18:10 **coffee break**

17:30-18:30 **Calder Daenzer** *A T-duality relation between Langland's dual groups*

18:30-19:30 **Sutanu Roy** *Quasitriangular C^*-quantum groups and its coaction category*

Wednesday, August 8

09:30-10:30 **Thomas Schick** *The topology of T-duality*

10:30-11:30 **Ralf Meyer** *On the category of groupoids*

11:30-12:00 **coffee break**

12:00-13:00 **Michel Hilsum** *TBA*

Thursday, August 9

09:30-10:30 **Romeo Brunetti** *Perturbative algebraic quantum field theories and deformation quantization III*

10:30-11:30 **Georges Skandalis** *Foliations, groupoids and index theorems III*

11:30-12:00 **coffee break**

12:00-13:00 **Mathai Varghese** *T-duality and parametrized strict deformation quantization*

16:00-16:40 **Marco Zambon** *Holonomy and singular foliations*

16:40-17:20 **Rajan Mehta** *Differential graded contact geometry*

17:20-17:50 **coffee break**

17:50-18:30 **Madeleine Jotz** *Dirac structures, Lie algebroids and Dorfman connections*

18:30-19:10 **Panayotis Batakides** *Representations of W-algebras via deformation quantization*

Friday, August 10

09:30-10:30 **Alberto Cattaneo** *Classical and Quantum Lagrangian Field Theories on Manifolds with Boundary*

10:30-11:30 **Marco Manetti** *Koszul brackets and coisotropic deformations of submanifolds*

11:30-12:00 **coffee break**

12:00-13:00 **Pantelis Damianou** *Transverse Poisson structures and ADE singularities*

Short Courses

Romeo Brunetti (University of Trento, Italy)

Perturbative algebraic quantum field theories and deformation quantization

In these lectures we review the basic features and results of the algebraic approach to quantum field theories in the light of deformation quantization. The approach relies on first principles as locality and covariance, which allows a systematic discussion of classical and quantum theories in terms of functors and natural transformations.

Georges Skandalis (University of Paris 7 "Denis Diderot", France)

Foliations, groupoids and index theorems

First lecture: Regular foliations, Holonomy Groupoids, C*-algebra, Pseudodifferential Calculus

Second lecture: The leafwise Laplacian and its spectrum, Index theorem for foliations.

Third Lecture: Singular foliations

Mathai Varghese (University of Adelaide, Australia)

T-duality: a basic introduction

I will introduce the notion of T-duality for spacetimes that are compactified as total spaces of principal circle bundles, with an integral, degree 3-differential form called the H-flux. Prerequisites are differential forms, line/circle bundles (eg. Bott and Tu).

T-duality: part 2

Sometimes it is important to consider the case when compactified spacetime has singular fibers, when the circle action is not free. T-duality with H-flux in this context will also be covered. Time permitting, other results will also be mentioned.

T-duality and parametrized strict deformation quantization

When spacetime is a principal torus bundle with background flux, and one tries to iterate T-duality for circle bundles (as proved with Bouwknegt and Evslin) one circle at a time, some of the circles tend to mysteriously disappear, thereby preventing one from obtaining a classical T-dual. In this lecture, I will talk about a parametrised version of Rieffel's strict deformation quantization, as developed with K. Hannabuss. Many of the noncommutative T-duals from the previous lecture, can be constructed explicitly as parametrised strict deformation quantization of principal torus bundles. This is mainly joint work with K. Hannabuss.

Other Lectures

Panayotis Batakides (University of Cyprus)

Representations of W-algebras via Deformation Quantization

The talk will cover some steps towards the classification of irreducible representations of finite W-algebras. We shall first describe the major advancements in the field during the last 10 years and make explicit comments on Losev's approach using Fedosov's deformation quantization techniques. We then propose an alternative W-algebra model based on Cattaneo-Felder-Torossian biquantization. This allows to compute explicitly some commutativity relations in the W-algebra, determining the irreducible representations at least for the minimal orbit case. Time permitting we will give some worked out examples for the simple Lie algebra case. This is joint work with N. Papalexiou.

Alberto Cattaneo (University of Zürich, Switzerland)

Classical and Quantum Lagrangian Field Theories on Manifolds with Boundary

Classical and quantum field theories may be thought of as appropriate functors from (some version of) the cobordism category. At the quantum level this was proposed by Segal as an axiomatization. Incarnations of this exist for nonperturbative topological field theory (by Witten following Atiyah's version of the axioms for TFTs) as well as in one and two dimensional field theories. This talk (based on joint work with Mnev and Reshetikhin) will give an introduction to the classical version and to the Batalin-Vilkovisky version, which forms the starting point for the perturbative quantization. The possibility of including boundaries of boundaries (and so on) naturally yields to a Lurie-type description. Eventually, one might be able to reconstruct perturbative quantum theories on manifolds by gluing simple pieces together. Work in progress on this will be presented.

Calder Daenzer (University of Penn State, U.S.A)

A T-duality relation between Langland's dual groups

I will give a quick tour of T-duality, followed by a quick tour of Langland's duality. The first duality is a relation between a pair of principal torus bundles with NS-flux, while the second is the relation between a pair of Lie groups whose root and co-root data is interchanged. A priori, these two have nothing to do with one another, but I will describe how in many cases Langland's may be realized as a T-dualization. This is joint work with Erik Van Erp.

Pantelis Damianou (University of Cyprus)

Transverse Poisson structures and ADE singularities

We give a brief general review of the ADE classification problem. The survey includes simple Kleinian singularities, symmetries of Platonic solids, finite subgroups of $SU(2)$, the Mckay correspondence, integer matrices of norm 2 and Brieskorn's theory of subregular orbits. We conclude with some joint work with H. Sabourin and P. Vanhaecke on transverse Poisson structures to subregular orbits in semisimple Lie algebras. We show that the structure may be computed by means of a simple Jacobian formula, involving the restriction of the Chevalley invariants on the slice. In addition, using results of Brieskorn and Slodowy, the Poisson structure is reduced to a three dimensional Poisson bracket, intimately related to the simple rational singularity that corresponds to the subregular orbit. Finally we present some recent results on the minimal orbit.

Michel Hilsum (C.N.R.S. and University of Paris 7 "Denis Diderot", France)

TBA

Madeleine Jotz (University of Göttingen, Germany)

Dirac structures, Lie algebroids and Dorfman connections

I will explain the notion of Dirac structure and how Dirac manifolds generalize simultaneously presymplectic, Poisson and foliated manifolds.

I will show how Dirac structures on Lie algebroids, that are compatible in a sense with the Lie algebroid structure, are comptelely determined by a connection-like map that I call a Dorfman connection. I will define these objects and show that they appear in several natural situations.

Jean-Marie Lescure (Clermont-Ferrand, France)

A pseudodifferential calculus adpated to stratified pseudomanifolds and Poincaré duality in K-theory.

One way to study index problems on a stratified pseudomanifold is to desingularize it into a manifold with fibered corners. For such a space, we develop and study an appropriate pseudodifferential calculus whose operators are defined as conormal distributions on a suitably blown-up double space, or, equivalently, as operators on a smooth groupoid naturally appearing in this framework. Classical properties of this calculus are investigated (symbols maps, continuity between Sobolev spaces, compactness, Fredholmness). We also introduce a semiclassical version of the calculus and the groupoid as well and use it to recover the Poincaré duality between the K-homology of the stratified pseudomanifold and the K-group of fully elliptic operators, the latter being isomorphic to the the K-theory of the noncommutative tangent space of the stratified pseudomanifold. This is a joint work with Claire Debord (Clermont-Ferrand, France) and Frédéric Rochon (Montréal, Canada).

Cyril Levy (University of Potsdam, Germany)

Spectral shift function and non-compact spectral action

The spectral action of Chamseddine-Connes is a functional which extract physical information from a general noncommutative space (spectral triple). We will discuss an application of the Krein spectral shift function to the Chamseddine-Connes spectral action in R^n. In particular, thanks to some results related to G-pseudodifferential calculus, we will see a general condition on the decay at infinity of the gauge potential which yields a well-defined "relative" spectral action.

Xiaobo Liu (Notre-Dame University, U.S.A.)

On Genus-1 Virasoro conjecture for Gromov-Witten invariants.

The Virasoro conjecture predicts that the generating function of Gromov-Witten invariants of any smooth projective variety is annihilated by an infinite sequence of differential operators which form a half branch of the Virasoro algebra. In case the underlying manifold is a point, this conjecture is equivalent to Witten's conjecture, proved by Kontsevich, that the generating function of intersection numbers on moduli spaces of stable cures is a tau function of the KdV hierarchy. In an earlier paper with G. Tian, we proved the genus-0 part of the Virasoro conjecture. In this talk I will discuss the current status of this conjecture for the genus-1 case.

Marco Manetti (Sapienza Universitá di Roma, Italy)

Koszul brackets and coisotropic deformations of submanifolds.

This is a report of a joint work with R. Bandiera. Given a coisotropic submanifold Z of a holomorphic Poisson manifold, the anchor map of a holomorphic 1-form on Z is a section of the normal bundle which can interpreted as a tangent vector to the Hilbert scheme of coisotropic submanifolds. We will show that, if Z is Kaehler, then this vector is unobstructed. The main ingredients of the proof are the (explicit) Lie formality theorem for Koszul-Magri brackets and the description of the DGLA governing coisotropic deformations.

Rajan Mehta (University of Penn State, U.S.A.)

Differential graded contact geometry

Differential graded symplectic geometry is known to have close relations to many areas of mathematical physics, including Poisson geometry, generalized complex geometry, and the AKSZ topological field theory. In this talk, I will describe the odd-dimensional analogue, differential graded contact geometry, and explain how, in its simplest manifestation, Jacobi structures appear. If there is time, I will briefly describe the "Jacobi sigma model" which arises from an AKSZ-type construction.

Ralf Meyer (University of Göttingen, Germany)

On the category of groupoids

Since spaces and groups are groupoid, we may view groupoids as a generalised spaces or as generalised groups. These two approaches begin to differ when we turn groupoids into categories. The point of view of generalised spaces leads to the usual approaches, using functors or Hilsum-Skandalis morphisms. The point of view of generalised groups requires another class of morphisms, due to Zakrzeweski and worked out by Buneci and Stachura. Concretely, these are actions of one groupoid on the arrow space of the other commuting with the right multiplication action. Conceptually, we show that these are equivalent to functorial ways to turn G-actions into H-actions on the same space, for the two groupoids G and H. Groupoid C^*-algebras are only functorial for these morphisms. The same goes for the inverse semigroup of bisections of an etale groupoid.

Sutanu Roy (University of Göttingen, Germany)

Quasitriangular C^*-quantum groups and it's coaction category

In this talk we define the notion of unitary R-matrix for a C^*-quantum group. Using this R-matrix we define a braiding in the corresponding category of Hilbert space. We also construct a unitary R-matrix on the quantum codouble which is dual of the Drinfeld double in C^*-algebraic framework. Theory of C^*-quantum groups involved in based on the manageable multiplicative unitaries.

Hisham Sati (University of Pittsburgh, U.S.A.)

TBA

Thomas Schick (University of Göttingen, Germany)

The topology of T-duality

(Joint work with Ulrich Bunke): Given a space-time manifold which is a circle bundle together with a background field (given by a three-form or gerbe or something similar) considerations from string theory suggest one should look for a "dual pair" - where the circles are replaced by "dual circles" and one has a "dual background field" on the resulting total space.

The physics on the two duals should be equivalent: in particular the (twisted) K-theory groups of the two spaces, which classify certain charges, should be isomorphic.

We present a purely topological approach to this, capturing at least all topological consequences of the proposed duality, among them the expected K-theory isomorphism. In particular, we give a precise mathematical definition of T-duality, show that T-duality actually is a representable functor with a classifying space, and derive a number of consequences concerning the classification of T-dual pairs.

Siye Wu (University of Colorado Boulder, U.S.A.)

Index gerbe and differential K-theory

We discuss results on determinant line bundles of Bismut-Freed, Quillen and Witten, the notion of index gerbe due to Carry-Mickelsson-Murray and Lott, and the recent index theorem of Freed-Lott in differential K-theory. Then we show, by calculations in differential K-theory, that for a family of Riemannian manifolds of odd dimensions, the index in the odd differential K-group maps to the Deligne cohomology class of the index gerbe. This is a joint work with V. Mathai.

Marco Zambon (Universidad Autonoma Madrid, Spain)

Holonomy and Singular Foliations

I will report on joint work with Iakovos Androulidakis. We study the geometry associated to singular foliations. A singular foliation $\mathcal{F}$ on M is defined as a submodule of vector fields, and contains more information than the induced partition of M into (singular) leaves. For instance, any vector field on M gives rise to a singular foliation, and any Lie algebroid on M also does.

We will focus on the notion of holonomy. Unlike the case of regular foliations, holonomy cannot be defined in terms of paths in the leaves. Its definition will involve a groupoid H, which was ingeniously associated to $(M, \mathcal{F})$ by Androulidakis-Skandalis. We will present simple examples and show that this notion specializes to the classical one for regular foliations.

As an application, we will describe the relation between the linearization of the foliation about a leaf L and the notion of holonomy. When L satisfies certain regularity conditions, it turns out that the restriction $H\,|_L$ is an honest Lie groupoid. From this, we will deduce some simple statements about the linearization problem (the singular version of the Reeb stability theorem).

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