

Advanced General Relativity Cambridge Monographs On Mathematical Physics

This is a book about physics, written for mathematicians. The readers we have in mind can be roughly described as those who: 1. are mathematics graduate students with some knowledge of global differential geometry 2. have had the equivalent of freshman physics, and find popular accounts of astrophysics and cosmology interesting 3. appreciate mathematical clarity, but are willing to accept physical motivations for the mathematics in place of mathematical ones 4. are willing to spend time and effort mastering certain technical details, such as those in Section 1. 1. Each book disappoints some readers. This one will disappoint: 1. physicists who want to use this book as a first course on differential geometry 2. mathematicians who think Lorentzian manifolds are wholly similar to Riemannian ones, or that, given a sufficiently good mathematical background, the essentials of a subject like cosmology can be learned without some hard work on boring details 3. those who believe vague philosophical arguments have more than historical and heuristic significance, that general relativity should somehow be "proved," or that axiomatization of this subject is useful 4. those who want an encyclopedic treatment (the

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

books by Hawking-Ellis [1], Penrose [1], Weinberg [1], and Misner-Thorne-Wheeler [1] go further into the subject than we do; see also the survey article, Sachs-Wu [1]). 5. mathematicians who want to learn quantum physics or unified field theory (unfortunately, quantum physics texts all seem either to be for physicists, or merely concerned with formal mathematics).

This book offers a systematic exposition of conformal methods and how they can be used to study the global properties of solutions to the equations of Einstein's theory of gravity. It shows that combining these ideas with differential geometry can elucidate the existence and stability of the basic solutions of the theory. Introducing the differential geometric, spinorial and PDE background required to gain a deep understanding of conformal methods, this text provides an accessible account of key results in mathematical relativity over the last thirty years, including the stability of de Sitter and Minkowski spacetimes. For graduate students and researchers, this self-contained account includes useful visual models to help the reader grasp abstract concepts and a list of further reading, making this the perfect reference companion on the topic.

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

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

physics of the twentieth century. The loop and spinfoam 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.

Written for researchers focusing on general relativity, supergravity, and cosmology, this is a self-contained exposition of the structure of the cosmological singularity in generic solutions of the Einstein equations, and an up-to-date mathematical derivation of the theory underlying the Belinski-Khalatnikov-Lifshitz (BKL) conjecture on this field. Part I provides a comprehensive review of the theory underlying the BKL conjecture. The generic asymptotic behavior near the cosmological singularity of the gravitational field, and fields describing other kinds of matter, is explained in detail. Part II focuses on the billiard reformulation of the BKL behavior. Taking a

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

general approach, this section does not assume any simplifying symmetry conditions and applies to theories involving a range of matter fields and space-time dimensions, including supergravities. Overall, this book will equip theoretical and mathematical physicists with the theoretical fundamentals of the Big Bang, Big Crunch, Black Hole singularities, the billiard description, and emergent mathematical structures.

The Springer Handbook of Spacetime is dedicated to the ground-breaking paradigm shifts embodied in the two relativity theories, and describes in detail the profound reshaping of physical sciences they ushered in. It includes in a single volume chapters on foundations, on the underlying mathematics, on physical and astrophysical implications, experimental evidence and cosmological predictions, as well as chapters on efforts to unify general relativity and quantum physics. The Handbook can be used as a desk reference by researchers in a wide variety of fields, not only by specialists in relativity but also by researchers in related areas that either grew out of, or are deeply influenced by, the two relativity theories: cosmology, astronomy and astrophysics, high energy physics, quantum field theory, mathematics, and philosophy of science. It should also serve as a valuable resource for graduate students and young researchers entering these areas, and for instructors who teach courses on these subjects. The Handbook is

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

divided into six parts. Part A: Introduction to Spacetime Structure. Part B: Foundational Issues. Part C: Spacetime Structure and Mathematics. Part D: Confronting Relativity theories with observations. Part E: General relativity and the universe. Part F: Spacetime beyond Einstein.

Quantum Field Effects on Curved Spacetime

Inflation and String Theory

Solitons and Instantons in High Energy Physics

Exact Space-Times in Einstein's General Relativity

Quantum Fields in Curved Space

Gravity Waves, Spinning Particles, and Black Holes

Carefully documenting the different formulations of general relativity, the author reveals valuable insight into the nature of the gravitational force and its interaction with matter. This book will interest graduate students and researchers in the fields of general relativity, gravitational physics and differential geometry. A self-contained introduction to advanced general relativity.

Emphasizing the applications of differential geometry to gauge theories in particle physics and general relativity, this work will be of special interest for researchers in applied mathematics or theoretical physics.

Deals with the twistor treatment of certain linear and non-linear partial differential

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

equations. The description in terms of twistors involves algebraic and differential geometry, and several complex variables.

The book covers mainstream topics at research level involving gravitational waves, spinning particles, and black holes, suitable for graduates and early postgraduates exploring avenues into research in general relativity.

Quantum Gravity

D-Branes

Springer Handbook of Spacetime

Gribov Lectures on Theoretical Physics

Special Relativity

The Wave Equation on a Curved Space-Time

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

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

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. Bičák and T. Ledvinka, published also by Springer Verlag.

This 2003 book provides a rigorous introduction to the theory of complex angular momenta, based on the methods of field theory. It comprises an English translation of the series of lectures given by V. N. Gribov in 1969, when the physics of high-energy hadron interactions was being created. Besides their historical significance, these lectures contain material which is highly relevant to research today. The basic physical results and the approaches Gribov developed are now being rediscovered in an alternative

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

context: in the microscopic theory of hadrons provided by quantum chromodynamics. The ideas and calculation techniques presented in this book are useful for analysing high-energy hadron scattering phenomena, deep inelastic lepton-hadron scattering, the physics of heavy ion collisions, kinetic phenomena in phase transitions, and will be instrumental in the analysis of electroweak processes at the next-generation particle accelerators, such as LHC and TESLA.

Modern physics rests on two fundamental building blocks: general relativity and quantum theory. General relativity is a geometric interpretation of gravity while quantum theory governs the microscopic behaviour of matter. Since matter is described by quantum theory which in turn couples to geometry, we need a quantum theory of gravity. In order to construct quantum gravity one must reformulate quantum theory on a background independent way. Modern Canonical Quantum General Relativity provides a complete treatise of the canonical quantisation of general relativity. The focus is on detailing the conceptual and mathematical framework, on describing physical applications and on summarising the status of this programme in its most popular incarnation, called loop quantum gravity. Mathematical concepts and their relevance to physics are provided within this book, which therefore can be read by graduate students with basic

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

knowledge of quantum field theory or general relativity.

This book presents a comprehensive review of the subject of gravitational effects in quantum field theory. Although the treatment is general, special emphasis is given to the Hawking black hole evaporation effect, and to particle creation processes in the early universe. The last decade has witnessed a phenomenal growth in this subject. This is the first attempt to collect and unify the vast literature that has contributed to this development. All the major technical results are presented, and the theory is developed carefully from first principles. Here is everything that students or researchers will need to embark upon calculations involving quantum effects of gravity at the so-called one-loop approximation level.

"Wald's book is clearly the first textbook on general relativity with a totally modern point of view; and it succeeds very well where others are only partially successful. The book includes full discussions of many problems of current interest which are not treated in any extant book, and all these matters are considered with perception and understanding."—S.

Chandrasekhar "A tour de force: lucid, straightforward, mathematically rigorous, exacting in the analysis of the theory in its physical aspect."—L. P. Hughston, Times Higher Education Supplement "Truly excellent. . . . A sophisticated text of manageable size that will probably be read by every

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

student of relativity, astrophysics, and field theory for years to come."—James W. York, *Physics Today*

Relativity and Gravitation

Introducing Einstein's Relativity

Conformal Methods in General Relativity

100 Years after Einstein in Prague

Loops, Knots, Gauge Theories and Quantum Gravity

The General Theory of Relativity

This book is written for theoretical and mathematical physicists and mathematicians interested in recent developments in complex general relativity and their application to classical and quantum gravity. Calculations are presented by paying attention to those details normally omitted in research papers, for pedagogical reasons. Familiarity with fibre-bundle theory is certainly helpful, but in many cases I only rely on two-spinor calculus and conformally invariant concepts in gravitational physics. The key concepts the book is devoted to are complex manifolds, spinor techniques, conformal gravity, $\mathbb{C}P^1$ -planes, $\mathbb{C}P^1$ -surfaces, Penrose transform, complex 3 1 - - space-time models with non-vanishing torsion, spin-fields and spin-potentials. 2 2 Problems have been inserted at the end, to help the reader to check his understanding of these topics. Thus, I can find at least four reasons for writing yet another book on spinor and twistor methods in general relativity: (i) to write a textbook useful to - ginning graduate students

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

and research workers, where two-component spinor calculus is the unifying mathematical language.

Describes random geometry and applications to strings, quantum gravity, topological field theory and membrane physics.

The book aims to expound the general theory of relativity with a mathematical point of view. Catering to the needs of postgraduate students and researchers in the field of astrophysics and mathematical physics, it offers the readers a comprehensive understanding of the advanced topics of the subject matter. It specifically discusses the mathematical foundation of tensor calculus, gives a background of geodesics, Einstein's field equations, linearised gravity, spacetime of spherically symmetric distribution of matter and black holes, and particle and photon orbits in spacetime. Apart from the formulation of general relativity, Lie derivatives and its applications, and causality of spacetime are also discussed in detail. Certain preliminary concepts of extrinsic curvature, Lagrangian formalism of general theory of relativity and $3 + 1$ decomposition of space-time are covered and are provided in the book as appendices.

This unique book gives a modern account of particle physics and gravity based on supersymmetry and supergravity, two of the most significant developments in theoretical physics since general relativity. The book begins with a brief overview of the history of unification and then goes into a detailed exposition of both fundamental and phenomenological topics. The topics in fundamental physics include Einstein gravity, Yang-Mills theory, anomalies, the standard model,

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

supersymmetry and supergravity, and the construction of supergravity couplings with matter and gauge fields, as well as computational techniques for SO(10) couplings. The topics of phenomenological interest include implications of supergravity models at colliders, CP violation, and proton stability, as well as topics in cosmology such as inflation, leptogenesis, baryogenesis, and dark matter. The book is intended for graduate students and researchers seeking to master the techniques for building grand unified models.

In this short book, renowned theoretical physicist and author Carlo Rovelli gives a straightforward introduction to Einstein's General Relativity, our current theory of gravitation. Focusing on conceptual clarity, he derives all the basic results in the simplest way, taking care to explain the physical, philosophical and mathematical ideas at the heart of "the most beautiful of all scientific theories". Some of the main applications of General Relativity are also explored, for example, black holes, gravitational waves and cosmology, and the book concludes with a brief introduction to quantum gravity. Written by an author well known for the clarity of his presentation of scientific ideas, this concise book will appeal to university students looking to improve their understanding of the principal concepts, as well as science-literate readers who are curious about the real theory of General Relativity, at a level beyond a popular science treatment.

***Supersymmetry, Supergravity, and Unification
A Deeper Understanding
Gravity and Strings***

General Relativity

The Theory of Complex Angular Momenta

Relativity on Curved Manifolds

The scalar-tensor theory of gravitation is one of the most popular alternatives to Einstein's theory of gravitation. This book provides a clear and concise introduction to the theoretical ideas and developments, exploring scalar fields and placing them in context with a discussion of Brans-Dicke theory. Topics covered include the cosmological constant problem, time variability of coupling constants, higher dimensional space-time, branes and conformal transformations. The authors emphasize the physical applications of the scalar-tensor theory and thus provide a pedagogical overview of the subject, keeping more mathematically detailed sections for the appendices. This book is suitable for graduate courses in cosmology, gravitation and relativity. It will also provide a valuable reference for researchers.

There is little doubt that Einstein's theory of relativity captures

the imagination. Not only has it radically altered the way we view the universe, but the theory also has a considerable number of surprises in store. This is especially so in the three main topics of current interest that this book reaches, namely: black holes, gravitational waves, and cosmology. The main aim of this textbook is to provide students with a sound mathematical introduction coupled to an understanding of the physical insights needed to explore the subject. Indeed, the book follows Einstein in that it introduces the theory very much from a physical point of view. After introducing the special theory of relativity, the basic field equations of gravitation are derived and discussed carefully as a prelude to first solving them in simple cases and then exploring the three main areas of application. This new edition contains a substantial extension content that considers new and updated developments in the field. Topics include coverage of the advancement of observational cosmology, the detection of gravitational waves from colliding black holes and neutron stars, and advancements in modern cosmology. Einstein's

theory of relativity is undoubtedly one of the greatest achievements of the human mind. Yet, in this book, the author makes it possible for students with a wide range of abilities to deal confidently with the subject. Based on both authors' experience teaching the subject this is achieved by breaking down the main arguments into a series of simple logical steps. Full details are provided in the text and the numerous exercises while additional insight is provided through the numerous diagrams. As a result this book makes an excellent course for any reader coming to the subject for the first time while providing a thorough understanding for any student wanting to go on to study the subject in depth

Einstein's General Theory of Relativity leads to two remarkable predictions: first, that the ultimate destiny of many massive stars is to undergo gravitational collapse and to disappear from view, leaving behind a 'black hole' in space; and secondly, that there will exist singularities in space-time itself. These singularities are places where space-time begins or ends, and the presently known laws of physics break down. They will

occur inside black holes, and in the past are what might be construed as the beginning of the universe. To show how these predictions arise, the authors discuss the General Theory of Relativity in the large. Starting with a precise formulation of the theory and an account of the necessary background of differential geometry, the significance of space-time curvature is discussed and the global properties of a number of exact solutions of Einstein's field equations are examined. The theory of the causal structure of a general space-time is developed, and is used to study black holes and to prove a number of theorems establishing the inevitability of singularities under certain conditions. A discussion of the Cauchy problem for General Relativity is also included in this 1973 book.

String theory is one of the most exciting and challenging areas of modern theoretical physics. This book guides the reader from the basics of string theory to recent developments. It introduces the basics of perturbative string theory, world-sheet supersymmetry, space-time supersymmetry, conformal field theory and the heterotic string, before describing modern

developments, including D-branes, string dualities and M-theory. It then covers string geometry and flux compactifications, applications to cosmology and particle physics, black holes in string theory and M-theory, and the microscopic origin of black-hole entropy. It concludes with Matrix theory, the AdS/CFT duality and its generalizations. This book is ideal for graduate students and researchers in modern string theory, and will make an excellent textbook for a one-year course on string theory. It contains over 120 exercises with solutions, and over 200 homework problems with solutions available on a password protected website for lecturers at www.cambridge.org/9780521860697.

Inflationary cosmology has been developed over the last twenty years to remedy serious shortcomings in the standard hot big bang model of the universe. This textbook, first published in 2005, explains the basis of modern cosmology and shows where the theoretical results come from. The book is divided into two parts; the first deals with the homogeneous and isotropic model of the Universe, the second part discusses how inhomogeneities

can explain its structure. Established material such as the inflation and quantum cosmological perturbation are presented in great detail, however the reader is brought to the frontiers of current cosmological research by the discussion of more speculative ideas. An ideal textbook for both advanced students of physics and astrophysics, all of the necessary background material is included in every chapter and no prior knowledge of general relativity and quantum field theory is assumed.

Exact Solutions in Three-Dimensional Gravity

Classical Solutions in Quantum Field Theory

Differential Geometry, Gauge Theories, and Gravity

The Cosmological Singularity

Gravity, Spinors and Differential Forms

The Large Scale Structure of Space-Time

Twenty-fifth anniversary edition featuring a new Preface, invaluable for graduate students and researchers in high energy physics and astrophysics.

This 2001 book gives a self-contained exposition of the theory of gravitational solitons and provides a comprehensive review of exact

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

soliton solutions to Einstein's equations. The text begins with a detailed discussion of the extension of the Inverse Scattering Method to the theory of gravitation, starting with pure gravity and then extending it to the coupling of gravity with the electromagnetic field. There follows a systematic review of the gravitational soliton solutions based on their symmetries. These solutions include some of the most interesting in gravitational physics such as those describing inhomogeneous cosmological models, cylindrical waves, the collision of exact gravity waves, and the Schwarzschild and Kerr black holes. A valuable reference for researchers and graduate students in the fields of general relativity, string theory and cosmology, this book will also be of interest to mathematical physicists in general.

Bridging the gap between modern differential geometry and the mathematical physics of general relativity, this text, in its second edition, includes new and expanded material on topics such as the instability of both geodesic completeness and geodesic incompleteness for general space-times, geodesic connectibility, the generic condition, the sectional curvature function in a neighbourhood of degenerate two-plane, and proof of the Lorentzian Splitting Theorem.;Five or more

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

copies may be ordered by college or university stores at a special student price, available on request.

Einstein's theory of general relativity is a theory of gravity and, as in the earlier Newtonian theory, much can be learnt about the character of gravitation and its effects by investigating particular idealised examples. This book describes the basic solutions of Einstein's equations with a particular emphasis on what they mean, both geometrically and physically. Concepts such as big bang and big crunch-types of singularities, different kinds of horizons and gravitational waves, are described in the context of the particular space-times in which they naturally arise. These notions are initially introduced using the most simple and symmetric cases. Various important coordinate forms of each solution are presented, thus enabling the global structure of the corresponding space-time and its other properties to be analysed. The book is an invaluable resource both for graduate students and academic researchers working in gravitational physics.

This book gives a rigorous discussion of the local effects of curvature on the behaviour of waves. In the course of this discussion many

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

techniques are developed which are also needed for a study of more general problems, in which the gravitational field itself plays a dynamical role.

Physical Foundations of Cosmology

Complex General Relativity

Advanced General Relativity

Gravitational Solitons

General Relativity: The Essentials

From Einstein to Strings

Advanced General Relativity Cambridge University Press

Self-contained and pedagogical introduction to key string theory ideas and techniques needed to understand D-branes.

The book provides a self-contained and accessible introduction to elementary twistor theory; a technique for solving differential equations in applied mathematics and theoretical physics. It starts with an introduction to integrability of ordinary and partial differential equations. Subsequent chapters explore symmetry analysis, gauge theory, gravitational instantons, twistor transforms, and anti-self-duality equations. The three appendices cover

basic differential geometry, complex manifold theory and the exterior differential system.

Self-contained and comprehensive, this definitive new edition provides a complete overview of the intersection of gravity, supergravity, and superstrings.

General relativity is now essential to the understanding of modern physics, but the power of the theory cannot be exploited fully without a detailed knowledge of its mathematical structure. This book aims to implement this structure, and then to develop those applications that have been central to the growth of the theory.

A Modern Introduction

The Scalar-Tensor Theory of Gravitation

Formulations of General Relativity

Global Lorentzian Geometry, Second Edition

A Mathematical Approach

A Statistical Field Theory Approach

A self-contained introduction to applications of loop representations and knot theory in quantum gravity.

An overview of semi-classical gravity theory and stochastic

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

gravity as theories of quantum gravity in curved space-time.

This book provides a thorough introduction to Einstein's special theory of relativity, suitable for anyone with a minimum of one year's university physics with calculus. It is divided into fundamental and advanced topics. The first section starts by recalling the Pythagorean rule and its relation to the geometry of space, then covers every aspect of special relativity, including the history. The second section covers the impact of relativity in quantum theory, with an introduction to relativistic quantum mechanics and quantum field theory. It also goes over the group theory of the Lorentz group, a simple introduction to supersymmetry, and ends with cutting-edge topics such as general relativity, the standard model of elementary particles and its extensions, superstring theory, and a survey of important unsolved problems. Each chapter comes with a set of exercises. The book is accompanied by a CD-ROM illustrating, through interactive animation, classic

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

problems in relativity involving motion.

Overview of classical solutions and their consequences in quantum field theory, high energy physics and cosmology for graduates and researchers.

The past two decades have seen transformative advances in cosmology and string theory. Observations of the cosmic microwave background have revealed strong evidence for inflationary expansion in the very early universe, while new insights about compactifications of string theory have led to a deeper understanding of inflation in a framework that unifies quantum mechanics and general relativity.

Written by two of the leading researchers in the field, this complete and accessible volume provides a modern treatment of inflationary cosmology and its connections to string theory and elementary particle theory. After an up-to-date experimental summary, the authors present the foundations of effective field theory, string theory, and string compactifications, setting the stage for a detailed examination of models of inflation in string theory. Three

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

appendices contain background material in geometry and cosmological perturbation theory, making this a self-contained resource for graduate students and researchers in string theory, cosmology, and related fields.
String Theory and M-Theory

Semiclassical and Stochastic Gravity
General Relativity for Mathematicians
Twistor Geometry and Field Theory

Modern Canonical Quantum General Relativity

A self-contained text, systematically presenting the determination and classification of exact solutions in three-dimensional Einstein gravity. This book explores the theoretical framework and general physical and geometrical characteristics of each class of solutions, and includes information on the researchers responsible for their discovery. Beginning with the physical character of the solutions, these are identified and ordered on the basis of their geometrical invariant properties, symmetries, and algebraic classifications, or from the standpoint of their physical nature, for example electrodynamic fields, fluid, scalar field, or dilaton. Consequently, this text

Read PDF Advanced General Relativity Cambridge Monographs On Mathematical Physics

serves as a thorough catalogue on $2+1$ exact solutions to the Einstein equations coupled to matter and fields, and on vacuum solutions of topologically massive gravity with a cosmological constant. The solutions are also examined from different perspectives, enabling a conceptual bridge between exact solutions of three- and four-dimensional gravities, and therefore providing graduates and researchers with an invaluable resource on this important topic in gravitational physics.

Solitons, Instantons, and Twistors

Quantum Geometry

Superstring Theory

25th Anniversary Edition