A Naturally Renormalized Quantum Field Theory

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Abstract

It was shown that quantum metric fluctuations smear out the singularities of Green's functions on the light cone [1], but it does not remove other ultraviolet divergences of quantum field theory. We have proved that the quantum field theory in Krein space, *i.e.* indefinite metric quantization, removes all divergences of quantum field theory with exception of the light cone singularity [2, 3]. In this paper, it is discussed that the combination of quantum field theory in Krein space together with consideration of quantum metric fluctuations, results in quantum field theory without any divergences.

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1 Introduction

One of the greatest challenges of physics today is the achievement of a proper theory of quantized gravitational fields. In other words a theory, which quantizes the gravitational fields without any anomaly, is sought for the past seven decades without a thorough success. The element of time, which has two completely different concepts in quantum mechanics as opposed to general relativity, is the most outstanding problem of this theory. By introduction of background field method this problem has been resolved-although it could not be applied to the very early moments of evaluation of universe (the Planck scale) where the perturbation of metric is in the same order as the background metric itself. The next problem, which appears in the background field method is the non-renormaliziability of the theory of quantum gravity. Three divergent opinions have been stated for explanation of this anomaly. The first view sees the problem as an inherent problem of general relativity and the second, as an intrinsic problem of quantum mechanics. The third group, believe that both, quantum mechanics and general relativity are problematic and an alternative theory has to replace them.

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Renormalized Quantum Field Theory

C. R. Hagen

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Renormalized Quantum Field Theory O.I. Zavialov,2012-12-06 Et moi Ii j avait su CClIIIIIIaIt CD 1 CVCDir ODe scmcc matbcmatK s bas I CIIdcRd be je D semis paiDt humaD mcc It bas put common sease bact Jules Vcmc WIIcR it bdoDp 011 be topmost sbdl JlCXt 10 be dully c uista t bdlcd cIiIc arded DOlI The series is diverpt therefore we may be sense Eric T BcII able 10 do sometbiD One service logic has rendered com puter science One service category theory has rendered mathematics All arguably true And all statements obtainable this way form part of the l Iison d etre of this series **Combinatorics and Renormalization in Quantum Field Theory** Eduardo Renato Caianiello,Eduardo R. Caianiello,1973 Lecture and reprint series **Mass Renormalization in Quantum Field Theory** C. R. Hagen,1964 *Renormalization Group and Fixed Points* Timothy J Hollowood,2013-03-28 This Brief presents an introduction to the theory of the renormalization group in the context of quantum field theories of relevance to particle physics Emphasis is placed on gaining a physical understanding of the running of the couplings The Wilsonian version of the renormalization group is related to conventional perturbative calculations with dimensional regularization and minimal subtraction An introduction is given to some of the remarkable renormalization group properties of supersymmetric theories *Mass Renormalization in Quantum Field Theory II* C. R. Hagen,1964 *Renormalization and Invariance in Quantum Field Theory* Eduardo Caianiello,2012-12-06 The subject matter of this Advanced Study Institute which has been rendered possible by the generous support of NATO gratefully acknow ledged here is of central importance to quantum field theory today The problems involved are both deep and complicated to a point that perhaps does not find easily a parallel in other branches of theoret ical physics From the first rule of thumb prescriptions on how to perform renormalization to the most recent advances which brighten our hopes to find eventually in field theory indications as to the ultimate composition of matter a great amount of progress has cer tainly been made We were fortunate to have among us many of the people who have most contributed to past and recent developments Although clues that point to what to do next are clearer now than might have been expected only a few years ago much hard work is still ahead It is hoped that both our meeting which brought to gether leaders in the field as well as bright and eager beginners and the present volume based on the NATO meeting may be useful as a mise a point and as an up to date reference book for researchers interested in the field **Renormalization and Effective Field Theory** Kevin Costello,2022-04-25 This book tells mathematicians about an amazing subject invented by physicists and it tells physicists how a master mathematician must proceed in order to understand it Physicists who know quantum field theory can learn the powerful methodology of mathematical structure while mathematicians can position themselves to use the magical ideas of quantum field theory in mathematics itself The retelling of the tale mathematically by Kevin Costello is a beautiful tour de force Dennis Sullivan This book is quite a remarkable contribution It should make perturbative quantum field theory accessible to mathematicians There is a lot of insight in the way the author uses the

renormalization group and effective field theory to analyze perturbative renormalization this may serve as a springboard to a wider use of those topics hopefully to an eventual nonperturbative understanding Edward Witten Quantum field theory has had a profound influence on mathematics and on geometry in particular However the notorious difficulties of renormalization have made quantum field theory very inaccessible for mathematicians This book provides complete mathematical foundations for the theory of perturbative quantum field theory based on Wilson s ideas of low energy effective field theory and on the Batalin Vilkovisky formalism As an example a cohomological proof of perturbative renormalizability of Yang Mills theory is presented An effort has been made to make the book accessible to mathematicians who have had no prior exposure to quantum field theory Graduate students who have taken classes in basic functional analysis and homological algebra should be able to read this book   **Renormalization and Invariance in Quantum Field Theory** Eduardo Caianiello,1974-07-01   **An Introduction To Quantum Field Theory** Michael E. Peskin,2018-05-04 An Introduction to Quantum Field Theory is a textbook intended for the graduate physics course covering relativistic quantum mechanics quantum electrodynamics and Feynman diagrams The authors make these subjects accessible through carefully worked examples illustrating the technical aspects of the subject and intuitive explanations of what is going on behind the mathematics After presenting the basics of quantum electrodynamics the authors discuss the theory of renormalization and its relation to statistical mechanics and introduce the renormalization group This discussion sets the stage for a discussion of the physical principles that underlie the fundamental interactions of elementary particle physics and their description by gauge field theories   **Universality and Renormalization** Ilia Binder,Dirk Kreimer, This book covers a wide range of phenomena in the natural sciences dominated by notions of universality and renormalization The contributions in this volume are equally broad in their approach to these phenomena offering the mathematical as well as the perspective of the applied sciences They explore renormalization theory in quantum field theory and statistical physics and its connections to modern mathematics as well as physics on scales from the microscopic to the macroscopic Information for our distributors Titles in this series are co published with the Fields Institute for Research in Mathematical Sciences Toronto Ontario Canada   **Wavelets And Renormalization** Guy Battle,1999-03-03 WAVELETS AND RENORMALIZATION describes the role played by wavelets in Euclidean field theory and classical statistical mechanics The author begins with a stream lined introduction to quantum field theory from a rather basic point of view Functional integrals for imaginary time ordered expectations are introduced early and naturally while the connection with the statistical mechanics of classical spin systems is introduced in a later chapter A vastly simplified wavelet version of the celebrated Glimm Jaffe construction of the 43 quantum field theory is presented It is due to Battle and Federbush and it bases an inductively defined cluster expansion on a wavelet decomposition of the Euclidean quantum field The presentation is reserved for the last chapter while the more basic aspects of cluster expansions are reviewed in the chapter on classical spin systems Wavelets themselves are studied from two different points of view arising from two

disciplines The mathematical point of view covers the basic properties of wavelets and methods for constructing well known wavelets such as Meyer wavelets Daubechies wavelets etc The physical point of view covers the renormalization group formalism where there is a close connection between wavelets and Gaussian fixed points The book is heavily mathematical but avoids the theorem proof theorem proof format in the interests of preserving the flow of the discussion i e it is written in the style of an old fashioned theoretical physics book but the major claims are rigorously proven The minor themes of the book are reflection positivity the combinatorics of cluster expansions and the issue of phase transitions themes which have nothing to do with wavelets but which provide necessary cultural background for the physical context **Quantum Field Theory and Critical Phenomena** Jean Zinn-Justin,2021-04-15 Introduced as a quantum extension of Maxwell s classical theory quantum electrodynamics has been the first example of a Quantum Field Theory QFT Eventually QFT has become the framework for the discussion of all fundamental interactions at the microscopic scale except possibly gravity More surprisingly it has also provided a framework for the understanding of second order phase transitions in statistical mechanics As this work illustrates QFT is the natural framework for the discussion of most systems involving an infinite number of degrees of freedom with local couplings These systems range from cold Bose gases at the condensation temperature about ten nanokelvin to conventional phase transitions from a few degrees to several hundred and high energy particle physics up to a TeV altogether more than twenty orders of magnitude in the energy scale Therefore this text sets out to present a work in which the strong formal relations between particle physics and the theory of critical phenomena are systematically emphasized This option explains some of the choices made in the presentation A formulation in terms of field integrals has been adopted to study the properties of QFT The language of partition and correlation functions has been used throughout even in applications of QFT to particle physics Renormalization and renormalization group properties are systematically discussed The notion of effective field theory and the emergence of renormalisable theories are described The consequences for fine tuning and triviality issue are emphasized This fifth edition has been updated and fully revised e g in particle physics with progress in neutrino physics and the discovery of the Higgs boson The presentation has been made more homogeneous througout the volume and emphasis has been put on the notion of effective field theory and discussion of the emergence of renormalisable theories *Combinatorics And Renormalization In Quantum Field Theory* E.r. Caianiello,2003-04-17 This volume is based upon work done by the author and his collaborators over a period of approximately twenty years and is dedicated to some selected topics of quantum field theory which have proved of increasing importance with the passing of time There are three parts Combinatoric Methods Equations for Green s Functions and Perturbative Expansions Regularization Renormalization and Mass Equations This work will be useful to anyone interested in learning or using quantum field theory many body physics and as well to many applied mathematicians because it introduces a number of combinatoric and analytic tools which drastically simplify and at times bypass treatments which customarily take up most of

the bulk of the standard texts   From Perturbative to Constructive Renormalization Vincent Rivasseau,2014-07-14 The last decade has seen striking progress in the subject of renormalization in quantum field theory The old subject of perturbative renormalization has been revived by the use of powerful methods such as multiscale decompositions precise estimates have been added to the initial theorems on finiteness of renormalized perturbation theory with new results on its large order asymptotics Furthermore constructive field theory has reached one of its major goals the mathematically rigorous construction of some renormalizable quantum field theories For these models one can in particular investigate rigorously the phenomenon of asymptotic freedom which plays a key role in our current understanding of the interaction among elementary particles However until this book there has been no pedagogical synthesis of these new developments Vincent Rivasseau who has been actively involved in them now describes them for a wider audience There are in fact common concepts at the heart of the progress on perturbative and constructive techniques Exploiting these similarities the author uses perturbative renormalization which is the more widely known and conceptually simpler of the two cases to explain the less familiar but more mathematically meaningful constructive renormalization Originally published in 1991 The Princeton Legacy Library uses the latest print on demand technology to again make available previously out of print books from the distinguished backlist of Princeton University Press These editions preserve the original texts of these important books while presenting them in durable paperback and hardcover editions The goal of the Princeton Legacy Library is to vastly increase access to the rich scholarly heritage found in the thousands of books published by Princeton University Press since its founding in 1905

Renormalization Laurie M. Brown,2012-12-06 The purpose of this section is to give you a sketch of how quantum field theory works where Feynman graphs come from and why they are so useful where the infinities come from and how we have learned to deal with them without compromising the physical principles involved I am purposely treating the problem at the level of the 1940s and 1950s so as to keep the basic ideas clear and avoid the more difficult problems and more sophisticated methods of recent years I shall relate my discussion simply to quantum electrodynamics QED since that is the most familiar case and the case that was in the forefront from the beginning though in fact I shall ignore many of the special complications that have to be dealt with when you quantize a gauge field The methods I shall be describing are applicable to all sorts of quantized fields the detailed factors are different but the structure of the logical development isjust the same Not surprisingly though the renormalization procedure breaks down if the theory in question is nonrenormalizable Whether nonrenormalizable theories are theories at all is a matter for debate in any case they hold no practical interest for physicists since they are essentially unusable Quantum electrodynamics was devised in 1927 by Dirac less than a year after the Schrodinger equation appeared and before the Dirac equa tion for the relativistic electron had been invented   Field Theory, the Renormalization Group, and Critical Phenomena D. J. Amit,1984   **Field Theory, the Renormalization Group, and Critical Phenomena** D. J. Amit,Victor Martin Mayor,2005-01-01   **Renormalization in Quantum Field**

Theory (after R. Borcherds) Estanislao Herscovich,2019 *Field Theory, The Renormalization Group, And Critical Phenomena: Graphs To Computers (3rd Edition)* Daniel J Amit,Victor Martin-mayor,2005-06-21 This volume links field theory methods and concepts from particle physics with those in critical phenomena and statistical mechanics the development starting from the latter point of view Rigor and lengthy proofs are trimmed by using the phenomenological framework of graphs power counting etc and field theoretic methods with emphasis on renormalization group techniques Non perturbative methods and numerical simulations are introduced in this new edition Abundant references to research literature complement this matter of fact approach The book introduces quantum field theory to those already grounded in the concepts of statistical mechanics and advanced quantum theory with sufficient exercises in each chapter for use as a textbook in a one semester graduate course The following new chapters are included I Real Space MethodsII Finite Size ScalingIII Monte Carlo Methods Numerical Field Theory *An Introduction to Quantum Field Theory* Michael Edward Peskin,Daniel V. Schroeder,1995 An Introduction to Quantum Field Theory is a textbook intended for the graduate physics course covering relativistic quantum mechanics quantum electrodynamics and Feynman diagrams The authors make these subjects accessible through carefully worked examples illustrating the technical aspects of the subject and intuitive explanations of what is going on behind the mathematics After presenting the basics of quantum electrodynamics the authors discuss the theory of renormalization and its relation to statistical mechanics and introduce the renormalization group This discussion sets the stage for a discussion of the physical principles that underlie the fundamental interactions of elementary particle physics and their description by gauge field theories

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Table of Contents Renormalized Quantum Field Theory

1. Understanding the eBook Renormalized Quantum Field Theory
    - The Rise of Digital Reading Renormalized Quantum Field Theory
    - Advantages of eBooks Over Traditional Books
2. Identifying Renormalized Quantum Field Theory
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Renormalized Quantum Field Theory
    - User-Friendly Interface
4. Exploring eBook Recommendations from Renormalized Quantum Field Theory
    - Personalized Recommendations
    - Renormalized Quantum Field Theory User Reviews and Ratings
    - Renormalized Quantum Field Theory and Bestseller Lists
5. Accessing Renormalized Quantum Field Theory Free and Paid eBooks
    - Renormalized Quantum Field Theory Public Domain eBooks
    - Renormalized Quantum Field Theory eBook Subscription Services
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