Physics Papers On Gravity

For several decades since its inception, Einstein's general theory of relativity stood somewhat aloof from the rest of physics. Paradoxically, the attributes which normally boost a physical theory - namely, its perfection as a theoreti cal framework and the extraordinary intellectual achievement underlying i- prevented the general theory from being assimilated in the mainstream of physics. It was as if theoreticians hesitated to tamper with something that is manifestly so beautiful. Happily, two developments in the 1970s have narrowed the gap. In 1974 Stephen Hawking arrived at the remarkable result that black holes radiate after all. And in the second half of the decade, particle physicists discovered that the only scenario for applying their grand unified theories was offered by the very early phase in the history of the Big Bang universe. In both cases, it was necessary to discuss the ideas of quantum field theory in the background of curved spacetime that is basic to general relativity. This is, however, only half the total story. If gravity is to be brought into the general fold of theoretical physics we have to know how to quantize it. To date this has proved a formidable task although most physicists would agree that, as in the case of grand unified theories, quantum gravity will have applications to cosmology, in the very early stages of the Big Bang universe. In fact, the present picture of the Big Bang universe necessarily forces us to think of quantum cosmology. With a focus on modified gravity this book presents a review of the recent developments in the fields of gravity and cosmology, presenting the state of the art, high-lighting the open problems, and outlining the directions of future research. General Relativity and the ?CDM framework are currently the standard lore and constitute the concordance paradigm of cosmology. Nevertheless, long-standing open theoretical issues, as well as possible new observational ones arising from the explosive development of cosmology in the last two decades, offer the motivation and lead a large amount of research to be devoted in constructing various extensions and modifications. In this review all extended theories and scenarios are first examined under the light of theoretical consistency, and are then applied in various geometrical backgrounds, such as the cosmological and the spherical symmetric ones. Their predictions at both the background and perturbation levels, and concerning cosmology at early, intermediate and late times, are then confronted with the huge amount of observational data that astrophysics and cosmology has been able to offer in the last two decades. Theories, scenarios and models that successfully and efficiently pass the above steps are classified as viable and are candidates for the description of

Nature, allowing readers to get a clear overview of the state of the art and where the field of modified gravity is likely to go. This work was performed in the framework of the COST European Action "Cosmology and Astrophysics Network for Theoretical Advances and Training Actions" - CANTATA.

Spacetime physics -- Physics in flat spacetime -- The mathematics of curved spacetime -- Einstein's geometric theory of gravity -- Relativistic stars -- The universe -- Gravitational collapse and black holes -- Gravitational waves -- Experimental tests of general relativity -- Frontiers

GravitationPrinceton University Press

The first textbook on this important topic, for graduate students and researchers in particle and condensed matter physics.

This book reviews various modified gravity models, including those with modifications in the pure gravitational sector; those involving extra fields, that is, scalar-tensor and vector-tensor gravity theories; gravity models with Lorentz symmetry breaking; and nonlocal gravity models. The authors discuss both classical and quantum aspects of these theories. The book is unique in bringing together all the current alternatives to Einstein gravity in one source and serves as an excellent starting point for graduate students and other newcomers seeking an overview.

This book seeks to present a new way of thinking about the interaction of gravitational fields with quantum systems. Despite the massive amounts of research and experimentation, the myriad meetings, seminars and conferences, all of the articles, treatises and books, and the seemingly endless theorization, quantization and just plain speculation that have been engaged in regarding our evolving understanding of the quantum world, that world remains an enigma, even to the experts. The usefulness of general relativity in this regard has proven to be imperfect at best, but there is a new approach. We do not simply have to accept the limitations of Einstein's most celebrated theorem in regard to quantum theory; we can also embrace them, and thereby utilize them, to reveal new facts about the behavior of quantum systems within inertial and gravitational fields, and therefore about the very structure of space–time at the quantum level. By taking existing knowledge of the essential functionality of spin (along with the careful identification of the omnipresent inertial effects) and applying it to the quantum world, the book gives the reader a much clearer picture of the difference between the classical and quantum behaviors of a particle, shows that Einstein's ideas may not be as incompatible within this realm as many have come to believe, sparks new revelations of the way in which gravity affects quantum systems and brings a new level of efficiency—quantum efficiency, if you will—to the study of gravitational theory.

Quantum gravity has developed into a fast-growing subject in physics and it is expected that probing the high-energy and high-curvature regimes of gravitating systems will shed some light on how to eventually achieve an ultraviolet complete quantum theory of gravity. Such a theory would provide the much needed information about fundamental problems of classical gravity, such as the initial big-bang singularity, the cosmological constant problem, Planck scale physics and the early-time inflationary evolution of our Universe. While in the first part of this book concepts of quantum gravity are introduced and approached from different angles, the second part discusses these theories in connection with cosmological models and observations, thereby exploring which types of signatures of modern and mathematically rigorous frameworks can be detected by experiments. The third and final part briefly reviews the observational status of dark matter and dark energy, and introduces alternative cosmological models. Edited and authored by leading researchers in the field and cast into the form of a multi-author textbook at postgraduate level, this volume will be of benefit to all postgraduate students and newcomers from neighboring disciplines wishing to find a comprehensive guide for their future research.

The 2015 centenary of the publication of Einstein's general theory of relativity, and the first detection of gravitational waves have focused renewed attention on the question of whether Einstein was right. This review of experimental gravity provides a detailed survey of the intensive testing of Einstein's theory of gravity, including tests in the emerging strong-field dynamical regime. It discusses the theoretical frameworks needed to analyze gravitational theories and interpret experiments. Completely revised and updated, this new edition features coverage of new alternative theories of gravity, a unified treatment of gravitational radiation, and the implications of the latest binary pulsar observations. It spans the earliest tests involving the Solar System to the latest tests using gravitational waves detected from merging black holes and neutron stars. It is a comprehensive reference for researchers and graduate students working in general relativity, cosmology, particle physics and astrophysics.

This book offers a detailed and stimulating account of the Lagrangian, or variational, approach to general relativity and beyond. The approach more usually adopted when describing general relativity is to introduce the required concepts of differential geometry and derive the field and geodesic equations from purely geometrical properties. Demonstration of the physical meaning then requires the weak field approximation of these equations to recover their Newtonian counterparts. The potential downside of this approach is that it tends to suit the mathematical mind and requires the physicist to study and work in a completely unfamiliar environment. In contrast, the approach to general relativity described in this book will be especially suited to physics students. After an introduction to field theories and the variational approach, individual sections focus on the variational approach in relation to special relativity, general relativity, and alternative theories of gravity. Throughout the text, solved exercises and examples are presented. The book will meet the needs of both students specializing in theoretical physics and those seeking a better understanding of particular aspects of the subject. 1946 is the year Bryce DeWitt entered Harvard graduate school. Quantum Gravity was his goal and remained his goal throughout his lifetime until the very end. The pursuit of Quantum Gravity requires a profound understanding of Quantum Physics and Gravitation Physics. As G. A. Vilkovisky commented , "Quantum Gravity is a combination of two words, and one should know both. Bryce understood this as nobody else, and this wisdom is completely unknown to many authors of the flux of papers that we see nowadays." Distinguished physicist Cecile DeWitt-Morette skillfully blends her personal and scientific account with a wealth of her late husband's often unpublished writings on the subject matter. This volume, through the perspective of the leading researcher on quantum gravity of his generation, will provide an invaluable source of reference for anyone working in the field.

In this Very Short Introduction Timothy Clifton looks at the development of our understanding of gravity since the early observations of Kepler and Newtonian theory. He discusses Einstein's theory of gravity, which now supplants Newton's, showing how it allows us to understand why the frequency of light changes as it passes through a gravitational field, why GPS satellites need their clocks corrected as they orbit the Earth, and why the orbits of distant neutron stars speed up. Today, almost 100 years after Einstein published his theory of gravity, we have even detected the waves of gravitational radiation that he predicted. Clifton concludes by considering the testing and application of general relativity in astrophysics and cosmology, and looks at dark energy and efforts such as string theory to combine gravity with quantum mechanics.

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.

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.

Apply yesterday's variation principle to Gell-Mann's quarks, pepper it with the inconsistencies of unfounded ad-hoc tactics - and there you are with grandpa's classical "Standard" model having no strategy, no future, topped only by "string" fantasies "beyond" physics, with all the great questions left open. By marrying Planck's quanta with Einstein's General Relativity, the author is presenting the unified top-down model of a consistent "New Physics" (Quantum Gravity, including the Grand Unification) free of singularities and in accord with experiment. Space-time is bent, fully quantized and "background-independent". Old problems of fundamental physics emerge as self-explaining: 4-dimensionality, the quark confinement, flavours, cosmic inflation, the arrow of time, the physics of Black Holes with their event horizons, the origins of (ordinary and dark) matter, and much more is dropping out as self-evident properties of nature. Future starts to-day. Come along on the journey! The amazing success of "New Physics"/"Neue Physik" (with almost 10.000 copies sold in a single year) gave rise to this extended, 2nd edition renamed "Flow of Time". Main target groups: Students, physicists, mathematicians, but also people interested in philosophy or with an inclination to leave the beaten dead-end tracks of actual fundamental models of the old style in favour of more promising, novel ways.

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 "the road less travelled": 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.
"It would be hard to imagine a better guide to this difficult subject."--Scientific American In Three Roads to Quantum Gravity, Lee Smolin provides an accessible overview of the attempts to build a final "theory of everything." He explains in simple terms

what scientists are talking about when they say the world is made from exotic entities such as loops, strings, and black holes and tells the fascinating stories behind these discoveries: the rivalries, epiphanies, and intrigues he witnessed firsthand. "Provocative, original, and unsettling." -The New York Review of Books "An excellent writer, a creative thinker."-Nature

The contemporary trends in the quantum unification of all interactions including gravity motivate this Course. The main goal and impact of modern string theory is to provide a consistent quantum theory of gravity. This, Course is intended to provide an updated understanding of the last developments and current problems of string theory in connection with gravity and the physics at the Planck energy scale. It is also the aim of this Course to discuss fundamental problems of quantum gravity in the present-day context irrespective of strings or any other models. Emphasis is given to the mutual impact of string theory, gravity and cosmology, within a deep a well defined programme, which provides, in addition, a careful interdisciplinarity. Since the most relevant new physics provided by strings concerns the quantization of gravity, we must, at least, understand string quantization in curved space-times to start. Curved space-times, besides their evident relevance m classical gravitation, are also important at energies of the order of the Planck scale. At the

Planck energy, gravitational interactions are at least as important as the rest and can not be neglected anymore. Special care is taken here to provide the grounds of the different lines of research in competition (not just only one approach); this provides an excellent opportunity to learn about the real state of the discipline, and to learn it in a critical way.

In these volumes, the most significant of the collected papers of the Chinese-American theoretical physicist Tsung-Dao Lee are printed. A complete list of his published papers, in order of publication, appears in the Bibliography of T.D. Lee. The papers have been arranged into ten categories, in most cases according to the subject matter. At the beginning of each of the first eight categories of papers, there is a commentary on the content and significance of all of the papers in the category. The two short final categories do not have any commentaries. The editor would like to thank Dr. Richard Friedberg for his assistance in the early stages of the editorial work on this project, as well as for writing commentaries on the papers of Categories III and IV. I would also like to thank Dr. Norman Christ for writing the commentary on the papers of Category VII. The assistance of Irene Tramm was in valuable in many aspects of preparing this collection, including locating copies of Lee's p~pers. GERALD FEINBERG List of Categories of

T.D. Lee's Papers Volume 1 I. Weak Interactions II. Early Papers on Astrophysics and Hydrodynamics III. Statistical Mechanics IV. Polarons and Solitons Volume 2 V. Quantum Field Theory VI. Symmetry Principles Volume 3 VII. Discrete Physics VIII. Strong Interaction Models IX. Historical Papers X. Gravity (Continuum Theory) Contents (Volume 3)*
The Cause of Gravity: The Holy Grail of all Scientific Revelation For over four centuries now, Natural Philosophers and Theoretical Physicists have been desperately searching for the answer to that elusive and intractable question that is still hanging around today: "What is the true cause of Gravity?" The present-day view by Theoretical Physics Academia is that gravity can be described as: "curved, or warped, space, or spacetime." So, how does this space, or spacetime, curve, or warp? Do certain particles of space get closer together in one vicinity of space and further apart in another? Are there compressions and rarefactions in space like there are in air? How can empty space form a path for a moving object to travel through if it is completely empty? The answer is that: Space is NOT empty. According to a brand-new type of physics called:

"Reality Physics", we now know that space is not empty but contains an "active" plenum structure that is continually being created by the "active", two-dimensional, outward motion of Time with Space. What this actually means is that the "Now Point" in Time expands outward into space with an "active", two-dimensional, omnidirectional, omnipositional displacement at the Speed of Light, or: "c" = 299, 792, 458 meters per second, and that it also forms an "inertial reference background pressure density" throughout the universe. We find that by placing a body of mass into this active inertial reference background pressure density we can create a vicinity of "less active pressure density" at that location where the mass is located. This would, obviously, cause the greater pressure density surrounding the mass to implode with an "accelerating motion" down towards the surface of the mass body where the pressure density is less. We call this implosively accelerating motion of the inertial reference background: "Gravitational Acceleration", and this is what actually causes small objects to "fall to the ground" at the surface of the large body of mass. Gravity is an "action", not a curvature or warpage of anything, and therefore it must be caused by an "action", as revealed here by: "ACTION GRAVITY" of Reality Physics.

This book, suitable for interested post-16 school pupils or undergraduates looking for a supplement to

their course text, develops our modern view of space-time and its implications in the theories of gravity and cosmology. While aspects of this topic are inevitably abstract, the book seeks to ground thinking in observational and experimental evidence where possible. In addition, some of Einstein's philosophical thoughts are explored and contrasted with our modern views. Written in an accessible yet rigorous style, Jonathan Allday, a highly accomplished writer, brings his trademark clarity and engagement to these fascinating subjects, which underpin so much of modern physics. Features: Restricted use of advanced mathematics, making the book suitable for post-16 students and undergraduates Contains discussions of key modern developments in quantum gravity, and the latest developments in the field, including results from the Laser Interferometer Gravitational-Wave Observatory (LIGO) Accompanied by appendices on the CRC Press website featuring detailed mathematical arguments for key derivations
This volume reviews conceptual conflicts at the foundations of physics now and in the past century. The focus is on the conditions and consequences of Einstein's pathbreaking achievements that sealed the decline of the classical notions of space, time, radiation, and matter, and resulted in the theory of relativity. Particular attention is paid to the implications of conceptual conflicts for scientific

views of the world at large, thus providing the basis for a comparison of the demise of the mechanical worldview at the turn of the 20th century with the challenges presented by cosmology at the turn of the 21st century. Throughout the work, Einstein's contributions are not seen in isolation but instead set into the wider intellectual context of dealing with the problem of gravitation in the twilight of classical physics; the investigation of the historical development is carried out with a number of epistemological questions in mind, concerning, in particular, the transformation process of knowledge associated with the changing worldviews of physics. 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.

In Newton's view, all objects exert a force that attracts other objects. That universal law of gravitation worked pretty well for predicting the motion of planets as well as objects on Earth and it's still used, for example, when making the calculations for a rocket launch. But Newton's view of gravity didn't work for some things, like Mercury's peculiar orbit around the sun. The orbits of planets shift over time, and Mercury's orbit shifted faster than Newton predicted.Einstein's idea was that gravity is not a force, but it is really an effect caused by the curvature of space and time. Although all its predictions have almost been confirmed by experiment, General relativity fails to explain details near space time singularities at the centre of Black holes and the mysterious dark matter. Which means Einstein equations cannot explain the motion of stars in galaxies and galaxy clusters. Mordehai Milgrom MOND explains the motion of stars in galaxies correctly without assuming Dark matter. Therefore

MOND is an alternative to Newton's law of Universal gravitation. However the most serious problem facing Milgrom's law is that it cannot completely eliminate the need for dark matter in all astrophysical systems.Most theorists believe that gravitons must exist, and that they could be candidates for Dark matter, because quantum theory has successfully explained every other force of nature. But not everyone agrees. No theory claiming to unify quantum theory with GR has been successfully verified, and this has raised suspicions that perhaps gravity isn't like any other force - in which case gravitons may not exist. The theory of quantum gravity is expected to be able to provide a satisfactory description of the microstructure of space time at the so called Planck scales, at which all fundamental constants of the ingredient theories, c (speed of light), h (Planck constant) and G (Newton's constant), come together to form units of mass, length and time. The search for the full theory of quantum gravity has been stymied by the fact that gravity's quantum properties never seem to manifest in actual experience. One option for a solution to this conundrum is string theory, or the idea that everything we perceive as a particle or force is simply an excitation of a closed or open string, vibrating at specific but unique frequencies. One of the major criticisms of string theory has to do not with the theory so much as with theorists. Not only that, the strings of string theory are stupendously small, thought to be somewhere around the Planck scale, a bare 10-34 meters across. That's far, far smaller than anything we can possibly hope to probe even with our most precise instruments. The strings are so small, in fact, that they appear to us to be point-like particles, such as electrons and photons and neutrons. We simply can't ever stare at a string directly.Therefore emergent gravity or entropic gravity is a theory in modern physics that describes gravity as an entropic force, a force with macro-scale homogeneity but which is subject to quantum level disorder and not a fundamental interaction.The theory has been controversial within the physics community but has sparked research and experiments to test its validity. The problem is, if emergent gravity just reproduces General Relativity, there's no way to test the idea. What we need instead is a prediction from emergent gravity that deviates from General Relativity.Finally when all is said and done, the fifth force is proposed and its first result is that it reproduces the MOND and Emergent gravity results from one single force equation and solves all gravitational problems leaving none untouched. Although it is accurate there is one problem; it can't explain the origin of gravity.Gravity is then fixed by postulating that it is as a result of the Casimir effect due to vacuum polarizations with sounding experimental proof. This book will help you fix Gravity.

Part of the new Ladybird Expert series, Gravity is an accessible and authoritative introduction to a force as familiar to us as breathing. What is gravity? How does it work? And why are there extreme gravitational environments? Written by celebrated physicist and broadcaster Jim Al-Khalili, Gravity proves to be so much more than the adage: 'what goes up must come down'. Stuck to the surface of our planet we experience gravity merely as a force pulling us down to the ground, but we will discover that it is far richer than that. Inside, you'll learn that gravity is not really a 'force' at all, but something altogether more profound. In fact, gravity controls the very shape of space and the passage of time themselves and, as such, the history and destiny of the entire Universe. Written by the leading lights and most outstanding communicators in their fields, the Ladybird Expert books provide clear, accessible and authoritative introductions to subjects drawn from science, history and culture. For an adult readership, the Ladybird Expert series is produced in the same iconic small hardback format pioneered by the original Ladybirds. Each beautifully illustrated book features the first new illustrations produced in the original Ladybird style for nearly forty years.

A pithy yet deep introduction to Einstein’s general theory of relativity Of the four fundamental forces of nature, gravity might be the least understood and yet the one with which we are most intimate. On Gravity combines depth with accessibility to take us on a compelling tour of Einstein's general theory of relativity. A. Zee begins with

the discovery of gravity waves, then explains how gravity can be understood in comparison to other classical field theories, presents the idea of curved spacetime, and explores black holes and Hawking radiation. Zee travels as far as the theory reaches, leaving us with tantalizing hints of the unknown, from the intransigence of quantum gravity to the mysteries of dark matter. Infused with Zee’s signature warmth and fresh style, On Gravity opens a unique pathway to comprehending relativity, gravity, spacetime, and the workings of the universe.
In early April 1911 Albert Einstein arrived in Prague to become full professor of theoretical physics at the German part of Charles University. It was there, for the first time, that he concentrated primarily on the problem of gravitation. Before he left Prague in July 1912 he had submitted the paper “Relativität und Gravitation: Erwiderung auf eine Bemerkung von M. Abraham” in which he remarkably anticipated what a future theory of gravity should look like. At the occasion of the Einstein-in-Prague centenary an international meeting was organized under a title inspired by Einstein's last paper from the Prague period: "Relativity and Gravitation, 100 Years after Einstein in Prague". The main topics of the conference included: classical relativity, numerical relativity, relativistic astrophysics and cosmology, quantum gravity, experimental aspects of gravitation and conceptual and historical issues. The conference attracted over 200 scientists from 31 countries, among them a number of leading experts in the field of general relativity and its applications. This volume includes abstracts of the plenary talks and full texts of contributed

talks and articles based on the posters presented at the conference. These describe primarily original results of the authors. Full texts of the plenary talks are included in the volume "General Relativity, Cosmology and Astrophysics--Perspectives 100 Years after Einstein in Prague", eds. J. Bi?ák and T. Ledvinka, published also by Springer Verlag.

The Feynman Lectures on Gravitation are based on notes prepared during a course on gravitational physics that Richard Feynman taught at Caltech during the 1962-63 academic year. For several years prior to these lectures, Feynman thought long and hard about the fundamental problems in gravitational physics, yet he published very little. These lectures represent a useful record of his viewpoints and some of his insights into gravity and its application to cosmology, superstars, wormholes, and gravitational waves at that particular time. The lectures also contain a number of fascinating digressions and asides on the foundations of physics and other issues.Characteristically, Feynman took an untraditional non-geometric approach to gravitation and general relativity based on the underlying quantum aspects of gravity. Hence, these lectures contain a unique pedagogical account of the development of Einstein's general theory of relativity as the inevitable result of the demand for a self-consistent theory of a massless spin-2 field (the graviton) coupled to the energy-momentum tensor of matter. This approach also demonstrates the intimate and fundamental connection between gauge invariance and the principle of equivalence.

A history of gravity, and a study of its importance and relevance to our lives, as well as its influence on other areas of science. Physicists will tell you that four forces control the universe. Of these, gravity may the most obvious, but it is also the most mysterious. Newton managed to predict the force of gravity but couldn't explain how it worked at a distance. Einstein picked up on the simple premise that gravity and acceleration are interchangeable to devise his mind-bending general relativity, showing how matter warps space and time. Not only did this explain how gravity worked – and how apparently simple gravitation has four separate components – but it predicted everything from black holes to gravity's effect on time. Whether it's the reality of anti-gravity or the unexpected discovery that a ball and a laser beam drop at the same rate, gravity is the force that fascinates.

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 fundamental questions of mathematical physics. It allows the reader to obtain a broad and up-to-date overview of a fascinating active research area.

A distinguished physicist takes an enlightening look at three scientists whose work unlocked many mysteries: Galileo, the first to examine the process of free and restricted fall; Newton, originator of a universal force; and Einstein, who proposed that gravity is no more than the curvature of the four-dimensional space-time continuum.

Quantum gravity is one of the major "open" problems in theoretical physics, and the loop and spinfoam approach in this book is a major research area in the field.

Emphasizing conceptual and foundational issues raised by quantum gravity, especially on the nature of space and time, the text is intended for researchers working in quantum gravity and graduate students.

Loop quantum gravity is one of the modern contenders for a unified description of quantum mechanics and gravity. Up to now no book has covered the material at the level of a college student or of other readers with some knowledge of college level physics. This book fills that gap.

Quantum theory and Einstein's theory of relativity are at the centre of modern theoretical physics, yet, the consistent unification of both theories is still elusive. This book offers an up-to-date introduction into the attempts to construct a unified theory of "quantum gravity".

In this important guide to science and society, a cosmologist argues that physics must embrace the excluded, listen to the unheard, and be unafraid of being wrong. Years ago, cosmologist Stephon Alexander received life-changing advice: to discover real physics, he needed to stop memorizing and start taking risks. In Fear of a Black Universe, Alexander shows that great physics requires us to think outside the mainstream -- to improvise and rely on intuition. His approach leads him to three principles that shape all theories of the universe: the principle of invariance, the quantum principle, and the principle of emergence. Alexander uses them to explore some of physics' greatest mysteries, from what happened before the big bang to how the universe makes consciousness possible. Drawing on his experience as a Black physicist, he makes a powerful case for diversifying our scientific communities. Compelling and empowering, Fear of a Black Universe offers remarkable insight into the art of physics.

This book provides insight into major facets of the physics of quantum gravity. The application of quantum field theory for explaining gravity is one of the main problems in contemporary elementary Physics. It has been in existence for nearly a century, but a definite answer is yet to be determined. Loop quantum gravity and string theory have answered several answers associated with this problem, but they have brought with themselves a huge set of added questions. Apart from these two theories, several other alternative theories have also been developed over the decades. Renowned authors from across the globe have contributed in this book. The content provided in this book deals with gravity and its quantization through known and alternative methods in order to provide a better understanding on the quantum nature of gravity. Readers will find an extensive compilation of physical and mathematical concepts along with updated research regarding the challenging puzzle of quantum gravity in this book.

A vastly improved physics model authenticates the testimony of people who claimed deep involvement with anti-gravity projects. Includes instructions on how to build your own device.

The first comprehensive survey of (2+1)-dimensional quantum gravity - for graduate students and researchers.

One of TIME's Ten Best Nonfiction Books of the Decade "Meet the new Stephen Hawking . . . The Order of Time is a dazzling book." --The Sunday Times From the bestselling author of Seven Brief Lessons on Physics, comes a concise, elegant exploration of time. Why do we remember the past and not the future? What does it mean for time to "flow"? Do we exist in time or does time exist in us? In lyric, accessible prose, Carlo Rovelli invites us to

consider questions about the nature of time that continue to puzzle physicists and philosophers alike. For most readers this is unfamiliar terrain. We all experience time, but the more scientists learn about it, the more mysterious it remains. We think of it as uniform and universal, moving steadily from past to future, measured by clocks. Rovelli tears down these assumptions one by one, revealing a strange universe where at the most fundamental level time disappears. He explains how the theory of quantum gravity attempts to understand and give meaning to the resulting extreme landscape of this timeless world. Weaving together ideas from philosophy, science and literature, he suggests that our perception of the flow of time depends on our perspective, better understood starting from the structure of our brain and emotions than from the physical universe. Already a bestseller in Italy, and written with the poetic vitality that made Seven Brief Lessons on Physics so appealing, The Order of Time offers a profoundly intelligent, culturally rich, novel appreciation of the mysteries of time.
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.