Rotating Fields In General Relativity

In this book the author gives a comprehensive picture of the physical laws that appear to regulate the functioning of the Universe from the atomic to the cosmic world. The book offers a description of the main fields of physics — classical physics, relativity, quantum mechanics and particle physics — as they are applied to the atomic world and the cosmos to describe how the whole Universe has evolved to the present state. The description concentrates on the essentials, describing our present knowledge of those physical laws and outlining our limitations in understanding the whole picture. This is done essentially without equations, except for a few important ones. The text includes a short Annex for mathematically inclined readers who wish to see how the physical principles and laws expressed in words can be visualized in the language of mathematics, but the book can be read without referring to that Annex. Also, The Universe explains in depth those laws and outlines their limitations. The author, however, does this in an accessible language that should be understandable to non-specialists. In particular, he occasionally uses two young characters placed in various situations to explain the physics involved in those situations by means of their observations. The author uses also numerous clear pictures and graphics that make the text more easily comprehensible./a

Einstein's general theory of relativity is widely considered to be one of the most elegant and successful scientific theories ever developed, and it is increasingly being taught in a simplified form at advanced undergraduate level within both physics and mathematics departments. Due to the increasing interest in gravitational physics, in both the academic and the public sphere, driven largely by widely-publicised developments such as the recent observations of gravitational waves, general relativity is also one of the most popular scientific topics pursued through self-study. Modern General Relativity introduces the reader to the general theory of relativity using an example-based approach, before describing some of its most important applications in cosmology and astrophysics, such as gamma-ray bursts, neutron stars, black holes, and gravitational waves. With hundreds of worked examples, explanatory boxes, and end-of-chapter problems, this textbook provides a solid foundation for understanding one of the towering achievements of twentieth-century physics.

This book is devoted to researchers who would like to investigate interactions among gravitational waves and matter fields beyond linear order, including the phenomena of memory effects, gravitational Faraday rotation, soft theorems, and formations of spacetime singularities due to the mutual focus of gravitational waves. Readers only require a basic understanding of general relativity to understand the materials.The book starts with an overview on the fundamentals of the Newman-Penrose formalism and a brief introduction to distribution theory, with which the author systematically develops a mathematical description of spacetimes of colliding plane waves. Then, the author presents a frame-independent definition of polarization of a plane gravitational wave in a curved spacetime, studies in detail the gravitational Faraday rotation of two plane gravitational waves, and shows that each of them can serve as a medium to the other precisely due to their nonlinear interactions. Exact solutions are also presented, which represent a variety of models including the collisions of two plane gravitational waves and the collisions of a plane gravitational wave with a dust shell, a massless scalar wave, an electromagnetic wave, or a neutrino wave. The formation of spacetime singularities due to nonlinear interactions and the effects of gravitational wave polarization on the nature of singularities are also explored.

This volume pulls together more than forty years of research to provide graduate students and researchers in astrophysics, gravitational physics, and astronomy with the first self-contained treatment of the structure, stability, and oscillations of rotating neutron stars.

This book “Foundation of quantum mechanics in Dual 4-dimension space-time——The spacetime origin of quantum probability,” is a new exploration discussing the physical foundations of quantum mechanics. It contains two parts. One is the interactive realism, the other is the quantum mechanical description of the dual-4 dimensional spacetime. The first one is the philosophical basis of the second. The author thought that the conventional mass-point model is no long proper for the microscopic quantum world. The author used the movement of the rotating matter wave sphere in complex space to deduce the de Broglie matter-wave formula, and pulled the metaphysical hypothesis of the wave function back into the real physical realism. A matte wave is the physical wave, and it has potential applications. The matter wave transfers in the dual-4 dimensional complex space-time, and the complex number enters the cognition domain of space-time intrinsically. The author pointed out that, the state of a moving microscopic object is the combination of its eigen-states from quantum slicing, coherent hence; after quantum measurement, projected into the real 4-dimensional space-time and showing a probability distribution of point particles. Before and after the quantum measurement, the object is not in the same cognition level, nor the same physical space-time, and the Hilbert space is just their common math application space. The quantum measurement induces the transition of the microscopic object in space-time, manifestation, physical model, and theoretical structure, and the quantum probability comes from the space distribution of the field matter sphere, representing the transition from dual-4 complex to real 4-dimensional space-time, and the sphere to the point model. Physical phenomena, phenomenal entity, physical space-time, physical model, and theoretical structure all must consist intrinsically in logic. These are changing with the change of human cognition, embodying the unity of the human being and the nature. Dual-4 dimensional space-time quantum mechanics gives the wave function the physical realism. So, the concepts of the quantum entanglement, quantum communication and quantum teleportation all may be clarified and understood physically. The book is self-consistent with detailed justification, wherein the interactive realism concept is a new innovation.

The black holes of nature are the most perfect macroscopic objects there are in the universe: the only elements in there that constructed our concept of space and time. Black holes are a class of gravitational objects predicted by Einstein's theory of general relativity given by him in 1915. And since the general theory of relativity provides only a single unique family of solutions for their descriptions, they are the simplest objects as well. Due to the gravitational effects on space-time, its most striking property is that there is a region of space around a black hole where light is unable to escape. The unique two-parameter family of solutions which describes the space-time around black hole is the Kerr family discovered by Roy Patrick Kerr in July, 1963. The two parameters are the mass and the angular momentum of the black holes. The static solution, with zero angular momentum was discovered by Karl Schwarzschild in December, 1915. A study of the black holes of nature is then a study of these solutions. It is to this study that this book is devoted.

This invaluable book presents gravitation and gauge fields as interrelated topics with a common physical and mathematical foundation, such as gauge theory of gravitation and other fields, giving emphasis to the physicist's point of view. About half of the material is devoted to Einstein's general relativity theory, and the rest to gauge fields that naturally blend well with gravitation, including spinor formulation, classification of SU(2) gauge fields and null-tetrad formulation of the Yang-Mills field in the presence of gravitation. The text includes a useful introduction to the physical foundation of the theory of gravitation. It also provides the mathematical theory of the geometry of curved space-times needed to describe Einstein's general relativity theory.

Proceedings of the International Symposium on General Relativity, University of Maryland, 1993.

This meeting addresses all aspects of computational methodology with applications to most branches of physics, especially massively parallel computing, symbolic computing, Monte Carlo simulations of quantum systems, neuro-computing, fluids and plasmas, physics education, mesoscopic physics, dynamical systems, molecular dynamics, Monte Carlo techniques, etc.

Contents:Neural Multigrid Methods for Gauge Theories and Other Disordered Systems (M Bäker et al.)On the Use of the Symbolic Language Maple in Physics and Chemistry: Several Examples (J ?í?ek et al.)Nonequilibrium Phase Transitions in Catalysis and Population Models (R Dickman)Computer Algebra, Symmetry Analysis and Integrability of Nonlinear Evolution Equations (V P Gerdt)The Path-Integral Quantum Simulation of Hydrogen in Metals (M J Gillan & F Christodoulos)Numerical Implementation of a K.A.M. Algorithm (H R Jauslin)A Review of the Lattice Boltzmann Method (S Succi et al.)Electronic Structure of Solids in the Self-Interaction Corrected Local-Spin-Density Approximation (A Svane)and others Readership: Physicists, chemists and computer scientists. keywords:

General Relativity provides an unusually broad survey of the current state of this field. Chapters on mathematical relativity cover many topics, including initial value problems, a new approach to the partial differential equations of physics, and work on exact solutions. The chapters on relativistic cosmology and black holes explore cosmology. Other chapters deal with gravitational waves, experimental relativity, quantum gravity, and aspects of computing in relativity. The book will be useful both to postgraduates and to established workers in the field.

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

Due to steadily improving experimental accuracy, relativistic concepts – based on Einstein’s theory of Special and General Relativity – are playing an increasingly important role in modern geodesy. This book offers an introduction to the emerging field of relativistic geodesy, and covers topics ranging from the description of clocks and test bodies, to time and frequency measurements, to current and future observations. Emphasis is placed on geodetically relevant definitions and fundamental methods in the context of Einstein’s theory (e.g. the role of observers, use of clocks, definition of reference systems and the geoid, use of relativistic approximation schemes). Further, the applications discussed range from chronometric and gradiometric determinations of the gravitational field, to the latest (satellite) experiments. The impact of choices made at a fundamental theoretical level on the interpretation of measurements and the planning of future experiments is also highlighted. Providing an up-to-the-minute status report on the respective topics discussed, the book will not only benefit experts, but will also serve as a guide for students with a background in either geodesy or gravitational physics who are interested in entering and exploring this emerging field.

In Topics in the Foundations of General Relativity and Newtonian Gravitation Theory, David B. Malament presents the basic logical-mathematical structure of general relativity and considers a number of special topics concerning the foundations of general relativity and its relation to Newtonian gravitation theory. These special topics include the geometrized formulation of Newtonian theory (also known as Newton-Cartan theory), the concept of rotation in general relativity, and Gödel spacetime. One of the highlights of the book is a no-go theorem that can be understood to show that there is no criterion of orbital rotation in general relativity that fully answers to our classical intuitions. Topics is intended for both students and researchers in mathematical physics and philosophy of science.

First published in 1922 and based on lectures delivered in May 1921, Albert Einstein’s The Meaning of Relativity offered an overview and explanation of the then new and controversial theory of relativity. The work would go on to become a monumental classic, printed in numerous editions and translations worldwide. Now, The Formative Years of Relativity introduces Einstein’s masterpiece to new audiences. This beautiful volume contains Einstein’s insightful text, accompanied by important historical materials and commentary looking at the origins and development of general relativity. Hanoch Gutfreund and Jürgen Renn provide fresh, original perspectives, placing Einstein’s achievements into a broader context for all readers. In this book, Gutfreund and Renn tell the rich story behind the early reception, spread, and consequences of Einstein’s ideas during the formative years of general relativity in the late 1910s and 1920s. They show that relativity’s meaning changed radically throughout the nascent years of its development, and they describe in detail the transformation of Einstein’s work from the esoteric pursuit of one individual communicating with a handful of colleagues into the preoccupation of a growing community of physicists, astronomers, mathematicians, and philosophers. This handsome edition quotes extensively from Einstein’s correspondence and reproduces historical documents such as newspaper articles and letters. Inserts are featured in the main text giving concise explanations of basic concepts, and short biographical notes and photographs of some of Einstein’s contemporaries are included. The first-ever English translations of two of Einstein’s popular Princeton lectures are featured at the book’s end.

This four-volume work represents the most comprehensive documentation and study of the creation of general relativity. Einstein’s 1912 Zurich notebook is published for the first time in facsimile and transcript and commented on by today’s major historians of science. Additional sources from Einstein and others, who from the late 19th to the early 20th century contributed to this monumental development, are presented here in translation for the first time. The volumes offer detailed commentaries and analyses of these sources that are based on a close reading of these documents supplemented by interpretations by the leading historians of relativity.

Outgrowth of 6th Int'l Conference on the History of General Relativity, held in Amsterdam on June 26-29, 2002 Contributions from notable experts offer both new and historical insights on gravitation, general relativity, cosmology, unified field theory, and the history of science Topics run gamet from detailed mathematical discussions to more personal recollections of relativity as seen through the eyes of the public and renowned relativists

Originally published in 1991. A multidisciplinary guide in the form of a bibliography of selected time-related books and articles divided into 25 existing academic disciplines and about 100 subdisciplines which have a wide application to time studies.

Divided into four parts, this book covers recent developments in topics pertaining to gravity theories, including discussions on the presence of scalar fields. Part One is devoted to exact solutions in general relativity, and is mainly concerned with the results of rotating null dust beams and fluids. Also included is a panoramic vision of new research directions in this area, which would require revising certain theorems and their possible extensions within gravity theories, new aspects concerning the Ernst potentials, double Kerr spacetimes, and rotating configurations.

In particular, there is a detailed discussion of totally symmetric and totally geodesic spaces, in which a method for generating (2+1)-dimensional solutions from (3+1)-dimensional solutions is given. Part Two deals with alternative theories of gravity, all of which include scalar fields and gauge fields. Here, quantum and cosmological effects, which arise from both gravity theories in four and higher dimensions and from metric-affine theories, are investigated. Part Three is devoted to cosmological and inflationary scenarios. Local effects, such as the influence of scalar fields in protogalactic interactions, numerical studies of the collapse of molecular cores, as well as the inverse inflationary problem and the blue eigenvalue spectrum of it, are considered. Moreover, the role of scalar fields as dark matter and quantum cosmology in the Bergman-Wagoner and Gowdy theories, together with the relation of the conformal symmetry and deflationary gas universe, are likewise presented. The last part of the book includes some mixed topics which are still in the experimental stage. Among them are the foundation of the Maxwell theory, a discussion on electromagnetic Thirring problems, a note on the staticity of black holes with non-minimally coupled scalar fields, and a study of the Lorentz force free charged fluids in general relativity. Thus, this book is the most up-to-date, comprehensive collection of papers on the subject of exact solutions and scalar fields in gravity and is a valuable tool for researchers in the area.

This is an excellent introduction to the subjects of gravitation and space-time structure. It discusses the foundations of Riemann geometry; the derivation of Einstein field equations; linearised theory; far fields and gravitational waves; the invariant characterisation of exact solutions; gravitational collapse; cosmology as well as alternative gravitational theories and the problem of quantum gravity.

Astronomy and Astrophysics Abstracts aims to present a comprehensive documen tation ofthe literatme concerning all aspects of astronomy, astrophysics, and their border fields. lt is devoted to the recording, summarizing, and indexing of the relevant publications throughout the world. Astronomy and Astrophysics Abstracts is prepared by a special department of the Astronomisches Rechen-Institut under the auspices of the International Astronomical Union. Volume 40 records literatme published in 1985 and received before February 15, 1986. Some older documents which we received late and which arenot surveyed in earlier volumes are included too. We acknowledge with thanks contributions of our colleagues all over the world. We also express our gratitude to all organiza tions, observatories, and publishers which provide us with complimentary copies of their publications. Starting with Volume 33, all the recording, correction, and data processing work was dorre by means of computers. The recording was dorre by om technical staff members Ms. Helga Ballmann, Ms. Mona El-Choura (t), Ms. Monika Kohl, Ms. Sylvia Matyssek. Ms. Karirr Burkhardt, Ms. Susanne Schlötelbmg, Mr. Mar tin Schlötelburg, and Mr. Stefan Wagner supported om task by careful proof reading. lt is a pleasure to thank them all for their encomagement.

Reissuing five works originally published between 1937 and 1991, this collection contains books addressing the subject of time, from a mostly philosophic point of view but also of interest to those in the science and mathematics worlds. These texts are brought back into print in this small set of works addressing how we think about time, the history of the philosophy of time, the measurement of time, theories of relativity and discussions of the wider thinking about time and space, among other aspects. One volume is a thorough bibliography collating references on the subject of time across many disciplines.

John Stachel, the author of this collection of 37 published and unpublished articles on Albert Einstein, has written about Einstein and his work for over 40 years. Trained as a theoretical physicist specializing in the theory of relativity, he was chosen as the founding editor of The Collected papers of Albert Einstein 25 years ago, and is currently Director of the Boston University Center for Einstein Studies. Based on a detailed study of documentary evidence, much of which was newly discovered in the course of his work, Stachel debunks many of the old (and some new) myths about Einstein and offers novel insight into his life and work. Throughout the volume, a new, more human picture of Einstein is offered to replace the plaster saint of popular legend. In particular, a youthful Einstein emerges from the obscurity that previously shrouded his early years, and much new light is shed on the origins of the special and general theories of relativity. Also discussed in some detail are Einstein's troubled relationship with his first wife, his friendships with other physicists such as Eddington, Bose, and Pauli, and his Jewish identity. The essays are grouped thematically into the following areas: * The Human Side * Editing the Einstein Papers * Surveys of Einstein's Work * Special Relativity * General Relativity * Quantum Theory * Einstein and Other Scientists * Book Reviews Because the essays are independent of one another, readers will be able to dip into this collection to satisfy varying interests. It will be of particular interest to historians of 20th century science, working physicists, and students, as well as to the many members of the general reading public who continue to be fascinated by aspects of Einstein's life and work.

In the late 20th and beginning 21st century high-precision astronomy, positioning and metrology strongly rely on general relativity. Supported by exercises and solutions this book offers graduate students and researchers entering those fields a self-contained and exhaustive but accessible treatment of applied general relativity. The book is written in a homogenous (graduate level textbook) style allowing the reader to understand the arguments step by step. It first introduces the mathematical and theoretical foundations of gravity theory and then concentrates on its general relativistic applications: clock rates, clock sychronization, establishment of time scales, astronomical references frames, relativistic astrometry, celestial mechanics and metrology. The authors present up-to-date relativistic models for applied techniques such as Satellite LASER Ranging (SLR), Lunar LASER Ranging (LLR), Globale Navigation Satellite Systems (GNSS), Very Large Baseline Interferometry (VLBI), radar measurements, gyroscopes and pulsar timing. A list of acronyms helps the reader keep an overview and a mathematical appendix provides required functions and terms.

Observational and experimental data pertaining to gravity and cosmology are changing our view of the Universe. General relativity is a fundamental key for the understanding of these observations and its theory is undergoing a continuing enhancement of its intersection with observational and experimental data. These data include direct observations and experiments carried out in our solar system, among which there are direct gravitational wave astronomy, frame dragging and tests of gravitational theories from solar system and spacecraft observations. This book explores John Archibald Wheeler's seminal and enduring contributions in relativistic astrophysics and includes: the General Theory of Relativity and Wheeler's influence; recent developments in the confrontation of relativity with experiments; the theory describing gravitational radiation, and its detection in Earth-based and space-based interferometer detectors as well

as in Earth-based bar detectors; the mathematical description of the initial value problem in relativity and applications to modeling gravitational wave sources via computational relativity; the phenomenon of frame dragging and its measurement by satellite observations. All of these areas were of direct interest to Professor John A. Wheeler and were seminally influenced by his ideas.

This book addresses physicists working in general relativity, astrophysics and cosmology. The contributions are based on reports given at a summer school the goal of which was to review modern research for students. The school was centered on the study of gravitational fields corresponding to rotating objects of astrophysical interest, under different viewpoints: theoretical, numerical and observational. Special emphasis is put on the analysis of interior and exterior fields of stationary axisymmetric systems. Lectures and contributions, collected here in Part I, ranged from basic information useful to newcomers to technical points pertaining to current research in this area. Part II contains lectures and contributions on other aspects of gravitation theory.

This volume is made up of papers presented at the Conference on Classical General Relativity held at the City University, London, in December 1983. New tests, arising from space experimentation, pulsars and black holes have revitalised the study of Einstein's theory of gravitation (classical general relativity). Nineteen contributors survey recent progress and identify future avenues of research.

The concept of reference frame was introduced in physics at an early stage when its formalisation had just begun and even before introduction of systems of co-ordinates and equations of motion; this concept continues to play a fundamental role in science ever since. In this book, the author considers mainly the problem of the description and further applications of reference frames in relativistic physics primarily using a general relativistic approach to them.

This book is based on the lecture notes of a one-semester course on black hole astrophysics given by the author and is aimed at advanced undergraduate and graduate students with an interest in astrophysics. The material included goes beyond that found in classic textbooks and presents details on astrophysical manifestations of black holes. In particular, jet physics and detailed accounts of objects like microquasars, active galactic nuclei, gamma-ray bursts, and ultra-luminous X-ray sources are covered, as well as advanced topics like black holes in alternative theories of gravity. The author avoids unnecessary technicalities and to some degree the book is self-contained. The reader will find some basic general relativity tools in Chapter 1. The appendices provide some additional mathematical details that will be useful for further study, and a guide to the bibliography on the subject.

An introductory textbook on mathematical cosmology for beginning graduate students.

This is the only book on the subject of group theory and Einstein's theory of gravitation. It contains an extensive discussion on general relativity from the viewpoint of group theory and gauge fields. It also puts together in one volume many scattered, original works, on the use of group theory in general relativity theory.There are twelve chapters in the book. The first six are devoted to rotation and Lorentz groups, and their representations. They include the spinor representation as well as the infinite-dimensional representations. The other six chapters deal with the application of groups -particularly the Lorentz and the SL(2,C) groups — to the theory of general relativity. Each chapter is concluded with a set of problems.The topics covered range from the fundamentals of general relativity theory, its formulation as an SL(2,C) gauge theory, to exact solutions of the Einstein gravitational field equations. The important Bondi-Metzner-Sachs group, and its representations, conclude the book. The entire book is self-contained in both group theory and general relativity theory, and no prior knowledge of either is assumed.The subject of this book constitutes a relevant link between field theoreticians and general relativity theoreticians, who usually work rather independently of each other. The treatise is highly topical and of real interest to theoretical physicists, general relativists and applied mathematicians. It is invaluable to graduate students and research workers in quantum field theory, general relativity and elementary particle theory.

The articles included in this Volume represent a broad and highly qualified view on the present state of general relativity, quantum gravity, and their cosmological and astrophysical implications. As such, it may serve as a valuable source of knowledge and inspiration for experts in these fields, as well as an advanced source of information for young researchers. The occasion to gather together so many leading experts in the field was to celebrate the centenary of Einstein's stay in Prague in 1911-1912. It was in fact during his stay in Prague that Einstein started in earnest to develop his ideas about general relativity that fully developed in his paper in 1915. Approaching soon the centenary of his famous paper, this volume offers a precious overview of the path done by the scientific community in this intriguing and vibrant field in the last century, defining the challenges of the next 100 years. The content is divided into four broad parts: (i) Gravity and Prague, (ii) Classical General Relativity, (iii) Cosmology and Quantum Gravity, and (iv) Numerical Relativity and Relativistic Astrophysics.

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.

The aim of this book is to introduce the reader to research work on a particular aspect of rotating fields in general relativity. The account begins with a short introduction to the relevant aspects of general relativity, written at a level accessible to a beginning graduate student in theoretical physics. There follows a detailed derivation of the Wehl-Lewis-

Papapetrou form of the stationary axially symmetric metric. The Kerr and Tomimatsu-Sato forms of the rotating interior and exterior solutions of the Einstein equations are then discussed. The last three chapters of the book illustrate the applications of the theory to rotating neutral dust, rotating Einstein-Maxwell fields, and rotating charged dust. The author has drawn on his own research work to produce a timely discussion of this important area of research.

This book is a collection of reprints on the structure of Poincar, anti-de Sitter and conformal supergravity theories in one to eleven dimensions, their anomalies and compactification. Each chapter contains introductory comments and an extensive list of references.

Many new tests of gravity and, in particular, of Einstein's general relativity theory will be carried out in the near future: The Lense--Thirring effect and the equivalence principle will be tested in space; moreover, gravitational waves will be detected, and new atomic interferometers and clocks will be built for measurements in gravitational and inertial fields. New high-precision devices have made these experiments feasible. They will contribute to a better understanding of gravitational physics. Both experimental developments and the theoretical concepts are collected in this volume. Exhaustive reviews give an overall insight into the subject of experimental gravitation.