

CONTEMPORARY MATHEMATICS

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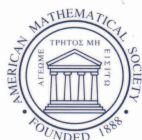
Noncommutative Geometry and Representation Theory in Mathematical Physics

Satellite Conference to the Fourth European
Congress of Mathematics

July 5–10, 2004

Karlstad University, Karlstad, Sweden

Jürgen Fuchs
Jouko Mickelsson
Grigori Rozenblioum
Alexander Stolin
Anders Westerberg
Editors



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Preface

Mathematics provides us with a language in which to formulate the laws that govern the phenomena observed in nature. This language has proven to be both powerful and effective, and, the question of how reasonable this effectiveness may be aside, in trying to understand the basic laws of nature one is bound to use the tools that mathematics supplies. A foundation of physics cannot be built solely on this ground, however; an even more essential ingredient is experiment, and any substantial progress in physics should eventually allow for predictions that can be tested experimentally. Nevertheless, the quest for a deeper understanding of fundamental physical issues, such as the interactions among elementary particles or the structure of space-time, tends to lead to theories which are ever harder to put to observational tests. In this situation, mathematical conciseness and internal consistency of a physical theory become increasingly important guidelines in the evolution of physics.

It is less evident what parts of mathematics are most relevant for the study of some given area of physics and whether or not the existing mathematical knowledge is already sufficient for addressing all problems within the area in question. In recent years, novel questions have emerged in mathematical physics, notably in quantum field theory. Accordingly, additional areas of mathematics have become influential and, in turn, been influenced themselves by the developments in physics. As a consequence, over the last two decades interactions between mathematicians and physicists have increased enormously, resulting in a fruitful cross-fertilization between different communities.

A central theme of this endeavour has been the algebraization of physical concepts. This principle manifests itself in several guises, notably in the form of non-commutative geometry and of representation theory. Each of these two areas may be discussed in its own right, but indeed they are intimately related, e.g. via the study of ‘non-classical’ algebraic structures which generalize the algebras of functions on a manifold. Arguably, the following list, while not being exhaustive, covers a major part of the most prominent topics encountered in these fields and in their application to the algebraization programme: quantum symmetries and quantum statistics; quantum groups, C^* -algebras, infinite-dimensional Lie algebras, vertex operator algebras, weak Hopf algebras, Lie superalgebras, Jordan triple systems; representation categories of those structures; Lie bialgebras, Gerstenhaber algebras, Frobenius and Hopf-Galois extensions; pseudodifferential operators on quantum spaces, non-commutative index theorems, moduli spaces in non-commutative geometry, operators on singular manifolds; deformation quantization, quantization of Poisson brackets, star products, Poisson-Lie groups, q -deformed and non-commutative Lagrangian field theory; modular tensor categories and the Verlinde

conjecture, Yang-Baxter equations, Calogero-Sutherland models, strings and membranes, conformal and topological quantum field theory.

Each of the topics in this list was represented by a leading expert at the international symposium *Non-commutative Geometry and Representation Theory in Mathematical Physics*. This meeting took place in July 2004 at Karlstad University in Karlstad, the capital of the Swedish province Värmland, as a satellite conference to the Fourth European Congress of Mathematics. The present volume collects contributions from most of the plenary speakers and from some of the speakers in the parallel sessions.

Browsing the table of contents or, for that matter, just the subject classification codes, the reader will undoubtedly notice that the scope of the symposium and of this volume is rather broad and that various different scientific communities are involved. Still, a detailed inspection will exhibit many interrelations between the various contributions and demonstrate that they can be regarded as different facets of a common theme. This is indeed what we experienced during the symposium ourselves and has been confirmed by many participants in their feedback after the meeting. We hope that this volume will enrich the future development in the areas to which it is devoted and that it will help to further intensify the prosperous interaction between mathematics and physics.

The 90 participants of the conference came from 25 different countries; about one third of them were from Sweden. The program consisted of 23 plenary talks and 39 presentations in parallel sessions. The schedule, abstracts of all talks and further details are available at the web site <http://www.ingvet.kau.se/teofys/conf/ncg-rt/>.

Financial support from several different sources allowed us to arrange the conference. Major contributions came from the Wenner-Gren Foundations, Längmanska kulturfonden, the Faculty Board of Karlstad University, and Karlstads kommun. Further support from Birkhäuser Publishing Inc. and from Journal of Physics A is also gratefully acknowledged. In addition, Olav Arnfinn Laudal generously provided funding for the support of several junior participants.

We are indebted to Setta Aspström, Niclas Bernhoff, Jonas Björnsson, Gabi Fuchs, Kerstin Haraldsson, Lasse Holmquist, Alma Löv, Kerstin Moatti, Marit Nilsson, Camilla Nygren, Mirela Vinerean, and Albrecht Wurtz. Without their invaluable help at various stages of the organization, we would never have been able to realize the conference.

We would also like to thank all the participants, the speakers and the authors of the contributions to this volume, as well as our colleagues who agreed to act as referees and devoted much time to the reviewing process.

Karlstad, June 2005

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In recent years, many novel questions have emerged in mathematical physics, particularly in quantum field theory. Indeed, several areas of mathematics have lately become increasingly influential in physics and, in turn, have become influenced by developments in physics. Over the last two decades, interactions between mathematicians and physicists have increased enormously and have resulted in a fruitful cross-fertilization of the two communities.

This volume contains the plenary talks from the international symposium on Noncommutative Geometry and Representation Theory in Mathematical Physics held at Karlstad University (Sweden) as a satellite conference to the Fourth European Congress of Mathematics.

The scope of the volume is large and its content is relevant to various scientific communities interested in noncommutative geometry and representation theory. It offers a comprehensive view of the state of affairs for these two branches of mathematical physics. The book is suitable for graduate students and researchers interested in mathematical physics.

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