

Quantum Spacetime obtaining, with a suitable definition of the interaction, a UV-finite theory (perturbatively to all orders). Moreover, the DFR analysis can be extended to spherically symmetric curved spacetimes, leading to consequences of cosmological interest.

- P. Piazza

*Higher Index Theory: a Survey*

The Atiyah-Singer index theorem on compact manifolds without boundary and the Atiyah-Patodi-Singer index theorem on compact manifolds with boundary are nowadays regarded as classic results in global analysis. They are also extremely important in Physics. Generalizations of these two theorems to Galois coverings and foliations involve noncommutative geometry in an essential way and have been in fact among the important motivations for its development. In this lecture I will survey these extensions, discuss some of the spectacular applications that have been given in topology and differential geometry and point to some open problems.

# Incontri di Geometria Noncommutativa

— A Neapolitan Workshop on Noncommutative Geometry —

Maurizio Brunetti  
Francesco D'Andrea  
Gaetano Fiore  
Davide Franco  
Fedele Lizzi  
Patrizia Vitale

Napoli, 20–22 September 2012

## Overview

This mini-workshop will be devoted to several aspects of the current research activity in noncommutative geometry, and its main aim is to bring together scientists working on this subject, in both mathematics and theoretical physics. It is divided in four thematic sessions, each consisting in two seminars and a discussion session, led by an expert of the field. The aim of the discussion sessions is to exchange ideas on specific topics, to popularize some lines of research, and point out to the community some open problems.

The conference is organized by the Departments of Mathematics and Physics of the University of Naples Federico II, and sponsored by the grant “Progetto FARO 2010” (Polo delle Scienze, Univ. of Naples Federico II) and by the Department of Mathematics of the University of Naples Federico II.

## The venue

The conference takes place at the polytechnic institute of the University of Naples Federico II, located in the area of Fuorigrotta, Piazzale Vincenzo Tecchio 80.

For further informations, please consult the website:

<http://www.dma.unina.it/ngc2012/>

## Thematic sessions

### I: Quantum Spaces and Quantum Symmetries

Discussion leader: Sergio Doplicher

Speakers: Ludwik Dabrowski, Gerardo Morsella

### II: Index Theory, Spectral Triples and Applications

Discussion leader: Davide Franco

Speakers: Paolo Piazza, Fabio Cipriani

### III: Gauge Theory

Discussion leader: Giorgio Immirzi

Speakers: Leonardo Castellani, Giovanni Landi

### IV: Poisson Geometry, Deformation Quantization and Drinfel'd Twist

Discussion leader: Paolo Aschieri

Speakers: Francesco Bonechi, Gaetano Fiore

## Schedule

### Thursday 20

**14:00–14:30** Introduction by S. Doplicher.

**14:30–15:20** L. Dabrowski, *Curved Noncommutative Torus and the Gauss-Bonnet Formula*.

**15:20–15:40** — COFFEE BREAK —

**15:40–16:30** G. Morsella, *Quantum Spacetime: from First Principles to Cosmological Implications*.

**16:30–18:00** Discussion session, with S. Doplicher.

### Friday 21

**9:30–10:20** P. Piazza, *Higher Index Theory: a Survey*.

**10:20–10:40** — COFFEE BREAK —

**10:40–11:30** F. Cipriani, *Analysis, Geometry and Physics on Fractals*.

**11:30–13:00** Discussion session, with D. Franco.

**13:00–14:30** — LUNCH BREAK —

**14:30–15:20** L. Castellani, *Extended Gauge and Gravity Theories from Noncommutativity*.

**15:20–15:40** — COFFEE BREAK —

**15:40–16:30** G. Landi, *Dimensional Reduction over the Quantum Sphere and non-Abelian  $q$ -Vortices*.

**16:30–18:00** Discussion session, with G. Immirzi.

### Saturday 22

**9:30–10:20** F. Bonechi, *The Quantization of the Symplectic Groupoid*.

**10:20–10:40** — COFFEE BREAK —

**10:40–11:30** G. Fiore, *Drinfel'd Twist: a Powerful Tool to Deform Algebras and Their Symmetries*.

**11:30–13:00** Discussion session, with P. Aschieri.

## Abstracts

- F. Bonechi

*The Quantization of the Symplectic Groupoid*

We discuss the role of Poisson geometry in noncommutative geometry. We introduce the symplectic groupoid as a canonical realization of a Poisson manifold. Its quantization gives a concrete connection between Poisson and noncommutative geometry. We discuss in general the geometric quantization and its relation with the theory of groupoid  $C^*$ -algebras. In the non unimodular case we are naturally led into the problem of integrability of the modular function. We discuss the examples coming from quantum groups and related homogeneous spaces.

- L. Castellani

*Extended Gauge and Gravity Theories from Noncommutativity*

- F. Cipriani

*Analysis, Geometry and Physics on Fractals*

In the first part of the talk we will analyze, on the basis of examples, the several aspects for which fractals escape from a classical Riemannian Geometry framework. This will require consideration of dimensions, distances, volumes and energies. In the second part we will see how exploiting the notion of energy, i.e. a Dirichlet form, an underlying differential calculus naturally emerges by which differential 1-forms and their line integrals along paths can be defined, topological invariants can be detected and a Conformal Geometry can be considered through the construction of a summable Fredholm module. At the end we will discuss the singularity between volume and energy distributions and the corresponding phenomenon of the discrepancy between the volume and energy dimensions.

- L. Dabrowski

*Curved Noncommutative Torus and the Gauss-Bonnet Formula*

- G. Fiore

*Drinfel'd Twist: a Powerful Tool to Deform Algebras and Their Symmetries*

- G. Landi

*Dimensional Reduction over the Quantum Sphere and non-Abelian  $q$ -Vortices*

- G. Morsella

*Quantum Spacetime: from First Principles to Cosmological Implications*

Several physical arguments combining Quantum Mechanics and General Relativity suggest that spacetime cannot be described by an ordinary manifold at distances below the Planck length, but most of them are based (sometimes implicitly) on spherically symmetric localization of events. Admitting a general localization led Doplicher, Fredenhagen and Roberts to a set of uncertainty relations between the spacetime coordinates of an event in Minkowski spacetime, which can be realized by replacing the latter with a noncommutative spacetime defined by suitable commutation relations, and enjoying symmetry under the usual Poincaré group. It is also possible to naturally define QFT on such a