Prof. Dr. Dirk Kreimer, IHES, Bures-sur-Yvette
Local Interactions: Which numbers make the point? (1)

TIME:
4 May 2010, 17:00 - 19:00

LOCATION:
HU
Institut für Mathematik
Rudower Chaussee 25, Raum 1.013
12489 Berlin

The lectures, given twice weekly for four weeks in the month of May, introduce, in a self-contained manner, the many consequences of the fact that the known laws of physics are based on local renormalizable interacting quantum fields. The lectures address students with interest in mathematical physics, mathematicians as well as physicists. They will be self-contained, but a good knowledge of some basic physics and/or mathematics is certainly helpful.

We will start with a careful review of the algebraic structures involved: Hopf algebras will provide the vehicle to define combinatorial objects needed to get started: we look at rooted trees, Feynman graphs, Kirchhoff polynomials, and such things.

A little bit of Hochschild cohomology allows us to give a precise treatment of the renormalization group, and then to look at equations of motion in relativistic quantum field theory.

Thats a good moment to digress into ideals of these Hopf algebras, and to see how the notion of symmetry for quantized fields can be captured by demanding that we divide by certain ideals. Slavnov-Taylor identities and Britto-Cachazo-Feng-Witten recursions shall be discussed from this angle, and so will be elementary properties of quantum gravity.

Contact:
Humboldt-Universität zu Berlin . Institut für Mathematik
SFB 647 . Unter den Linden 6 . 10099 Berlin
Tel. +49 30 2093 1804 . Fax. +49 30 2093 2727
sfb647@math.hu-berlin.de

Finally, we will review basic properties of Kirchhoff polynomials and consider connections to transcendental number theory and algebraic geometry in Feynman graphs. By then, we hope the audience appreciates the many open and baffling questions which remain as a future challenge.

The lectures aim at a mixed audience of mathematicians and physicists, and hopefully are comprehensible without specific prerequisites.

For literature, the following links might be helpful to start:

i) Dominique Manchon's review on Hopf algebras and renormalization
http://math.univ-bpclermont.fr/ manchon/biblio/bogota2002.pdf

ii) Dirk Kreimer "Algebra for quantum fields" (Clay math Inst. Proc., in press)
http://arxiv.org/pdf/0906.1851

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