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Advanced School and Conference on Non-commutative Geometry

(9 - 27 August 2004)

Miramare, Trieste, Italy

SUGGESTED READING

Course: "Computer Algebra", by Gerhard Pfister

References

G.-M. Greuel, G. Pfister, *A SINGULAR Introduction to Commutative Algebra*, Springer 2002

Eisenbud, Grayson, Stillman, Sturmfels, *Computations in Algebraic Geometry with Macaulay2*, Springer 2001

Kreuzer, Robbiano, *Computational Commutative Algebra I*, Springer 2000.

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Course: "Non-commutative Differential Geometry, C*-algebras, etc.", by Thomas Schücker

Prerequisites

In these lectures noncommutative geometry will be applied to the physics of forces. On the physical side, some knowledge of the following theories would be useful: general relativity, e.g. [1], Dirac spinors at the level of e.g. the first few chapters in [2] and Yang-Mills theory with spontaneous symmetry break-down, for example the standard model electromagnetic, weak and strong forces, e.g. [3]. The mathematical treatment will be low-tech. We will use *local* differential and Riemannian geometry at the level of e.g. the first few chapters in[4]. Local means that our spaces or manifolds can be thought of as open subsets of $\mathbb{R}^4$. Nevertheless, we sometimes use compact spaces like the torus: only to simplify some integrals. We will need a little group theory, e.g. [5], mostly matrix groups and their representations, and a few basic facts on associative algebras [6]. The chapters of noncommutative geometry relevant for the mentioned application [7] will be motivated and developped as we go along.

References

[1] S. Weinberg, *Gravitation and Cosmology*, Wiley (1972)\\
R. Wald, *General Relativity*, The University of Chicago Press (1984)

[2] J. D. Bjørken & S. D. Drell, *Relativistic Quantum Mechanics*, McGraw--Hill (1964)

[3] L. O'Raifeartaigh, *Group Structure of Gauge Theories*, Cambridge University Press (1986)

[4] M. Göckeler & T. Schücker, *Differential Geometry, Gauge Theories, and Gravity*, Cambridge University Press (1987)

[5] R. Gilmore, *Lie Groups, Lie Algebras and Some of Their Applications*, Wiley (1974)
H. Bacry, *Lectures Notes in Group Theory and Particle Theory*, Gordon and Breach (1977)

[6] N. Jacobson, *Basic Algebra I, II*, Freeman (1974, 1980)

[7] G. Landi, *An Introduction to Noncommutative Spaces and Their Geometry*, hep-th/9701078, Springer (1997)
J. M. Gracia-Bondía, J. C. Várilly & H. Figueroa, *Elements of Noncommutative Geometry*, Birkhäuser (2000)
T. Schücker, *Forces from Connes' geometry*, hep-th/0111236, lectures at the Autumn School "Topology and Geometry in Physics", Rot an der Rot, 2001, eds.: E. Bick & F. Steffen, Lecture Notes in Physics, Springer, to appear

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Course: "Homological Algebra ", by Michel Van den Bergh

Abelian categories

In the course I will highlight the main point of the theory of abelian categories but it would be good to have some prior exposure to this material. In particular the technique of diagram chasing is very important as well as the classical definitions of derived functors such as Ext and Tor. This material is standard and can be found in many old and new books.

One example is

Mitchell, Barry; Theory of categories, *Pure and Applied Mathematics*, Vol. XVII, Academic Press, New York-London, 1965 xi+273 pp.

Another nice book is

Rotman, Joseph J.; An introduction to homological algebra, *Pure and Applied Mathematics*, 85. Academic Press, Inc. [Harcourt Brace Jovanovich, Publishers], New York-London, 1979. xi+376 pp., ISBN 0-12-599250-5

Derived categories

This will be dealt with in a fairly detailed way in the course. Yet again it might be useful to have had some prior exposure. Possible references are:

Verdier's appendix in

Deligne, P.; Cohomologie étale, Séminaire de Géométrie Algébrique du Bois-Marie SGA 4 1/2. Avec la collaboration de J. F. Boutot, A. Grothendieck, L. Illusie et J. L. Verdier. *Lecture Notes in Mathematics*, Vol. 569, Springer-Verlag, Berlin-New York, 1977. iv+312pp.

The chapter on derived categories in

Borel, A.; Algebraic D-modules, Perspectives in Mathematics, 2. Academic Press, Inc., Boston, MA, 1987. xii+355 pp., ISBN 0-12-117740-8