Proceedings of the International Symposium

Quantum Theory and Symmetries

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Preface

All descriptions of quantum systems are inherently based on symmetries in their most general sense. For these descriptions one needs mathematical structures which involve geometrical objects and their algebraic analogues, like groups and their deformations, typically in a differential geometric or topological setting. This includes the related functional analytic structure of these objects, which is necessary for a physical interpretation of the results. Already for the description of classical systems this structure appears and reflects the fact that these systems carry deeply rooted inbuilt general symmetries. Symmetry induced models successfully explain larger parts of physical phenomena and effects and especially also the technology based on their applications. In this somehow geometrical design the symposium QUANTUM THEORY AND SYMMETRIES covers fundamental as well as applied topics.

The Symposium was held in the Conference Centre 'Achtermann', Goslar, 18-22 July 1999. It was organised by H.-D. Doebner, V.K. Dobrev, J.-D. Hennig and W. Lücke in the framework of the international conference, symposium, workshop and seminar programme of the Institute of Theoretical Physics (until 1984) and the former Arnold Sommerfeld Institute (since 1984) at the Technical University of Clausthal. This programme was initiated by one of us (H.-D.D.) in 1977 with a workshop on Differential Geometric Methods, followed by larger or smaller meetings, at least one or two every year, on different topics in mathematical physics with emphasis on mathematical modelling of physical systems with geometrical methods in their widest sense, including all the related topological, differential and analytical structures; for example, quantum groups, partial differential equations, quantum field theory, artificial neural networks. These meetings took place in Clausthal, Goslar, in Italy (1981), in Bulgaria (1980, 1982, 1984, 1987), and in Poland (1992, 1995, 1999). Some were part of well known conference series (e.g. the XVI. and XXI. International Colloquium on Group Theoretical Methods in Physics in 1987 and 1996, or the II. Wigner Symposium in 1991). The material presented in the meetings was regularly published in refereed proceedings volumes by Springer or World Scientific. The list of these meetings (omitting smaller seminars) is given at the end of this volume. The programme was sponsored by various national and international organisations and institutions, especially the Technical University of Clausthal and the State Government of Lower Saxonia.

As asked by many colleagues and friends three of us (V.K.D., J.-D.H., W.L.) arranged a plenary session (with talks by L. O'Raifeartaigh, S.T. Ali, G.A. Goldin and A. Bohm) dedicated to Prof. H.-D. Doebner because of his "phase transition" to the state of Professor Emeritus (on 1 October 1999). In the same connection we organised, together with the Rector of the Technical University of Clausthal, a celebration including a harangue 'From Athens to Clausthal' by Y. Ne'eman. During this celebration Professor Doebner was awarded the Werner Heisenberg Medal of the Alexander von Humboldt Foundation, the Medal of 1st degree of the Technical vi

University of Prague, and the "Médaille de l'Université" of the University of Nancy.

This volume gives insight into the interplay between symmetry and quantum theory and of a geometrical approach to classical and quantum mechanical systems with applications and comments on old problems and on trends in status nascendi. We invited experts for various topics and facets to report on new or to review recent results. Also controversial subjects were included as, e.g., the evening lecture by G. Nimtz entitled 'Demonstrating Superluminal Signal Velocity'.

We arranged the material in the following sections:

- Quantisation
- Nonlinear Evolution Equations
- Special Problems in Quantum Theory
- Algebraic Quantum Field Theory
- Gauge, String and Field Theories
- Quantum Information
- Quantum Groups
- Discrete Symmetries
- Groups and Geometrical Modelling

The plenary talks are contained in the corresponding sections. The order in each section is subject related. We regret that some of the lecturers were not able to send a contribution in time.

The Symposium was sponsored by the following institutions:

- Niedersächsisches Ministerium für Wissenschaft und Kultur
- Deutsche Forschungsgemeinschaft
- Alexander von Humboldt Stiftung
- Deutscher Akademischer Austauschdienst
- Technische Universität Clausthal

We are grateful for their support which, in particular, made it possible to invite also participants from different parts of south-eastern Europe and from developing countries.

Last but not least we would like to thank the coworkers and students of the Physics Department, and the conference secretary Susanne Krieghoff, for their help in organising this Symposium so smoothly and efficiently.

H.-D. Doebner, V.K. Dobrev, J.-D. Hennig, W. Lücke Clausthal, January 2000 Preface

Celebration

Programme

Harangue: From Athens to Y. Ne'eman

Quantisation

Quantum theory over until V.S. Varadarajan

A generalized Wigner function S.T. Ali

Anomalies and star product H. Römer and C. Par

Hamiltonian quantization of manifold with boundary A. Carey and J. Micke

Bi-Hamiltonian systems and G. Marmo and A. Sim

Moyal quantization and too V.I. Man'ko

Quantization of classical m F.E. Schroeck, Jr.

Quantization of Yang-Mill J. Śniatycki

Representation spaces of the constrained on a manifold Y. Ohnuki