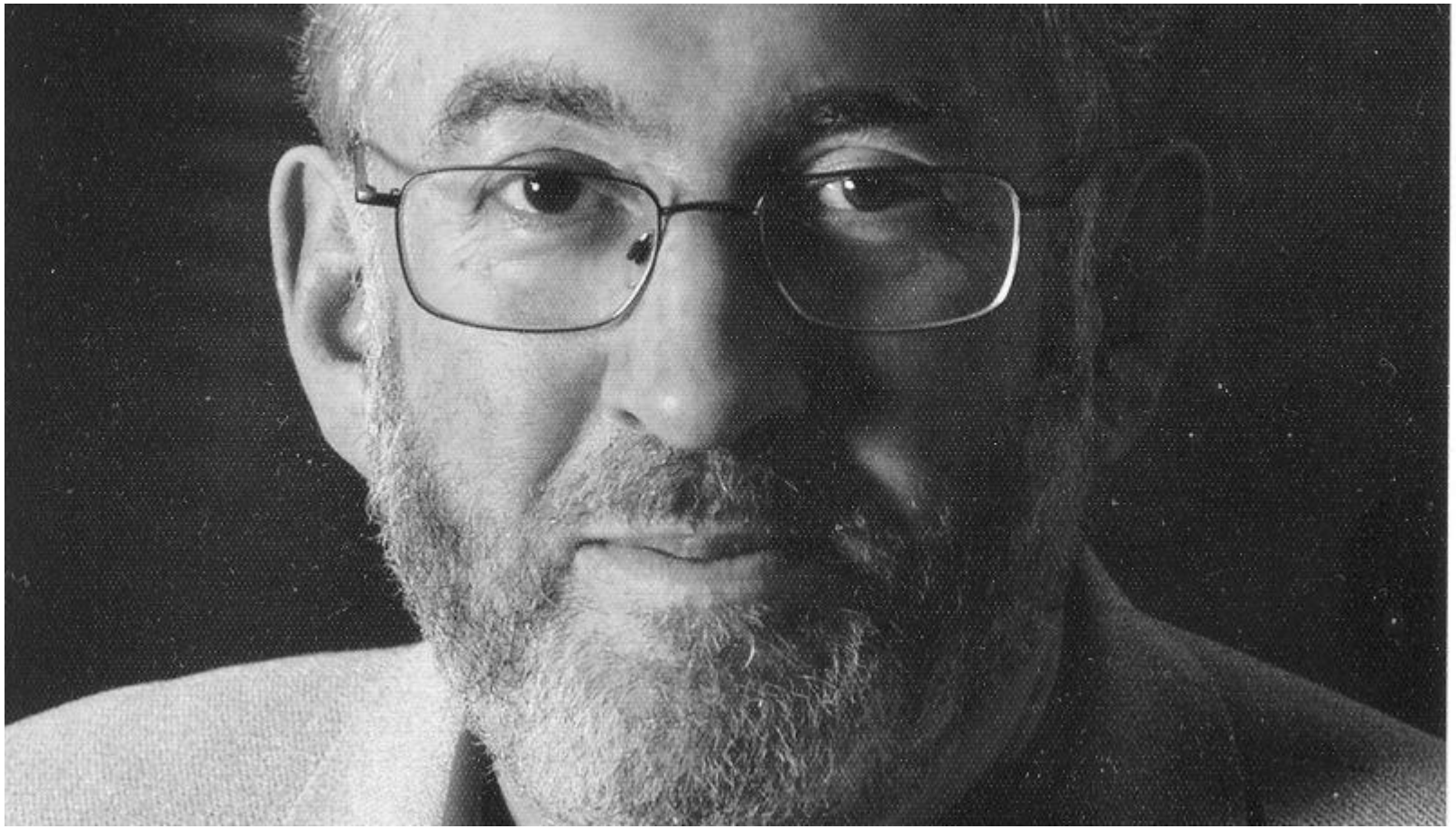
NEW PERSPECTIVES IN CONFORMAL FIELD THEORY AND GRAVITY

DESY Theory Workshop
26 - 29 September 2023 at DESY Hamburg, Germany



Dedicated to the memory of

Prof. Dr. Gerhard Mack

*4. Juli 1940 in Tübingen
† 4. Mai 2023 in Hamburg

Prof. Dr. Gerhard Mack

* 4.Juli 1940 in Tübingen

Studied in Stuttgart, Munich, Princeton

1967 PhD in Bern[Prof. Dr Hans Kastrup]

1971 Habilitation in Munich

1972 Professor at University of Bern

1975 Professor at Universität Hamburg

Kurt Symanzik, Harry Lehmann

1991-93 Head of Physics Department

2005 Member of Academy of Sciences and Humanities in Hamburg

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ANNALS OF PHYSICS: 53, 174–202 (1969)

Finite-Component Field Representations of the Conformal Group

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We review work done on realization of broken symmetry under the conformal group of space-time in the framework of finite-component field theory. Topics discussed include: Most general transformation law of fields over Minkowski space. Consistent formulation of an orderly broken conformal symmetry in the framework of Lagrangian field theory; algebra of currents and their divergences; Manifestly conformally covariant fields and their couplings.

I. INTRODUCTION

The conformal symmetry of space time as a possible generalization of Poincaré symmetry has provided a recurrent theme in particle physics.[1] The problems associated with conformal symmetry are (i) its physical interpretation and (ii) the problems arising from its broken character and the precise manner of descent to Poincaré invariance.

Gerhard Mack was one of the Pioneers of Conformal Field Theory

- Convergence of OPE in CFT
- Representations of SU(2,2)
- Global Conformal Invariance

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Convergence of Operator Product Expansions on the Vacuum in Conformal Invariant Quantum Field Theory

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Abstract. In a conformal invariant quantum field theory (in 4 space time dimensions) Wilson operator product expansions converge on the vacuum, because they are closely related to conformal partial wave expansions.

1. Introduction

Let $\phi^l(x)$, $\phi^j(y)$ two local quantum fields. According to Wilson [1], their product should admit an asymptotic expansion at short distances of the form

$$\phi^l(\tfrac{1}{2}x)\phi^j(-\tfrac{1}{2}x)\Omega = \sum_k C^{ljk}(x)\phi^k(0)\Omega. \qquad (1.1a)$$


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Global Conformal Invariance in Quantum Field Theory

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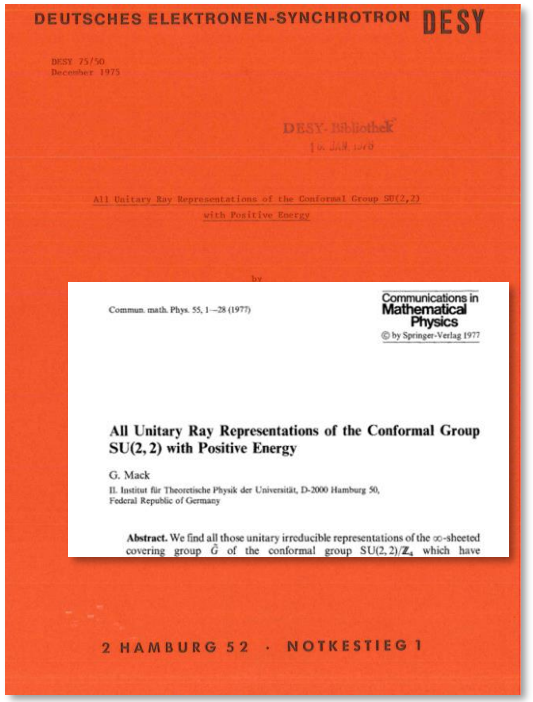
Received October 17, 1974

Abstract. Suppose that there is given a Wightman quantum field theory (QFT) whose Euclidean Green functions are invariant under the Euclidean conformal group $\mathfrak{G} \simeq SO_4(5,1)$. We show that its Hilbert space of physical states carries then a unitary representation of the universal (∞-sheeted) covering group $\mathfrak{G}^*$ of the Minkowskian conformal group $SO_4(4,2)/\mathbb{Z}_2$. The Wightman functions can be analytically continued to a domain of holomorphy which has as a real boundary an ∞-sheeted covering $\tilde{M}$ of Minkowski-space M^4. It is known that $\mathfrak{G}^*$ can act on this space $\tilde{M}$ and that $\tilde{M}$ admits a globally $\mathfrak{G}^*$-invariant causal ordering; $\tilde{M}$ is thus the natural space on which a globally $\mathfrak{G}^*$- invariant local QFT could live. We discuss some of the properties of such a theory, in particular the spectrum of the conformal Hamiltonian $H = \frac{1}{2}(P^0 + K^0)$.

As a tool we use a generalized Hille-Yosida theorem for Lie semigroups. Such a theorem is stated and proven in Appendix C. It enables us to analytically continue contractive representations of a certain maximal subsemigroup $\mathfrak{S}$ of $\mathfrak{G}$ to unitary representations of $\mathfrak{G}^*$.

1. Introduction

Conformal invariant quantum field theory (QFT) is of interest from the point of view of constructive quantum field theory because such theories can be analyzed to a remarkable extent by nonperturbative methods, i.e. without recourse to iterative techniques [1, 2]. One adopts the usual postulates of local QFT (Wightman axioms [3]): Spectrum condition, positivity, and locality. In addition one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All Unitary Ray Representations of the Conformal Group SU(2,2) with Positive Energy

by

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All Unitary Ray Representations of the Conformal Group SU(2, 2) with Positive Energy

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Abstract. We find all those unitary irreducible representations of the ∞-sheeted covering group $\tilde{G}$ of the conformal group $SU(2,2)/\mathbb{Z}_4$ which have

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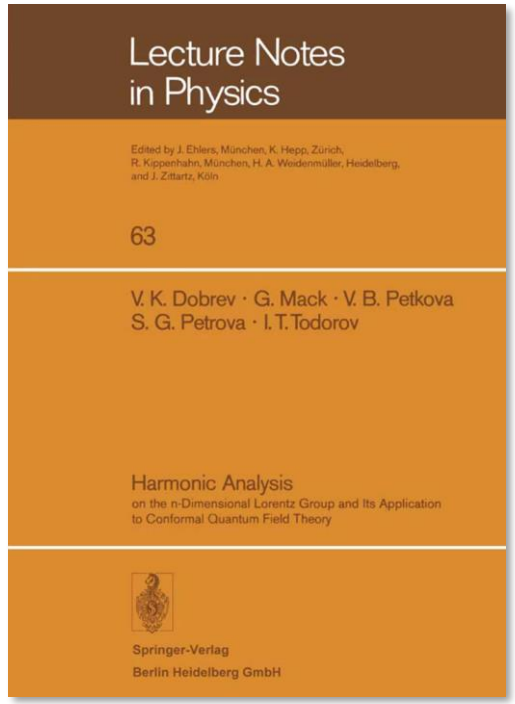
Lecture Notes in Physics

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V. K. Dobrev · G. Mack · V. B. Petkova
S. G. Petrova · I. T. Todorov

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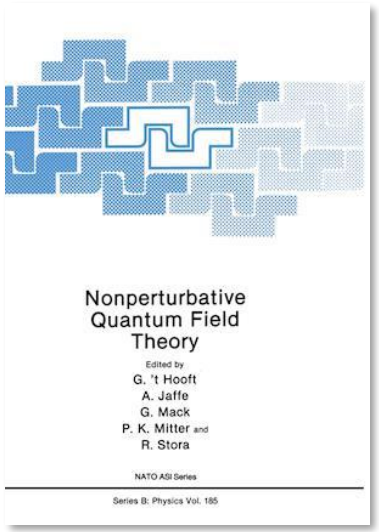

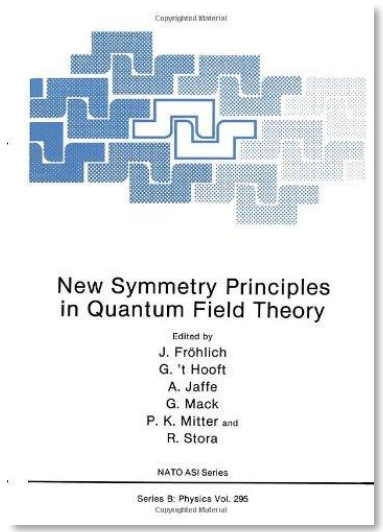

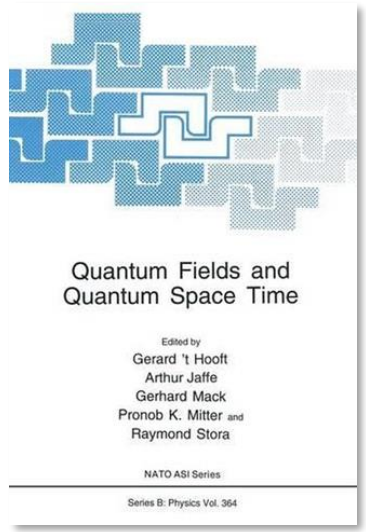

D-independent representation of Conformal Field Theories in D dimensions via transformation to auxiliary Dual Resonance Models. Scalar amplitudes

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July 14, 2009

Abstract

The Euklidean correlation functions and vacuum expectation values of products of n field operators $\phi^{k_i}(x_i)$ of some Lorentz spin l_i and dimension d_i are expressed through Mellin amplitudes $M_{k_n,\ldots k_1}(\{\delta_{ij}\})$ which depend on complex dimensions $\delta_{ij} = \delta_{ji}$, $1 \leq i < j \leq n$ subject to linear constraints $\sum_j \delta_{ij} = d_i$. The constraints can be solved in terms of conserved momenta p_i whose squares are given by the field dimensions d_i, and related Mandelstam variables $s_{ij} = (p_i + p_j)^2$, viz. $\delta_{ij} = -p_i p_j$. The Mellin amplitudes furnish a universal representation of conformal field theories without explicit reference to D. The costumary principles of quantum field theory plus conformal invariance and operator product expansions (OPE) say that the Mellin amplitudes are amplitudes of dual resonance models with exotic duality and