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Selected Topics in Gravity, Field Theory and Quantum Mechanics

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Quantum Mechanics And Gravity

Daniele Oriti



Quantum Mechanics And Gravity:

Quantum Gravity Carlo Rovelli, 2004-11-15 Publisher Description *Quantum Gravity* Claus Kiefer, 2007-02-22 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 The second edition will add some sections on topical issues These include loop quantum cosmology dynamical triangulation renormalization group approach primordial black holes and information loss problem for black holes The second edition will also contain some pedagogical extensions 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 Structural Foundations of Quantum Gravity* Dean Rickles, Steven French, Juha T. Saatsi, 2006-11-16 What is spacetime General relativity and quantum field theory answer this question in different ways This collection of essays looks at the problem of uniting these two fundamental theories of our world focusing on the nature of space and time within this quantum framework *Quantum Mechanics and Gravity* Mendel Sachs, 2004-01-12 This book describes a paradigm change in modern physics from the philosophy and mathematical expression of the quantum theory to those of general relativity The approach applies to all domains from elementary particles to cosmology The change is from the positivistic views in which atomism nondeterminism and measurement are fundamental to a holistic view in realism wherein matter electrons galaxies are correlated modes of a single continuum the universe A field that unifies electromagnetism gravity and inertia is demonstrated explicitly with new predictions in terms of quaternion and spinor field equations in a curved spacetime Quantum mechanics emerges as a linear flat space approximation for the equations of inertia in general relativity **The Problem of Time** Edward Anderson, 2017-09-18 This book is a treatise on time and on background independence in physics It first considers how time is conceived of in each accepted paradigm of physics Newtonian special relativity quantum mechanics QM and general relativity GR Substantial differences are moreover uncovered between what is meant by time in QM and in GR These

differences jointly source the Problem of Time Nine interlinked facets which arise upon attempting concurrent treatment of the QM and GR paradigms as is required in particular for a background independent theory of quantum gravity A sizeable proportion of current quantum gravity programs e g geometrodynamical and loop quantum gravity approaches to quantum GR quantum cosmology supergravity and M theory are background independent in this sense This book s foundational topic is thus furthermore of practical relevance in the ongoing development of quantum gravity programs This book shows moreover that eight of the nine facets of the Problem of Time already occur upon entertaining background independence in classical rather than quantum physics By this development and interpreting shape theory as modelling background independence this book further establishes background independence as a field of study Background independent mechanics as well as minisuperspace spatially homogeneous models of GR and perturbations thereabout are used to illustrate these points As hitherto formulated the different facets of the Problem of Time greatly interfere with each others attempted resolutions This book explains how none the less a local resolution of the Problem of Time can be arrived at after various reconceptualizations of the facets and reformulations of their mathematical implementation Self contained appendices on mathematical methods for basic and foundational quantum gravity are included Finally this book outlines how supergravity is refreshingly different from GR as a realization of background independence and what background independence entails at the topological level and beyond

Conversations on Quantum Gravity Jácome Armas,2021-08-26 Leading theorists share their important insights into the ongoing quest of theoretical physics to find a quantum theory of gravity

Progress and Visions in Quantum Theory in View of Gravity Felix Finster,Domenico Giulini,Johannes Kleiner,Jürgen Tolksdorf,2020-04-09 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

Approaches to Quantum Gravity Daniele Oriti,2009-03-05 The theory of quantum gravity promises a revolutionary new understanding of gravity and spacetime valid from microscopic to cosmological distances Research in this field involves an exciting blend of rigorous mathematics and bold speculations foundational questions and technical issues Containing contributions from leading researchers in this field this book presents the fundamental issues involved in the construction of a quantum theory of gravity and building up a

quantum picture of space and time It introduces the most current approaches to this problem and reviews their main achievements Each part ends in questions and answers in which the contributors explore the merits and problems of the various approaches This book provides a complete overview of this field from the frontiers of theoretical physics research for graduate students and researchers

Advances in the Interplay Between Quantum and Gravity Physics Peter G.

Bergmann,V. de Sabbata,2012-12-06 In this XVII Course of the International School of Cosmology and Gravitation devoted to ADVANCES IN THE INTERPLAY BETWEEN QUANTUM AND GRAVITY PHYSICS we have considered different aspects of the influence of gravity on quantum systems In order to achieve this aim in many lectures seminars and discussions we have strengthened the interplay between gravity and quantum systems starting from the situation in the early universe based on astrophysical observations up to the earthly based experiments with atom interferometry for probing the structure of space time Thus we have had timely lectures on the quantum field and horizon of a black hole including reviews of the problem of black holes thermodynamics and entropy quantum information quantum black holes quantum evaporation and Hawking radiation recent advances in stockastic gravity We have also discussed quantum fluctuations in inflationary universe quantum effects and reheating after inflation and superplanckian energies in Hawking radiation In this regard the subject of spinors in purely affine space time and Dirac matter according to Weyl in the generalized theory of gravitation were developed The dualism between space time and matter has been deeply analyzed in order to see why for general relativity this is an obstacle for quantization of the theory Also canonical Gravity and Mach s principle torsion and curvature as commutator for Quantum Gravity and Dirac Geometry of real space time were analysed together with the problem of 5 Dimensional Projective Unified Field theory and Multidimensional Gravity and Cosmology

Quantum Mechanics in Curved Space-Time Jurgen

Audretsch,V. de Sabbata,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 for a simple reason it was a 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

Reality Is Not What It Seems Carlo

Rovelli, 2016-10-06 The physicist transforming how we see the universe Financial Times An utter joy Adam Rutherford Do space and time truly exist What is reality made of Can we understand its deep texture Scientist Carlo Rovelli has spent his whole life exploring these questions and pushing the boundaries of what we know In this mind expanding book he shows how our understanding of reality has changed throughout centuries from Democritus to loop quantum gravity Taking us on a wondrous journey he invites us to imagine a whole new world where black holes are waiting to explode spacetime is made up of grains and infinity does not exist a vast universe still largely undiscovered A hugely engaging book Rovelli is a charming thought provoking tour guide Manjit Kumar Prospect Translated by Simon Carnell and Erica Segre **Beyond Spacetime**

Nick Huggett, Keizo Matsubara, Christian Wuthrich, 2020-02 A collection of essays on the philosophy and foundations of quantum gravity by leading philosophers and physicists in the field *Covariant Loop Quantum Gravity* Carlo Rovelli, Francesca Vidotto, 2015 A comprehensible introduction to the most fascinating research in theoretical physics advanced quantum gravity Ideal for researchers and graduate students **Physics Meets Philosophy at the Planck Scale**

Craig Callender, Nick Huggett, 2001-01-29 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 **Quantum Space** Jim Baggott, 2018-11-08 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 Pursuit of Quantum Gravity** Cécile DeWitt-Morette, 2011-02-15 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

Quantum Gravity in a Nutshell1 Second Edition Balungi Francis, 2019-06-04 This second edition to the bestselling *Quantum Gravity in a Nutshell1* is a good introduction to quantum gravity and has a lot of interesting history about the development of the theory since 1899 It's an informal introduction to a very difficult and doubtfully intelligible theory doubted even by its most ingenious contributors The reader should expect that he/she will have to concentrate hard on what Balungi says but the rewards are significant He is a talented physicist and a good writer If you read it carefully and stop to think about the message as it unfolds then you will get a worthwhile if imperfect picture of what the theory is saying and how it was invented It's buried treasure and you will have to do some digging It is a really serious attempt to do all that can be done in an informal style Balungi explains and redefines Einstein's theory of general relativity quantum mechanics black holes the complex architecture of the universe elementary particles gravity and the nature of the mind This wonderful and exciting book is optimal for physics graduate students and researchers Not since Stephen W Hawking's celebrated best seller *Brief History of Time* has physics been so vividly intelligently and entertainingly revealed

Loop Quantum Gravity For Everyone Rodolfo Gambini, Jorge Pullin, 2020-01-08 In this remarkably well written text the authors introduce readers gently to the conceptual bricks of LQG without using any mathematics quite an achievement The debate started with the discovery that the space time geometry of general relativity can be written in terms of the electromagnetic field This led to intersecting graphs called loops Now known as spin networks they are the foundations of LQG This slender volume discusses applications of LQG to black holes and cosmology and introduces the notion of spin foam acknowledging that as yet the theory though elegant has no experimental confirmation This book offers a fascinating introduction to an esoteric realm otherwise accessible to only a fortunate few

Summing Up Highly recommended Upper division undergraduates Graduate students and faculty researchers

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Loop quantum gravity is one of the main contenders to unify Einstein's general theory of relativity and quantum mechanics therefore providing a quantum theory of gravity If these words do not mean much to you do not worry we will define them in simple terms This book describes loop quantum gravity and its applications to cosmology black holes and spin foams without using formulas It is concise and has a light style that makes for easy reading yet covering many of the cutting edge developments in the field It also addresses some of the controversies that surround these topics as they are incomplete science

Experimental Search for Quantum Gravity Sabine Hossenfelder, 2017-11-15 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

Physics in Theory Becky Brasfield, 2009-01-01 One of the greatest challenges in modern physics is to successfully unify general relativity and quantum mechanics It is believed that if these two seemingly incompatible theories can be unified then that theory will explain all the behavior in the universe *Physics in Theory* outlines a unified theory of quantum gravity Which variable has prevented the unification of general relativity and quantum mechanics What is the causal process of the material universe What experiment provides empirical support for the unified theory The following project answers these questions as it forwards a unified theory

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