Modern General Relativity Black Holes Gravitation

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Classical and Quantum Black Holes P Fre 1999-09-01 Black holes are becoming increasingly important in contemporary research in astrophysics, cosmology, theoretical physics, and mathematics. Indeed, they provoke some of the most fascinating questions in fundamental physics, which may lead to revolutions in scientific thought. Written by distinguished scientists, Classical and Quantum Black Holes provides a comprehensive panorama of black hole physics and mathematics from a modern point of view. The book begins with a general introduction, followed by five parts that cover several modern aspects of the subject, ranging from the observational and the experimental to the more theoretical and mathematical issues. The material is written at a level suitable for postgraduate students entering the field.

Gravitational Radiation, Luminous Black Holes and Gamma-Ray Burst Supernovae Maurice H. P. M. van Putten 2005-12-15 Black holes and gravitational radiation are two of the most dramatic predictions of general relativity. The quest for rotating black holes - discovered by Roy P. Kerr as exact solutions to the Einstein equations - is one of the most exciting challenges facing physicists and astronomers. Gravitational Radiation, Luminous Black Holes and Gamma-Ray Burst Supernovae takes the reader through the theory of gravitational radiation and rotating black holes, and the phenomenology of GRB-supernovae. Topics covered include Kerr black holes and the frame-dragging of spacetime, luminous black holes, compact tori around black holes, and black-hole spin interactions. It concludes with a discussion of prospects for gravitational-wave detections of a long-duration burst in gravitational-waves as a method of choice for identifying Kerr black holes in the Universe. This book is ideal for a special topics graduate course on gravitational-wave astronomy and as an introduction to those interested in this contemporary development in physics.

Introducing General Relativity Mark Hindmarsh 2022-04-25 Introducing General Relativity An accessible and engaging introduction to general relativity for undergraduates In Introducing General Relativity, the authors deliver a structured introduction to the core concepts and applications of General Relativity. The book leads readers from the basic ideas of relativity—including the Equivalence Principle and curved space-time—to more advanced topics, like Solar System tests and gravitational wave detection. Each chapter contains practice

problems designed to engage undergraduate students of mechanics, electrodynamics, and special relativity. A wide range of classical and modern topics are covered in detail, from exploring observational successes and astrophysical implications to explaining many popular principles, like space-time, redshift, black holes, gravitational waves and cosmology. Advanced topic sections introduce the reader to more detailed mathematical approaches and complex ideas, and prepare them for the exploration of more specialized and sophisticated texts. Introducing General Relativity also offers: Structured outlines to the concepts of General Relativity and a wide variety of its applications Comprehensive explorations of foundational ideas in General Relativity, including space-time curvature and tensor calculus Practical discussions of classical and modern topics in relativity, from space-time to redshift, gravity, black holes, and gravitational waves Optional, in-depth sections covering the mathematical approaches to more advanced ideas Perfect for undergraduate physics students who have studied mechanics, dynamics, and Special Relativity, Introducing General Relativity is an essential resource for those seeking an intermediate level discussion of General Relativity placed between the more qualitative books and graduate-level textbooks.

Topics On Strong Gravity: A Modern View On Theories And Experiments Vasconcellos Cesar Augusto Zen 2019-12-26 For more than a century, our understanding of gravitational physics was based on Albert Einstein's theory of General Relativity, which fundamentally changed our understanding of the Universe, its origin, and its evolutionary process. General Relativity accurately describes a large number of phenomena on very different scales. As such, it has been very well tested and its remarkable predictions are compatible with most experimental and observational data. However, the observational and experimental results compatible with General Relativity fall in its vast majority under the weak gravitational field regime. In recent years, discrepancies between the data and the corresponding predictions of General Relativity have been observed and have generated intense research activity. One of the most critical aspects of General Relativity is the presence of singularities in extreme physical situations. These discrepancies indicate that either the parameters of the theory must be modified in the regime of strong field gravity/high energy and large space-time curvature, or the theory itself should be modified. In this book, we focus our attention on extended alternative gravity theories and the best astrophysical laboratories to probe the strong field regime: black holes, pulsars, and neutron stars.

Einstein Was Right Jed Z. Buchwald 2020-10-13 An authoritative interdisciplinary account of the historic discovery of gravitational waves In 1915, Albert Einstein predicted the existence of gravitational waves—ripples in the fabric of spacetime caused by the movement of large masses—as part of the theory of general relativity. A century later, researchers with the Laser Interferometer Gravitational-Wave Observatory (LIGO) confirmed Einstein's prediction, detecting gravitational waves generated by the collision of two black holes. Shedding new light on the hundred-year history of this momentous achievement, Einstein Was Right brings together essays by two of the physicists who won the Nobel Prize for their instrumental roles in the discovery, along with contributions by leading scholars who offer unparalleled insights into one of the most significant scientific breakthroughs of our time. This illuminating book features an introduction by Tilman Sauer and invaluable firsthand perspectives on the history and significance of the LIGO consortium by physicists Barry Barish and Kip Thorne. Theoretical physicist Alessandra Buonanno discusses the new

possibilities opened by gravitational wave astronomy, and sociologist of science Harry Collins and historians of science Diana Kormos Buchwald, Daniel Kennefick, and Jürgen Renn provide further insights into the history of relativity and LIGO. The book closes with a reflection by philosopher Don Howard on the significance of Einstein's theory for the philosophy of science. Edited by Jed Buchwald, Einstein Was Right is a compelling and thought-provoking account of one of the most thrilling scientific discoveries of the modern age.

Stars and Stellar Processes Mike Guidry 2019-02-07 Presents the physics of stars in relation to modern topics such as neutrino oscillations, supernovae, black holes, and gravitational waves.

Compact Objects in Astrophysics Max Camenzind 2007-02-24 Modern comprehensive introduction and overview of the physics of White Dwarfs, Neutron Stars and Black Holes, including all relevant observations. Contains a basic introduction to General Relativity, including the modern 3+1 split of spacetime and of Einstein’s equations. The split is used for the first time to derive the structure equations for rapidly rotating neutron stars and Black Holes. Detailed discussions and derivations of current theoretical results. In particular also the most recent equations of state for neutron star matter are explained. Topics , such as colour superconductivity are discussed and used for modelling. A book for graduate students and researchers. Contains exercises and some solutions.

The Story of Collapsing Stars Pankaj S. Joshi 2015 This book describes some of the most fascinating occurences in the universe - black holes and space-time singularities. These arise when massive stars reach the end of their life cycle and collapse and shrink under their own gravity as they exhaust their supply of internal nuclear fuel. A star that was once millions of kilometers in size shrinks to a pinprick smaller than the dot on an "i". This is the space-time singularity, an extreme region of the universewhere densities, temperatures, and all other physical quantities take arbitrarily large values. According to Einstein's theory of gravity, the singularity is either covered within an event horizon, thusgiving a black hole, or it can be a visible naked singularity. The final fate of the star depends on its internal structure. In cases of the singularity being visible to faraway observers in the universe, we have the possibility to witness the workings of quantum gravity effects. Such observational signatures related to how the gravity and quantum may operate together could help us formulate the quantum gravity theory, a long cherished dream of physicists. Thus these issues are found to beintimately related to our search for the Unification of Physics, understanding all the basic forces in nature in a single theoretical framework.

General Relativity and Its Applications Valeria Ferrari 2020-11-26 Containing the latest, groundbreaking discoveries in the field, this text outlines the basics of Einstein's theory of gravity with a focus on its most important astrophysical consequences, including stellar structures, black holes and the physics of gravitational waves. Blending advanced topics - usually not found in introductory textbooks - with examples, pedagogical boxes, mathematical tools and practical applications of the theory, this textbook maximises learning opportunities and is ideal for master and graduate students in Physics and Astronomy. Key features: - Provides a self-contained and consistent treatment of the subject that does not require advanced previous knowledge of the field. - Explores the subject with a new focus on gravitational waves and astrophysical relativity, unlike

current introductory textbooks. - Fully up-to-date, containing the latest developments and discoveries in the field.

Modern General Relativity Mike Guidry 2019-01-03 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.

Einstein's General Theory of Relativity Øyvind Grøn 2007-05-04 This book introduces the general theory of relativity and includes applications to cosmology. The book provides a thorough introduction to tensor calculus and curved manifolds. After the necessary mathematical tools are introduced, the authors offer a thorough presentation of the theory of relativity. Also included are some advanced topics not previously covered by textbooks, including Kaluza-Klein theory, Israel's formalism and branes. Anisotropic cosmological models are also included. The book contains a large number of new exercises and examples, each with separate headings. The reader will benefit from an updated introduction to general relativity including the most recent developments in cosmology.

Gravitation Charles W. Misner 2017-10-24 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

Introduction to General Relativity, Black Holes, and Cosmology Yvonne Choquet-Bruhat 2015-01-21 General Relativity is a beautiful geometric theory, simple in its mathematical formulation but leading to numerous consequences with striking physical interpretations: gravitational waves, black holes, cosmological models, and so on. This introductory textbook is written for mathematics students interested in physics and physics students interested in exact mathematical formulations (or for anyone with a scientific mind who is curious to know more of the world we live in), recent remarkable experimental and observational results which confirm the theory are clearly described and no specialised physics knowledge is required. The mathematical level of Part A is aimed at undergraduate students and could be the basis for a course on General Relativity. Part B is more advanced, but still does not require sophisticated mathematics. Based on Yvonne Choquet-Bruhat's more advanced text, General Relativity and the Einstein Equations, the aim of this book is to give with precision, but as simply as possible, the foundations and main consequences of General Relativity. The first five chapters from General Relativity and the Einstein Equations have been updated with new sections and chapters on

black holes, gravitational waves, singularities, and the Reissner-Nordstrom and interior Schwarzchild solutions. The rigour behind this book will provide readers with the perfect preparation to follow the great mathematical progress in the actual development, as well as the ability to model, the latest astrophysical and cosmological observations. The book presents basic General Relativity and provides a basis for understanding and using the fundamental theory.

Canonical Gravity and Applications Martin Bojowald 2010-12-23 Canonical methods are a powerful mathematical tool within the field of gravitational research, both theoretical and experimental, and have contributed to a number of recent developments in physics. Providing mathematical foundations as well as physical applications, this is the first systematic explanation of canonical methods in gravity. The book discusses the mathematical and geometrical notions underlying canonical tools, highlighting their applications in all aspects of gravitational research from advanced mathematical foundations to modern applications in cosmology and black hole physics. The main canonical formulations, including the Arnowitt-Deser-Misner (ADM) formalism and Ashtekar variables, are derived and discussed. Ideal for both graduate students and researchers, this book provides a link between standard introductions to general relativity and advanced expositions of black hole physics, theoretical cosmology or quantum gravity.

Gravity James B. Hartle 2021-06-24 Einstein's theory of general relativity is a cornerstone of modern physics. It also touches upon a wealth of topics that students find fascinating – black holes, warped spacetime, gravitational waves, and cosmology. Now reissued by Cambridge University Press, this ground-breaking text helped to bring general relativity into the undergraduate curriculum, making it accessible to virtually all physics majors. One of the pioneers of the 'physics-first' approach to the subject, renowned relativist James B. Hartle, recognized that there is typically not enough time in a short introductory course for the traditional, mathematics-first, approach. In this text, he provides a fluent and accessible physics-first introduction to general relativity that begins with the essential physical applications and uses a minimum of new mathematics. This market-leading text is ideal for a one-semester course for undergraduates, with only introductory mechanics as a prerequisite.

Gravity's Century Ron Cowen 2019-05-06 Ron Cowen offers a sweeping account of the century of experimentation that has consistently confirmed Einstein's general theory of relativity. He shows how we got from Eddington's pivotal observations of the 1919 eclipse to the Event Horizon Telescope, aimed at starlight wrapping around the black hole at our galaxy's center.

Spacetime and Geometry Sean M. Carroll 2019-07-31 Spacetime and Geometry is an introductory textbook on general relativity, specifically aimed at students. Using a lucid style, Carroll first covers the foundations of the theory and mathematical formalism, providing an approachable introduction to what can often be an intimidating subject. Three major applications of general relativity are then discussed: black holes, perturbation theory and gravitational waves, and cosmology. Students will learn the origin of how spacetime curves (the Einstein equation) and how matter moves through it (the geodesic equation). They will learn what black holes really are, how gravitational waves are generated and detected, and the modern view of the expansion of the

universe. A brief introduction to quantum field theory in curved spacetime is also included. A student familiar with this book will be ready to tackle research-level problems in gravitational physics.

General Relativity Norbert Straumann 2013-11-11 The foundations are thoroughly developed together with the required mathematical background from differential geometry developed in Part III. The author also discusses the tests of general relativity in detail, including binary pulsars, with much space is devoted to the study of compact objects, especially to neutron stars and to the basic laws of black-hole physics. This well-structured text and reference enables readers to easily navigate through the various sections as best matches their backgrounds and perspectives, whether mathematical, physical or astronomical. Very applications oriented, the text includes very recent results, such as the supermassive black-hole in our galaxy and first double pulsar system

Modern General Relativity Mike Guidry 2019-01-03 Introduces the physics of general relativity in relation to modern topics such as gamma-ray bursts, black holes, and gravitational waves.

A Student's Guide to Vectors and Tensors Daniel A. Fleisch 2011-09-22 Vectors and tensors are among the most powerful problem-solving tools available, with applications ranging from mechanics and electromagnetics to general relativity. Understanding the nature and application of vectors and tensors is critically important to students of physics and engineering. Adopting the same approach used in his highly popular A Student's Guide to Maxwell's Equations, Fleisch explains vectors and tensors in plain language. Written for undergraduate and beginning graduate students, the book provides a thorough grounding in vectors and vector calculus before transitioning through contra and covariant components to tensors and their applications. Matrices and their algebra are reviewed on the book's supporting website, which also features interactive solutions to every problem in the text where students can work through a series of hints or choose to see the entire solution at once. Audio podcasts give students the opportunity to hear important concepts in the book explained by the author.

A General Relativity Workbook Thomas A. Moore 2015-03-06

Introduction to Black Hole Physics Valeri P. Frolov 2011-09-22 What is a black hole? How many of them are in our Universe? Can black holes be created in a laboratory or in particle colliders? Can objects similar to black holes be used for space and time travel? This book discusses these and many other questions providing the reader with the tools required to explore the Black Hole Land independently.

Space, Time, and Gravity Robert M. Wald 1992-05 Writing for the general reader or student, Wald has completely revised and updated this highly regarded work to include recent developments in black hole physics and cosmology. Nature called the first edition "a very readable and accurate account of modern relativity physics for the layman within the unavoidable constraint of almost no mathematics. . . . A well written, entertaining and authoritative book."

Advanced General Relativity Claude Barrabès 2013-05-23 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.

Exploring Black Holes Edwin F. Taylor 2010 This unique book offers a concise, introductory overview of general relativity and black holes, motivating students to become active participants in carrying out their own investigations. To this end, the book uses calculus and algebra, rather than tensors, to make general relativity accessible to sophomores and juniors. Five chapters introduce basic concepts, and seven projects require the reader to apply these basic concepts to real astronomical applications.

Black Holes Jean-Pierre Luminet 1992-08-28 Offers an accessible introduction to black holes requiring no mathematical background.

The Little Book of Black Holes Steven S. Gubser 2017-10-10 Dive into a mind-bending exploration of the physics of black holes Black holes, predicted by Albert Einstein's general theory of relativity more than a century ago, have long intrigued scientists and the public with their bizarre and fantastical properties. Although Einstein understood that black holes were mathematical solutions to his equations, he never accepted their physical reality—a viewpoint many shared. This all changed in the 1960s and 1970s, when a deeper conceptual understanding of black holes developed just as new observations revealed the existence of quasars and X-ray binary star systems, whose mysterious properties could be explained by the presence of black holes. Black holes have since been the subject of intense research—and the physics governing how they behave and affect their surroundings is stranger and more mind-bending than any fiction. After introducing the basics of the special and general theories of relativity, this book describes black holes both as astrophysical objects and theoretical "laboratories" in which physicists can test their understanding of gravitational, quantum, and thermal physics. From Schwarzschild black holes to rotating and colliding black holes, and from gravitational radiation to Hawking radiation and information loss, Steven Gubser and Frans Pretorius use creative thought experiments and analogies to explain their subject accessibly. They also describe the decades-long quest to observe the universe in gravitational waves, which recently resulted in the LIGO observatories' detection of the distinctive gravitational wave "chirp" of two colliding black holes—the first direct observation of black holes' existence. The Little Book of Black Holes takes readers deep into the mysterious heart of the subject, offering rare clarity of insight into the physics that makes black holes simple yet destructive manifestations of geometric destiny.

Introduction to General Relativity Lewis Ryder 2009-06-11 Student-friendly, well illustrated textbook for advanced undergraduate and beginning graduate students in physics and mathematics.

Neutron Stars, Black Holes and Gravitational Waves James J Kolata 2019-04-10 Albert Einstein's General Theory of Relativity, published in 1915, made a remarkable prediction: gravitational radiation. Just like light (electromagnetic radiation), gravity could travel through space as a wave and affect any objects it encounters by alternately compressing and expanding them. However, there was a problem. The force of gravity is

around a trillion, trillion, trillion times weaker than electromagnetism so the calculated compressions and expansions were incredibly small, even for gravity waves resulting from a catastrophic astrophysical event such as a supernova explosion in our own galaxy. Discouraged by this result, physicists and astronomers didn't even try to detect these tiny, tiny effects for over 50 years. Then, in the late 1960's and early 1970's, two events occurred which started the hunt for gravity waves in earnest. The first was a report of direct detection of gravity waves thousands of times stronger than even the most optimistic calculation. Though ultimately proved wrong, this result started scientists thinking about what instrumentation might be necessary to detect these waves. The second was an actual, though indirect, detection of gravitational radiation due to the effects it had on the period of rotation of two "neutron stars" orbiting each other. In this case, the observations were in exact accord with predictions from Einstein's theory, which confirmed that a direct search might ultimately be successful. Nevertheless, it took another 40 years of development of successively more sensitive detectors before the first real direct effects were observed in 2015, 100 years after gravitational waves were first predicted. This is the story of that hunt, and the insight it is producing into an array of topics in modern science, from the creation of the chemical elements to insights into the properties of gravity itself.

Black Holes, Cosmology And Extra Dimensions (Second Edition) Kirill A Bronnikov 2021-06-29 Assuming basic knowledge of special and general relativity, this book guides the reader to problems under consideration in modern research, concerning black holes, wormholes, cosmology, and extra dimensions. Its first part is devoted to local strong field configurations (black holes and wormholes) in general relativity and its most relevant extensions: scalar-tensor, f(R), and multidimensional theories. The second part discusses cosmology, including inflation and problems of a unified description of the whole evolution of the universe. The third part concerns multidimensional theories of gravity and contains a number of original results obtained by the authors. Expository work is conducted for a mechanism of symmetries and fundamental constants formation. The original approach to nonlinear multidimensional gravity that is able to construct a unique perspective describing different phenomena is highlighted.Much of the content was previously presented only in journal publications and is new for book contents, e.g., on regular black holes, various scalar field solutions, wormholes and their stability, inflation, clusters of primordial black holes, and multidimensional gravity. The last two topics are added in this new edition of the book. The other chapters are also updated to include new discoveries like the detection of gravitational waves.

Relativity and Cosmology Kip S. Thorne 2021-06-15 A groundbreaking textbook on twenty-first-century general relativity and cosmology Kip Thorne and Roger Blandford’s monumental Modern Classical Physics is now available in five stand-alone volumes that make ideal textbooks for individual graduate or advanced undergraduate courses on statistical physics; optics; elasticity and fluid dynamics; plasma physics; and relativity and cosmology. Each volume teaches the fundamental concepts, emphasizes modern, real-world applications, and gives students a physical and intuitive understanding of the subject. Relativity and Cosmology is an essential introduction to the subject, including remarkable recent advances. Written by award-winning physicists who have made fundamental contributions to the field and taught it for decades, the book differs from most others on the subject in important ways. It highlights recent transformations in our understanding of black holes, gravitational waves, and the cosmos; it emphasizes the physical interpretation of general

relativity in terms of measurements made by observers; it explains the physics of the Riemann tensor in terms of tidal forces, differential frame dragging, and associated field lines; it presents an astrophysically oriented description of spinning black holes; it gives a detailed analysis of an incoming gravitational wave's interaction with a detector such as LIGO; and it provides a comprehensive, in-depth account of the universe's evolution, from its earliest moments to the present. While the book is designed to be used for a one-quarter or full-semester course, it goes deep enough to provide a foundation for understanding and participating in some areas of cutting-edge research. Includes many exercise problems Features color figures, suggestions for further reading, extensive cross-references, and a detailed index Optional "Track 2" sections make this an ideal book for a one-quarter or one-semester course An online illustration package is available to professors The five volumes, which are available individually as paperbacks and ebooks, are Statistical Physics; Optics; Elasticity and Fluid Dynamics; Plasma Physics; and Relativity and Cosmology.

Gravitational-Wave Astronomy Nils Andersson 2019-11-28 This book is an introduction to gravitational waves and related astrophysics. It provides a bridge across the range of astronomy, physics and cosmology that comes into play when trying to understand the gravitational-wave sky. Starting with Einstein's theory of gravity, chapters develop the key ideas step by step, leading up to the technology that finally caught these faint whispers from the distant universe. The second part of the book makes a direct connection with current research, introducing the relevant language and making the involved concepts less mysterious. The book is intended to work as a platform, low enough that anyone with an elementary understanding of gravitational waves can scramble onto it, but at the same time high enough to connect readers with active research - and the many exciting discoveries that are happening right now. The first part of the book introduces the key ideas, following a general overview chapter and including a brief reminder of Einstein's theory. This part can be taught as a self-contained one semester course. The second part of the book is written to work as a collection of "set pieces" with core material that can be adapted to specific lectures and additional material that provide context and depth. A range of readers may find this book useful, including graduate students, astronomers looking for basic understanding of the gravitational-wave window to the universe, researchers analysing data from gravitational-wave detectors, and nuclear and particle physicists.

Black Hole Physics V. Frolov 2012-12-06 It is not an exaggeration to say that one of the most exciting predictions of Einstein's theory of gravitation is that there may exist "black holes": putative objects whose gravitational fields are so strong that no physical bodies or signals can break free of their pull and escape. The proof that black holes do exist, and an analysis of their properties, would have a significance going far beyond astrophysics. Indeed, what is involved is not just the discovery of yet another even if extremely remarkable, astro physical object, but a test of the correctness of our understanding of the properties of space and time in extremely strong gravitational fields. Theoretical research into the properties of black holes, and into the possible corol laries of the hypothesis that they exist, has been carried out with special vigor since the beginning of the 1970's. In addition to those specific features of black holes that are important for the interpretation of their possible astrophysical manifestations, the theory has revealed a number of unexpected characteristics of physical interactions involving black holes. By the middle of the 1980's a fairly detailed understanding had been achieved of the properties of the black holes, their possible astrophysical

manifestations, and the specifics of the various physical processes involved. Even though a completely reliable detection of a black hole had not yet been made at that time, several objects among those scrutinized by astrophysicists were considered as strong candidates to be confirmed as being black holes.

Einstein's Enigma or Black Holes in My Bubble Bath C.V. Vishveshwara 2006-11-03 This is a fascinating and enjoyable popular science book on gravity and black holes. It offers an absorbing account on the history of research on the universe and gravity from Aristotle via Copernicus via Newton to Einstein. The author possesses high literary qualities and is celebrated relativist. The physics of black holes constitutes one of the most fascinating chapters in modern science. At the same time, there is a fanciful quality associated with this strange and beautiful entity. The black hole story is undoubtedly an adventure through physics, philosophy, history, fiction and fantasy. This book is an attempt to blend all these elements together.

Gravity James B. Hartle 2021-06-24 Best-selling, accessible physics-first introduction to GR uses minimal new mathematics and begins with the essential physical applications.

General Relativity: The Essentials Carlo Rovelli 2021-08-31 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.

Lectures on General Relativity, Cosmology and Quantum Black Holes Badis Ydri 2017 "This book is a rigorous text for students in physics and mathematics requiring an introduction to the implications and interpretation of general relativity in areas of cosmology. Readers of this text will be well prepared to follow the theoretical developments in the field and undertake research projects as part of an MSc or PhD programme. This ebook contains interactive Q & A technology, allowing the reader to interact with the text and reveal answers to selected exercises posed by the author within the book. This feature may not function in all formats and on reading devices."--Prové de l'editor.

Gravity, Black Holes, and the Very Early Universe Tai L. Chow 2007-10-24 Here it is, in a nutshell: the history of one genius’s most crucial work – discoveries that were to change the face of modern physics. In the early 1900s, Albert Einstein formulated two theories that would forever change the landscape of physics: the Special Theory of Relativity and the General Theory of Relativity. Respected American academic Professor Tai Chow tells us the story of these discoveries. He details the basic ideas of Einstein, including his law of gravitation. Deftly employing his inimitable writing style, he goes on to explain the physics behind black

holes, weaving into his account an explanation of the structure of the universe and the science of cosmology.

Astrophysical Black Holes Francesco Haardt 2015-11-03 Based on graduate school lectures in contemporary relativity and gravitational physics, this book gives a complete and unified picture of the present status of theoretical and observational properties of astrophysical black holes. The chapters are written by internationally recognized specialists. They cover general theoretical aspects of black hole astrophysics, the theory of accretion and ejection of gas and jets, stellar-sized black holes observed in the Milky Way, the formation and evolution of supermassive black holes in galactic centers and quasars as well as their influence on the dynamics in galactic nuclei. The final chapter addresses analytical relativity of black holes supporting theoretical understanding of the coalescence of black holes as well as being of great relevance in identifying gravitational wave signals. With its introductory chapters the book is aimed at advanced graduate and post-graduate students, but it will also be useful for specialists.

Mass and Motion in General Relativity Luc Blanchet 2011-01-19 From the infinitesimal scale of particle physics to the cosmic scale of the universe, research is concerned with the nature of mass. While there have been spectacular advances in physics during the past century, mass still remains a mysterious entity at the forefront of current research. Our current perspective on gravitation has arisen over millennia, through the contemplation of falling apples, lift thought experiments and notions of stars spiraling into black holes. In this volume, the world's leading scientists offer a multifaceted approach to mass by giving a concise and introductory presentation based on insights from their respective fields of research on gravity. The main theme is mass and its motion within general relativity and other theories of gravity, particularly for compact bodies. Within this framework, all articles are tied together coherently, covering post-Newtonian and related methods as well as the self-force approach to the analysis of motion in curved space-time, closing with an overview of the historical development and a snapshot on the actual state of the art. All contributions reflect the fundamental role of mass in physics, from issues related to Newton's laws, to the effect of self-force and radiation reaction within theories of gravitation, to the role of the Higgs boson in modern physics. High-precision measurements are described in detail, modified theories of gravity reproducing experimental data are investigated as alternatives to dark matter, and the fundamental problem of reconciling any theory of gravity with the physics of quantum fields is addressed. Auxiliary chapters set the framework for theoretical contributions within the broader context of experimental physics. The book is based upon the lectures of the CNRS School on Mass held in Orléans, France, in June 2008. All contributions have been anonymously refereed and, with the cooperation of the authors, revised by the editors to ensure overall consistency.