Foundations Of Quantum Gravity

Introducing a geometric view of fundamental physics, ideal for advanced undergraduate and graduate students in quantum mechanics and mathematical physics.

This book provides a compilation of in-depth articles and reviews on key topics within gravitation, cosmology and related issues. It is a celebratory volume dedicated to Prof. Thanu Padmanabhan (“Paddy”), the renowned relativist and cosmologist from IUCAA, India, on the occasion of his 60th birthday. The authors, many of them leaders of their fields, are all colleagues, collaborators and former students of Paddy, who have worked with him over a research career spanning more than four decades. Paddy is a scientist of diverse interests, who attaches great importance to teaching. With this in mind, the aim of this compilation is to provide an accessible pedagogic introduction to, and overview of, various important topics in cosmology, gravitation and astrophysics. As such it will be an invaluable resource for scientists, graduate students and also advanced undergraduates seeking to broaden their horizons.

This book is the most complete collection of John S Bell's research papers, review articles and lecture notes on the foundations of quantum mechanics. Some of this material has hitherto been difficult to access. The book also appears in a paperback edition, aimed at students and young researchers. This volume will be very useful to researchers in the foundations and applications of quantum mechanics.

The aim of this two-volume title is to give a comprehensive review of one hundred years of development of general relativity and its scientific influences. This unique title provides a broad introduction and review to the fascinating and profound subject of general relativity, its historical development, its important theoretical consequences, gravitational wave detection and applications to astrophysics and cosmology. The series focuses on five aspects of the theory: The first three topics are covered in Volume 1 and the remaining two are covered in Volume 2. While this is a two-volume title, it is designed so that each volume can be a standalone reference volume for the related topic.

This book summarizes recent developments in the research area of quantum gravity phenomenology. A series of short and nontechnical essays lays out the prospects of various experimental possibilities and their current status. Finding observational evidence for the quantization of space-time was long thought impossible. In the last decade however, new experimental design and technological advances have changed the research landscape and opened new perspectives on quantum gravity. Formerly dominated by purely theoretical constructions, quantum gravity now has a lively phenomenology to offer. From high precision measurements using macroscopic quantum oscillators to new analysis methods of the cosmic microwave background, no stone is being left unturned in the experimental search for quantum gravity. This book sheds new light on the connection of astroparticle physics with the quantum gravity problem. Gravitational waves and their detection are covered. It illustrates findings from the interconnection between general relativity, black holes and Planck stars. Finally, the return on investment in quantum-gravitation research is illuminated. The book is intended for graduate students and researchers entering the field.

A sophisticated and original introduction to the philosophy of quantum mechanics from one of the world’s leading philosophers of physics. In this book, Tim Maudlin, one of the world’s leading philosophers of physics, offers a sophisticated, original introduction to the philosophy of quantum mechanics. The briefest, clearest, and most refined account of his influential approach to the subject, the book will be invaluable to all students of philosophy and physics. Quantum mechanics holds a unique place in the history of physics. It has produced the most accurate predictions of any scientific theory, but, more astonishing, there has never been any agreement about what the theory implies about physical reality. Maudlin argues that the very term “quantum theory” is a misnomer. A proper physical theory should clearly describe what is there and what it does—yet standard textbooks present quantum mechanics as a predictive recipe in search of a physical theory. In contrast, Maudlin explores three proper theories that recover the quantum predictions: the indeterministic wavefunction collapse theory of Ghirardi, Rimini, and Weber; the deterministic particle theory of deBroglie and Bohm; and the conceptually challenging Many Worlds theory of Everett. Each offers a radically different proposal for the nature of physical reality, but Maudlin shows that none of them are what they are generally taken to be.

This text shows that insights in quantum physics can be obtained by exploring the mathematical structure of quantum mechanics. It presents the theory of Hermitean operators and Hilbert spaces, providing the framework for transformation theory, and using th

This book provides an in-depth and accessible description of special relativity and quantum mechanics which together form the foundation of 21st century physics. A novel aspect is that symmetry is given its rightful prominence as an integral part of this foundation. The book offers not only a conceptual understanding of symmetry, but also the mathematical tools necessary for quantitative analysis. As such, it provides a valuable precursor to more focused, advanced books on special relativity or quantum mechanics.

Students are introduced to several topics not typically covered until much later in their education. These include space-time diagrams, the action principle, a proof of Noether’s theorem, Lorentz vectors and tensors, symmetry breaking and general relativity. The book also provides extensive descriptions on topics of current general interest such as gravitational waves, cosmology, Bell’s theorem, entanglement and quantum computing. Throughout the text, every opportunity is taken to emphasize the intimate connection between physics, symmetry and mathematics. The style remains light despite the rigorous and intensive content. The book is intended as a stand-alone or supplementary physics
text for a one or two semester course for students who have completed an introductory calculus course and a first-year physics course that includes Newtonian mechanics and some electrostatics. Basic knowledge of linear algebra is useful but not essential, as all requisite mathematical background is provided either in the body of the text or in the Appendices. Interspersed through the text are well over a hundred worked examples and unsolved exercises for the student.

This book provides an introduction to the conceptual foundations of quantum mechanics, from classical mechanics and a discussion of the quantum phenomena that undermine our classical intuitions about how the physical world works, to the quantum measurement problem and alternatives to the standard von Neumann-Dirac formulation.

The Structural Foundations of Quantum Gravity

Oxford University Press

Exploring how the subtleties of quantum coherence can be consistently incorporated into Einstein's theory of gravitation, this book is ideal for researchers interested in the foundations of relativity and quantum physics. The book examines those properties of coherent gravitating systems that are most closely connected to experimental observations. Examples of consistent co-gravitating quantum systems whose overall effects upon the geometry are independent of the coherence state of each constituent are provided, and the properties of the trapping regions of non-singular black objects, black holes and a dynamic de Sitter cosmology are discussed analytically, numerically and diagrammatically. The extensive use of diagrams to summarise the results of the mathematics enables readers to bypass the need for a detailed understanding of the steps involved. Assuming some knowledge of quantum physics and relativity, the book provides text boxes featuring supplementary information for readers particularly interested in the philosophy and foundations of the physics.

The Euclidean approach to Quantum Gravity was initiated almost 15 years ago in an attempt to understand the difficulties raised by the spacetime singularities of classical general relativity which arise in the gravitational collapse of stars to form black holes and the entire universe in the Big Bang. An important motivation was to develop an approach capable of dealing with the nonlinear, non-perturbative aspects of quantum gravity due to topologically non-trivial spacetimes. There are important links with a Riemannian geometry. Since its inception the theory has been applied to a number of important physical problems including the thermodynamic properties of black holes, quantum cosmology and the problem of the cosmological constant. It is currently at the centre of a great deal of interest. This is a collection of survey lectures and reprints of some important lectures on the Euclidean approach to quantum gravity in which one expresses the Feynman path integral as a sum over Riemannian metrics. As well as papers on the basic formalism there are sections on Black Holes, Quantum Cosmology, Wormholes and Gravitational Instantons.

Quantum mechanics is an extraordinarily successful scientific theory. But it is also completely mad. Although the theory quite obviously works, it leaves us chasing ghosts and phantoms; particles that are waves and waves that are particles; cats that are at once both alive and dead; lots of seemingly spooky goings-on; and a desperate desire to lie down quietly in a darkened room. The Quantum Cookbook explains why this is. It provides a unique bridge between popular exposition and formal textbook presentation, written for curious readers with some background in physics and sufficient mathematical capability. It aims not to teach readers how to do quantum mechanics but rather helps them to understand how to think about quantum mechanics. Each derivation is presented as a 'recipe' with listed ingredients, including standard results from the mathematician's toolkit, set out in a series of easy-to-follow steps. The recipes have been written sympathetically, for readers who - like the author - will often struggle to follow the logic of a derivation which misses out steps that are 'obvious', or which use techniques that readers are assumed to know.

A collection of essays discussing the philosophy and foundations of quantum gravity. Written by leading philosophers and physicists in the field, chapters cover the important conceptual questions in the search for a quantum theory of gravity, and the current state of understanding among philosophers and physicists.

Was the first book to examine the exciting area of overlap between philosophy and quantum mechanics with chapters by leading experts from around the world. This is the first book to lay the physical foundations of quantum cosmology, complete with an introduction to space-time physics, quantum theory, and the main approaches to quantum gravity. It is an essential guide for researchers in quantum gravity and astrophysicists interested in fundamental aspects of cosmology.

Encapsulates the latest debates on this topic, giving researchers and graduate students an up-to-date view of the field.

This textbook covers a broad spectrum of developments in QFT, emphasizing those aspects that are now well consolidated and for which satisfactory theoretical descriptions have been provided. The book is unique in that it offers a new approach to the subject and explores many topics merely touched upon, if covered at all, in standard reference works. A detailed and largely non-technical introductory chapter traces the development of QFT from its inception in 1926. The elegant functional differential approach put forward by Schwinger, referred to as the quantum dynamical (action) principle, and its underlying theory are used systematically in order to generate the so-called vacuum-to-vacuum transition amplitude of both abelian and non-abelian gauge theories, in addition to Feynman's well-known functional integral approach, referred to as the path-integral approach. Given the wealth of information also to be found in the abelian case, equal importance is put on both abelian and non-abelian gauge theories. Particular emphasis is placed on the concept of a quantum field and its particle content to provide an appropriate description of physical processes at high energies, where relativity becomes indispensable. Moreover, quantum mechanics implies that a wave function renormalization arises in the QFT field independent of any perturbation theory - a point not sufficiently emphasized in the literature. The book provides an overview of all the fields encountered in present high-energy physics, together with the details of the underlying derivations. Further, it presents "deep inelastic" experiments as a fundamental application of quantum chromodynamics. Though the author makes a point of deriving points in detail, the
book still requires good background knowledge of quantum mechanics, including the Dirac Theory, as well as elements of the Klein-Gordon equation. The present volume sets the language, the notation and provides additional background for reading Quantum Field Theory II - Introduction to Quantum Gravity, Supersymmetry and String Theory, by the same author. Students in this field might benefit from first reading the book Quantum Theory: A Wide Spectrum (Springer, 2006), by the same author.

Quantum gravity is perhaps the most important open problem in fundamental physics. It is the problem of merging quantum mechanics and general relativity, the two great conceptual revolutions in the physics of the twentieth century. The loop and spin foam approach, presented in this 2004 book, is one of the leading research programs in the field. The first part of the book discusses the reformulation of the basis of classical and quantum Hamiltonian physics required by general relativity. The second part covers the basic technical research directions. Appendices include a detailed history of the subject of quantum gravity, hard-to-find mathematical material, and a discussion of some philosophical issues raised by the subject. This fascinating text is ideal for graduate students entering the field, as well as researchers already working in quantum gravity. It will also appeal to philosophers and other scholars interested in the nature of space and time.

"Exploring how the subtleties of quantum coherence can be consistently incorporated into Einstein's theory of gravitation, this book is ideal for researchers interested in the foundations of relativity and quantum physics. The book examines those properties of coherent gravitating systems that are most closely connected to experimental observations. Examples of consistent co-gravitating quantum systems whose overall effects upon the geometry are independent of the coherence state of each constituent are provided, and the properties of the trapping regions of non-singular black objects, black holes, and a dynamic de Sitter cosmology are discussed analytically, numerically, and diagrammatically. The extensive use of diagrams to summarise the results of the mathematics enables readers to bypass the need for a detailed understanding of the steps involved. Assuming some knowledge of quantum physics and relativity, the book provides textboxes featuring supplementary information for readers particularly interested in the philosophy and foundations of the physics"--

The search for a quantum theory of the gravitational field is one of the great open problems in theoretical physics. This book presents a self-contained discussion of the concepts, methods and applications that can be expected in such a theory. The two main approaches to its construction — the direct quantisation of Einstein's general theory of relativity and string theory — are covered. Whereas the first attempts to construct a viable theory for the gravitational field alone, string theory assumes that a quantum theory of gravity will be achieved only through a unification of all the interactions. However, both employ the general method of quantization of constrained systems, which is described together with illustrative examples relevant for quantum gravity. There is a detailed presentation of the main approaches employed in quantum general relativity: path-integral quantization, the background-field method and canonical quantum gravity in the metric, connection and loop formulations. The discussion of string theory centres around its quantum-gravitational aspects and the comparison with quantum general relativity. Physical applications discussed at length include the quantization of black holes, quantum cosmology, the indications of a discrete structure of spacetime, and the origin of irreversibility. This third edition contains new chapters or sections on quantum gravity phenomenology, Horava-Lifshitz quantum gravity, analogue gravity, the holographic principle, and affine quantum gravity. It will present updates on loop quantum cosmology, the LTB model, asymptotic safety, and various discrete approaches. The third edition also contains pedagogical extensions throughout the text. This book will be of interest to researchers and students working in relativity and gravitation, cosmology, quantum field theory and related topics. It will also be of interest to mathematicians and philosophers of science.

The aim of this book is to develop a modified quantum theory of gravity, to solve the problems involving the combination of very high energy and very small dimensions of space, such as the behavior of Black holes and the origin of the universe.

This volume provides a sample of the present research on the foundations of quantum mechanics and related topics by collecting the papers of the Italian scholars who attended the conference entitled "The Foundations of Quantum Mechanics? Historical Analysis and Open Questions? (Lecce, 1998). The perspective of the book is interdisciplinary, and hence philosophical, historical and technical papers are gathered together so as to allow the reader to compare different viewpoints and cultural approaches. Most of the papers confront, directly or indirectly, the objectivity problem, taking into account the positions of the founders of QM or more recent developments. More specifically, the technical papers in the book pay special attention to the interpretation of the experiments on Bell's inequalities and to decoherence theory, but topics on unsharp QM, the consistent-history approach, quantum probability and alternative theories are also discussed. Furthermore, a number of historical and philosophical papers are devoted to Planck's, Weyl's and Pauli's thought, but topics such as quantum ontology, predictivity of quantum laws, etc., are treated.

A comprehensible introduction to the most fascinating research in theoretical physics: advanced quantum gravity. Ideal for researchers and graduate students.

The aim of this book is twofold: to provide a comprehensive account of the foundations of the theory and to outline a theoretical and philosophical interpretation suggested from the results of the last twenty years. There is a need to provide an account of the foundations of the theory because recent experience has largely confirmed the theory and offered a wealth of new discoveries and possibilities. On the other side, the following results have generated a new basis for discussing the problem of the interpretation: the new developments in measurement theory; the experimental generation of ?Schrödinger cats?; recent developments which allow, for the first time, the simultaneous measurement of complementary observables; quantum information processing, teleportation and computation. To accomplish this task, the book combines historical, systematic and thematic approaches.
The second volume of a primer on the conceptual foundations of quantum physics. A comprehensive A-Z guide to the 21st century quantum revolution. Applications of quantum field theoretical methods to gravitational physics, both in the semiclassical and the full quantum frameworks, require a careful formulation of the fundamental basis of quantum theory, with special attention to such important issues as renormalization, quantum theory of gauge theories, and especially effective action formalism. The first part of this graduate textbook provides both a conceptual and technical introduction to the theory of quantum fields. The presentation is consistent, starting from elements of group theory, classical fields, and moving on to the effective action formalism in general gauge theories. Compared to other existing books, the general formalism of renormalization in described in more detail, and special attention paid to gauge theories. This part can serve as a textbook for a one-semester introductory course in quantum field theory. In the second part, we discuss basic aspects of quantum field theory in curved space, and perturbative quantum gravity. More than half of Part II is written with a full exposition of details, and includes elaborated examples of simplest calculations. All chapters include exercises ranging from very simple ones to those requiring small original investigations. The selection of material of the second part is done using the “must-know” principle. This means we included detailed expositions of relatively simple techniques and calculations, expecting that the interested reader will be able to learn more advanced issues independently after working through the basic material, and completing the exercises.

Today we are blessed with two extraordinarily successful theories of physics. The first is Albert Einstein's general theory of relativity, which describes the large-scale behaviour of matter in a curved spacetime. This theory is the basis for the standard model of big bang cosmology. The discovery of gravitational waves at the LIGO observatory in the US (and then Virgo, in Italy) is only the most recent of this theory's many triumphs. The second is quantum mechanics. This theory describes the properties and behaviour of matter and radiation at their smallest scales. It is the basis for the standard model of particle physics, which builds up all the visible constituents of the universe out of collections of quarks, electrons and force-carrying particles such as photons. The discovery of the Higgs boson at CERN in Geneva is only the most recent of this theory's many triumphs. But, while they are both highly successful, these two structures leave a lot of important questions unanswered. They are also based on two different interpretations of space and time, and are therefore fundamentally incompatible. We have two descriptions but, as far as we know, we've only ever had one universe. What we need is a quantum theory of gravity. Approaches to formulating such a theory have primarily followed two paths. One leads to String Theory, which has for long been fashionable, and about which much has been written. But String Theory has become mired in problems. In this book, Jim Baggott describes "an approach which takes relativity as its starting point, and leads to a structure called Loop Quantum Gravity. Baggott tells the story through the careers and pioneering work of two of the theory's most prominent contributors, Lee Smolin and Carlo Rovelli. Combining clear discussions of both quantum theory and general relativity, this book offers one of the first efforts to explain the new quantum theory of space and time. 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.

Quantum gravity seeks a unified theory in which quantum matter is dynamically related to generally relativistic spacetime. Although a continuing work in progress, research programmes in the field such as string theory, loop quantum gravity, and causal set theory make it clear that a successful theory of quantum gravity will raise important challenges to our conceptions of space, time, and matter—perhaps abolishing them altogether as fundamental entities. But just as important, there is good reason to think that some of the problems in finding a theory of quantum gravity are themselves conceptual, in need of philosophical analysis. Philosophy Beyond Spacetime: Implications from Quantum Gravity assembles original papers from philosophers (and one physicist), establishing a definitive statement of the current state of play, on which future research into
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this area can build. Aiming to expand knowledge and understanding of the philosophy of quantum gravity, it emphasizes how debates in metaphysics—regarding emergence, composition, or grounding for example—shed light on the conceptual questions of quantum gravity. And conversely, how quantum theories of space and time call into question philosophical views grounded in classical spacetime. Furthermore, the philosophy of quantum gravity raises methodological questions, for instance concerning the relation between physics and metaphysics. The essays have been chosen to demonstrate to a wide range of philosophers the significance of the subject, as well as making novel contributions to it.

Containing contributions from leading researchers in this field, this book provides a complete overview of this field from the frontiers of theoretical physics research for graduate students and researchers. It introduces the most current approaches to this problem, and reviews their main achievements.

What is spacetime? General relativity and quantum field theory answer this question in different ways. This collection of essays looks at the problem of unifying these two fundamental theories of our world, focusing on the nature of space and time within this quantum framework.

This book focuses on a critical discussion of the status and prospects of current approaches in quantum mechanics and quantum field theory, in particular concerning gravity. It contains a carefully selected cross-section of lectures and discussions at the seventh conference “Progress and Visions in Quantum Theory in View of Gravity” which took place in fall 2018 at the Max Planck Institute for Mathematics in the Sciences in Leipzig. In contrast to usual proceeding volumes, instead of reporting on the most recent technical results, contributors were asked to discuss visions and new ideas in foundational physics, in particular concerning foundations of quantum field theory. A special focus has been put on the question of which physical principles of quantum (field) theory can be considered fundamental in view of gravity. The book is mainly addressed to mathematicians and physicists who are interested in foundational questions of mathematical physics. It allows the reader to obtain a broad and up-to-date overview of a fascinating active research area.

Based on a two-semester course held at the University of Heidelberg, Germany, this book provides an adequate resource for the lecturer and the student. The contents are primarily aimed at graduate students who wish to learn about the fundamental concepts behind constructing a Relativistic Quantum Theory of particles and fields. So it provides a comprehensive foundation for the extension to Quantum Chromodynamics and Weak Interactions, that are not included in this book.

The holy grail of theoretical physics is to find the theory of everything that combines all the forces of nature, including gravity. This book addresses the question: how far are we from such discovery? Over the last few decades, multiple roads to finding a quantum theory of gravity have been proposed but no obvious description of nature has emerged in this domain. What is to be made of this situation? This volume probes the state-of-the art in this daunting quest of theoretical physics by collecting critical interviews with nearly forty leading theorists in this field. These broad-ranging conversations give important insights and candid opinions on the various approaches to quantum gravity, including string theory, loop quantum gravity, causal set theory and asymptotic safety. This unique, readable overview provides a gateway into cutting edge research for students and others who wish to engage with the open problem of quantum gravity.

This 2004 textbook provides a pedagogical introduction to the formalism, foundations and applications of quantum mechanics. Part I covers the basic material which is necessary to understand the transition from classical to wave mechanics. Topics include classical dynamics, with emphasis on canonical transformations and the Hamilton-Jacobi equation, the Cauchy problem for the wave equation, Helmholtz equation and eikonal approximation, introduction to spin, perturbation theory and scattering theory. The Weyl quantization is presented in Part II, along with the postulates of quantum mechanics. Part III is devoted to topics such as statistical mechanics and black-body radiation, Lagrangian and phase-space formulations of quantum mechanics, and the Dirac equation. This book is intended for use as a textbook for beginning graduate and advanced undergraduate courses. It is self-contained and includes problems to aid the reader's understanding.

Authored by an acclaimed teacher of quantum physics and philosophy, this textbook pays special attention to the aspects that many courses sweep under the carpet. Traditional courses in quantum mechanics teach students how to use the quantum formalism to make calculations. But even the best students - indeed, especially the best students - emerge rather confused about what, exactly, the theory says is going on, physically, in microscopic systems. This supplementary textbook is designed to help such students understand that they are not alone in their confusions (luminaries such as Albert Einstein, Erwin Schroedinger, and John Stewart Bell having shared them), to sharpen their understanding of the most important difficulties associated with interpreting quantum theory in a realistic manner, and to introduce them to the most promising attempts to formulate the theory in a way that is physically clear and coherent. The text is accessible to students with at least one semester of prior exposure to quantum (or "modern") physics and includes over a hundred engaging end-of-chapter "Projects" that make the book suitable for either a traditional classroom or for self-study.

The aim of this two-volume title is to give a comprehensive review of one hundred years of development of general relativity and its scientific influences. This unique title provides a broad introduction and review to the fascinating and profound subject of general relativity, its historical development, its important theoretical consequences, gravitational wave detection and applications to astrophysics and cosmology. The series focuses on five aspects of the theory: Genesis, Solutions and Energy Empirical Foundations Gravitational Waves Cosmology Quantum Gravity The first three topics are covered in Volume 1 and the remaining two are covered in Volume 2. While this is a two-volume title, it is designed so that each volume can be a standalone reference volume for the related topic.

Quantum gravity is the name given to a theory that unites general relativity - Einstein's theory of gravitation and spacetime - with quantum field theory, our framework for describing non-

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gravitational forces. The Structural Foundations of Quantum Gravity brings together philosophers and physicists to discuss a range of conceptual issues that surface in the effort to unite these theories, focusing in particular on the ontological nature of the spacetime that results. Although there has been a great deal written about quantum gravity from the perspective of physicists and mathematicians, very little attention has been paid to the philosophical aspects. This volume closes that gap, with essays written by some of the leading researchers in the field. Individual papers defend or attack a structuralist perspective on the fundamental ontologies of our physical theories, which offers the possibility of shedding new light on a number of foundational problems. It is a book that will be of interest not only to physicists and philosophers of physics but to anyone concerned with foundational issues and curious to explore new directions in our understanding of spacetime and quantum physics.

Explores how quantum coherence can be consistently incorporated into Einstein's theory of gravitation, for researchers in the foundations of physics.