

PREFACE

This volume collects twelve essays written in honor of Wolfhart Zimmermann on the occasion of his 80th birthday. Ten of them are based on talks given at a Symposium in his honor, held at the Ringberg castle of the Max Planck Society from February 3rd to 6th, 2008.

Wolfhart Zimmermann has been in the forefront of research in Quantum Field Theory since the 1950s, when the famous work of ‘LSZ’ (Lehmann, Symanzik, Zimmermann) was created, which is at the basis of all modern applications of Quantum Field Theory to Accelerator Physics, and without which results expected from the LHC at CERN – scheduled to start operation this year – would not be possible. But he was also the first person to construct composite operators in Quantum Field Theory, thus laying the groundwork for the mathematical description of symmetries and their breaking in perturbation theory with its undisputable success in the standard model of particle physics. On the more abstract level this led to the understanding of anomalies: all anomalies known up to date have their origin in an identity which he proved for normal products of different subtraction degrees. In particular anomaly coefficients are given in terms of the coefficients of this identity. The range of this observation has not yet been fully exhausted until the present day, but remains a source of new structural relations.

The perturbatively formulated operator product expansion which he established gave safe ground to the corresponding non-perturbative conjecture of Kenneth Wilson which lead to quantitatively successful results in Quantum Chromodynamics.

His study of asymptotic freedom in the case of several coupling constants introduced the concept of reduction of couplings which enlarges the notion of symmetry and under mild assumptions builds a bridge from perturbation theory to the non-perturbative regime of a theory. The proof that theories exist which have vanishing dilatation and conformal anomalies to all orders of perturbation theory is based on this concept. Amongst these models is the famous supersymmetric Yang-Mills theory with four supersymmetries.

Some of the contributors of this volume were his students, some were

his collaborators, some just shared his interest in the subject, but all of them are inspired by him and his work. Analogously one might classify the contributions by content. Some continue work originally initiated by him and employ his tools directly. Some are devoted to lay new groundwork in quantum physics or to broaden and to deepen applications. But all are close in spirit and originality. Two of the contributions are particularly remarkable by the fact that they employ ideas and concepts of Quantum Field Theory in different areas of physics, such as the mathematical theory of electrons in disordered media and the theory of dynamical systems. They thus prove how fruitfully renormalization theory has transcended its origin in particle physics and leads to new insight in otherwise seemingly disjoint parts of physics.

A glance at the subjects covered also reveals the enormous richness and diversity of a theory that originally aimed at a mathematically sound theory of elementary particles. New concepts of spacetime are being checked, fundamentals of quantum mechanics are formulated; Quantum Field Theory is embedded in new structures. The essays in this volume attest both to Wolfhart Zimmermann's inspiring influence and the power and continuing vigor of Quantum Field Theory in our days.

We have tried to arrange the contributions roughly according to increasing distance from Wolfhart Zimmermann's own work in Quantum Field Theory; of course the linear order required by the presentation cannot do justice at all to the various interconnections between the different articles.

We would like to thank all contributors for their carefully written essays which provide an entertaining tour through part of today's theoretical physics.

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