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Frank Close

Neutrino Frank Close

Frank Close breaks down complex concepts in physics in this collection of three of his bestselling books. Including

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**Neutrino, Antimatter, and
The Void, this set brings
to life the fascinating
science of particle
physics, neutrinos,
antimatter, and nothing.
Combing the knowledge**

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of a renowned physicist with the art of a skilled writer, enter the world of physics in an enthralling and readable way.

It was at the height of the Cold War, in the

**summer of 1950, when
Bruno Pontecorvo
mysteriously vanished
behind the Iron Curtain.
Who was he, and what
caused him to disappear?
Was he simply a**

**physicist, or also a spy
and communist radical? A
protégé of Enrico Fermi,
Pontecorvo was one of
the most promising
nuclear physicists in the
world. He spent years**

hunting for the Higgs boson of his day—the neutrino—a nearly massless particle thought to be essential to the process of particle decay. His work on the

Manhattan Project helped to usher in the nuclear age, and confirmed his reputation as a brilliant physicist. Why, then, would he disappear as he stood on the cusp of true

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**greatness, perhaps even
the Nobel Prize? In Half-
Life, physicist and
historian Frank Close
offers a heretofore untold
history of Pontecorvo's
life, based on**

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unprecedented access to Pontecorvo's friends and family and the Russian scientists with whom he would later work. Close takes a microscope to Pontecorvo's life,

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**combining a thorough
biography of one of the
most important scientists
of the twentieth century
with the drama of Cold
War espionage. With all
the elements of a Cold**

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War thriller—classified atomic research, an infamous double agent, a possible kidnapping by Soviet operatives—Half-Life is a history of nuclear physics at perhaps its

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**most powerful: when it
created the bomb.physics
at perhaps its most
powerful: when it created
the bomb.**

**An essential introduction
to particle physics, with**

**coverage ranging from
the basics through to the
very latest developments,
in an accessible and
carefully structured text.
Particle Physics: Third
Edition is a revision of a**

**highly regarded
introduction to particle
physics. In its two
previous editions this
book has proved to be an
accessible and balanced
introduction to modern**

**particle physics, suitable
for those students
needed a more
comprehensive
introduction to the
subject than provided by
the 'compendium' style**

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**physics books. In the
Third Edition the
standard model of
particle physics is
carefully developed
whilst unnecessary
mathematical formalism**

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is avoided where possible. Emphasis is placed on the interpretation of experimental data in terms of the basic properties of quarks and

leptons. One of the major developments of the past decade has been the establishing of the existence of neutrino oscillations. This will have a profound effect on

**the plans of
experimentalists. This
latest edition brings the
text fully up-to-date, and
includes new sections on
neutrino physics, as well
as expanded coverage of**

detectors, such as the LHC detector. End of chapter problems with a full set of hints for their solutions provided at the end of the book. An accessible and carefully

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**structured introduction to
this demanding subject.
Includes more advanced
material in optional
'starred' sections.
Coverage of the
foundations of the**

**subject, as well as the
very latest developments.
Takaaki Kajita and Arthur
McDonald have been
jointly awarded the 2015
Nobel Prize in Physics
"for the discovery of**

**neutrino oscillations,
which shows that
neutrinos have mass".
Takaaki Kajita is a
Japanese physicist who is
well known for neutrino
experiments at the**

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Kamiokande and the even more outsized Super-Kamiokande. This volume of collected works of Kajita on neutrino oscillations provides a good glimpse into the

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rise of Asian research in the frontiers of neutrino physics. Japan is now a major force in the study of the three families of neutrinos. Much remains to be done to clarify the

Dirac vs. Majorana nature of the neutrino, and the cosmological implications of the neutrino. The collected works of Kajita and his Super-Kamiokande group will

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**leave an indelible
footprint in the history of
big and better science.
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Kamioka Observatory,
ICRR (Institute for Cosmic**

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**Ray Research), The
University of Tokyo.
Fits, Density Estimation
and Supervised Learning
Neutrino
Nature's Elementary
Particles, From the Atom**

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**to the Neutrino and
Beyond
Enrico Fermi, Physicist
The Breathtaking Beauty
of Particle Physics
Quantum Field Theory
and the Hunt for an**

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Orderly Universe

Almost weightless and able to pass through the densest materials with ease, neutrinos may offer answers to questions ranging from relativity and quantum mechanics to more radical theories about dark energy and supersymmetry. Heinrich Päs serves

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as our fluent guide to a particle world that tests the boundaries of space, time, and human knowledge.

This book provides a comprehensive overview of modern particle physics accessible to anyone with a true passion for wanting to know how the universe works. We are introduced to

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the known particles of the world we live in. An elegant explanation of quantum mechanics and relativity paves the way for an understanding of the laws that govern particle physics. These laws are put into action in the world of accelerators, colliders and detectors found at institutions such as

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CERN and Fermilab that are in the forefront of technical innovation. Real world and theory meet using Feynman diagrams to solve the problems of infinities and deduce the need for the Higgs boson. Facts and Mysteries in Elementary Particle Physics offers an incredible insight from an eyewitness

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and participant in some of the greatest discoveries in 20th century science. From Einstein's theory of relativity to the spectacular discovery of the Higgs particle, this book will fascinate and educate anyone interested in the world of quarks, leptons and gauge theories. This book also contains many

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thumbnail sketches of particle physics personalities, including contemporaries as seen through the eyes of the author. Illustrated with pictures, these candid sketches present rare, perceptive views of the characters that populate the field. The Chapter on Particle Theory, in a pre-

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publication, was termed "superbly lucid" by David Miller in Nature (Vol. 396, 17 Dec. 1998, p. 642). Contents: Introduction Preliminaries The Standard Model Quantum Mechanics. Mixing Energy, Momentum and Mass-Shell Detection Accelerators and Storage Rings The CERN Neutrino

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ExperimentThe Particle ZooParticle
TheoryFinding the HiggsQuantum
ChromodynamicsEpilogueAddendum
Readership: Students, lay people and
anyone interested in the world of
elementary particles. Keywords:
Particle Physics;Quantum Mechanics;
Relativity;Quarks;Leptons;Gauge

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Theories; Higgs Particle Review:

Reviews of the First Edition:

"Veltman's life spans the history of particle physics, from Antiparticles to Z bosons. So does his crystal clear book, which tells all you want to know about the strange sub-nuclear world and the stranger scientists that study it

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... a thrilling tale about the world's tiniest things." Sheldon Glashow Nobel laureate Boston University "I must congratulate you! The book you have written is truly a masterpiece. Not only have you explained the physics of the world of elementary particles to the young aspiring student, but you have

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made it available to the intelligent layman. On top of that you gave it the humanity it deserves; reading this book brought me back to the most exciting period of my life in which every day brought a new discovery and we all fought for recognition. I can truly say that there is no book like

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this." Melvin Schwartz Nobel laureate
Columbia University "Veltman's ...
transparent explanations of the
abstract theories of quantum
mechanics and special relativity, his
lucid accounts of esoteric subjects in
particle physics, such as scaling,
Higgs particle and renormalizability ...

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are very impressive. The book will interest anyone who is interested in the view of the physical world held by contemporary fundamental physicists." T Y Cao Boston University
"I greatly enjoyed finally reading a book that goes into the details I always wanted ... Veltman has the courage to

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try a deeper level about what we understand and what is simply fact ... Even if you have read books popularizing physics before A history of the neutrino discusses how the atomic particle was sought and found, and how it allows astronomers to perform more in-depth

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research about distant galaxies and stars.

Ideas, theories, experiments, and unanswered questions in particle physics, explained (with anecdotes) for the general reader. The elementary particles of matter hold the secrets of Nature together with the fundamental

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forces. In *Ever Smaller*, neutrino physicist Antonio Ereditato describes the amazing discoveries of the “particle revolution,” explaining ideas, theories, experiments, and unanswered questions in particle physics in a way that is accessible (and enjoyable) for the general reader.

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Ereditato shows us that physics is not the exclusive territory of scientists in white lab coats exclaiming “Eureka” but that its revelations can be appreciated by any reader curious about the mysteries of the universe. Ereditato's overview takes us through a century of particle physics, from the

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discovery of the components of the atom through an endless procession of subatomic particles—the pion, the muon, the quarks, the W, Z, gluon, Higgs boson, and the mysterious, ubiquitous neutrino (Ereditato's chosen specialty)—interweaving the history of these discoveries with basic

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explanations of the physics itself as well as the technology behind the discoveries. He considers the particle physicist's impulse to pursue the “ever smaller”—to divide matter into ever more minuscule parts, until reaching the elementary constituents of the universe; explains how Nature likes

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symmetries; describes the workings of particle accelerators and detectors; demonstrates how to distinguish between three identical quarks; and warns that the ugliest experimental data are more important than the most beautiful theory. With *Ever Smaller*, Ereditato invites readers to join him in

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appreciating the beauty of the
microcosm.

Modern Particle Physics

Sea Change

Experimental Studies of Neutrino
Oscillations

Particle Physics: A Very Short
Introduction

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Particle Physics

Statistical Analysis Techniques in
Particle Physics

Examines the subatomic world, the science of particle physics, and its attempt to understand the very nature of matter and energy.

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Modern analysis of HEP data needs advanced statistical tools to separate signal from background. This is the first book which focuses on machine learning techniques. It will be of interest to almost every high energy physicist, and, due to

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its coverage, suitable for students. The search for the elementary constituents of the physical universe and the interactions between them has transformed over time and continues to evolve today, as we seek answers to

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questions about the existence of stars, galaxies, and humankind. Integrating both theoretical and experimental work, *Exploring Fundamental Particles* traces the development of this fascinating field, from the discoveries of

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Newton, Fermi, and Feynman to the detection of CP violation and neutrinos to the quest to observe the Higgs boson and beyond. An Accessible yet In-Depth Account of How Fundamental Particles Shape Our World The book first examines

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the experiments and theoretical ideas that gave rise to the standard model. It discusses special relativity, angular momentum, spin, the Dirac electron, quantum field theory, Feynman diagrams, Pauli's

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neutrino, Fermi's weak interaction, Yukawa's pion, the muon neutrino, quarks, leptons, and flavor symmetry. The authors then explain the violation of the symmetry between matter and antimatter, known as CP violation.

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They cover the discoveries of CP violation in the decays of kaons and B mesons as well as future experiments that could detect possible CP violation beyond the standard model. In the next part, the authors present experimental

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results involving the once-mysterious neutrino. They explore the evidence that neutrinos have mass, new neutrino experiments in various countries, and the potential of neutrino astronomy to offer a new perspective on stars

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and galaxies. The final section focuses on the one undetected particle of the standard model: the Higgs boson. The authors review the experiments that established important constraints on the mass of the Higgs particle. They also

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highlight recent experiments of the Tevatron particle accelerator at Fermilab, along with the near future impact of the Large Hadron Collider (LHC) at CERN and the longer term impact of the International Linear Collider (ILC).

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The Foundation for New Discoveries A clear picture of the historic breakthroughs and latest findings in the particle physics community, this book guides you through the theories and experiments surrounding

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fundamental particles and the main forces between them. It sets the stage for the next transformation in modern science. “A vivid account of what the process of discovery was really like for an insider.” —Peter Higgs

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“Butterworth is an insider’s insider. His narrative seethes with insights on the project’s science, technology and ‘tribes,’ as well as his personal (and often amusing) journey as a frontier physicist.”—Nature The discovery

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of the Higgs boson has brought us a giant step closer to understanding how our universe works. But before the Higgs was found, its existence was hotly debated. Even Peter Higgs, who first pictured it, did not expect to

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see proof within his lifetime. The quest to find the Higgs would ultimately require perhaps the most ambitious experiment in human history. Jon Butterworth was there—a leading physicist on the ATLAS project at the Large

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Hadron Collider in Geneva, Switzerland. In *Most Wanted Particle*, he gives us the first insider account of the hunt for the Higgs, and of life at the collider itself—the world's largest and most powerful particle accelerator,

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17 miles long, 20 stories underground, and designed to “replay” the original Big Bang by smashing subatomic particles at nearly the speed of light. Writing with clarity and humor, Butterworth revels as much in the

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hard science—which he carefully reconstructs for readers of all levels—as in the messiness, uncertainty, and humanness of science—from the media scrutiny and late-night pub debates, to the false starts and intense pressure

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to generate results. He captures a moment when an entire field hinged on the proof or disproof of a 50-year-old theory—and even science's top minds didn't know what to expect. Finally, he explains why physics will never be

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the same after our first glimpse of the elusive Higgs—and where it will go from here.

Exploring Fundamental Particles
A Question and Answer Guide to
Astronomy
Neutrino Hunters

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The Perfect Wave

Eclipse

Most Wanted Particle

Physicist Frank Close takes the reader to the frontiers of science in a vividly told investigation of revolutionary science and

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enterprise from the seventeenth century to the present. He looks at what has been meant by theories of everything, explores the scientific breakthroughs they have allowed, and shows the far-reaching effects they have had

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on crucial aspects of life and belief. Theories of everything, he argues, can be described as those which draw on all relevant branches of knowledge to explain everything known about the universe. Such accounts

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may reign supreme for centuries. Then, often as a result of the advances they themselves have enabled, a new discovery is made which the current theory cannot explain. A new theory is needed which inspiration,

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sometimes, supplies. Moving from Isaac Newton's work on gravity and motion in the seventeenth century to thermodynamics and James Clerk Maxwell's laws of electromagnetism in the

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nineteenth to Max Planck's and Paul Dirac's quantum physics in the twentieth, Professor Close turns finally to contemporary physics and the power and limitations of the current theory of everything. The cycle in which

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one theory of everything is first challenged and then replaced by another is continuing right now. Winner of the prestigious 2013 Royal Society Winton Prize for Science Books “A modern voyage of discovery.” —Frank

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Wilczek, Nobel Laureate, author of The Lightness of Being The Higgs boson is one of our era's most fascinating scientific frontiers and the key to understanding why mass exists. The most recent book on the

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subject, The God Particle, was a bestseller. Now, Caltech physicist Sean Carroll documents the doorway that is opening—after billions of dollars and the efforts of thousands of researchers at the Large Hadron

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Collider in Switzerland—into the mind-boggling world of dark matter. The Particle at the End of the Universe has it all: money and politics, jealousy and self-sacrifice, history and cutting-edge physics—all grippingly told

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**by a rising star of science
writing.**

**Unique in its coverage of all
aspects of modern particle
physics, this textbook provides a
clear connection between the
theory and recent experimental**

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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

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**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**

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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

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instructors, numerical solutions
and hints to the problems for
students and PowerPoint slides**

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and JPEGs of figures from the book.

Forty years ago, three physicists - Peter Higgs, Gerard 't Hooft, and James Bjorken - made the spectacular breakthroughs that led to the world's largest

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experiment, CERN's Large Hadron Collider. Against a backdrop of high politics and billion dollar budgets, this is the story of their work, the quest for the Higgs boson, and its eventual discovery.

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**Our Hundred-Year Search for
Dark Matter
The Last Man Who Knew
Everything
The Particle Explosion
Small Things and Nothing
An Introductory Course in**

Modern Particle Physics
The Particle at the End of the
Universe

*„Ich habe ein Teilchen
postuliert, das nicht
entdeckt werden kann“,
stellte der Physiker*

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*Wolfgang Pauli einst fest.
Es brauchte lange Jahre,
viel Geduld und großen
Einfallsreichtum, um einen
indirekten, flüchtigen
Blick auf das schwer
fassbare Neutrino zu*

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*erhaschen und jene Kiste
Champagner zu gewinnen,
die Pauli auf dessen
Entdeckung gewettet hatte.
Hier nun ist die
Geschichte, wie dieses
außergewöhnlichste aller*

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*Teilchen - ohne Ladung,
fast ohne Masse, kaum mit
Materie interagierend -
gesucht und gefunden wurde
und wie uns die Neutrino-
Astronomie heute tiefe
Einblicke in die Herzen*

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*ferner Galaxien
ermöglicht.*

*Explores what is known
about the world of
antimatter, from its
prediction to the
discovery of the first*

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antiparticles and explains how its existence can offer clues about the origin and structure of the universe.

A mixture of memoir and biography, Chasing the

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Ghost: Nobelist Fred Reines and the Neutrino tells a deeply human story that appeals both to scientists and non-scientists. Although the book relates to the

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important discovery of neutrinos, it is more intimately about Fred Reines than the technical details of neutrino physics. Narrated in a fashion to interest and

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excite the reader, the science presented here is accessible to a broad audience. Coursing through Reines' life, his various challenges and encounters, the book reveals constants

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of his persona. Reines displayed a sustained consistency as a respected leader, admired by students and colleagues as a fount of big ideas and ambition. A continuing

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source of inspiration and motivation to others, his most basic consistency was his passion for science. The quest for knowledge about the wondrous universe is a profoundly

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human endeavor. Fred Reines' life and his unremitting scientific curiosity are emblematic of that truth. 'This book is a most welcome account about Frederick Reines and

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*his great contributions to
neutrino physics and
astrophysics. The methods
he designed in the 1950s
to discover neutrinos in
nuclear reactor
experiments are still*

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being used. His later work included the detection of atmospheric neutrinos which was a forerunner to the discovery of neutrino oscillations, the ability of neutrinos to change

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*from one type to another.
This finding was a
significant step to other
experiments that aim to
answer profound questions
about the nature of the
universe including why it*

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*is composed of
matter. 'Takaaki
Kajita Nobel Laureate in
Physics Neutrino
Researcher, University of
Tokyo 'Cole has provided a
compelling personal and*

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*scientific account of a
remarkable pioneer in
Neutrino Physics. 'Arthur B
McDonald Nobel Laureate in
Physics Director of the
Sudbury Neutrino
Observatory Professor,*

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*Queen's University,
Ontario, Canada*

*In this biography of
Enrico Fermi (1901-54),
who won the Nobel Prize in
physics in 1938 for his
work on radioactivity by*

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*neutron bombardment and
his discovery of
transuranic elements and
who achieved the first
controlled nuclear chain
reaction in Chicago in
1942, his student,*

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collaborator, fellow Nobel Prize winner and lifelong friend Emilio Segrè presents the scientist, and explains in nontechnical terms Fermi's work and his achievements.

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“Segrè’s description of Fermi’s early life and his involvement with and commitment to physics is extremely interesting... Segrè understands and describes very clearly the

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*outstanding
characteristics of Fermi's
theoretical work: clarity
and completeness... Segrè
has succeeded admirably in
describing Fermi's entire
scientific career, and*

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this book is strongly recommended.” – M. L. Goldberger, Science “We must thank Emilio Segrè for this authoritative, revealing and inspiring book. It covers in a

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*masterly fashion the most
exciting thirty years of
modern physics and the
character and activities
of one of its greatest
contributors.” – Nature “A
rich, well-rounded*

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*portrait of [Fermi] the
scientist, his methods,
intellectual history, and
achievements. Explaining
in nontechnical terms the
scientific problems Fermi
faced or solved, Enrico*

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Fermi, Physicist contains illuminating material concerning Fermi's youth in Italy and the development of his scientific style.” – Physics Today “All that

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*might be hoped for in a
biography of one Nobel
Prize winner in physics by
another has been realized
in Emilio Segrè's
biography of his friend,
Enrico Fermi... A truly*

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*masterly drawing of
Fermi's character, along
with his physics and the
events through which he
moved, Segrè has provided
us with a brilliant
appreciation of one of the*

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*most pre-eminent figures
of modern physics.” –
Physics Bulletin “This
excellent biography,
written by one of the
original group who worked
with him during the 1930s*

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*at Rome, catches
beautifully the style and
spirit of its subject...
With Fermi's passing the
age of the universal
experimental and
theoretical physicist is*

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gone. Segre's book tells the story of this heroic age of physics and of its principal actor; it is a delight to read, and I recommend it heartily." – American Scientist "Here

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*we meet the man at work
and we see the meticulous
scientist... This book
also shows us another
facet of Fermi: that of
the conscientious
scientist torn between his*

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love of pure research and his love of teaching.” – V. Barocas, Annals of Science “Segrè is a sensitive biographer, responsive to all problems that can plague the

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creative scientist; he shows, above all, Fermi's dedication, zeal, and extraordinary talents. Segrè has provided more than sympathy. Much that is new about Fermi's youth

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*in Italy appears here...
[A] very rewarding book...
Every physicist will want
to read this biography,
along with every reader
who has an interest in
intellectual developments*

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during the 1920–1960 era.”

*– J. Z. Fullmer, The Ohio
Journal of Science*

*Concepts of Elementary
Particle Physics*

*How the Hunt for the Higgs
Boson Leads Us to the Edge*

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*of a New World
Half-Life*

*A Modern Introduction to
Neutrino Physics
The Infinity Puzzle*
An award-winning science

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journalist details the quest to isolate and understand dark matter--and shows how that search has helped us to understand the universe we inhabit.

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When you train a telescope on outer space, you can see luminous galaxies, nebulae, stars, and planets. But if you add all that together, it

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constitutes only 15 percent of the matter in the universe. Despite decades of research, the nature of the remaining 85 percent is unknown. We call it dark matter.

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In *The Elephant in the Universe*, Govert Schilling explores the fascinating history of the search for dark matter. Evidence for its existence comes from a

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wealth of astronomical observations. Theories and computer simulations of the evolution of the universe are also suggestive: they can be reconciled with

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astronomical
measurements only if
dark matter is a
dominant component of
nature. Physicists have
devised huge, sensitive
instruments to search

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for dark matter, which may be unlike anything else in the cosmos--some unknown elementary particle. Yet so far dark matter has escaped every experiment.

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Indeed, dark matter is so elusive that some scientists are beginning to suspect there might be something wrong with our theories about gravity or with the

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current paradigms of cosmology. Schilling interviews both believers and heretics and paints a colorful picture of the history and current status of

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dark matter research,
with astronomers and
physicists alike trying
to make sense of theory
and observation. Taking
a holistic view of dark
matter as a problem, an

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opportunity, and an
example of science in
action, The Elephant in
the Universe is a vivid
tale of scientists
puzzling their way
toward the true nature

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of the universe.
Antimatter explores a
strange mirror world,
where particles have
identical yet opposite
properties to those that
make up the familiar

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matter we encounter
everyday; where left
becomes right, positive
becomes negative; and
where, should matter and
antimatter meet, the two
annihilate in a blinding

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flash of energy that makes even thermonuclear explosions look feeble by comparison. It is an idea long beloved of science-fiction stories--but here,

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renowned science writer
Frank Close shows that
the reality of
antimatter is even more
fascinating than the
fiction itself. We know
that once, antimatter

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and matter existed in perfect counterbalance, and that antimatter then perpetrated a vanishing act on a cosmic scale that remains one of the greatest mysteries of

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the universe. Today, antimatter does not exist normally, at least on Earth, but we know that it is real for scientists are now able to make small pieces of

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it in particle
accelerators, such as
that at CERN in Geneva.
Looking at the
remarkable prediction of
antimatter and how it
grew from the meeting

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point of relativity and quantum theory in the early 20th century, at the discovery of the first antiparticles, at cosmic rays, annihilation, antimatter

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bombs, and antiworlds,
Close separates the
facts from the fiction
about antimatter, and
explains how its
existence can give us
profound clues about the

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origins and structure of
the universe. Oxford
Landmark Science books
are 'must-read' classics
of modern science
writing which have
crystallized big ideas,

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and shaped the way we think.

Many mysteries of the atom have come unraveled, but one remains intractable—what Frank Close calls

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the "Infinity puzzle".
The problem was simple
to describe. Although
clearly very powerful,
quantum field theory was
making one utterly
ridiculous prediction:

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that certain events had an infinite probability of occurring. The Infinity Puzzle charts the birth and life of the idea, and the scientists, who realized

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it. Based on numerous firsthand interviews and extensive research, this book captures an era of great mystery and greater discovery. Even if the Higgs boson is

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never found,
renormalization- the
pursuit of an orderly
universe- has led to one
of the richest and most
productive intellectual
periods in human

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history.--[book jacket]
What is 'the void'? What
remains when you take
all the matter away? Can
empty space - 'nothing'
- exist? This little
book explores the

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science and the history
of the elusive void:
from Aristotle who
insisted that the vacuum
was impossible, via the
theories of Newton and
Einstein, to our very

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latest discoveries and why they can tell us extraordinary things about the cosmos. Frank Close tells the story of how scientists have explored the elusive

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void, and the rich discoveries that they have made there. He takes the reader on a lively and accessible history through ancient ideas and cultural

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superstitions to the
frontiers of current
research. He describes
how scientists
discovered that the
vacuum is filled with
fields; how Newton,

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Mach, and Einstein
grappled with the nature
of space and time; and
how the mysterious
'aether' that was long
ago supposed to permeate
the void may now be

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making a comeback with the latest research into the 'Higgs field'. We now know that the vacuum is far from being 'nothing' - it seethes with virtual particles

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and antiparticles that erupt spontaneously into being, and it also may contain hidden dimensions that we were previously unaware of. These new discoveries

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may provide answers to some of cosmology's most fundamental questions: what lies outside the universe, and, if there was once nothing, then how did the universe

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begin?

An Introduction to

Quarks and Partons

Theories of Everything:

Ideas in Profile

The Void

The Thrilling Chase for

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a Ghostly Particle to
Unlock the Secrets of
the Universe

A Toon Graphic

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*On 21 August 2017, over
100 million people will*

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*gather in a narrow belt
across the USA to witness
the most watched total solar
eclipse in history. Eclipse -
Journeys to the Dark Side of
the Moon, written by well-
known popular science*

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*author Frank Close,
describes the spellbinding
allure of this most beautiful
natural phenomenon. The
book explains why eclipses
happen, reveals their role in
history, literature and myth,*

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and focuses on eclipse chasers, who travel with ecstatic fervour to some of the most inaccessible places on the globe to be present at the moment of totality. The book includes the author's

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*quest to solve a 3000 years
old mystery: how did the
moonmove backwards
during a total solar eclipse,
as claimed in the Book of
Joshua?It is an inspirational
tale: how a teacher and an*

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eclipse inspired the author, aged eight, to a life in science, and a love affair with eclipses, which takes him to a war zone in the Western Sahara, to the South Pacific and the

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African bush. The tale comes full circle with another eight-year old boy - the author's grandson - at the 2017 great American eclipse. Readers of all ages will be drawn to this inspirational chronicle

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*of the mesmerizing
experience of total solar
eclipse.*

*The purpose of this textbook
is to explain the Standard
Model of particle physics to
a student with an*

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*undergraduate preparation
in physics. Today we can
claim to have a fundamental
picture of the strong and
weak subnuclear forces.
Through an interplay
between theory and*

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experiment, we have learned the basic equations through which these forces operate, and we have tested these equations against observations at particle accelerators. The story is

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beautiful and full of surprises. Using a simplified presentation that does not assume prior knowledge of quantum field theory, this book begins from basic concepts of special relativity

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*and quantum mechanics,
describes the key
experiments that have
clarified the structure of
elementary particle
interactions, introduces the
crucial theoretical concepts,*

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and builds up to the full description of elementary particle interactions as we know them today.

We are living in a Golden Age of physics. With the mind of a scientist and the

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*skill of a journalist,
bestselling author and
renowned physicist Frank
Close gives us an insider's
look at one of the most
inspiring - and challenging -
scientific breakthroughs of*

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our time: the Large Hadron Collider in Geneva. About 40 years ago, 3 brilliant, yet little-known scientists made breakthroughs that later inspired the construction of the Large Hadron Collider at

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*CERN in Geneva: a
27-kilometre-long machine
which has already cost \$10
billion, taken 20 years to
build and now promises to
reveal how the universe
itself came to be. The*

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Infinity Puzzle is the inside story of those 40 years of research, breakthrough and endeavour. The work of Peter Higgs, Gerard 't Hooft and James Bjorken is explored here, played out

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across the decades against a backdrop of high politics, low behaviour and billion-dollar budgets. In The Infinity Puzzle, eminent physicist and award-winning author Frank Close writes

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from within the action and draws upon his close friendships with those involved.

Critically acclaimed author and artist Frank Viva brings us this warm, funny and

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*innovatively designed
coming-of-age story.*

*The Personalities, Politics,
and Extraordinary Science
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Chasing The Ghost: Nobelist
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Facts and Mysteries in
Elementary Particle Physics
Ever Smaller
Deep Down Things
Quarks and Leptones
This self-contained text*

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describes breakthroughs in our understanding of the structure and interactions of elementary particles. It provides students of theoretical or experimental physics with the background material to grasp the significance

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***of these developments.
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In this compelling introduction to
the fundamental particles that
make up the universe, Frank
Close takes us on a journey into
the atom to examine known***

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particles such as quarks, electrons, and the ghostly neutrino. Along the way he provides fascinating insights into how discoveries in particle physics have actually been made, and discusses how our

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picture of the world has been radically revised in the light of these developments. He concludes by looking ahead to new ideas about the mystery of antimatter, the number of dimensions that there might be

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in the universe, and to what the next 50 years of research might reveal. ABOUT THE SERIES: The Very Short Introductions series from Oxford University Press contains hundreds of titles in almost every subject area. These

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pocket-sized books are the perfect way to get ahead in a new subject quickly. Our expert authors combine facts, analysis, perspective, new ideas, and enthusiasm to make interesting and challenging topics highly

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A useful scientific theory, claimed Einstein, must be explicable to any intelligent person. In Deep Down Things, experimental particle physicist Bruce Schumm has taken this

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dictum to heart, providing in clear, straightforward prose an elucidation of the Standard Model of particle physics -- a theory that stands as one of the crowning achievements of twentieth-century science. In this

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one-of-a-kind book, the work of many of the past century's most notable physicists, including Einstein, Schrodinger, Heisenberg, Dirac, Feynman, Gell-Mann, and Weinberg, is knit together in a thorough and

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accessible exposition of the revolutionary notions that underlie our current view of the fundamental nature of the physical world. Schumm, who has spent much of his life emmersed in the subatomic

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world, goes far beyond a mere presentation of the "building blocks" of matter, bringing to life the remarkable connection between the ivory tower world of the abstract mathematician and the day-to-day, life-enabling

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***properties of the natural world.
Schumm leaves us with an
insight into the profound open
questions of particle physics,
setting the stage for
understanding the progress the
field is poised to make over the***

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next decade or two. Introducing readers to the world of particle physics, Deep Down Things opens new realms within which are many clues to unraveling the mysteries of the universe. Journeys to the Dark Side of the

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***Large Hadron Collider
Antimatter***

***The Inside Story of the Hunt for
the Higgs, the Heart of the Future
of Physics***

Reviews the current state of
knowledge of neutrino masses

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and the related question of neutrino oscillations. After an overview of the theory of neutrino masses and mixings, detailed accounts are given of the laboratory limits on neutrino masses, astrophysical and

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cosmological constraints on those masses, experimental results on neutrino oscillations, the theoretical interpretation of those results, and theoretical models of neutrino masses and mixings. The book concludes with an

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examination of the potential of long-baseline experiments. This is an essential reference text for workers in elementary-particle physics, nuclear physics, and astrophysics.

Edited by internationally

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recognized authorities in the field, this handbook focuses on Linacs, Synchrotrons and Storage Rings and is intended as a vade mecum for professional engineers and physicists engaged in these subjects. Here one will find, in

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addition to the common formulae of previous compilations, hard to find specialized formulae, recipes and material data pooled from the lifetime experiences of many of the world's most able practitioners of the art and science of

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accelerator building and
operation.

The definitive biography of the
brilliant, charismatic, and very
human physicist and innovator
Enrico Fermi In 1942, a team at
the University of Chicago

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achieved what no one had before:
a nuclear chain reaction. At the
forefront of this breakthrough
stood Enrico Fermi. Straddling the
ages of classical physics and
quantum mechanics, equally at
ease with theory and experiment,

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Fermi truly was the last man who knew everything--at least about physics. But he was also a complex figure who was a part of both the Italian Fascist Party and the Manhattan Project, and a less-than-ideal father and husband

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who nevertheless remained one of history's greatest mentors. Based on new archival material and exclusive interviews, *The Last Man Who Knew Everything* lays bare the enigmatic life of a colossus of twentieth century

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physics.

A central quest in the study of musical instruments is to understand why the sound of the 'same' note depends greatly on the instrument, and to elucidate which aspects of an instrument

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are most critical in producing the musical tones characteristic of the instrument. The primary goal of this book is to investigate these questions for the piano.

The Elephant in the Universe

The Divided Life of Bruno

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Pontecorvo, Physicist or Spy
Physics of the Piano
The Life and Times of Enrico
Fermi, Father of the Nuclear Age
Winner of the Canadian Science Writers
Association 2014 Science in Society Book
Award A Publishers Weekly Top 10

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Science Book of the Season A Book to Watch Out For, The New Yorker's Page-Turner Blog A Los Angeles Times Gift Guide Selection One of the Best Physics Books of 2013, Cocktail Party Physics Blog, Scientific American Detective thriller meets astrophysics in this adventure into neutrinos and the scientists

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who pursue them The incredibly small bits of matter we call neutrinos may hold the secret to why antimatter is so rare, how mighty stars explode as supernovae, what the universe was like just seconds after the big bang, and even the inner workings of our own planet. For more than eighty years, adventurous minds from around the

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world have been chasing these ghostly particles, trillions of which pass through our bodies every second. Extremely elusive and difficult to pin down, neutrinos are not unlike the brilliant and eccentric scientists who doggedly pursue them. In *Neutrino Hunters*, the renowned astrophysicist and award-winning writer

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Ray Jayawardhana takes us on a thrilling journey into the shadowy world of neutrinos and the colorful lives of those who seek them. Demystifying particle science along the way, Jayawardhana tells a detective story with cosmic implications—interweaving tales of the sharp-witted theorist Wolfgang Pauli; the

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troubled genius Ettore Majorana; the harbinger of the atomic age Enrico Fermi; the notorious Cold War defector Bruno Pontecorvo; and the dynamic dream team of Marie and Pierre Curie. Then there are the scientists of today who have caught the neutrino bug, and whose experimental investigations stretch from a working

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nickel mine in Ontario to a long tunnel through a mountain in central Italy, from a nuclear waste site in New Mexico to a bay on the South China Sea, and from Olympic-size pools deep underground to a gigantic cube of Antarctic ice—called, naturally, IceCube. As Jayawardhana recounts a captivating saga of scientific

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discovery and celebrates a glorious human quest, he reveals why the next decade of neutrino hunting will redefine how we think about physics, cosmology, and our lives on Earth.

This text gives an introduction to particle physics at a level accessible to advanced undergraduate students. It is based on

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lectures given to 4th year physics students over a number of years, and reflects the feedback from the students. The aim is to explain the theoretical and experimental basis of the Standard Model (SM) of Particle Physics with the simplest mathematical treatment possible. All the experimental discoveries that led to the

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understanding of the SM relied on particle detectors and most of them required advanced particle accelerators. A unique feature of this book is that it gives a serious introduction to the fundamental accelerator and detector physics, which is currently only available in advanced graduate textbooks. The mathematical

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tools that are required such as group theory are covered in one chapter. A modern treatment of the Dirac equation is given in which the free particle Dirac equation is seen as being equivalent to the Lorentz transformation. The idea of generating the SM interactions from fundamental gauge symmetries is

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explained. The core of the book covers the SM. The tools developed are used to explain its theoretical basis and a clear discussion is given of the critical experimental evidence which underpins it. A thorough account is given of quark flavour and neutrino oscillations based on published experimental results, including

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some from running experiments. A simple introduction to the Higgs sector of the SM is given. This explains the key idea of how spontaneous symmetry breaking can generate particle masses without violating the underlying gauge symmetry. A key feature of this book is that it gives an accessible explanation of the discovery of

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the Higgs boson, including the advanced statistical techniques required. The final chapter gives an introduction to LHC physics beyond the standard model and the techniques used in searches for new physics. There is an outline of the shortcomings of the SM and a discussion of possible solutions and future

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experiments to resolve these outstanding questions. For updates, new results, useful links as well as corrections to errata in this book, please see the book website maintained by the authors:

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A practical answer guide to humankind's age-old questions on planets, our universe

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and everything beyond and between. A deeper understanding of neutrinos, with the goal to reveal their nature and exact role within particle physics, is at the frontier of current research. This book reviews the field in a concise fashion and highlights the most pressing issues and areas of strongest topical interest. It

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provides a clear, self-contained, and logical treatment of the fundamental physics aspects, appropriate for graduate students. Starting with the relevant basics of the SM, neutrinos are introduced, and the quantum mechanical effect of oscillations is explained in detail. A strong focus is then set on the phenomenon of

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lepton number violation, especially in $0\nu\beta\beta$ decay, as the crucial probe to understand the nature of neutrinos. The role of neutrinos in astrophysics, expected to be of increasing importance for future research, is then described. Finally, models to explain the neutrino properties are outlined. The central theme of the

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book is the nature of neutrino masses and the above topics will revolve around this issue.