

Black Hole

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,

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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.

Seattle teenagers of the 1970s are suddenly faced with a devastating, disfiguring, and incurable plague that spreads only through sexual contact.

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

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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

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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

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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.

A black hole isn't really a hole . . . is it? Get ready to S-T-R-E-T-C-H your mind with this beloved and best-selling science book. Updated with an all-new chapter about the first black-hole image ever! What are black holes, what causes them, and how the heck did scientists discover them? Acclaimed STEM writer Carolyn DeCristofano's playful text shares how

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astronomers find black holes, introduces our nearest black-hole neighbors, and provides an excellent introduction to an extremely complex scientific topic. Gorgeous space paintings supplement real telescopic images, and funny doodles and speech bubbles keep the content light and fun.

This book discusses the state of the art of the basic theoretical and observational topics related to black hole astrophysics. It covers all the main topics in this wide field, from the theory of accretion disks and formation mechanisms of jet and outflows, to their observed electromagnetic spectrum, and attempts to measure the spin of these objects. Black holes are one

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of the most fascinating predictions of general relativity and are currently a very hot topic in both physics and astrophysics. In the last five years there have been significant advances in our understanding of these systems, and in the next five years it should become possible to use them to test fundamental physics, in particular to predict the general relativity in the strong field regime. The book is both a reference work for researchers and a textbook for graduate students. The Weird Science of the Most Mysterious Objects in the Universe

*Black Holes: The Reith Lectures
An Analytic Description*

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The Mathematical Theory of Black Holes And Other Cosmic Quandaries

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

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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

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simple, nontechnical terms and imparts an appreciation of the cosmos, helping you see how time traveling may not be so far-fetched after all.

"...an absurdly motivating book." -A.J. Jacobs, New York Times bestselling author Don't get stuck on a career path you have no passion for. Don't waste your intelligence on something that doesn't really mean anything more to you than a paycheck. Let Isaiah Hankel help you define a focus so powerful

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that everything in your life will be pulled towards it. Create your purpose and change your life. Be focused. Be fulfilled. Be successful. Black Hole Focus has been endorsed by top names in business, entrepreneurship, and academia, including 4 times New York Times bestseller AJ Jacobs and Harvard Medical School Postdoc Director Dr. Jim Gould. The book is broken up into 3 different sections; the first section shows you why you need a purpose in

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life, the second section shows you how to find your new purpose, and the third section shows you how to achieve your goals when facing adversity. In this book, you will learn: How to understand what you really want in life and how to get it Why people with a powerful purpose live to 100 How to rapidly improve focus and change your life using the secret techniques of an international memory champion How people like Jim Carrey, Oprah Winfrey,

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and J.K. Rowling transformed pain into purpose How to start a business by avoiding willpower depletion and the life hack lie Black Hole Focus includes exclusive case studies from medical practitioners, research scientists, lawyers, corporate executives and small business owners who have used the techniques described in this book to achieve massive success in their own lives. About the Author: Dr. Hankel is an internationally recognized expert in

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the biotechnology industry and prolific public speaker. He's given over 250 seminars in 22 different countries while working with many of the world's most respected companies and institutions, including Harvard University, Oxford University, Roche Pharmaceuticals, Eli Lilly & Company, Baxter International and Pfizer. Dr. Hankel uses the science of purpose and the principles of entrepreneurship to help people achieve their biggest

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goals.

The legendary physicist explores his favorite subject in a pair of enlightening, accessible, and cleverly illustrated essays for curious readers, originally delivered as BBC lectures.

“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, but they are firmly

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matters of science fact.” For decades, Stephen Hawking has been fascinated by black holes. He believes that if we understood the challenges they pose to the very nature of space and time, we could unlock the secrets of the universe. In these conversational pieces, Hawking’s sense of wonder is infectious as he holds forth on what we know about black holes, what we still don’t know, and theoretical answers to more specific questions, such as: What

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would happen if you ever got sucked into one? Annotated and with an introduction by BBC News science editor David Shukman, featuring whimsical and illuminating illustrations, *Black Holes* offers a candid peek into one of the great scientific mysteries of all time. Praise for Stephen Hawking “[Hawking] can explain the complexities of cosmological physics with an engaging combination of clarity and wit. . . . His is a brain of extraordinary

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*power.”—The New York Review of Books
“Hawking clearly possesses a natural
teacher’s gifts—easy, good-natured
humor and an ability to illustrate
highly complex propositions with
analogies plucked from daily life.”—The
New York Times “A high priest of
physics, one of a handful of theorists
who may be on the verge of reading
God’s mind.”—Los Angeles Times
This book is based on the lecture notes
of a one-semester course on black hole*

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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

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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.

“It is said that fact is sometimes

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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

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time, we could unlock the secrets of the universe.

Black Holes, Wormholes and Time Machines, Second Edition

The Shadow of Black Holes

Modeling Black Hole Evaporation

Classical and Quantum Black Holes

From Fundamental Aspects to Latest Developments

Offers an accessible introduction to black holes requiring no mathematical background.

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The scope of this book is two-fold: the first part gives a fully detailed and pedagogical presentation of the Hawking effect and its physical implications, and the second discusses the backreaction problem, especially in connection with exactly solvable semiclassical models that describe analytically the black hole evaporation process. The book aims to establish a link between the general relativistic viewpoint on black hole evaporation and the new CFT-type approaches to the subject. The detailed

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discussion on backreaction effects is also extremely valuable. Contents: Classical Black Holes The Hawking Effect Near-Horizon Approximation and Conformal Symmetry Stress Tensor, Anomalies and Effective Actions Models for Evaporating Black Holes Readership: Graduate students and researchers in gravitation, high energy physics and astrophysics. Key Features: Detailed and pedagogical presentation of the Hawking effect Derivation of black hole radiance using the Rindler and AdS space near-

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horizon approximation Extensive use of two-dimensional conformal symmetry and intuitive derivation of the trace anomaly using equivalence principle arguments Use of solvable models for the study of backreaction effects and the information loss problem in black hole spacetimes

Keywords: Black Holes; Quantum Fields in Curved Space; Semiclassical Gravity; Hawking Effect; Black Hole Evaporation; Conformal Symmetry; Quantum Stress Tensor; Backreaction

Spark your child's imagination through

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science and learning with this captivating astronomy book for toddlers. When it comes to kids books about black holes nothing else can compare to this clever science parody from the #1 science author for kids, Chris Ferrie! PLUS, use a black light to reveal secret, invisible text and artwork that reverses the story from nothing to the scientific creation of everything! Using the familiar rhythm of "There Was an Old Lady Who Swallowed a Fly," follow along as the black hole swallows up the universe and everything

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that exists in it, from the biggest to the smallest pieces of matter. The silly, vibrant artwork is sure to make stargazers of all ages smile and start a love of science in your baby. There was a black hole that swallowed the universe. I don't know why it swallowed the universe—oh well, it couldn't get worse. There was a black hole that swallowed a galaxy. It left quite a cavity after swallowing that galaxy. It swallowed the galaxies that filled universe. I don't know why it swallowed the universe—oh well, it

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couldn't get worse.

A sophisticated introduction to how astronomers identify, observe, and understand black holes. Emitting no radiation or any other kind of information, black holes mark the edge of the universe—both physically and in our scientific understanding. Yet astronomers have found clear evidence for the existence of black holes, employing the same tools and techniques used to explore other celestial objects. In this sophisticated introduction, leading

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astronomer Charles Bailyn goes behind the theory and physics of black holes to describe how astronomers are observing these enigmatic objects and developing a remarkably detailed picture of what they look like and how they interact with their surroundings. Accessible to undergraduates and others with some knowledge of introductory college-level physics, this book presents the techniques used to identify and measure the mass and spin of celestial black holes. These key measurements demonstrate the existence of

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two kinds of black holes, those with masses a few times that of a typical star, and those with masses comparable to whole galaxies—supermassive black holes. The book provides a detailed account of the nature, formation, and growth of both kinds of black holes. The book also describes the possibility of observing theoretically predicted phenomena such as gravitational waves, wormholes, and Hawking radiation. A cutting-edge introduction to a subject that was once on the border between physics and science

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fiction, this book shows how black holes are becoming routine objects of empirical scientific study.

"[Tyson] tackles a great range of subjects...with great humor, humility, and—most important—humanity."

—Entertainment Weekly Loyal readers of the monthly "Universe" essays in Natural History magazine have long recognized Neil deGrasse Tyson's talent for guiding them through the mysteries of the cosmos with clarity and enthusiasm. Bringing together more than forty of Tyson's favorite

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essays, *Death by Black Hole* explores a myriad of cosmic topics, from what it would be like to be inside a black hole to the movie industry's feeble efforts to get its night skies right. One of America's best-known astrophysicists, Tyson is a natural teacher who simplifies the complexities of astrophysics while sharing his infectious fascination for our universe.

A Novel

The Inside Story of Astronomers' Decades-Long Quest to Take the First Picture of a

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Black Hole

Light in the Darkness

Black Holes, the Universe, and Us

The Membrane Paradigm

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

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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.

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As a result of significant research over the past 20 years, black holes are now linked to some of the most spectacular and exciting phenomena in the Universe, ranging in size from those that have the same mass as stars to the super-massive objects that lie at the heart of most galaxies, including our own Milky Way. This book first introduces the properties of simple isolated holes, then adds in complications like rotation, accretion, radiation, and magnetic fields, finally arriving at a basic understanding of how these immense engines work. Black Hole Astrophysics • reviews our current

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knowledge of cosmic black holes and how they generate the most powerful observed phenomena in the Universe; • highlights the latest, most up-to-date theories and discoveries in this very active area of astrophysical research; • demonstrates why we believe that black holes are responsible for important phenomena such as quasars, microquasars and gamma-ray bursts; • explains to the reader the nature of the violent and spectacular outflows (winds and jets) generated by black hole accretion.

Looks at the discovery of the true nature and immense size of the universe, tracing the decades of

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work done by a select group of scientists to make it possible.

Documents the author's professional battles with Stephen Hawking and Gerard 't Hooft over their theories about black holes, a conflict that has significantly influenced the modern scientific community's understanding of the universe's fundamental laws. By the author of *The Cosmic Landscape*.

From the acclaimed author of *Black Hole Blues and Other Songs from Outer Space*--an authoritative and accessible guide to the most alluring and challenging

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phenomena of contemporary science. "[Levin will] take you on a safe black hole trip, an exciting travel story enjoyed from your chair's event horizon."

--Boston Globe Through her writing, astrophysicist Janna Levin has focused on making the science she studies not just comprehensible but also, and perhaps more important, intriguing to the nonscientist. In this book, she helps us to understand and find delight in the black hole--perhaps the most opaque theoretical construct ever imagined by physicists--illustrated with original artwork by American painter and photographer Lia

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Halloran. Levin takes us on an evocative exploration of black holes, provoking us to imagine the visceral experience of a black hole encounter. She reveals the influence of black holes as they populate the universe, sculpt galaxies, and even infuse the whole expanse of reality that we inhabit. Lively, engaging, and utterly unique, *Black Hole Survival Guide* is not just informative--it is, as well, a wonderful read from first to last.

Black Hole Astrophysics

Black Hole Blues and Other Songs from Outer Space

Death by Black Hole

The Black Hole War

A NEW YORK TIMES EDITOR'S CHOICE

Einstein's Shadow follows a team of elite scientists on their historic mission to take the first picture of a black hole, putting Einstein's theory of relativity to its ultimate test and helping to answer our deepest questions about space, time, the origins of the universe, and the nature of reality
Photographing a black hole sounds

impossible, a contradiction in terms. But Shep Doeleman and a global coalition of scientists are on the cusp of doing just that. With exclusive access to the team, journalist Seth Fletcher spent five years following Shep and an extraordinary cast of characters as they assembled the Event Horizon Telescope, a virtual radio observatory the size of the Earth. He witnessed their struggles, setbacks, and breakthroughs, and along the way, he explored the latest thinking on the most profound questions about black holes.

Do they represent a limit to our ability to understand reality? Or will they reveal the clues that lead to the long-sought Theory of Everything? Fletcher transforms astrophysics into something exciting, accessible, and immediate, taking us on an incredible adventure to better understand the complexity of our galaxy, the boundaries of human perception and knowledge, and how the messy human endeavor of science really works. Weaving a compelling narrative account of human ingenuity with excursions

into cutting-edge science, Einstein's Shadow is a tale of great minds on a mission to change the way we understand our universe—and our place in it.

Discusses how we know about black holes, how they affect matter around them, and what would happen if you got inside one.

The authoritative story of the headline-making discovery of gravitational waves—by an eminent theoretical astrophysicist and award-winning writer. From the author of How the Universe Got Its Spots and A

Madman Dreams of Turing Machines, the epic story of the scientific campaign to record the soundtrack of our universe. Black holes are dark. That is their essence. When black holes collide, they will do so unilluminated. Yet the black hole collision is an event more powerful than any since the origin of the universe. The profusion of energy will emanate as waves in the shape of spacetime: gravitational waves. No telescope will ever record the event; instead, the only evidence would be the sound of spacetime ringing. In 1916, Einstein

predicted the existence of gravitational waves, his top priority after he proposed his theory of curved spacetime. One century later, we are recording the first sounds from space, the soundtrack to accompany astronomy's silent movie. In Black Hole Blues and Other Songs from Outer Space, Janna Levin recounts the fascinating story of the obsessions, the aspirations, and the trials of the scientists who embarked on an arduous, fifty-year endeavor to capture these elusive waves. An experimental ambition that began

as an amusing thought experiment, a mad idea, became the object of fixation for the original architects—Rai Weiss, Kip Thorne, and Ron Drever. Striving to make the ambition a reality, the original three gradually accumulated an international team of hundreds. As this book was written, two massive instruments of remarkably delicate sensitivity were brought to advanced capability. As the book draws to a close, five decades after the experimental ambition began, the team races to intercept a wisp of

a sound with two colossal machines, hoping to succeed in time for the centenary of Einstein's most radical idea. Janna Levin's absorbing account of the surprises, disappointments, achievements, and risks in this unfolding story offers a portrait of modern science that is unlike anything we've seen before.

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, astrophysical 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 corollaries 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.

There are no old drug addicts. That's what everyone says, at least. So how did Chuck get to his forty-third birthday and find himself

still neck-deep in this scene? He knows he's the creepy old guy with the drugs or the guy who's too old to be at the party doing everyone else's drugs, but if it ain't broke ... Well, he manages to make it to work at the dwarf whale distributor every day. He may hate that his dearly seedy San Francisco has become overrun with Starbucks, startups, and Lululemon moms, but he makes do every month for the rent-controlled apartment he shares with roommates he never sees. It's not perfect, but it's livable. In the end,

though, every addict has that one special vice that can tip them from relatively functional to completely unhinged. For Chuck, it's a new drug that doesn't even have a name yet; it's just a smokable, everlasting gobstopper of mellow high. But when chunks of time begin to disappear and rearrange themselves , he wonders if this really is just another life-ruining drug or if it's something straight out of a Philip K. Dick universe. Word on the street is that this

Death by Black Hole: And Other Cosmic

Quandaries

Einstein's Shadow

Introduction to Black Hole Astrophysics

Black Hole Physics

The Day We Found the Universe

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.

"The theory of black holes is the most simple consequence of

Einstein's relativity theory. Dealing with relativity theory, this book details one of the most beautiful areas of mathematical physics; the theory of black holes. It represents a personal testament to the work of the author, who spent several years working-out the subject matter."--WorldCat. Based on Prof. Lüst's Masters course at the University of Munich, this book begins with a short introduction to general relativity. It then presents black hole solutions, and discusses Penrose diagrams, black hole thermodynamics and entropy, the Unruh effect, Hawking radiation, the black hole information problem, black holes in supergravity and string theory, the black hole microstate counting in string theory, asymptotic symmetries in general relativity, and a particular

quantum model for black holes. The book offers an up-to-date summary of all the pertinent questions in this highly active field of physics, and is ideal reading for graduate students and young researchers.

"Since the eighteenth century, astronomers have predicted the existence of black holes. Now, sophisticated technologies are bringing us closer to seeing them in action. Meet the scientists whose work is radically shaping how we understand our universe."

Black HolePantheon

The Engine Paradigm

The Little Book of Black Holes

Black Holes

Introduction to Black Hole Physics

Black Hole Survival Guide

This book introduces an analytic method to describe the shadow of black holes. As an introduction, it presents a survey of the attempts to observe the shadow of galactic black holes. Based on a detailed discussion of the Pleba – Demiański class of space-times, the book derives analytical formulas for the photon regions and for the boundary curve of the shadow as seen by an observer in the domain of outer communication. It also analyzes how the shadow depends on the motion of the observer. For

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all cases, the photon regions and shadows are visualized for various values of the parameters. Finally, it considers how the analytical formulas can be used for calculating the horizontal and vertical angular diameters of the shadow, and estimates values for the black holes at the centers of our Galaxy near Sgr A* and of the neighboring galaxy M87.

This introduction to the fascinating subject of black holes fills a significant gap in the literature which exists between popular, non-mathematical expositions and advanced textbooks at the research

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level. It is designed for advanced undergraduates and first year postgraduates as a useful stepping-stone to the advanced literature. The book provides an accessible introduction to the exact solutions of Einstein's vacuum field equations describing spherical and axisymmetric (rotating) black holes. The geometry and physical properties of these spacetimes are explored through the motion of particles and light. The use of different coordinate systems, maximal extensions and Penrose diagrams is explained. The association of the surface area of a black hole with its entropy is discussed and it is

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shown that with the introduction of quantum mechanics black holes cease to be black and can radiate. This result allows black holes to satisfy the laws of thermodynamics and thus be consistent with the rest of physics. In this new edition the problems in each chapter have been revised and solutions are provided. The text has been expanded to include new material on wormholes and clarify various other issues.

A collection of essays on the cosmos, written by an American Museum of Natural History astrophysicist, includes "Holy Wars," "Ends of the World," and

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"Hollywood Nights."

The award-winning science writer “packs a lot of learning into a deceptively light and enjoyable read” exploring the contentious history of the black hole (New Scientist). For more than half a century, physicists and astronomers engaged in heated dispute over the possibility of black holes in the universe. The strange notion of a space-time abyss from which not even light escapes seemed to confound all logic. Now Marcia Bartusiak, author of Einstein’s Unfinished Symphony and The Day We Found the Universe, recounts the frustrating,

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exhilarating, and at times humorous battles over one of history's most dazzling ideas. Bartusiak shows how the black hole helped revive Einstein's greatest achievement, the general theory of relativity, after decades of languishing in obscurity. Not until astronomers discovered such surprising new phenomena as neutron stars and black holes did the once-sedate universe transform into an Einsteinian cosmos, filled with sources of titanic energy that can be understood only in the light of relativity. Black Hole explains how Albert Einstein, Stephen Hawking, and other leading thinkers completely

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changed the way we see the universe.

The International Bestseller On April 10, 2019, award-winning astrophysicist Heino Falcke presented the first image ever captured of a black hole at an international press conference—a turning point in astronomy that Science magazine called the scientific breakthrough of the year. That photo was captured with the unthinkable commitment of an intercontinental team of astronomers who transformed the world into a global telescope. While this image achieved Falcke’s goal in making a black hole “visible” for the first time, he recognizes that the

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photo itself asks more questions for humanity than it answers. Light in the Darkness takes us on Falcke's extraordinary journey to the darkest corners of the universe. From the first humans looking up at the night sky to modern astrophysics, from the study of black holes to the still-unsolved mysteries of the universe, Falcke asks, in even the greatest triumphs of science, is there room for doubts, faith, and a God? A plea for curiosity and humility, Light in the Darkness sees one of the great minds shaping the world today as he ponders the big, pressing questions that present themselves when we look up

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at the stars.

An Introduction

Physics of Black Holes

My Battle with Stephen Hawking to Make the World
Safe for Quantum Mechanics

Commander Toad and the Big Black Hole

A Guided Tour

This book overviews the extensive literature on apparent cosmological and black hole horizons. In theoretical gravity, dynamical situations such as gravitational collapse, black hole evaporation, and black holes interacting with non-trivial environments, as well as the attempts to model gravitational waves occurring in highly dynamical astrophysical processes, require that

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the concept of event horizon be generalized. Inequivalent notions of horizon abound in the technical literature and are discussed in this manuscript. The book begins with a quick review of basic material in the first one and a half chapters, establishing a unified notation. Chapter 2 reminds the reader of the basic tools used in the analysis of horizons and reviews the various definitions of horizons appearing in the literature. Cosmological horizons are the playground in which one should take baby steps in understanding horizon physics. Chapter 3 analyzes cosmological horizons, their proposed thermodynamics, and several coordinate systems. The remaining chapters discuss analytical solutions of the field equations of General Relativity, scalar-tensor, and $f(R)$ gravity which exhibit time-varying apparent horizons and horizons which appear and/or disappear in pairs. An extensive bibliography

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enriches the volume. The intended audience is master and PhD level students and researchers in theoretical physics with knowledge of standard gravity.

*From the acclaimed author of *Black Hole Blues and Other Songs from Outer Space*—an authoritative and accessible guide to the most alluring and challenging phenomena of contemporary science.*

"[Levin will] take you on a safe black hole trip, an exciting travel story enjoyed from your chair's event horizon." —Boston Globe

Through her writing, astrophysicist Janna Levin has focused on making the science she studies not just comprehensible but also, and perhaps more important, intriguing to the nonscientist. In this book, she helps us to understand and find delight in the black hole—perhaps the most opaque theoretical construct ever imagined by physicists—illustrated with original artwork by American painter

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and photographer Lia Halloran. Levin takes us on an evocative exploration of black holes, provoking us to imagine the visceral experience of a black hole encounter. She reveals the influence of black holes as they populate the universe, sculpt galaxies, and even infuse the whole expanse of reality that we inhabit. Lively, engaging, and utterly unique, Black Hole Survival Guide is not just informative—it is, as well, a wonderful read from first to last. The space ship Star Warts, commanded by Commander Toad, encounters a black hole which threatens the vehicle with doom. Introduces the physics of black holes and the methods employed in it, and reviews the main results of this branch of physics. Frolov (physics, U. of Alberta) and Novikov (theoretical astrophysics, U. of Copenhagen) focus on questions that have been answered relatively recently. Among the topics treated are: space-time of stationary

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black holes, general theory of black holes, black hole perturbations, numerics, electrodynamics, black holes in unified theories of gravity, quantum black holes, final states of evaporating black holes, and the information loss puzzle. Special attention is paid to the role of black holes in astrophysics and observational evidence of black hole existence. Many exotic subjects linked with black holes, such as white holes, wormholes, and time machines, are discussed. Appendices cover mathematical aspects of general relativity and black holes and quantum field theory in curved spacetime. Annotation copyrighted by Book News, Inc., Portland, OR

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?

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This book discusses these and many other questions providing the reader with the tools required to explore the Black Hole Land independently.

There Was a Black Hole that Swallowed the Universe

The Shadow of the Black Hole

Cosmological and Black Hole Apparent Horizons

How Intelligent People Can Create a Powerful Purpose for Their Lives

Black Hole Focus

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

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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

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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.

A Black Hole is Not a Hole

What Does a Black Hole Look Like?

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Basic Concepts and New Developments

Black Hole

How an Idea Abandoned by Newtonians, Hated by Einstein, and Gambled on by Hawking Became Loved