Quantum Field Theory in Curved Spacetime

Quantum Field Theory in Curved Spacetime-Leonard Parker 2009-08-20 Quantum field theory in curved spacetime has been remarkably fruitful. It can be used to explain how the large-scale structure of the universe and the anisotropies of the cosmic background radiation that we observe today first arose. Similarly, it provides a deep connection between general relativity, thermodynamics, and quantum field theory. This book develops quantum field theory in curved spacetime in a pedagogical style, suitable for graduate students. The authors present detailed, physically motivated, derivations of cosmological and black hole processes in which curved spacetime plays a key role. They explain how such processes in the rapidly expanding early universe leave observable effects today, and how in the context of evaporating black holes, these processes uncover deep connections between gravitation and elementary particles. The authors also lucidly describe many other aspects of free and interacting quantized fields in curved space. The topics covered include thermal states, the Hawking effect, black hole evaporation, and particle creation processes in the early universe. Last decade has witnessed a phenomenal growth in this subject. This is the first attempt to collect and unify the vast literature that has contributed to this development. All the major technical results are presented, and the theory is developed carefully from first principles. Here is everything that students or researchers will need to embark upon calculations involving quantum effects of gravity at the so-called one-loop approximation level.

Quantum Field Theory in Curved Spacetime-Stephen A. Fulling 1989-08-24 The theory of quantum fields on curved spacetimes has attracted great attention since the discovery, by Stephen Hawking, of black-hole evaporation. It remains an important subject for the understanding of such contemporary topics as inflationary cosmology, quantum gravity and superstring theory. This book provides, for mathematicians, an introduction to this field of physics in a language and from a viewpoint which such a reader should find congenial. Physicists should also gain from reading this book a sound grasp of various aspects of the theory, some of which have not been particularly emphasised in the existing review literature. The topics covered include normal-mode expansions for a general elliptic operator, Fock space, the Casimir effect, the ‘Klein’ paradox, particle definition and particle creation in expanding universes, asymptotic expansion of Green’s functions and heat kernels, and renormalisation of the stress tensor. The style is pedagogic rather than formal; some knowledge of general relativity and differential geometry is assumed, but the author does supply background material on functional analysis and quantum field theory as required. The book arose from a course taught to graduate students and could be used for self-study or for advanced courses in relativity and quantum field theory. Quantum Fields in Curved Space-N. D. Birrell 1984-02-23 This book presents a comprehensive review of the subject of gravitational effects in quantum field theory. Although the treatment is general, special emphasis is given to the Hawking black hole evaporation effect, and to particle creation processes in the early universe. The last decade has witnessed a phenomenal growth in this subject. This is the first attempt to collect and unify the vast literature that has contributed to this development. All the major technical results are presented, and the theory is developed carefully from first principles. Here is everything that students or researchers will need to embark upon calculations involving quantum effects of gravity at the so-called one-loop approximation level.

Quantum Field Theory in Curved Spacetime-Thomas-Paul Hack 2015-08-17 This book provides a largely self-contained and broadly accessible exposition on two cosmological applications of algebraic quantum field theory in curved spacetime. The first of these applications is to the study of the cosmic background radiation that we observe today first arose. Similarly, it provides a deep connection between general relativity, thermodynamics, and quantum field theory. This book develops quantum field theory in curved spacetime in a pedagogical style, suitable for graduate students. The authors present detailed, physically motivated, derivations of cosmological and black hole processes in which curved spacetime plays a key role. They explain how such processes in the rapidly expanding early universe leave observable effects today, and how in the context of evaporating black holes, these processes uncover deep connections between gravitation and elementary particles. The authors also lucidly describe many other aspects of free and interacting quantized fields in curved space. The topics covered include thermal states, the Hawking effect, black hole evaporation, and particle creation processes in the early universe. Last decade has witnessed a phenomenal growth in this subject. This is the first attempt to collect and unify the vast literature that has contributed to this development. All the major technical results are presented, and the theory is developed carefully from first principles. Here is everything that students or researchers will need to embark upon calculations involving quantum effects of gravity at the so-called one-loop approximation level.

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Cosmological Applications of Algebraic Quantum Field Theory in Curved Spacetimes-Thomas-Paul Hack 2015-08-17 This book provides a largely self-contained and broadly accessible exposition on two cosmological applications of algebraic quantum field theory (QFT) in curved spacetime: a fundamental analysis of the cosmological evolution according to the Standard Model of Cosmology, and a study of the perturbations in inflation. The two central sections of the book develop these two aspects, but are preceded by sections providing a pedagogical introduction to the subject. Introductory material on the construction of linear QFTs on general curved spacetimes with and without gauge symmetry in the algebraic approach, physically meaningful quantum states on general curved spacetimes, and the backreaction of quantum fields in curved spacetimes via the semiclassical Einstein equation is also given. The reader should have a basic understanding of General Relativity and QFT on Minkowski spacetime, but no background in QFT on curved spacetimes or the algebraic approach to QFT is required.

Semiclassical and Stochastic Gravity-Beïk B. H. 2020-01-31 An overview of semi-classical gravity theory and stochastic gravity as theories of quantum gravity in curved space-time.

Introduction to Quantum Effects in Gravity-Vladislav Mukhanov 2007-06-14 Publisher description

Advances in Algebraic Quantum Field Theory-Romeo Brunetti 2015-09-04 This text focuses on the algebraic formulation of quantum field theory, from the introductory aspects to the applications to concrete problems of physical interest. The book is divided in thematic chapters covering both introductory and more advanced topics. These include the algebraic, perturbative approach to interacting quantum field theories, algebraic quantum field theory on curved spacetimes (from its structural aspects to the applications in cosmology and to the role of quantum spacetimes), algebraic conformal field theory, the Kitaev's quantum double model, quantum gravity and string theory. The book provides a useful guide to master and graduate students both in mathematics and in physics, who are interested in learning the structural aspects and the applications of algebraic quantum field theory.

Path Integrals and Anomalies in Curved Space-Fioranzo Battanini 2006-07-20 Path integrals provide a powerful method for describing quantum phenomena. This book introduces the quantum mechanics of particles that move in curved space by employing path integrals and then using them to compute anomalies in quantum field theories. The authors start by deriving path integrals for particles moving in curved space and their symmetries. They then discuss the regularization schemes essential to constructing and computing these path integrals. This topic is used to introduce regularization and renormalization in quantum field theories in a wider context. These methods are then applied to discuss and calculate anomalies in quantum field theory. Such anomalies provide enormous constraints in the search for physical theories of elementary particles, quantum gravity and string theories. An advanced text for researchers and graduate students of quantum field theory and string theory, the first part is also a stand-alone introduction to path integrals in quantum mechanics.
Diffential Topology and Quantum Field Theory-Charles Nash 1991 The remarkable developments in differential topology and how these recent advances have been applied as a primary research tool in quantum field theory are presented here in a style reflecting the genuinely two-sided interaction between mathematical physics and applied mathematics. The author, following his previous work (Nash/Sen: Differential Topology for Physicists, Academic Press, 1983), covers elliptic theory, topological quantum field theory, string theory, and knot theory. The explanatory approach serves to illuminate and clarify these theories for graduate students and research workers entering the field for the first time. Treats differential geometry, differential topology, and quantum field theory includes elliptic differential and pseudo-differential operators, Atiyah-Singer index theory, topological quantum field theory, string theory, and knot problems of quantum field theory using differential topology as a tool.

Quantum Field Theory Of Point Particles And Strings-Brian Hatfield 2018-03-09 First Published in 2018. Routledge is an imprint of Taylor & Francis, an Informa company.

Effective Action in Quantum Gravity-I.J Buchbinder 2017-09-29 In part one of Effective Action in Quantum Gravity, the book describes the principles of quantum field theory and the significance of and theory behind effective action. Part two deals with quantum field theory in curved spacetime and the effective action approach. Part three presents the quantum theory of the vacuum in curved spacetime. Part four is devoted to the book which is grouped around effective actions and plays a major role. The book assumes only a basic understanding of quantum field theory and general relativity and will be of interest to postgraduate students and researchers in theoretical high-energy physics and gravitational theory.

Quantum Mechanics in Curved Space-Time-Jurgen Audretsch 2012-12-06 Quantum mechanics and quantum field theory on one hand and Gravity as a theory of curved space-time on the other are the two great conc- tual schemes of modern theoretical physics. For many decades they have lived peacefully together on one hand: a complete coexistence wi- out much interaction. There has been the family of relativists and the other family of elementary particle physicists and both sides have been convinced that their problems have not very much to do with the problems of the respective other side. This was a situation which could not last forever, because the two theoretical schemes have a particular structural trait in common: their claim for totality and universality. Namely on one hand all physical theories have to be formulated in a quantum mechanical manner, and on the other hand gravity as curved space-time influences all processes and vice versa. It was therefore only a question of time that physically relevant domains of application would attract a general int- est, which demand a combined application of both theoretical schemes. But it is immediately obvious that such an application of both schemes is - possible if the schemes are taken as they are. Something new is needed which reconciles gravity and quantum mechanics. During the last two de- des we are now doing the first steps towards this more general theory and we are confronted with fundamental difficulties.

Perturbative Algebraic Quantum Field Theory-Kasia Rejzner 2016-03-16 Perturbative Algebraic Quantum Field Theory (pAQFT), the subject of this book, is a complete and mathematically rigorous treatment of perturbative quantum field theory (pQFT) that doesn’t require the use of divergent quantities and works on a large class of Lorentzian manifolds. We discuss in detail the examples of scalar fields, gauge theories and the effective quantum gravity. pQFT models describe a wide range of physical phenomena and have remarkable agreement with experimental results. Despite this success, the theory suffers from many conceptual problems. pAQFT is a good candidate to solve many, if not all, of these conceptual problems. Chapters 1-3 provide some background in mathematics and physics. Chapter 4 concerns classical theory of the scalar field, which is subsequently quantized in chapters 5 and 6. Chapter 7 covers gauge theory and chapter 8 discusses effective quantum gravity. The book aims to be accessible to researchers and graduate students, who are interested in the mathematical foundations of pQFT.

Quantum Field Theory in a Nutshell-A. Zee 2010-02-01 A fully updated edition of the classic text by acclaimed physicist A. Zee Since it was first published, Quantum Field Theory in a Nutshell has quickly established itself as the most accessible and comprehensive introduction to this profound and deeply fascinating area of theoretical physics. Now in this fully revised and updated version, Zee covers the latest advances while providing a solid conceptual foundation for students to build on, making this the most up-to-date and modern textbook on quantum field theory available. This expanded edition features several additional chapters, as well as an entirely new section describing recent developments in quantum field theory and the unification of gravity with other fundamental forces. The book is ideal as a textbook or self-study guide for advanced undergraduates and graduate students in theoretical physics, and it is also a great introduction for researchers working in related fields.

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First, a great deal of significant experimental data became available. Key contributions were made to the incorporation of general relativity into the formalism of quantum theory. In particular, the three last years, exciting novel techniques have been developed in order to construct a quantum field theory in a rigorous way, and to describe what is perhaps the first approach to a more refined quantum theory of gravitation, which is known as supergravity.

Local Quantum Physics-Rudolf Haag 2012-12-06 The new edition provided the opportunity of adding a new chapter entitled “Principles and Lessons of Quantum Physics”. It was a tempting challenge to try to sharpen the points at issue in the long lasting debate on the Copenhagen Spirit, to assess the significance of various arguments from our present vantage point, seventy years after the advent of quantum theory, where, after all, some problems appear in a different light. It includes a section on the arguments leading to the specific mathematical formalism of quantum theory and a section entitled “The evolutionary picture” describing my personal conclusions. Altogether this discussion suggests that the conventional notion of antiparticle production and annihilation is not sufficient for our understanding of the particle physics and quantum field theory. Future theories will demand radical changes even in the direction of a return to determinism. Essential lessons taught by Bohr will persist. This chapter is essentially self-contained. Some new material has been added in the last chapter. It concerns the clar articulation of specific theories within the general framework and recent progress in quantum field theory on curved space-time manifolds. Two chapters are dedicated to new methods for calculating scattering amplitudes (spinor helicity, on-shell recursion relations), cutting-edge questions in field theory. The volume concludes with a chapter on the application of field theoretical computing to many-body quantum mechanics. Additional advanced topics are explored, with detail on effective field theories, quantum anomalies, stable extended field configurations, lattice field theory, and field theory at a finite temperature or in the strong field regime. Two chapters are dedicated to new methods for calculating scattering amplitudes (spinor-helicity, on-shell recursion relations), cutting-edge questions in field theory. This volume addresses both physicists and mathematicians and serves as an introduction to ongoing research in very active areas of mathematics and physics at the border line between geometry, topology, algebra and quantum field theory.

General Relativity and Gravitation-Abhay Ashtekar 2015-06-01 Explore spectacular advances in contemporary physics with this unique celebration of the centennial of Einstein’s discovery of general relativity. The Global Approach to Quantum Field Theory-Bryce Seligman DeWitt 2003 This new volume takes a complete look at how classical field theory, quantum mechanics and quantum field theory are interrelated. It takes a global approach and discusses the equivalence of quantization by relating it to different theories such as tree amplitude and conservation laws. There are special chapters devoted to Euclidean renormalization and algebraic quantum field theory. A new chapter on the observer who performs it. Specific examples of this are given to highlight the awkwardness of the problem.

Quantization, Geometry and Noncommutative Structures in Mathematics and Physics-Alexander Cardona 2017-10-26 This monograph presents various ongoing approaches to the vast topic of quantization, which is the process of forming a quantum mechanical system starting from a classical one, and discusses their numerous fruitful interactions with mathematics. The opening chapter introduces the various forms of quantization and their interactions with each other and with mathematics. A first approach to quantization, called deformation quantization, consists of viewing the Planck constant as a small parameter. This approach provides a deformation of the structure of the algebra of classical observables rather than a radical change in the nature of the observables. When symmetries come into play, deformation quantization needs to be merged with group actions, which is presented in chapter 2, by Simone Gutt.

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Quantum Field Theory-François Gélin 2019-07-11 This modern text combines fundamental principles with advanced topics and recent techniques in a rigorous and self-contained treatment of quantum field theory. Beginning with a review of basic principles, starting with quantum mechanics and special relativity, students can refresh their knowledge of elementary aspects of quantum field theory and perturbative calculations in the Standard Model. Results and tools relevant to many applications are covered, including canonical quantization, path integrals, non-Abelian gauge theories, and the renormalization group. Advanced topics are explored, with detail on effective field theories, quantum anomalies, extended field configurations, lattice field theory, and field theory at a finite temperature or in the strong field regime. Two chapters are dedicated to new methods for calculating scattering amplitudes (spinor helicity, on-shell recursion relations), cutting-edge questions in field theory. This volume addresses both physicists and mathematicians and serves as an introduction to ongoing research in very active areas of mathematics and physics at the border line between geometry, topology, algebra and quantum field theory.

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Quantum Field Theory In Curved Spacetime-A. H. Najmi 1982

Beyond Einstein-David E. Rowe 2018-06-28 Beyond Einstein: Perspectives on Geometry, Gravitation, and Cosmology explores the rich interplay between mathematical and physical ideas by studying the interactions of major actors and the roles of important research communities over the course of the last century.
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