

Preface

This volume contains the written versions of invited lectures presented at the “39. Internationale Universitätswochen für Kern- und Teilchenphysik” in Schladming, Austria, which took place from February 26th to March 4th, 2000. The title of the school was “Methods of Quantization”. This is, of course, a very broad field, so only some of the new and interesting developments could be covered within the scope of the school.

About 75 years ago Schrödinger presented his famous wave equation and Heisenberg came up with his algebraic approach to the quantum-theoretical treatment of atoms. Aiming mainly at an appropriate description of atomic systems, these original developments did not take into consideration Einstein’s theory of special relativity. With the work of Dirac, Heisenberg, and Pauli it soon became obvious that a unified treatment of relativistic and quantum effects is achieved by means of local quantum field theory, i.e. an intrinsic many-particle theory. Most of our present understanding of the elementary building blocks of matter and the forces between them is based on the quantized version of field theories which are locally symmetric under gauge transformations. Nowadays, the prevailing tools for quantum-field theoretical calculations are covariant perturbation theory and functional-integral methods. Being not manifestly covariant, the Hamiltonian approach to quantum-field theories lags somewhat behind, although it resembles very much the familiar nonrelativistic quantum mechanics of point particles. A particularly interesting Hamiltonian formulation of quantum-field theories is obtained by quantizing the fields on hypersurfaces of the Minkowski space which are tangential to the light cone. The “time evolution” of the system is then considered in “light-cone time” $x^+ = t + z/c$. The appealing features of “light-cone quantization”, which are the reasons for the renewed interest in this formulation of quantum field theories, were highlighted in the lectures of Bernard Bakker and Thomas Heinzl. One of the open problems of light-cone quantization is the issue of spontaneous symmetry breaking. This can be traced back to zero modes which, in general, are subject to complicated constraint equations. A general formalism for the quantization of physical systems with constraints was presented by John Klauder. The perturbative definition of quantum field theories is in general afflicted by singularities which are overcome by a regularization and renormalization procedure. Structural aspects of the renormal-

ization problem in the case of gauge invariant field theories were discussed in the lecture of Klaus Sibold. A review of the mathematics underlying the functional-integral quantization was given by Ludwig Streit.

Apart from the topics included in this volume there were also lectures on the Kaluza–Klein program for supergravity (P. van Nieuwenhuizen), on dynamical r -matrices and quantization (A. Alekseev), and on the quantum Liouville model as an instructive example of quantum integrable models (L. Faddeev). In addition, the school was complemented by many excellent seminars. The list of seminar speakers and the topics addressed by them can be found at the end of this volume. The interested reader is requested to contact the speakers directly for detailed information or pertinent material.

Finally, we would like to express our gratitude to the lecturers for all their efforts and to the main sponsors of the school, the Austrian Ministry of Education, Science, and Culture and the Government of Styria, for providing generous support. We also appreciate the valuable organizational and technical assistance of the town of Schladming, the Steyr-Daimler-Puch Fahrzeugtechnik, Ricoh Austria, Styria Online, and the Hornig company. Furthermore, we thank our secretaries, S. Fuchs and E. Monschein, a number of graduate students from our institute, and, last but not least, our colleagues from the organizing committee for their assistance in preparing and running the school.

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