

# General Principles of Quantum Field Theory

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# General Principles Of Quantum Field Theory Mathematical Physics And Applied Mathematics

**N.N. Bogolubov, Anatoly A.  
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## **General Principles Of Quantum Field Theory Mathematical Physics And Applied Mathematics:**

*General Principles of Quantum Field Theory* N.N. Bogolubov, Anatoly A. Logunov, A.I. Oksak, I. Todorov, 2012-12-06 The majority of the memorable results of relativistic quantum theory were obtained within the framework of the local quantum field approach The explanation of the basic principles of the local theory and its mathematical structure has left its mark on all modern activity in this area Originally the axiomatic approach arose from attempts to give a mathematical meaning to the quantum field theory of strong interactions of Yukawa type The fields in such a theory are realized by operators in Hilbert space with a positive Poincare invariant scalar product This classical part of the axiomatic approach attained its modern form as far back as the sixties It has retained its importance even to this day in spite of the fact that nowadays the main prospects for the description of the electro weak and strong interactions are in connection with the theory of gauge fields In fact from the point of view of the quark model the theory of strong interactions of Wightman type was obtained by restricting attention to just the physical local operators such as hadronic fields consisting of fundamental quark fields acting in a Hilbert space of physical states In principle there are enough such physical fields for a description of hadronic physics although this means that one must reject the traditional local Lagrangian formalism The connection is restored in the approximation of low energy phe nomenological Lagrangians

*General Principles of Quantum Field Theory* N.N. Bogolubov, Anatoly A. Logunov, A. I. Oksak, I. Todorov, 2012-02-09 The majority of the memorable results of relativistic quantum theory were obtained within the framework of the local quantum field approach The explanation of the basic principles of the local theory and its mathematical structure has left its mark on all modern activity in this area Originally the axiomatic approach arose from attempts to give a mathematical meaning to the quantum field theory of strong interactions of Yukawa type The fields in such a theory are realized by operators in Hilbert space with a positive Poincare invariant scalar product This classical part of the axiomatic approach attained its modern form as far back as the sixties It has retained its importance even to this day in spite of the fact that nowadays the main prospects for the description of the electro weak and strong interactions are in connection with the theory of gauge fields In fact from the point of view of the quark model the theory of strong interactions of Wightman type was obtained by restricting attention to just the physical local operators such as hadronic fields consisting of fundamental quark fields acting in a Hilbert space of physical states In principle there are enough such physical fields for a description of hadronic physics although this means that one must reject the traditional local Lagrangian formalism The connection is restored in the approximation of low energy phe nomenological Lagrangians

**Quantum Field Theory I: Basics in Mathematics and Physics** Eberhard Zeidler, 2007-04-18 This is the first volume of a modern introduction to quantum field theory which addresses both mathematicians and physicists at levels ranging from advanced undergraduate students to professional scientists The book bridges the acknowledged gap between the different languages used by mathematicians and physicists For students of mathematics the author shows that detailed knowledge of the physical

background helps to motivate the mathematical subjects and to discover interesting interrelationships between quite different mathematical topics For students of physics fairly advanced mathematics is presented which goes beyond the usual curriculum in physics

**Introduction to Quantum Field Theory** Anthony G. Williams, 2022-08-04 This textbook offers a detailed and uniquely self contained presentation of quantum and gauge field theories Writing from a modern perspective the author begins with a discussion of advanced dynamics and special relativity before guiding students steadily through the fundamental principles of relativistic quantum mechanics and classical field theory This foundation is then used to develop the full theoretical framework of quantum and gauge field theories The introductory opening half of the book allows it to be used for a variety of courses from advanced undergraduate to graduate level and students lacking a formal background in more elementary topics will benefit greatly from this approach Williams provides full derivations wherever possible and adopts a pedagogical tone without sacrificing rigour Worked examples are included throughout the text and end of chapter problems help students to reinforce key concepts A fully worked solutions manual is available online for instructors

**Mathematical Methods in Physics** Philippe Blanchard, Erwin Brüning, 2015-04-07 The second edition of this textbook presents the basic mathematical knowledge and skills that are needed for courses on modern theoretical physics such as those on quantum mechanics classical and quantum field theory and related areas The authors stress that learning mathematical physics is not a passive process and include numerous detailed proofs examples and over 200 exercises as well as hints linking mathematical concepts and results to the relevant physical concepts and theories All of the material from the first edition has been updated and five new chapters have been added on such topics as distributions Hilbert space operators and variational methods The text is divided into three parts Part I A brief introduction to Schwartz distribution theory Elements from the theories of ultra distributions and Fourier hyperfunctions are given in addition to some deeper results for Schwartz distributions thus providing a rather comprehensive introduction to the theory of generalized functions Basic properties and methods for distributions are developed with applications to constant coefficient ODEs and PDEs The relation between distributions and holomorphic functions is considered as well as basic properties of Sobolev spaces Part II Fundamental facts about Hilbert spaces The basic theory of linear bounded and unbounded operators in Hilbert spaces and special classes of linear operators compact Hilbert Schmidt trace class and Schrödinger operators as needed in quantum physics and quantum information theory are explored This section also contains a detailed spectral analysis of all major classes of linear operators including completeness of generalized eigenfunctions as well as of completely positive mappings in particular quantum operations Part III Direct methods of the calculus of variations and their applications to boundary and eigenvalue problems for linear and nonlinear partial differential operators The authors conclude with a discussion of the Hohenberg Kohn variational principle The appendices contain proofs of more general and deeper results including completions basic facts about metrizable Hausdorff locally convex topological vector spaces Baire's fundamental results and

their main consequences and bilinear functionals Mathematical Methods in Physics is aimed at a broad community of graduate students in mathematics mathematical physics quantum information theory physics and engineering as well as researchers in these disciplines Expanded content and relevant updates will make this new edition a valuable resource for those working in these disciplines

**Lectures on Classical and Quantum Theory of Fields** Henryk Arodz, Leszek Hadasz, 2017-04-22 This textbook addresses graduate students starting to specialize in theoretical physics It provides didactic introductions to the main topics in the theory of fields while taking into account the contemporary view of the subject The student will find concise explanations of basic notions essential for applications of the theory of fields as well as for frontier research in theoretical physics One third of the book is devoted to classical fields Each chapter contains exercises of varying degree of difficulty with hints or solutions plus summaries and worked examples as useful It aims to deliver a unique combination of classical and quantum field theory in one compact course

**Wilson Lines in Quantum Field Theory** Igor Olegovich Cherednikov, Tom Mertens, Frederik F. Van der Veken, 2014-10-29 Wilson lines also known as gauge links or eikonal lines can be introduced in any gauge field theory Although the concept of the Wilson exponentials finds an enormously wide range of applications in a variety of branches of modern quantum field theory from condensed matter and lattice simulations to quantum chromodynamics high energy effective theories and gravity there are surprisingly few books or textbooks on the market which contain comprehensive pedagogical introduction and consecutive exposition of the subject The objective of this book is to get the potential reader acquainted with theoretical and mathematical foundations of the concept of the Wilson loops in the context of modern quantum field theory to teach him her to perform independently some elementary calculations with Wilson lines and to familiarize him her with the recent development of the subject in different important areas of research The target audience of the book consists of graduate and postgraduate students working in various areas of quantum field theory as well as researchers from other fields

**The Formalisms of Quantum Mechanics** Francois David, 2014-11-06 These lecture notes present a concise and introductory yet as far as possible coherent view of the main formalizations of quantum mechanics and of quantum field theories their interrelations and their theoretical foundations The standard formulation of quantum mechanics involving the Hilbert space of pure states self adjoint operators as physical observables and the probabilistic interpretation given by the Born rule on one hand and the path integral and functional integral representations of probabilities amplitudes on the other are the standard tools used in most applications of quantum theory in physics and chemistry Yet other mathematical representations of quantum mechanics sometimes allow better comprehension and justification of quantum theory This text focuses on two of such representations the algebraic formulation of quantum mechanics and the quantum logic approach Last but not least some emphasis will also be put on understanding the relation between quantum physics and special relativity through their common roots causality locality and reversibility as well as on the relation between quantum theory information theory correlations and measurements and

quantum gravity Quantum mechanics is probably the most successful physical theory ever proposed and despite huge experimental and technical progresses in over almost a century it has never been seriously challenged by experiments In addition quantum information science has become an important and very active field in recent decades further enriching the many facets of quantum physics Yet there is a strong revival of the discussions about the principles of quantum mechanics and its seemingly paradoxical aspects sometimes the theory is portrayed as the unchallenged and dominant paradigm of modern physical sciences and technologies while sometimes it is considered a still mysterious and poorly understood theory waiting for a revolution This volume addressing graduate students and seasoned researchers alike aims to contribute to the reconciliation of these two facets of quantum mechanics

### **Geometry of the Standard Model of Elementary Particles**

Andrzej Derdzinski, 2013-12-01 The book gives an exposition of the standard model of elementary particles based on coordinate free differential geometric foundations It addresses students in physics and mathematics *What is the  $i\epsilon$  for the S-matrix?* Holmfridur Sigridar Hannesdottir, Sebastian Mizera, 2023-01-01 This book provides a modern perspective on the analytic structure of scattering amplitudes in quantum field theory with the goal of understanding and exploiting consequences of unitarity causality and locality It focuses on the question Can the S matrix be complexified in a way consistent with causality The affirmative answer has been well understood since the 1960s in the case of  $2 \rightarrow 2$  scattering of the lightest particle in theories with a mass gap at low momentum transfer where the S matrix is analytic everywhere except at normal threshold branch cuts We ask whether an analogous picture extends to realistic theories such as the Standard Model that include massless fields UV IR divergences and unstable particles Especially in the presence of light states running in the loops the traditional  $i\epsilon$  prescription for approaching physical regions might break down because causality requirements for the individual Feynman diagrams can be mutually incompatible We demonstrate that such analyticity problems are not in contradiction with unitarity Instead they should be thought of as finite width effects that disappear in the idealized  $2 \rightarrow 2$  scattering amplitudes with no unstable particles but might persist at higher multiplicity To fix these issues we propose an  $i\epsilon$  like prescription for deforming branch cuts in the space of Mandelstam invariants without modifying the analytic properties of the physical amplitude This procedure results in a complex strip around the real part of the kinematic space where the S matrix remains causal We illustrate all the points on explicit examples both symbolically and numerically in addition to giving a pedagogical introduction to the analytic properties of the perturbative S matrix from a modern point of view To help with the investigation of related questions we introduce a number of tools including holomorphic cutting rules new approaches to dispersion relations as well as formulae for local behavior of Feynman integrals near branch points This book is well suited for anyone with knowledge of quantum field theory at a graduate level who wants to become familiar with the complex analytic structure of Feynman integrals

### **Quantum Field Theory II: Quantum Electrodynamics**

Eberhard Zeidler, 2008-09-03 And God said Let there be light and there was light Genesis 1:3 Light is not only the basis of our

biological existence but also an essential source of our knowledge about the physical laws of nature ranging from the seventeenth century geometrical optics up to the twentieth century theory of general relativity and quantum electrodynamics

Folklore Don't give us numbers give us insight A contemporary natural scientist to a mathematician The present book is the second volume of a comprehensive introduction to the mathematical and physical aspects of modern quantum field theory which comprehends the following six volumes Volume I Basics in Mathematics and Physics Volume II Quantum Electrodynamics Volume III Gauge Theory Volume IV Quantum Mathematics Volume V The Physics of the Standard Model Volume VI Quantum Gravitation and String Theory It is our goal to build a bridge between mathematicians and physicists based on the challenging question about the fundamental forces in macrocosmos the universe and microcosmos the world of elementary particles The six volumes address a broad audience of readers including both undergraduate and graduate students as well as experienced scientists who want to become familiar with quantum field theory which is a fascinating topic in modern mathematics and physics

**Dyson-Schwinger Equations, Renormalization Conditions, and the Hopf Algebra of Perturbative Quantum Field Theory** Paul-Hermann Baldus, 2024-04-26 This book offers a systematic introduction to the Hopf algebra of renormalization in quantum field theory with a special focus on physical motivation the role of Dyson-Schwinger equations and the renormalization group All necessary physical and mathematical constructions are reviewed and motivated in a self-contained introduction The main part of the book concerns the interplay between Dyson-Schwinger equations DSEs and renormalization conditions The book is explicit and consistent about whether a statement is true in general or only in particular renormalization schemes or approximations and about the dependence of quantities on regularization parameters or coupling constants With over 600 references the original literature is cited whenever possible and the book contains numerous references to other works discussing further details generalizations or alternative approaches There are explicit examples and remarks to make the connection from the scalar fields at hand to QED and QCD The book is primarily targeted at the mathematically oriented physicist who seeks a systematic conceptual overview of renormalization Hopf algebra and DSEs These may be graduate students entering the field as well as practitioners seeking a self-contained account of the Hopf algebra construction Conversely the book also benefits the mathematician who is interested in the physical background of the exciting interplay between Hopf algebra combinatorics and physics that is renormalization theory today

**Spectral methods in infinite-dimensional analysis. 1 (1995)** I. U. Makarov, Berezanskiĭ, I. U. Grigor'evich Kondrat'ev, 1995 *Parton Densities in Quantum Chromodynamics* Igor Olegovich Cherednikov, Frederik F. Van der Veken, 2016-11-21 The purpose of this book is to give a systematic pedagogical exposition of the quantitative analysis of Wilson lines and gauge invariant correlation functions in quantum chromodynamics Using techniques from the previous volume Wilson Lines in Quantum Field Theory 2014 an ab initio methodology is developed and practical tools for its implementation are presented Emphasis is put on the implications of gauge invariance and path

dependence properties of transverse momentum dependent parton density functions The latter are associated with the QCD factorization approach to semi inclusive hadronic processes studied at currently operating and planned experimental facilities Contents Introduction Particle Number Operators in Quantum Mechanics and in Quantum Field Theory Geometry of Quantum Field Theories Basics of Wilson Lines in QCD Gauge Invariant Parton Densities Simplifying Wilson Line Calculations Brief Literature Guide Conventions and Reference Formulae Integrations Bibliography Index

*Non-perturbative Quantum Field Theory: Mathematical Aspects And Applications* Jurg Frohlich, 1992-04-29 Compiled to illustrate the recent history of Quantum Field Theory and its trends this collection of selected reprints by J rg Fr hlich a leading theoretician in the field is a comprehensive guide of the more mathematical aspects of the subject Results and methods of the past fifteen years are reviewed The analytical methods employed are non perturbative and for the larger part mathematically rigorous Most articles are review articles surveying certain important developments in quantum field theory and guiding the reader towards the original literature The volume begins with a comprehensive introduction by J rg Fr hlich The theory of phase transitions and continuous symmetry breaking is reviewed in the first section The second section discusses the non perturbative quantization of topological solitons The third section is devoted to the study of gauge fields A paper on the triviality of 4 theory in four and more dimensions is found in the fourth section while the fifth contains two articles on random geometry The sixth and final part addresses topics in low dimensional quantum field theory including braid statistics two dimensional conformal field theory and an application to condensed matter theory [An Introduction to Non-Perturbative Foundations of Quantum Field Theory](#) Franco Strocchi, 2013-02-14 Quantum Field Theory QFT has proved to be the most useful strategy for the description of elementary particle interactions and as such is regarded as a fundamental part of modern theoretical physics In most presentations the emphasis is on the effectiveness of the theory in producing experimentally testable predictions which at present essentially means Perturbative QFT However after more than fifty years of QFT we still are in the embarrassing situation of not knowing a single non trivial even non realistic model of QFT in 3 1 dimensions allowing a non perturbative control As a reaction to these consistency problems one may take the position that they are related to our ignorance of the physics of small distances and that QFT is only an effective theory so that radically new ideas are needed for a consistent quantum theory of relativistic interactions in 3 1 dimensions The book starts by discussing the conflict between locality or hyperbolicity and positivity of the energy for relativistic wave equations which marks the origin of quantum field theory and the mathematical problems of the perturbative expansion canonical quantization interaction picture non Fock representation asymptotic convergence of the series etc The general physical principles of positivity of the energy Poincare covariance and locality provide a substitute for canonical quantization qualify the non perturbative foundation and lead to very relevant results like the Spin statistics theorem TCP symmetry a substitute for canonical quantization non canonical behaviour the euclidean formulation at the basis of the functional integral approach

the non perturbative definition of the S matrix LSZ Haag Ruelle Buchholz theory A characteristic feature of gauge field theories is Gauss law constraint It is responsible for the conflict between locality of the charged fields and positivity it yields the superselection of the unbroken gauge charges provides a non perturbative explanation of the Higgs mechanism in the local gauges implies the infraparticle structure of the charged particles in QED and the breaking of the Lorentz group in the charged sectors A non perturbative proof of the Higgs mechanism is discussed in the Coulomb gauge the vector bosons corresponding to the broken generators are massive and their two point function dominates the Goldstone spectrum thus excluding the occurrence of massless Goldstone bosons The solution of the U 1 problem in QCD the theta vacuum structure and the inevitable breaking of the chiral symmetry in each theta sector are derived solely from the topology of the gauge group without relying on the semiclassical instanton approximation What Is a Quantum Field Theory? Michel

Talagrand,2022-03-17 Quantum field theory QFT is one of the great achievements of physics of profound interest to mathematicians Most pedagogical texts on QFT are geared toward budding professional physicists however whereas mathematical accounts are abstract and difficult to relate to the physics This book bridges the gap While the treatment is rigorous whenever possible the accent is not on formality but on explaining what the physicists do and why using precise mathematical language In particular it covers in detail the mysterious procedure of renormalization Written for readers with a mathematical background but no previous knowledge of physics and largely self contained it presents both basic physical ideas from special relativity and quantum mechanics and advanced mathematical concepts in complete detail It will be of interest to mathematicians wanting to learn about QFT and with nearly 300 exercises also to physics students seeking greater rigor than they typically find in their courses Erratum for the book can be found at [michel talagrand net erratum pdf](#)

**Introduction to Quantum Field Theory with Applications to Quantum Gravity** Iosif L. Buchbinder,Ilya Shapiro,2021 This textbook presents a detailed introduction to the general concepts of quantum field theory with special emphasis on principal aspects of functional methods and renormalization in gauge theories and includes an introduction to semiclassical and perturbative quantum gravity in flat and curved spacetimes **Quantum Field Theory** O. Kovras,2005 Quantum field theory was invented to deal simultaneously with special relativity and quantum mechanics the two greatest discoveries of early twentieth century physics but it has become increasingly important to many areas of physics including quantum hall physics surface growth string theory D branes and quantum gravity as well as condensed matter and high energy applications and particle physics This important new book presents leading edge research from throughout the world

**Theoretical and Mathematical Physics** Vasiliĭ Sergeevich Vladimirov,Evgeniĭ Frolovich Mishchenko,A. K. Gushchin,1988

Delve into the emotional tapestry woven by in Dive into the Emotion of **General Principles Of Quantum Field Theory Mathematical Physics And Applied Mathematics** . This ebook, available for download in a PDF format ( Download in PDF: \*), is more than just words on a page; it's a journey of connection and profound emotion. Immerse yourself in narratives that tug at your heartstrings. Download now to experience the pulse of each page and let your emotions run wild.

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