Titles and abstracts of the talks of the

Closing Meeting of the Thematic Year:
Perspectives in Deformation Quantization and Noncommutative Geometry

RIMS, Kyoto University — February 21 - 23, 2011

Harald Grosse
University of Vienna

Renormalizable noncommutative Quantum Fields

Abstract:

I. Introduction: First we summarize the formulation of local quantum fields over Minkowski and Euclidean space-time and emphasize the need to cure the old problems (IR, UV and the convergence problem connected to the Landau ghost).

II. In order to improve this situation (and to include certain gravity effects) models defined over noncommutative space-time have been proposed. This leads to noncommutative regularizations and to the IR/UV mixing problem, which implies nonrenormalizability.

III. Euclidean NCQFT: We identify four relevant/marginal operators of the renormalization group flow and cure this mixing problem. This leads to a taming of the Landau ghost. (Based on work together with Raimar Wulkenhaar)

We describe the treatments of nc gauge models and emphasize the connection to matrix models, treated extensively in Japan. (Based on work together with Raimar Wulkenhaar, Michael Wohlgenannt and collaborators in Vienna)

IV. Construction: At the self-dual point the model for a scalar matter field has a vanishing beta function. We combine a Ward identity with the Schwinger-Dyson equations and obtain integral equations for the renormalized correlation functions, which may lead to the construction of a four dimensional quantum field. (Based on work together with Raimar Wulkenhaar)

V. Minkowski NCQFT: These are more complicated, mixing occurs too. We show that locality is replaced by wedge locality and describe a noncommutative Wick rotation. (Based on work together with Gandalf Lechner)

Pedram Hekmati
University of Adelaide

Twisted K-classes and 1-cocycles

Abstract: Families of Dirac type operators, transforming covariantly under the projective action of the loop group LG, determine a class in twisted K-theory on compact Lie groups G. An interesting problem is to try to generalise LG to a mapping group $Map(M, G)$, where M is a higher dimensional compact manifold. This is far from obvious and some of the difficulties can be modelled in a slightly simpler setting, by replacing LG and gauge connections by objects which have only small differentiability in the Sobolev sense. In this talk, I will provide some background to this problem and explain why 1-cocycles naturally arise in this construction. This is joint work with Jouko Mickelsson.

Yukiko Konishi
Kyoto University

Local B-model and Mixed Hodge structure

Abstract: Local mirror symmetry is a variant of mirror symmetry. Its B-model concerns a family of affine curves in the two-dimensional algebraic torus and the variation of mixed Hodge structures. In this talk I would like to explain a direct definition of the Yukawa coupling for the local B-model. This is the joint work with Satoshi Minabe.

Hitoshi Moriyoshi
Nagoya University

Eta cocycle and relative index theorem

Abstract: Let X be an even-dimensional compact oriented manifold with boundary Y. On such a manifold Atiyah-Patodi-Singer established the index theorem:

$$sgn(X) = \int_X L(R_X) + \eta_Y(0).$$

Here $sgn(X)$ denotes the signature of X, $L(R_X)$ is the L-polynomial of X and $\eta Y(0)$ the eta invariant of Y. In this talk we shall exhibit a viewpoint in noncommutative Differential Geometry, namely a relative index theorem, from which the Atiyah-Patodi-Singer index theorem is well understood. The crucial object is a short exact sequence of C^*-algebras involved with kernel functions on X and a manifold V that is obtained from X by attaching an infinite cylindrical end. It turns out to be isomorphic to the Wiener-Hopf extension for $C^*\mathbb{R}$. We then construct a relative cyclic cocycle for those algebras and makes a pairing with the relative index class, which yields the Atiyah-Patodi-Singer index theorem. This description makes clear the role of the integral $\int L(R_X)$ and $\eta Y(0)$ in the formula above.

Shin-ichi Oguni
Ehime University

Relatively hyperbolic groups and relatively quasiconvex subgroups

Abstract: We give an introduction to relatively hyperbolic groups and relatively quasiconvex subgroups, and also discuss recent development containing our results of a joint work with Yoshifumi Matsuda and Saeko Yamagata.

Jonathan Rosenberg
University of Maryland

Dualities in field theories and the role of K-theory

Abstract: It is now known (or in some cases just believed) that many quantum field theories exhibit "dualities" — equivalences with the same or a different theory in which things appear very different, but the overall physical implications are the same. Examples of such dualities include electric-magnetic duality, T-duality, S-duality, and the AdS/CFT correspondence. We will discuss some of these dualities from the point of view of a mathematician, focusing on "charge conservation" and the role played by K-theory and noncommutative geometry.

Lecture 1: Overview with some classical examples

Lecture 2: Topological T-duality and various current approaches to it (using axiomatics and noncommutative geometry, including my joint work with Mathai)

Lecture 3: Problems presented by S-duality and other dualities (including joint work with my student S. Mendez-Diez)

Hiroshi Takai
Tokyo Metropolitan University

Entire Cyclic Cohomology of Noncommutative Riemann Surfaces

Abstract: In noncommutative geometry, Connes defined two categories of cyclic cohomology, namely periodic and entire ones as a generalization of the De Rham homology with complex coefficients. Actually, the former is a subspace of the latter one. They are quite essentially useful to noncommutative index theory. Many informations bave been obtained in the periodic case, especially computation of important examples, Pimsner-Voiclescu type theorem, Thom isomorphism type one, Qunneth formula and so on. In the entire case, there are only few examples computed by Meyer, Brodzki-Plymen, Mathai-Stevenson, Kawashima, and Kawashima-T.

In this talk, we show that the both notions coincide for noncommutative Riemann surfaces with genus greater than 1. The basic plans we use are contructing smooth version of topological one of noncommutative Riemann surfaces by Natsume-Nest and tranferring the fundamental ideas of excision for E-theory by Thomsen to ones for entire cyclic theory.

Alan Weinstein
UC Berkeley

Symplectic and quantum categories

Abstract: One approach to quantization is to represent classical and quantum mechanics by categories and then to construct functors between them. In these talks, I will describe a "classical" rigid monoidal category whose objects are symplectic manifolds and whose morphisms include all the canonical relations (also known as lagrangian correspondences). The "quantum" category will have as objects rigged Hilbert spaces (also known as Gelfand triples), with the morphisms being certain partially defined continuous linear mappings. Finally, I will discuss the problem of constructing quantization functors.

Ping Xu
Pennsylvania State University

Gerbes and twisted equivariant cohomology

Abstract: Let G be a compact Lie group, M a compact manifold on which G acts smoothly. For any $\alpha \in H^3_G(M, Z)$, we introduce a notion of delocalized twisted equivariant cohomology $H^*_G(M, \alpha)$. Its relation with twisted equivariant K-theory will be discussed. This is a joint work with Jean-Louis Tu.