Black Hole Physics Basic Concepts And New Developments 1st Edition

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Introduction to Black Hole Physics Springer
The astonishing science of black holes and their role in understanding the history and future of our universe. Black holes are the most extreme objects in the universe, and yet they are ubiquitous. Every massive star leaves behind a black hole when it dies, and every galaxy harbors a supermassive black hole at its center. Frighteningly enigmatic, these dark giants continue to astound even the scientists who spend their careers studying them. Which came first, the galaxy or its central black hole? What happens if you travel into one—instant death or something weirder? And, perhaps most important, how can we ever know anything for sure about black holes when they destroy information by their very nature? In Einstein's Monsters, distinguished astronomer Chris Impey takes readers on an exploration of these and other questions at the cutting edge of astrophysics, as well as the history of black holes' role in theoretical physics—from confirming Einstein's equations for general relativity to testing string theory. He blends this history with a poignant account of the phenomena scientists have witnessed while observing black holes: stars swarming like bees around the center of our galaxy; black holes performing gravitational waltzes with visible stars; the cymbal clash of two black holes colliding, releasing ripples in space-time. Clear, compelling, and profound, Einstein's Monsters reveals how our comprehension of black holes is intrinsically linked to how we make sense of the universe and our place within it. From the small questions to the big ones—from the tiniest particles to the nature of space-time itself—black holes might be the key to a deeper understanding of the cosmos.
From Astrophysical Black Holes to Analogous Systems in Lab Charlesbridge Publishing
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.

Beyond the Quantum Springer Science & Business Media
Suitable for advanced undergraduates and graduate students of mathematics as well as for physicists, this unique monograph and self-contained treatment constitutes an introduction to modern techniques in differential geometry. 1995 edition.
Highlights of Astronomy, Volume 11A Random House
The supermassive black hole in the center of our Milky Way is the nearest such object and relatively easy to observe and study. Not surprisingly therefore, it is the best studied supermassive black hole. Many astrophysical and even general relativistic effects can be investigated in great detail. The Galactic Black Hole: Lectures on General Relativity and Astrophysics provides a systematic introduction to the physics/astrophysics and mathematics of black holes at a level suitable for graduate students, postdocs, and researchers in physics, astrophysics, astronomy, and applied mathematics. The focus is mainly on the supermassive black hole in the center of our Milky Way but the results can be easily generalized taking it as an example. Leading international experts provide first-hand accounts of the observational and theoretical aspects of this black hole. Topics range from the properties of the Schwarzschild metric and the collapse of a black hole, to quantum gravity, and from the structure of the Galaxy to accretion of matter and the emission properties of the Galactic Center black hole.
Black Hole Anchor
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.
Black Holes CRC Press
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.
Introduction to Black Hole Physics Princeton University Press
A pedagogical introduction to the physics of black holes. The membrane paradigm represents the four-dimensional spacetime of the black hole's "event horizon" as a two-dimensional membrane in three-dimensional space, allowing the reader to understand and compute the behavior of black holes in complex astrophysical environments.
Basic Concepts of String Theory Springer Science & Business Media
Examines such phenomena as black holes, wormholes, singularities, gravitational waves, and time machines, exploring the fundamental principles that control the universe.
Optics, Fluids, Plasmas, Elasticity, Relativity, and Statistical Physics Springer
Bringing the material up to date, Black Holes, Wormholes and Time Machines, Second Edition captures the new ideas and discoveries made in physics since the publication of the best-selling first edition. While retaining the popular format and style of its predecessor, this edition explores the latest developments in high-energy astroparticle physics and Big Bang cosmology. The book continues to make the ideas and theories of modern physics easily understood by anyone, from researchers to students to general science enthusiasts. Taking you on a journey through space and time, author Jim Al-Khalili covers some of the most fascinating topics in physics today, including: Black holes Space warps The Big Bang Time travel Wormholes Parallel universes Professor Al-Khalili explains often complex scientific concepts in simple, nontechnical terms and imparts an appreciation of the cosmos, helping you see how time traveling may not be so far-fetched after all.
Copernicus
Providing students with an in-depth account of the astrophysics of high energy phenomena in the Universe, the third edition of this well-established textbook is ideal for advanced undergraduate and beginning graduate courses in high energy astrophysics. Building on the concepts and techniques taught in standard undergraduate courses, this textbook provides the astronomical and astrophysical background for students to explore more advanced topics. Special emphasis is given to the underlying physical principles of high energy astrophysics, helping students understand the essential physics. Now consolidated into a single-volume treatment, the third edition has been completely rewritten. It covers the most recent discoveries in areas such as gamma-ray bursts, ultra-high energy cosmic rays and ultra-high energy gamma rays. The topics have been rearranged and streamlined to make them more applicable to a wide range of different astrophysical problems.
Black Holes World Scientific
Black Holes are still considered to be among the most mysterious and fascinating objects in our universe. Awaiting the era of gravitational astronomy, much progress in theoretical modeling and understanding of classical and quantum black holes has already been achieved. The present volume serves as a tutorial, high-level guided tour through the black-hole landscape: information paradox and blackhole thermodynamics, numerical simulations of black-hole formation and collisions, braneworld scenarios and stability of black holes with respect to perturbations are treated in great detail, as is their possible occurrence at the LHC. An outgrowth of a topical and tutorial summer school, this extensive set of carefully edited notes has been set up with the aim of constituting an advanced-level, multi-authored textbook which meets the needs of both postgraduate students and young researchers in the fields of modern cosmology, astrophysics and (quantum) field theory.
Quantum Black Holes Taylor & Francis
This volume deals with extensions of special relativity, general relativity, and their applications in relation to intragalactic and extragalactic dynamics. The book comprises chapters authored by various researchers and edited by an expert active in the relativity research area. It provides a thorough overview of the latest research efforts by international authors on relativity, opening new possible research paths for further novel developments.
Physics of Black Holes Springer Science & Business Media
This 2004 textbook fills a gap in the literature on general relativity by providing the advanced student with practical tools for the computation of many physically interesting quantities. The context is provided by the mathematical theory of black holes, one of the most elegant, successful, and relevant applications of general relativity. Among the topics discussed are congruencies of timelike and null geodesics, the embedding of spacelike, timelike and null hypersurfaces in spacetime, and the Lagrangian and Hamiltonian formulations of general relativity. Although the book is self-contained, it is not meant to serve as an introduction to general relativity. Instead, it is meant to help the reader acquire advanced skills and become a competent researcher in relativity and gravitational physics. The primary readership consists of graduate students in gravitational physics. It will also be a useful reference for more seasoned researchers working in this field.
A Bibliography with Indexes World Scientific
This NATO Advanced Study Institute provided an up dated understanding, from a fundamental and deep point of view, of the progress and current problems in the early universe, cosmic microwave background radiation, large scale structure, dark matter problem, and the interplay between them. The focus was placed on the Cosmic Microwave Background Radiation. Emphasis was given to the mutual impact of fundamental physics and cosmology, both at theoretical and experimental-or observational-levels, within a deep and well defined programme, and a global unifying view, which, in addition, provides of careful inter-disciplinarity. Special Lectures were devoted to neutrinos in astrophysics and high energy astrophysics. In addition, each Course of this series, introduced and promoted topics or subjects, which, although not being of purely astrophysical or cosmological nature, were of relevant physical interest for astrophysics and cosmology. Deep understanding, clarification, synthesis, careful interdisciplinarity within a fundamental physics framework, werethe maingoals ofthe course. Lectures ranged from a motivation and pedagogical introduction for students and participants not directly working in the field to the latest developmentsand most recent results. All Lectures were plenary, had the same duration and were followed by a discussion. The Course brought together experimentalists and theoretical physicists, astrophysicists and astronomers from a variety of backgrounds, including young scientists at post-doctoral level, senior scientists and advanced graduatestudentsas well.
Black Hole Physics W. W. Norton & Company
The basic subjects and main topics covered by this book are: (1) Physics of Black Holes (classical and quantum); (2) Thermodynamics, entropy and internal dynamics; (3) Creation of particles and evaporation; (4) Mini black holes; (5) Quantum mechanics of black holes in curved spacetime; (6) The role of spin and torsion in the black hole physics; (7) Equilibrium geometry and membrane paradigm; (8) Black hole in string and superstring theory; (9) Strings, quantum gravity and black holes; (10) The problem of singularity; (11) Astrophysics of black holes; (12) Observational evidence of black holes. The book reveals the deep connection between gravitational, quantum and statistical physics and also the importance of black hole behaviour in the very early universe. An important new point discussed concerns the introduction of spin in the physics of black holes, showing its central role when correctly put into the Einstein equations through the geometric concept of torsion, with the new concept of a time-temperature uncertainty relation, minimal time, minimal entropy, quantization of entropy and the connection of black hole with wormholes. Besides theoretical aspects, the reader will also find observational evidence for black holes in active galactic nuclei, in binary X-ray sources and in supernova remnants. The book will thus interest physicists, astronomers, and astrophysicists at different levels of their career who specialize in classical properties, quantum processes, statistical thermodynamics, numerical collapse, observational evidence, general relativity and other related problems.
Black Hole Survival Guide Springer Nature
Some 400 years after the first known patent application for a telescope by Hans Lipperhey, The Astronomy Revolution: 400 Years of Exploring the Cosmos surveys the effects of this instrument and explores the questions that have arisen out of scientific research in astronomy and cosmology. Inspired by the international New Vision 400 conference held
A Guided Tour Springer
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.
Introduction to Black Hole Astrophysics Nova Publishers
“It is said that fact is sometimes stranger than fiction, and nowhere is that more true than in the case of black holes. Black holes are stranger than anything dreamed up by science fiction writers.” In 2016 Professor Stephen Hawking delivered the BBC Reith Lectures on a subject that fascinated him for decades – black holes. In these flagship lectures the legendary physicist argued that if we could only understand black holes and how they challenge the very nature of space and time, we could unlock the secrets of the universe.
Lectures on General Relativity and Astrophysics Princeton University Press
Black holes entered the world of science fiction and films in the 1960s, and their popularity in our

culture remains today. The buzz surrounding black holes was and is due, in large part, to their speculative nature. It is still difficult for the general public to determine fact versus fiction as it pertains to this terrifying idea: something big enough to swallow anything and everything in close proximity, with a gravitational force so strong that nothing, including light, can escape. In the fall of 2015, scientists at the Laser Interferometry Gravitational-Wave Observatory (LIGO) detected the first sounds from black holes, brought to earth by the gravitational waves that emitted from the merging of two black holes 1.4 billion light years away in space. This confirmed the existence of gravitational waves, which Albert Einstein predicted in 1916. In the spring of 2017, physicists and astronomers who were working on the Event Horizon Telescope (EHT) project captured the first image of a black hole. This was the supermassive black hole hosted by the galaxy M87 in the constellation Virgo, 53 million light years away, and the image shows the shadow the black hole casts upon the bright light surrounding it. In this book, John Moffat shares the history of black holes and presents the latest research into these mysterious celestial objects, including the astounding results from gravitational wave detection and the shadow of the black hole.

Relativity and the Birth of Black Hole Physics BoD – Books on Demand

One of the most exciting predictions of Einstein's theory of gravitationisthat there may exist 'black holes': putative objects whose gravitational fields are so strong that no physical bodies and signals can break free of their pull and escape. Even though a completely reliable discovery of a black hole has not yet been made, several objects among those scrutinized by astrophysicists will very likely be conformed as black holes. The proof that they 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, astrophysical object, but a test of the correctness of our understanding the properties of space and time in extremely strong gravitational fields. Theoretical research into the properties of black holes and into the possible corollaries of the hypothesis that they exist, has been carried out with special vigor since the beginning of the 1970s. 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 nurober of unexpected characteristics of physical interactions involving black holes. By now, a fairly detailed understanding has been achieved of the properties of the black holes, their possible astrophysical manifestations, and the specifics of the various physical processes involved. Furthermore, profound links were found between black-hole theory and such seemingly very distant fields as thermodynamics, information theory, and quantum theory.