ICC Lectures on Particle Physics

Presentation

As a contribution to the education of our graduate students, but open to everyone, the ICC has decided to sponsor a series of advanced lectures on different topics related to the activities of our Institute.

We shall start with a set of lectures on theoretical particle physics: Fedele Lizzi "Introduction to non-commutative geometry", and David Mateos "The gauge/string duality and its applications to QCD".

The lectures will be on Tuesdays 11am to 1pm, room 507 (Aula Pere Pascual) which has been booked until the end of May. Each speaker is aiming to provide something between 8 and 12 hours or lectures.

The first lecture will be given by D. Mateos on Tuesday March 10th, where the organization of the lectures will be discussed.

We plan to extend thes lectures to selected topics in nuclear theory and astrophysics or cosmology in the future hoping that they become an important ingredient for the formation of our students.

Schedule

All lectures take place on Tuesday from 11am to 1pm, Aula 507.

- D. Mateos, "**The gauge/string duality and its applications to QCD**", March 10, 17, 24, 31 and April 14, 21.
- F. Lizzi, "**Non-commutative geometry**"

Starting on April 28, more information to follow -- check the ICC website.

Information on the lectures by D. Mateos

Plan

1) Why QCD should have a string dual.

2) String theory basics.

3) AdS/CFT from D3-branes.

4) Finite temperature and connection to RHIC physics (I)

5) Confinement/deconfinement phase transitions.

6) Fundamental matter as D-brane probes.

7) Finite T temperature and connection to RHIC physics (II)

General References

D. Mateos, "String theory and QCD", arXiv:0709.1523 [hep-th].

Aharony et al., hep-th/9905111.

You can also watch the lectures on-line:

RTN Winter School (15-19 January 2007)

More basic, covers 1), 3), 4) and 5).

SISW02 event list (you have to click on my lectures and then on download file) Covers 6), 7) and beyond.

Specific References

1) Large-N limit: Beautiful review by Witten, Nucl.Phys.B160:57,1979.

2) Notes on String Basics (Last part of Lecture 1, and Lecture 2)

More information to follow -- check the ICC website

Information on the lectures by F. Lizzi

28 April: Lecture 1

Mathematical Foundations. Equivalence betwen topological spaces and algebras. The noncommutative Geometry of the quantum phase space.

The first lecture will introduce the mathematical foundations of noncommutative geometry, and in particular how to encode geometrical information in the algebra of functions, seen as algebra of operators on a Hilbert space. I will also discuss the original example of noncommutative

geometry: the phase space of quantum mechanics seen as a noncommutative geometry.

Reference: Chapter 6 in

Aschieri, Dimitrijevic, Kulish, Lizzi, Wess, Noncommutative Spacetimes: Symmetries in Noncommutative Geometry and Field Theory Lecture Notes in Physics , Vol. 774 This book should be avaliable in mid may on line from IP numbers at the University of Barcelona.

Till then it is on line on my homepage:

http://people.na.infn.it/~lizzi/chapter6.pdf

There will a pause of two weeks.

On 5 May there is a miniworkshop on Strings and QCD On 12 May David Mateos will finish his lectures.

19 May: Lecture 2

Noncommutative field theory.

I will mostly discuss field theories on noncommutative spaces with noncommutativity given by the Gronewold-Moyal product. Connection with string theory. The Ultraviolet/Infrared mixing. I will also venture into some tentative phenomenological consequences.

Reference: Quantum field theory on noncommutative spaces.

Richard J. Szabo

Phys.Rept.378:207-299,2003.

e-Print: hep-th/0109162

26 May: Lecture 3

Symmetries of noncommutative geometry. Brief introduction to quantum groups.

I will discuss quantum symmetries, with a brief introduction to quantum groups and Hopf algebras (which alone could fill a whole course). I will in particular discus the symmetries of noncommutative field theories described by a Drinfeld twist.

Reference: Chapters 1, 2 and 7 of the Lecture Notes in Physics cited above.

2 June: Lecture 4

Connes Approach to the Standard Model and the Higgs.

In this lecture I will discuss Connes approach to geometry, and show how the standard model emerges as a noncommutative geometry (or rather an almost commutative geometry), with the Higgs the "vector" boson corresponding to the internal noncommutative degrees of freedom, on a par with the other (legitimate) vector bosons of the standard model. The spectral action.

Reference: The Uncanny Precision of the Spectral Action.

Ali H. Chamseddine, Alain Connes

arXiv:0812.0165 [hep-th]

and notes I will circulate