Accelerator Physics 3rd Edition

From the reviews: "This book is a very welcome and valuable addition to the accelerator literature. As noted by the authors, there is relatively little material in the book specifically for low-energy machines, but industrial users may still find it useful to read." Cern Courier
In this second edition of Particle Accelerator Physics, Vol. 1, is mainly a reprint of the first edition without significant changes in content. The bibliography has been updated to include more recent progress in the field of particle accelerators. With the help of many observant readers a number of misprints and errors could be eliminated. The author would like to express his sincere appreciation to all those who have pointed out such shortcomings and wel comes such information and any other relevant information in the future. The author would also like to express his special thanks to the editor Dr. Helmut Lotsch and his staff for editorial as well as technical advice and support which contributed greatly to the broad acceptance of this text and made a second edition of both volumes necessary. Palo Alto, California Helmut Wiedemann November 1998 VII Preface to the First Edition The purpose of this textbook is to provide a comprehensive introduction into the physics of particle accelerators and particle beam dynamics. Parti cle accelerators have become important research tools in high energy physics as well as sources of incoherent and coherent radiation from the far infra red to hard x-rays for basic and applied research. During years of teaching accelerator physics it became clear that the single most

annoying obstacle to get introduced into the field is the absence of a suitable textbook.

TO THE SECOND EDITION In the nine years since this book was first written, rapid progress has been made scientifically in nuclear fusion, space physics, and nonlinear plasma theory. At the same time, the energy shortage on the one hand and the exploration of Jupiter and Saturn on the other have increased the national awareness of the important applications of plasma physics to energy production and to the understanding of our space environment. In magnetic confinement fusion, this period has seen the attainment 13 of a Lawson number nTE of 2 x 10 cm -3 sec in the Alcator tokamaks at MIT; neutral-beam heating of the PL T tokamak at Princeton to KTi = 6. 5 keV; increase of average ß to 3%-5% in tokamaks at Oak Ridge and General Atomic; and the stabilization of mirror-confined plasmas at Livermore, together with injection of ion current to near field-reversal conditions in the 2XIIß device. Invention of the tandem mirror has given magnetic confinement a new and exciting dimension. New ideas have emerged, such as the compact torus, surface-field devices, and the EßT mirror-torus hybrid, and some old ideas, such as the stellarator and the reversed-field pinch, have been revived. Radiofrequency heat ing has become a new star with its promise of dc current drive. Perhaps most importantly, great progress has been made in the understanding of the MHD behavior of toroidal plasmas: tearing modes, magnetic Vll Vlll islands, and disruptions. This self-contained textbook with exercises discusses a broad range of selected topics from classical mechanics

and electromagnetic theory that inform key issues related to modern accelerators. Part I presents fundamentals of the Lagrangian and Hamiltonian formalism for mechanical systems, canonical transformations, action-angle variables, and then linear and nonlinear oscillators. The Hamiltonian for a circular accelerator is used to evaluate the equations of motion, the action, and betatron oscillations in an accelerator. From this base, we explore the impact of field errors and nonlinear resonances. This part ends with the concept of the distribution function and an introduction to the kinetic equation to describe large ensembles of charged particles and to supplement the previous single-particle analysis of beam dynamics. Part II focuses on classical electromagnetism and begins with an analysis of the electromagnetic field from relativistic beams, both in vacuum and in a resistive pipe. Plane electromagnetic waves and modes in waveguides and radio-frequency cavities are also discussed. The focus then turns to radiation processes of relativistic beams in different conditions, including transition, diffraction, synchrotron, and undulator radiation. Fundamental concepts such as the retarded time for the observed field from a charged particle, coherent and incoherent radiation, and the formation length of radiation are introduced. We conclude with a discussion of laser-driven acceleration of charged particles and the radiation damping effect. Appendices on electromagnetism and special relativity are included, and references are given in some chapters as a launching point for further reading. This text is intended for graduate students who are beginning to

explore the field of accelerator physics, but is also recommended for those who are familiar with particle accelerators but wish to delve further into the theory underlying some of the more pressing concerns in their design and operation.

A self-contained guide to the Physics GRE, reviewing all of the topics covered alongside three practice exams with fully worked solutions.

A comprehensive and engaging textbook, providing a graduate-level, non-historical, modern introduction of quantum mechanical concepts.

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

Edited by internationally recognized authorities in the field, this expanded and updated new edition of the bestselling Handbook, containing more than 100 new articles, is aimed at the design and operation of modern particle accelerators. It is intended as a vade mecum for professional engineers and physicists engaged in these subjects. With a collection of more than 2000 equations, 300 illustrations and 500 graphs and tables, here one will find, in addition to the common formulae of previous compilations, hard-to-find, specialized formulae, recipes and material data pooled from the lifetime experience of many of the world's most able practitioners of the art and science of accelerators.The eight chapters include both theoretical and practical matters as well as an extensive glossary of accelerator types. Chapters on beam dynamics and electromagnetic and nuclear interactions deal with linear and nonlinear single particle and collective effects including spin motion, beam-environment, beam-beam, beam-electron, beam-ion and intrabeam interactions. The impedance concept and related calculations are dealt with at length as are the instabilities associated with the various interactions mentioned. A chapter on operational considerations

includes discussions on the assessment and correction of orbit and optics errors, real-time feedbacks, generation of short photon pulses, bunch compression, tuning of normal and superconducting linacs, energy recovery linacs, free electron lasers, cooling, space-charge compensation, brightness of light sources, collider luminosity optimization and collision schemes. Chapters on mechanical and electrical considerations present material data and important aspects of component design including heat transfer and refrigeration. Hardware systems for particle sources, feedback systems, confinement and acceleration (both normal conducting and superconducting) receive detailed treatment in a subsystems chapter, beam measurement techniques and apparatus being treated therein as well. The closing chapter gives data and methods for radiation protection computations as well as much data on radiation damage to various materials and devices.A detailed name and subject index is provided together with reliable references to the literature where the most detailed information available on all subjects treated can be found.

Linear Accelerators for Radiation Therapy, Second Edition focuses on the fundamentals of accelerator systems, explaining the underlying physics and the different features of these systems. This edition includes expanded sections on the treatment head, on x-ray production via multileaf and dynamic collimation for the production of wedged and other i

Understanding and controlling the physics of space charge effects in linear and circular proton and ion accelerators are essential to their operation, and to future high-intensity facilities. This book presents the status quo of this field from a

theoretical perspective, compares analytical approaches with multi-particle computer simulations and – where available – with experiments. It discusses fundamental concepts of phase space motion, matched beams and modes of perturbation, along with mathematical models of analysis – from envelope to Vlasov-Poisson equations. The main emphasis is on providing a systematic description of incoherent and coherent resonance phenomena; parametric instabilities and sum modes; mismatch and halo; error driven resonances; and emittance exchange due to anisotropy, as well as the role of Landau damping. Their distinctive features are elaborated in the context of numerous sample simulations, and their potential impacts on beam quality degradation and beam loss are discussed. The book is intended for advanced beginners in accelerator research, and for experts interested in the mechanisms of direct space charge interaction and their modeling.

Edited by internationally 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 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 accelerator building and operation.

A Tour of the Subatomic Zoo: A guide to particle physics is a brief and ambitious expedition into the remarkably simple ingredients of all the wonders of nature. With hardly a mathematical formula, Professor Cindy Schwarz clearly explains the language and much of the substance of elementary particle physics for the 99% of students who do not aspire to a career in physics. Views of matter from the atom to the quark are discussed in a form that an interested

person with no physics background can easily understand. College and university courses can be developed around this book and it can be used alone or in conjunction with other material. Even college physics majors would enjoy reading this book as an introduction to particle physics. High-school, and even middle-school, teachers could also use this book to introduce this material to their students. It will also be beneficial for high-school teachers who have not been formally exposed to high-energy physics, have forgotten what they once knew, or are no longer up to date with recent developments.

I have been teaching courses on experimental techniques in nuclear and particle physics to master students in physics and in engineering for many years. This book grew out of the lecture notes I made for these students. The physics and engineering students have rather different expectations of what such a course should be like. I hope that I have nevertheless managed to write a book that can satisfy the needs of these different target audiences. The lectures themselves, of course, need to be adapted to the needs of each group of students. An engineering student will not qu- tion a statement like “the velocity of the electrons in atoms is ?1% of the velocity of light”, a physics student will. Regarding units, I have written factors h and c explicitly in all equations throughout the book. For physics students it would be preferable to use the convention that is common in physics and omit these constants in the equations, but that would probably be confusing for the engineering students. Physics students tend to be more interested in theoretical physics courses. However, physics is an experimental science and physics students should und- stand how experiments work, and be able to make experiments work.

Accelerator PhysicsSecond EditionWorld Scientific Publishing Company

This book introduces some of the key ideas of RF Superconductivity by using a pedagogic approach, and presents a comprehensive overview of the field. It is divided into four parts. The first part introduces the basic concepts of microwave cavities for particle acceleration. The second part is devoted to the observed behavior of superconducting cavities. In the third part, general issues connected with beam-cavity interaction and related issues for critical components are covered. The final part discusses applications of superconducting cavities to frontier accelerators of the future, drawing heavily on examples that are in their most advanced stage. Each part of the book ends in a problems section to illustrate and amplify text material as well as to draw on example applications of superconducting cavities to existing and future accelerators. FROM THE CONTENTS: * Basics * Performance of Superconducting Cavities * Couplers and Tuners * Frontier Accelerators

The use of non-standard technologies such as superconductivity, cryogenics and radiofrequency pose challenges for the safe operation of accelerator facilities that cannot be addressed using only best practice from occupational safety in conventional industry. This book introduces readers to different occupational safety issues at accelerator facilities and is directed to managers, scientists, technical personnel and students working at current or future accelerator facilities. While the focus is on occupational safety – how to protect the people working at these facilities – the book also touches on “machine safety” – how to prevent accelerators from doing structural damage to themselves. This open access book offers a first introduction to safety at accelerator facilities. Presenting an overview of the safety-related aspects of the specific technologies employed in particle accelerators, it highlights the potential hazards at such facilities and current prevention and protection

measures. It closes with a review of safety management and organization at accelerator facilities.

The development of high energy accelerators began in 1911, when Rutherford discovered the atomic nuclei inside the atom. Since then, progress has been made in the following: (1) development of high voltage dc and rf accelerators, (2) achievement of high field magnets with excellent field quality, (3) discovery of transverse and longitudinal beam focusing principles, (4) invention of high power rf sources, (5) improvement of high vacuum technology, (6) attainment of high brightness (polarized/unpolarized) electron/ion sources, (7) advancement of beam dynamics and beam manipulation schemes, such as beam injection, accumulation, slow and fast extraction, beam damping and beam cooling, instability feedback, etc. The impacts of the accelerator development are evidenced by the many ground-breaking discoveries in particle and nuclear physics, atomic and molecular physics, condensed matter physics, biomedical physics, medicine, biology, and industrial processing. This book is intended to be used as a graduate or senior undergraduate textbook in accelerator physics and science. It can be used as preparatory course material for graduate accelerator physics students doing thesis research. The text covers historical accelerator development, transverse betatron motion, synchrotron motion, an

introduction to linear accelerators, and synchrotron radiation phenomena in low emittance electron storage rings, introduction to special topics such as the free electron laser and the beam-beam interaction. Attention is paid to derivation of the action-angle variables of the phase space, because the transformation is important for understanding advanced topics such as the collective instability and nonlinear beam dynamics. Each section is followed by exercises, which are designed to reinforce the concept discussed and to solve a realistic accelerator design problem.

Awarded one of BookAuthority's best new Particle Physics books in 2019! Hands-On Accelerator Physics Using MATLAB® provides an introduction into the design and operational issues of a wide range of particle accelerators, from ion-implanters to the Large Hadron Collider at CERN. Many aspects from the design of beam optical systems and magnets, to the subsystems for acceleration, beam diagnostics, and vacuum are covered. Beam dynamics topics ranging from the beam-beam interaction to free-electron lasers are discussed. Theoretical concepts and the design of key components are explained with the help of MATLAB® code. Practical topics, such as beam size measurements, magnet construction and measurements, and radio-frequency measurements are explored in student labs without requiring access

to an accelerator. This unique approach provides a look at what goes on 'under the hood' inside modern accelerators and presents readers with the tools to perform their independent investigations on the computer or in student labs. This book will be of interest to graduate students, postgraduate researchers studying accelerator physics, as well as engineers entering the field. Features: Provides insights into both synchrotron light sources and colliders Discusses technical subsystems, including magnets, radio-frequency engineering, instrumentation and diagnostics, correction of imperfections, control, and cryogenics Accompanied by MATLAB® code, including a 3D-modeler to visualize the accelerators, and additional appendices which are available on the CRC Press website

This is the solutions manual for many (particularly odd-numbered) end-of-chapter problems in Subatomic Physics, 3rd Edition by Henley and Garcia. The student who has worked on the problems will find the solutions presented here a useful check on answers and procedures.

An introduction to various issues related to the theory and phenomenology of massive neutrinos for the nonexpert, also providing a discussion of results in the field for the active researcher. All the necessary techniques and logics are included and topics such as supersymmetry are covered.

An accessible introduction to nuclear and particle

physics with equal coverage of both topics, this text covers all the standard topics in particle and nuclear physics thoroughly and provides a few extras, including chapters on experimental methods; applications of nuclear physics including fission, fusion and biomedical applications; and unsolved problems for the future. It includes basic concepts and theory combined with current and future applications. An excellent resource for physics and astronomy undergraduates in higher-level courses, this text also serves well as a general reference for graduate studies.

Detailed enough to serve as both text and reference, this volume addresses topics vital to understanding high-power accelerators and high-brightness-charged particle beams, including stochastic cooling, high-brightness injectors, and the free electron laser. 1990 edition.

Research and development of high energy accelerators began in 1911. Since then, progresses achieved are:The impacts of the accelerator development are evidenced by the many ground-breaking discoveries in particle and nuclear physics, atomic and molecular physics, condensed matter physics, biology, biomedical physics, nuclear medicine, medical therapy, and industrial processing. This book is intended to be used as a graduate or senior undergraduate textbook in accelerator physics and science. It can be used as

preparatory course material in graduate accelerator physics thesis research. The text covers historical accelerator development, transverse betatron motion, synchrotron motion, an introduction to linear accelerators, and synchrotron radiation phenomena in low emittance electron storage rings, introduction to special topics such as the free electron laser and the beam-beam interaction. Hamiltonian dynamics is used to understand beam manipulation, instability and nonlinearity. Each section is followed by exercises, which are designed to reinforce the concept discussed and to solve a realistic accelerator design problem.

This BriefBook is a much extended glossary or a much condensed handbook, depending on the way one looks at it. It deals with detectors in particle and nuclear physics experiments. The authors describe, in encyclopedic format, the physics, the application, and the analysis of data from these detectors. Ample reference is made to the published literature. An introduction for newcomers, a reference for scientists.

This book deals with the new method of laser-driven acceleration for application to radiation biophysics and medicine. It provides multidisciplinary contributions from world leading scientist in order to assess the state of the art of innovative tools for radiation biology research and medical applications of ionizing radiation. The book contains insightful contributions on highly topical aspects

of spatio-temporal radiation biophysics, evolving over several orders of magnitude, typically from femtosecond and sub-micrometer scales. Particular attention is devoted to the emerging technology of laser-driven particle accelerators and their application to spatio-temporal radiation biology and medical physics, customization of non-conventional and selective radiotherapy and optimized radioprotection protocols.

This textbook fills the gap between the very basic and the highly advanced volumes that are widely available on the subject. It offers a concise but comprehensive overview of a number of topics, like general relativity, fission and fusion, which are otherwise only available with much more detail in other textbooks. Providing a general introduction to the underlying concepts (relativity, fission and fusion, fundamental forces), it allows readers to develop an idea of what these two research fields really involve. The book uses real-world examples to make the subject more attractive and encourage the use of mathematical formulae. Besides short scientists' biographies, diagrams, end-of-chapter problems and worked solutions are also included. Intended mainly for students of scientific disciplines such as physics and chemistry who want to learn about the subject and/or the related techniques, it is also useful to high school teachers wanting to refresh or update their knowledge and to interested non-experts.

In this book the characteristics of synchrotron radiation, including insertion device radiation, are described and derived from first principles. The reader is first introduced to the subject in an intuitive way in order to gain

familiarity with the underlying physical processes. A rigorous mathematical derivation of the theory follows. Since the characteristics of synchrotron radiation are intimately connected with the parameters of the electron beam and its accelerator, a basic introduction to electron beam dynamics and accelerator design is included. The book is aimed at graduate students and scientists working with synchrotron radiation.

This Open Access biography chronicles the life and achievements of the Norwegian engineer and physicist Rolf Widerøe. Readers who meet him in the pages of this book will wonder why he isn't better known. The first of Widerøe's many pioneering contributions in the field of accelerator physics was the betatron. He later went on to build the first radiation therapy machine, an advance that would eventually revolutionize cancer treatment. Hospitals worldwide installed his machine, and today's modern radiation treatment equipment is based on his inventions. Widerøe's story also includes a fair share of drama, particularly during World War II when both Germans and the Allies vied for his collaboration. Widerøe held leading positions in multinational industry groups and was one of the consultants for building the world's largest nuclear laboratory, CERN, in Switzerland. He gained over 200 patents, received several honorary doctorates and a number of international awards. The author, a professional writer and maker of TV documentaries, has gained access to hitherto restricted archives in several countries, which provided a wealth of new material and insights, in particular in relation to the war years. She tells here a gripping and illuminating

story.

Hardly any other discovery of the nineteenth century did have such an impact on science and technology as Wilhelm Conrad Röntgen's seminal find of the X-rays. X-ray tubes soon made their way as excellent instruments for numerous applications in medicine, biology, materials science and testing, chemistry and public security. Developing new radiation sources with higher brilliance and much extended spectral range resulted in stunning developments like the electron synchrotron and electron storage ring and the freeelectron laser. This handbook highlights these developments in fifty chapters. The reader is given not only an inside view of exciting science areas but also of design concepts for the most advanced light sources. The theory of synchrotron radiation and of the freeelectron laser, design examples and the technology basis are presented. The handbook presents advanced concepts like seeding and harmonic generation, the booming field of Terahertz radiation sources and upcoming brilliant light sources driven by laser-plasma accelerators. The applications of the most advanced light sources and the advent of nanobeams and fully coherent x-rays allow experiments from which scientists in the past could not even dream. Examples are the diffraction with nanometer resolution, imaging with a full 3D reconstruction of the object from a diffraction pattern, measuring the disorder in liquids with high spatial and temporal resolution. The 20th century was dedicated to the development and improvement of synchrotron light sources with an ever ongoing increase of brilliance. With ultrahigh brilliance sources, the 21st

century will be the century of x-ray lasers and their applications. Thus, we are already close to the dream of condensed matter and biophysics: imaging single (macro)molecules and measuring their dynamics on the femtosecond timescale to produce movies with atomic resolution.

This book describes the basic knowledge in nuclear, neutron, and reactor physics necessary for understanding the principle and implementation of accelerator driven subcritical nuclear reactors (ADSRs), also known as hybrid reactors. Since hybrid reactors may contribute to future nuclear energy production, the book begins with a discussion of the general energy problem. It proceeds by developing the elementary physics of neutron reactors, including the basic nuclear physics involved. The book then presents computational methods, with special emphasis on Monte Carlo methods. It examines the specifics of ADSR, starting from the neutron spallation source to safety features. A thorough discussion is given on the size of hybrid reactors, which follows very different constraints from that of critical reactors. The possibility to optimize the source importance is examined in detail. The discussion of the fuel evolution follows with its relevance to safety and to the waste production and incineration. The conditions for having a constant reactivity over sufficiently long lapse of time are also discussed. The book also evaluates a number of practical designs that have been proposed. Finally, the last chapter deals with the examination of proposed and possible waste transmutation policies and the role which could be

played by ADSR in this context. The potential advantage of the Thorium cycle is discussed as well as different scenarios that could be used to implement it.

This book explores the physics, technology and applications of particle accelerators. It illustrates the interconnections between applications and basic physical principles, enabling readers to better understand current and upcoming technologies and see beyond the paradigmatic borders of the individual fields. The reader will discover why accelerators are no longer just toys for scientists, but have also become modern and efficient nuclear workhorses. The book starts with an introduction to the relevant technologies and radiation safety aspects of accelerating electrons and ions from several keV to roughly 250 MeV. It subsequently describes the physics behind the interactions of these particle beams with matter. Mathematical descriptions and state-of-the-art computer models of energy-loss and nuclear interactions between the particle beams and targets round out the physics coverage. On this basis, the book then presents the most important accelerator applications in science, medicine, and industry, explaining and comparing more than 20 major application fields, encompassing semiconductors, cancer treatment, and space exploration. Despite the disparate fields involved, this book demonstrates how the same essential technology and physics connects all of these applications.

Particle Accelerator Physics covers the dynamics of relativistic particle beams, basics of particle guidance and focusing, lattice design, characteristics of beam

transport systems and circular accelerators. Particle-beam optics is treated in the linear approximation including sextupoles to correct for chromatic aberrations. Perturbations to linear beam dynamics are analyzed in detail and correction measures are discussed, while basic lattice design features and building blocks leading to the design of more complicated beam transport systems and circular accelerators are studied. Characteristics of synchrotron radiation and quantum effects due to the statistical emission of photons on particle trajectories are derived and applied to determine particle-beam parameters. The discussions specifically concentrate on relativistic particle beams and the physics of beam optics in beam transport systems and circular accelerators such as synchrotrons and storage rings. This book forms a broad basis for further, more detailed studies of nonlinear beam dynamics and associated accelerator physics problems, discussed in the subsequent volume.

This book is written for students who ever wondered about the mysterious and fascinating world of particle accelerators. What exciting physics and technologies lie within? What clever and ingenious ideas were applied in their seven decades of evolution? What promises still lay ahead in the future?Accelerators have been driving research and industrial advances for decades. This textbook illustrates the physical principles behind these incredible machines, often with intuitive pictures and simple mathematical models. Pure formalisms are

avoided as much as possible. It is hoped that the readers would enjoy the fascinating physics behind these state-of-the-art devices.The style is informal and aimed for a graduate level without prerequisite of prior knowledge in accelerators. To serve as a textbook, references are listed only on the more established original literature and review articles instead of the constantly changing research frontiers.

When Kai Zuber's pioneering text on neutrinos was published in 2003, the author correctly predicted that the field would see tremendous growth in the immediate future. In that book, Professor Zuber provided a comprehensive self-contained examination of neutrinos, covering their research history and theory, as well as their application to particle physics, astrophysics, nuclear physics, and the broad reach of cosmology; but now to be truly comprehensive and accurate, the field's seminal reference needs to be revised and expanded to include the latest research, conclusions, and implications. Revised as needed to be equal to the research of today, Neutrino Physics, Second Edition delves into neutrino cross sections, mass measurements, double beta decay, solar neutrinos, neutrinos from supernovae, and high energy neutrinos, as well as new experimental results in the context of theoretical models. It also provides entirely new discussion on: Resolution of the solar neutrino problem The first real-time measurement of

solar neutrinos below 1 MeV Geoneutrinos Long baseline accelerator experiments Written to be accessible to readers from diverse backgrounds, this edition, like the first, provides both an introduction to the field as well as the information needed by those looking to make their own contribution to it. And like the first edition, it whets the researcher's appetite, going beyond certainty to pose those questions that still need answers.

This textbook provides an introduction to radiation, the principles of interaction between radiation and matter, and the exploitation of those principles in the design of modern radiation detectors. Both radiation and detectors are given equal attention and their interplay is carefully laid out with few assumptions made about the prior knowledge of the student. Part I is dedicated to radiation, broadly interpreted in terms of energy and type, starting with an overview of particles and forces, an extended review of common natural and man-made sources of radiation, and an introduction to particle accelerators. Particular attention is paid to real life examples, which place the types of radiation and their energy in context. Dosimetry is presented from a modern, user-led point of view, and relativistic kinematics is introduced to give the basic knowledge needed to handle the more formal aspects of radiation dynamics and interaction. The explanation of the physics principles of interaction between radiation

and matter is given significant space to allow a deeper understanding of the various technologies based on those principles. Following an introduction to the ionisation mechanism, detectors are introduced in Part II, grouped according to the physical principle that underpins their functionality, with chapters covering gaseous detectors, semiconductor detectors, the scintillation process and light detectors. The final two chapters describe the phenomenology of showers and the design of calorimeters, and cover additional phenomena including Cherenkov and transition radiation and the detection of neutrinos. An appendix offers the reader a useful review of statistics and probability distributions. The mathematical formalism is kept to a minimum throughout and simple derivations are presented to guide the reasoning and facilitate understanding of the working principles. The book is unique in its wide scope and introductory level, and is suitable for undergraduate and graduate students in physics and engineering. The reader will acquire an awareness of how radiation and its exploitation are becoming increasingly relevant in the modern world, with over 140 experimental figures, detector schematics and photographs helping to relate the material to a broader research context.

The Black Book of Quantum Chromodynamics is an in-depth introduction to the particle physics of current and future experiments at particle accelerators. The

book offers the reader an overview of practically all aspects of the strong interaction necessary to understand and appreciate modern particle phenomenology at the energy frontier. It assumes a working knowledge of quantum field theory at the level of introductory textbooks used for advanced undergraduate or in standard postgraduate lectures. The book expands this knowledge with an intuitive understanding of relevant physical concepts, an introduction to modern techniques, and their application to the phenomenology of the strong interaction at the highest energies. Aimed at graduate students and researchers, it also serves as a comprehensive reference for LHC experimenters and theorists. This book offers an exhaustive presentation of the technologies developed and used by practitioners in the field of fixed-order perturbation theory and an overview of results relevant for the ongoing research programme at the LHC. It includes an in-depth description of various analytic resummation techniques, which form the basis for our understanding of the QCD radiation pattern and how strong production processes manifest themselves in data, and a concise discussion of numerical resummation through parton showers, which form the basis of event generators for the simulation of LHC physics, and their matching and merging with fixed-order matrix elements. It also gives a detailed presentation of the physics behind

the parton distribution functions, which are a necessary ingredient for every calculation relevant for physics at hadron colliders such as the LHC, and an introduction to non-perturbative aspects of the strong interaction, including inclusive observables such as total and elastic cross sections, and non-trivial effects such as multiple parton interactions and hadronization. The book concludes with a useful overview contextualising data from previous experiments such as the Tevatron and the Run I of the LHC which have shaped our understanding of QCD at hadron colliders.

This is the third and fully updated edition of the classic textbook on physics at the subatomic level. An up-to-date and lucid introduction to both particle and nuclear physics, the book is suitable for both experimental and theoretical physics students at the senior undergraduate and beginning graduate levels. Topics are introduced with key experiments and their background, encouraging students to think and empowering them with the capability of doing back-of-the-envelope calculations in a diversity of situations. Earlier important experiments and concepts as well as topics of current interest are covered, with extensive use of photographs and figures to convey principal concepts and show experimental data. The coverage includes new material on: Detectors and acceleratorsNucleon elastic form factor dataNeutrinos, their masses and

oscillationsChiral theories and effective field theories, and lattice QCDRelativistic heavy ions (RHIC)Nuclear structure far from the region of stabilityParticle astrophysics and cosmology Errata(s) Errata for Chapter 6 Errata for Chapter 11 This first open access volume of the handbook series contains articles on the standard model of particle physics, both from the theoretical and experimental perspective. It also covers related topics, such as heavy-ion physics, neutrino physics and searches for new physics beyond the standard model. A joint CERN-Springer initiative, the "Particle Physics Reference Library" provides revised and updated contributions based on previously published material in the well-known Landolt-Boernstein series on particle physics, accelerators and detectors (volumes 21A,B1,B2,C), which took stock of the field approximately one decade ago. Central to this new initiative is publication under full open access.
One of the field’s most respected introductory texts, Modern Physics provides a deep exploration of fundamental theory and experimentation. Appropriate for second-year undergraduate science and engineering students, this esteemed text presents a comprehensive introduction to the concepts and methods that form the basis of modern physics, including examinations of relativity, quantum physics, statistical physics, nuclear physics, high energy physics, astrophysics, and

cosmology. A balanced pedagogical approach examines major concepts first from a historical perspective, then through a modern lens using relevant experimental evidence and discussion of recent developments in the field. The emphasis on the interrelationship of principles and methods provides continuity, creating an accessible “storyline” for students to follow. Extensive pedagogical tools aid in comprehension, encouraging students to think critically and strengthen their ability to apply conceptual knowledge to practical applications. Numerous exercises and worked examples reinforce fundamental principles.

By the mid-1950s, a linear accelerator suitable for treating deep-seated tumors was built in the Stanford Microwave Laboratory and installed at Stanford Hospital. It served as a prototype for commercial units that were built later. Since that time, medical linear accelerators gained in popularity as major radiation therapy devices, but few basic training materials on their operation had been produced for use by medical professionals. C.J. Karzmark, a radiological physicist at Stanford University, was involved with medical linacs since their development, and he agreed to collaborate with Robert Morton of the Center for Devices and Radiological Health (formerly the Bureau of Radiological Health), U.S. Food and Drug Administration, in writing the first

edition of this primer.