Fundamental Problems of Gauge Field Theory

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PREFACE

The sixth Ettore Majorana International School of Mathematical Physics was held at the Centro della Cultura Scientifica Erice, Sicily, 1-14 July 1985. The present volume collects lecture notes on the session which was devoted to Fundamental Problems of Gauge Field Theory. The School was a NATO Advanced Study Institute sponsored by the Italian Ministry of Public Education, the Italian Ministry of Scientific and Technological Research and the Regional Sicilian Government.

As a result of the experimental and theoretical developments of the last two decades, gauge field theory, in one form or another, now provides the standard language for the description of Nature; QCD and the standard model of the electroweak interactions illustrate this point. It is a basic task of mathematical physics to provide a solid foundation for these developments by putting the theory in a physically transparent and mathematically rigorous form.

The lectures and seminars of the school concentrated on the many unsolved problems which arise here, and on the general ideas and methods which have been proposed for their solution. In particular, we mention the use of rigorous renormalization group methods to obtain control over the continuum limit of lattice gauge field theories, the exploration of the extraordinary enigmatic connections between Kac-Moody-Virasoro algebras and string theory, and the systematic use of the theory of local algebras and indefinite metric spaces to classify the charged C^* states in gauge field theories.

In addition, there was the stochastic realization of quantum field theory which provides not only an alternative framework but a possible practical numerical approach to the solution of gauge theories. Finally, we had the remarkable application of topological and differential geometric tools to the analysis of anomalies.

We hope that the lecture notes will provide both a summary of current research in this field and an introduction for those who are just entering it.

G. Velo
A. S. Wightman

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