James Hartle Gravity Solutions

More emphasis is placed on an intuitive grasp of the subject and calculational facility than on rigorous exposition in this introduction to general relativity for mathematics undergraduates or graduate physicists.
"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 student of relativity, astrophysics, and field theory for years to come."—James W. York, Physics Today
An ideal introduction to Einstein's general theory of relativity This unique textbook provides an accessible introduction to Einstein's general theory of relativity, a subject of breathtaking beauty and supreme importance in physics. With his trademark blend of wit and incisiveness, A. Zee guides readers from the fundamentals of Newtonian mechanics to the most exciting frontiers of research today, including de Sitter

and anti-de Sitter spacetimes, Kaluza-Klein theory, and brane worlds. Unlike other books on Einstein gravity, this book emphasizes the action principle and group theory as guides in constructing physical theories. Zee treats various topics in a spiral style that is easy on beginners, and includes anecdotes from the history of physics that will appeal to students and experts alike. He takes a friendly approach to the required mathematics, yet does not shy away from more advanced mathematical topics such as differential forms. The extensive discussion of black holes includes rotating and extremal black holes and Hawking radiation. The ideal textbook for undergraduate and graduate students, Einstein Gravity in a Nutshell also provides an essential resource for professional physicists and is accessible to anyone familiar with classical mechanics and electromagnetism. It features numerous exercises as well as detailed appendices covering a multitude of topics not readily found elsewhere. Provides an accessible introduction to Einstein's general theory of relativity Guides readers from Newtonian mechanics to the frontiers of modern research Emphasizes symmetry and the Einstein-Hilbert action Covers topics not found in standard textbooks on Einstein gravity Includes interesting historical asides Features numerous exercises and detailed appendices Ideal for students, physicists, and scientifically minded lay readers Solutions manual (available only to teachers) The masses of neutron stars are limited by an instability to gravitational collapse and an instability driven by gravitational waves limits their spin. Their oscillations are relevant to x-ray observations of accreting binaries and

to gravitational wave observations of neutron stars formed during the coalescence of double neutron-star systems. This volume includes 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 monograph treats the equations of stellar equilibrium; key approximations, including slow rotation and perturbations of spherical and rotating stars; stability theory and its applications, from convective stability to the r-mode instability; and numerical methods for computing equilibrium configurations and the nonlinear evolution of their oscillations. The presentation of fundamental equations, results and applications is accessible to readers who do not need the detailed derivations.

Einstein Gravity in a Nutshell

With Complete Solutions

Feynman Lectures On Gravitation

Einstein's General Theory of Relativity

Analogue Spacetimes and Horizons, from Theory to Experiment

From Newton's Bucket to Quantum Gravity

The Feynman Lectures on Gravitation are based on notes prepared during a course on gravitational physics that Richard Feynman taught at Caltech during the 1962-63 academic year. For several years prior to these lectures, Feynman thought long and hard about the fundamental problems in gravitational physics,

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

This book invites the reader to understand our Universe, not just marvel at it. From the clock-like motions of the planets to the catastrophic collapse of a star into a black hole, gravity controls the Universe. Gravity is central to modern physics, helping to answer the deepest questions about the nature of time, the origin of the Universe and the unification of the forces of nature. Linking key experiments and observations through careful physical reasoning,

the author builds the reader's insight step-by-step from simple but profound facts about gravity on Earth to the frontiers of research. Topics covered include the nature of stars and galaxies, the mysteries of dark matter and dark energy, black holes, gravitational waves, inflation and the Big Bang. Suitable for general readers and for undergraduate courses, the treatment uses only high-school level mathematics, supplemented by optional computer programs, to explain the laws of physics governing gravity.

Best-selling, accessible physics-first introduction to GR uses minimal new mathematics and begins with the essential physical applications.

Einstein's theories of special relativity and general relativity form a core part of today's undergraduate (or Masters-level) physics curriculum. This is a supplementary problem book or student's manual, consisting of 150 problems in each of special and general relativity. The problems, which have been developed, tested and refined by the authors over the past two decades, are a mixture of short-form and multi-part extended problems, with hints provided where appropriate. Complete solutions are elaborated for every problem, in a different section of the book; some solutions include brief discussions on their physical or historical significance. Designed as a companion text to complement a main relativity textbook, it does not assume access to any specific textbook. This

is a helpful resource for advanced students, for self-study, a source of problems for university teaching assistants, or as inspiration for instructors and examiners constructing problems for their lectures, homework or exams.

Mass and Motion in General Relativity

Mathematical Reviews

An Introduction for Physicists

What Makes Time Special?

An Introduction to Einstein's General Relativity

The Philosophy of Cosmology

Publisher Description

Based on lectures given in honour of Stephen Hawking's sixtieth birthday, this book comprises contributions from some of the world's leading theoretical physicists. It begins with a section containing chapters by successful scientific popularisers, bringing to life both Hawking's work and other exciting developments in physics. The book then goes on to provide a critical evaluation of advanced subjects in modern cosmology and theoretical physics. Topics covered include the origin of the universe, warped spacetime, cosmological singularities, quantum gravity, black holes, string theory, quantum cosmology and inflation. As well as providing a fascinating overview of the wide variety of subject areas to which Stephen Hawking has contributed, this book represents an important assessment of prospects for the future of fundamental physics and cosmology.

A working knowledge of Einstein's theory of general relativity is an essential tool for every physicist today. This self-contained book is an introductory text on the subject aimed at first-year graduate students, or advanced undergraduates, in physics that assumes only a basic understanding of classical Lagrangian mechanics. The

mechanics problem of a point mass constrained to move without friction on a two-dimensional surface of arbitrary shape serves as a paradigm for the development of the mathematics and physics of general relativity. After reviewing special relativity, the basic principles of general relativity are presented, and the most important applications are discussed. The final special topics section guides the reader through a few important areas of current research. This book will allow the reader to approach the more advanced texts and monographs, as well as the continual influx of fascinating new experimental results, with a deeper understanding and sense of appreciation.

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

Black Holes and Time Warps

The Rise of String Theory, the Fall of a Science, and what Comes Next

Modern Particle Physics

Einstein's Outrageous Legacy

Contemporary Theories in Quantum Gravity

Rotating Relativistic Stars

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.

The influence of materialist ontology largely dominates philosophical and scientific discussions. However, there is a resurgent interest in alternative ontologies from panpsychism (the view that at the base of reality exists potential minds, minds, or mind-lets) to idealism and dualism (the view that all of reality is material and mental). The Routledge Handbook of Idealism and Immaterialism is an outstanding reference source and the first major collection of its kind. Historically grounded and constructively motivated, it covers the key topics in philosophy, science, and theology, providing students and scholars with a comprehensive introduction to idealism and immaterialism. Also addressed are post-materialism developments, with explicit attention to variations of idealism and immaterialism (the view that reality depends on a mind or a set of minds). Comprising 44 chapters written by an international and interdisciplinary team of contributors, the Handbook is organised into five

clear parts: Idealism and the history of philosophy Important figures in idealism Systematic assessment of idealism Idealism and science Idealism, physicalism, panpsychism, and substance dualism Essential reading for students and researchers in metaphysics, philosophy of science, philosophy of religion, and philosophy of mind, The Routledge Handbook of Idealism and Immaterialism will also be of interest to those in related discplines where idealist and immaterialist ontology impinge on history, science, and theology.

Was the first book to examine the exciting area of overlap between philosophy and quantum mechanics with chapters by leading experts from around the world.

The subject of Quantum Cosmology is concerned with providing a quantum mechanical description of the universe as a whole and, within that description, to constructing a theory of the universe's initial condition whose predictions can be compared with observation. The recent progress in this area has profound implications for physics at all scales. The lectures at this School describe these theories and their implications. They cover basic quantum mechanics of cosmology, proposals for theories of initial conditions, and their application to the prediction of the large scale features of our universe. A special emphasis of the School is the implication of topological fluctuations of spacetime (wormholes, baby universes) for the observed coupling constants of the low energy interactions of elementary

particles and as a potential explanation for the vanishing of the cosmological constant.
Quantum Cosmology And Baby Universes: Proceedings Of 7th Jerusalem Winter School
Analogue Gravity Phenomenology
General Relativity and Gravitational Waves
An Introduction to Relativity
Gravitation in Astrophysics
Cosmology, time and you

What happens to us when we die? It's a question that has exercised humanity's finest minds for thousands of years. Most have sought the answer in religion; others have looked to philosophers, to the supernatural, or, more recently, to evidence from 'near death' experience. But never, it seems, to science. Yet that's where the answer appears to lie. Specifically, in cosmology, the study of the history and future of the universe. Taking his inspiration from Stephen Hawking's groundbreaking A Brief History of Time, author Andrew McLauchlin brings his background as a physicist to bear on this fascinating subject. He examines developments in cosmology and shows how they point to a conclusion about the dimension of time that has very real implications not only

for the universe but also for us. What Really Happens When We Die? is a journey of discovery into a realm that offers an astonishing explanation for one of life's imponderables.

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.
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.

An internationally famous physicist and electrical engineer, the author of this text was a pioneer in the investigation of gravitational waves. Joseph Weber's General Relativity and Gravitational

Waves offers a classic treatment of the subject. Appropriate for upper-level undergraduates and graduate students, this text remains ever relevant. Brief but thorough in its introduction to the foundations of general relativity, it also examines the elements of Riemannian geometry and tensor calculus applicable to this field. Approximately a quarter of the contents explores theoretical and experimental aspects of gravitational radiation. The final chapter focuses on selected topics related to general relativity, including the equations of motion, unified field theories, Friedman's solution of the cosmological problem, and the Hamiltonian formulation of general relativity. Exercises. Index.
Sixth Marcel Grossmann Meeting, The: On Recent Developments In Theoretical And Experimental General Relativity, Gravitation And Relativistic Field Theories (In 2 Volumes)
The Future of Theoretical Physics and Cosmology
Space, Time, and Gravity
Differential Forms and the Geometry of General Relativity
Gravitation

Physics Meets Philosophy at the Planck Scale

A theoretical physicist describes the evolution of modern-day string theory, the flaws in the attempt to formulate a "theory of everything" to explain all the forces and particles of nature and the origins of the universe, and their repercussions for physics.

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."

Unique in its coverage of all aspects of modern particle physics, this textbook provides a clear connection between the theory and recent experimental results, including the discovery of the Higgs boson at CERN. It provides a comprehensive and self-contained description of the Standard Model of particle physics suitable for upper-level undergraduate students and graduate students studying experimental particle physics. Physical theory is introduced in a straightforward manner with full mathematical derivations throughout. Fully-worked examples enable students to link the mathematical theory to results from modern particle physics experiments. End-of-chapter exercises, graded by difficulty, provide students with a deeper understanding of the subject.

Online resources available at www.cambridge.org/MPP feature password-protected fully-worked solutions to problems for instructors, numerical solutions and hints to the problems for students and PowerPoint slides and JPEGs of figures from the book.

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.

Astrophysical Black Holes

With Modern Applications in Cosmology

Technical Abstract Bulletin

Relativity

The Trouble with Physics

Three Roads To Quantum Gravity

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.

Examines such phenomena as black holes, wormholes, singularities, gravitational waves, and time machines, exploring the fundamental principles that control the universe.

Analogue Gravity Phenomenology is a collection of contributions that cover a vast range of areas in physics, ranging from surface wave propagation in fluids to nonlinear optics. The underlying common aspect of all these topics, and hence the main focus and perspective from which they are explained here, is the attempt to develop analogue models for gravitational systems. The original and main motivation of the field is the verification and study of Hawking radiation from a horizon: the enabling feature is the possibility to generate horizons in the laboratory with a wide range of physical systems that involve a flow of one kind or another. The years around 2010 and onwards witnessed a sudden surge of experimental activity in this expanding field of research.

However, building an expertise in analogue gravity requires the researcher to be equipped with a rather broad range of knowledge and interests. The aim of this book is to bring the reader up to date with the latest developments and provide the basic background required in order to appreciate the goals, difficulties, and success stories in the field of analogue gravity. Each chapter of the book treats a different topic explained in detail by the major experts for each specific discipline. The first chapters give an overview of black hole spacetimes and Hawking radiation before moving on to describe the large variety of analogue spacetimes that have been proposed and are currently under investigation. This introductory part is then followed by an in-depth description of what are currently the three most promising analogue spacetime settings, namely surface waves in flowing fluids, acoustic oscillations in Bose-Einstein condensates and electromagnetic waves in nonlinear optics. Both theory and experimental endeavours are explained in detail. The final chapters refer to other aspects of analogue gravity beyond the study of Hawking radiation, such as Lorentz invariance violations and Brownian motion in curved spacetimes, before concluding with a return to the origins of the field and a description of the available observational evidence for horizons in astrophysical black holes. Differential Forms and the Geometry of General Relativity provides readers with a coherent path to understanding relativity. Requiring little more than calculus and some linear algebra, it helps readers learn just enough differential geometry to grasp the basics of general relativity. The book contains two intertwined but distinct

halves. Designed for advanced undergraduate or beginning graduate students in mathematics or physics, most of the text requires little more than familiarity with calculus and linear algebra. The first half presents an introduction to general relativity that describes some of the surprising implications of relativity without introducing more formalism than necessary. This nonstandard approach uses differential forms rather than tensor calculus and minimizes the use of "index gymnastics" as much as possible. The second half of the book takes a more detailed look at the mathematics of differential forms. It covers the theory behind the mathematics used in the first half by emphasizing a conceptual understanding instead of formal proofs. The book provides a language to describe curvature, the key geometric idea in general relativity.

The Routledge Handbook of Idealism and Immaterialism

Celebrating Stephen Hawking's Contributions to Physics

An Introduction to General Relativity

An Introduction to Special and General Relativity

300 Problems in Special and General Relativity

The Large Scale Structure of Space-Time

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 singualarities under certain conditions. A discussion of the Cauchy problem for General Relativity is also included in this 1973 book.

With the discovery of pulsars, quasars, and galactic X-ray sources in the late 60's and early 70's, and the coincident expansion in the search for gravitational waves, rela tivistic gravity assumed an important place in the astrophysics of localized objects. Only by pushing Einstein's solar-system-tested general theory of relativity to the study of the extremes of gravitational collapse and its outcomes did it seem that one could explain these frontier astronomical phenomena. This conclusion continues to be true today. Relativistic gravity had always played the central role in cosmology. The discov ery of the cosmic background radiation in 1965, the increasing understanding of matter physics at high energies in the decades following, and the growing wealth of observations on the large scale structure meant that it was possible to make increasingly detailed mod els of the universe, both today and far in the past. This development, not accidentally, was contemporary to that for localized objects described above.

Following a long-term international collaboration between leaders in cosmology and the philosophy of science, this volume addresses foundational questions

at the limit of science across these disciplines, questions raised by observational and theoretical progress in modern cosmology. Space missions have mapped the Universe up to its early instants, opening up questions on what came before the Big Bang, the nature of space and time, and the quantum origin of the Universe. As the foundational volume of an emerging academic discipline, experts from relevant fields lay out the fundamental problems of contemporary cosmology and explore the routes toward finding possible solutions. Written for graduates and researchers in physics and philosophy, particular efforts are made to inform academics from other fields, as well as the educated public, who wish to understand our modern vision of the Universe, related philosophical questions, and the significant impacts on scientific methodology.

As we navigate through life we instinctively model time as having a flowing present that divides a fixed past from open future. This model develops in childhood and is deeply saturated within our language, thought and behavior, affecting our conceptions of the universe, freedom and the self. Yet as central as it is to our lives, physics seems to have no room for this flowing present. What Makes Time Special? demonstrates this claim in detail and then turns to two novel positive tasks. First, by looking at the world "sideways" - in the spatial directions — it shows that physics is not "spatializing time" as is commonly alleged. Even relativity theory makes significant distinctions between the spacelike and timelike directions, often with surprising consequences. Second, if the flowing present is an illusion, it is a deep one worthy of explanation. The author develops a picture whereby the temporal flow arises as an interaction effect between an observer and the physics of the world. Using

insights from philosophy, cognitive science, biology, psychology and physics, the theory claims that the flowing present model of time is the natural reaction to the perceptual and evolutionary challenges thrown at us. Modeling time as flowing makes sense even if it misrepresents it.

Spacetime and Geometry

Introduction to General Relativity

Gravity from the Ground Up

What Really Happens When You Die?

An Introductory Guide to Gravity and General Relativity

General Relativity

Written for advanced undergraduate and graduate students, this is a clear mathematical introduction to Einstein's theory of general relativity and its physical applications. Concentrating on the theory's physical consequences, this approachable textbook contains over 300 exercises to illuminate and extend the discussion.

General relativity is now an essential part of undergraduate and graduate courses in physics, astrophysics and applied mathematics. This simple, user-friendly introduction to relativity is ideal for a first course in the subject. Beginning with a comprehensive but simple review of special relativity, the book creates a framework from which to launch the ideas of general relativity. After describing the basic theory, it moves on to describe important applications to astrophysics, black hole physics, and cosmology. Several worked examples, and numerous figures and images, help students appreciate the underlying concepts. There are also 180 exercises which test and develop students' understanding of the subject. The textbook presents all the necessary information and discussion for an elementary approach to relativity. Password-protected

solutions to the exercises are available to instructors at www.cambridge.org/9780521735612.

"It would be hard to imagine a better guide to this difficult subject."--Scientific American In Three Roads to Quantum Gravity, Lee Smolin provides an accessible overview of the attempts to build a final "theory of everything." He explains in simple terms what scientists are talking about when they say the world is made from exotic entities such as loops, strings, and black holes and tells the fascinating stories behind these discoveries: the rivalries, epiphanies, and intrigues he witnessed firsthand. "Provocative, original, and unsettling." -The New York Review of Books "An excellent writer, a creative thinker."-Nature

This volume is a collection of scholarly articles on the Mach Principle, the impact that this theory has had since the end of the 19th century, and its role in helping Einstein formulate the doctrine of general relativity. 20th-century physics is concerned with the concepts of time, space, motion, inertia and gravity. The documentation on all of these makes this book a reference for those who are interested in the history of science and the theory of general relativity

Gravity

Mach's Principle

The Theory of the Big Bang and Black Holes

Cargèse 1986

A General Relativity Workbook