Introduction To Particle Cosmology The Standard Model Of Cosmology And Its Open Problems Unitext For Physics

A substantial update of this award-winning and highly regarded cosmology textbook, for advanced undergraduates in physics and astronomy.

A comprehensive treatment of modern theoretical and experimental particle physics, in two volumes.

The Standard Model is the most comprehensive physical theory ever developed. This textbook conveys the basic elements of the Standard Model using elementary concepts, without the theoretical rigor found in most other texts on this subject. It contains examples of basic experiments, allowing readers to see how measurements and theory interplay in the development of physics. The author examines leptons, hadrons and quarks, before presenting the dynamics and the surprising properties of the charges of the different forces. The textbook concludes with a brief discussion on the discoveries of physics beyond the Standard Model, and its connections with cosmology. Quantitative examples are given, and the reader is guided through the necessary calculations. Each chapter ends in the exercises, and solutions to some problems are included in the book. Complete solutions are available to instructors at www.cambridge.org/9781107406094.

This book introduces particle physics, astrophysics and cosmology. Starting from an experimental perspective, it provides a unified view of these fields that reflects the very rapid advances being made. This new edition has a number of improvements and has been updated to describe the recent discovery of gravitational waves and astrophysical neutrinos, which started the new era of multimessenger astrophysics; it also includes new results on the Higgs particle. Astroparticle and particle physics share a common problem: we still don’t have a description of the main ingredients of the Universe from the point of view of its energy budget. Addressing these fascinating issues, and offering a balanced introduction to particle and astroparticle physics that requires only a basic understanding of quantum and classical physics, this book is a valuable resource, particularly for advanced undergraduate students and for those embarking on graduate courses. It includes exercises that offer readers practical insights. It can be used equally well as a self-study book, a reference and a textbook.

This book contains the lecture courses conducted at the School of the Theoretical Advanced Study Institute (TASI, Colorado, USA) on Elementary Particle Physics in 2002. In this School, three series of lectures are presented in parallel in the area of phenomenology, TeV-scale physics, and astroparticles physics. The phenomenology lecture series covered a broad spectrum of standard research techniques used to interpret present day and future collider data. The TeV-scale physics lecture series focused on modern speculations about physics beyond the Standard Model, with an emphasis on supersymmetry and extra-dimensional theories. The lecture series on astroparticle physics treated recent developments in theories of dark matter and dark energy, the cosmic microwave background, and prospects for the upcoming era of gravitational wave astronomy. Contents: Phenomenology Lecture Series: Neutrinos (Y Grossman); Precision Electroweak Physics (K Matchev); Effective Field Theories (I Z

Rothstein); Bottom Quark Physics and the Heavy Quark Expansion (M Luke); The Top Quark, QCD and New Physics (S Dawson); Tevatron Physics (J Womersley); TeV-Scale Physics Lecture Series: Non-Perturbative Sypersymmetry (J Terning); New Directions for New Dimensions: KaluzaOCoKlein Theory, Large Extra Dimensions and the Brane World (K R Dienes); New Ideas in Symmetry Breaking (M Quiros); Extra Dimensions and Branes (C Csaki); Astroparticle Physics Lecture Series: Introduction to Cosmology (M Trodden & S M Carroll); Dark Matter (K A Olive); Gravitational Waves from the Early Universe (A Buonanno). Readership: Researchers, academics and graduate students in high energy physics, mathematical physics and astrophysics."

The second edition of this well-received book is a clear and readable introduction to the ideas and concepts of particle physics. It bridges the gap between traditional textbooks on the subject and popular accounts that assume little or no background in the physical sciences on the part of the reader. This edition has been carefully revised throughout to provide a completely up-to-date and comprehensive overview of this fascinating subject. Historical aspects are discussed together with the most important recent experiments, and the theoretical development of the subject is traced from its foundations in relativity and quantum mechanics through to the very latest theories. There are also three completely new chapters covering quantum gravity, super-unification, and the relationship between particle physics and cosmology.

An accessible and carefully structured introduction to Particle Physics, including important coverage of the Higgs Boson and recent progress in neutrino physics. Fourth edition of this successful title in the Manchester Physics series Includes information on recent key discoveries including: An account of the discovery of exotic hadrons, byond the simple quark model; Expanded treatments of neutrino physics and CP violation in B-decays; An updated account of ‘physics beyond the standard model’, including the interaction of particle physics with cosmology Additional problems in all chapters, with solutions to selected problems available on the book’s website Advanced material appears in optional starred sections

The book provides theoretical and phenomenological insights on the structure of matter, presenting concepts and features of elementary particle physics and fundamental aspects of nuclear physics. Starting with the basics (nomenclature, classification, acceleration techniques, detection of elementary particles), the properties of fundamental interactions (electromagnetic, weak and strong) are introduced with a mathematical formalism suited to undergraduate students. Some experimental results (the discovery of neutral currents and of the W± and Z0 bosons; the quark structure observed using deep inelastic scattering experiments) show the necessity of an evolution of the formalism. This motivates a more detailed description of the weak and strong interactions, of the Standard Model of the microcosm with its experimental tests, and of the Higgs mechanism. The open problems in the Standard Model of the microcosm and macrocosm are presented at the end of the book. For example, the CP violation currently measured does not explain the matter-antimatter asymmetry of the observable universe; the neutrino oscillations and the estimated amount of cosmological dark matter seem to require new physics beyond the Standard Model. A list of other introductory texts, work reviews and some specialized publications is reported in the bibliography. Translation from the Italian Language Edition "Particelle e interazioni fondamentali" by Sylvie Braibant, Giorgio Giacomelli, and Maurizio Spurio

The scope of the book is to give an overview of the history of astroparticle physics, starting with the discovery of cosmic rays (Victor Hess, 1912) and its background (X-ray, radioactivity). The book focusses on the ways in which physics changes in the course of this history. The following changes run parallel, overlap, and/or interact: - Discovery of effects like X-rays, radioactivity, cosmic rays, new particles but also progress through non-discoveries (monopoles) etc. - The change of the description of nature in physics, as consequence of new theoretical questions at the beginning of the 20th century, giving rise to quantum physics, relativity, etc. - The change of experimental methods, cooperations, disciplinary divisions. With regard to the latter change, a main topic of the book is to make the specific multi-diciplinary features of astroparticle physics clear.

This book provides a comprehensive and instructive coverage of particle physics in the early universe, in a logical way. It starts from the thermal history of the universe by investigating some of the main arguments such as Big Bang nucleosynthesis, the cosmic microwave background (CMB) and the inflation, before treating in details the direct and indirect detection of dark matter and then some aspects of the physics of neutrino. Following, it describes possible candidates for dark matter and its interactions. The book is targeted at theoretical physicists who deal with particle physics in the universe, dark matter detection and astrophysical constraints, and at particle physicists who are interested in models of inflation or reheating. This book offers also material for astrophysicists who work with quantum field theory computations. All that is useful to compute any physical process is included: mathematical tables, all the needed functions for the thermodynamics of early universe and Feynman rules. In light of this, this book acts as a crossroad between astrophysics, particle physics and cosmology.

To cope with modern developments, especially in nuclear physics research, this textbook presents nuclear and particle physics from a unifying point of view. The first part, Analysis, is devoted to disentangling the substructure of matter. The second part, Synthesis, shows how the elementary particles may be combined to build hadrons and nuclei. A section on neutrino oscillations and one on nuclear matter at high temperatures bridge the field of "nuclear and particle physics" and "modern astrophysics and cosmology". New developments are also covered. This concise text has become a standard reference for advanced and undergraduate courses.

In this book, the author leads the reader, step by step and without any advanced mathematics, to a clear understanding of the foundations of modern elementary particle physics and cosmology. He also addresses current and controversial questions on topics such as string theory. The book contains gentle introductions to the theories of special and general relativity, and also classical and quantum field theory. The essential aspects of these concepts are understood with the help of simple calculations; for example, the force of gravity as a consequence of the curvature of the space-time. Also treated are the Big Bang, dark matter and dark energy, as well as the presently known interactions of elementary particles: electrodynamics, the strong and the weak interactions including the Higgs boson. Finally, the book sketches as yet speculative theories: Grand Unification theories, supersymmetry, string theory and the idea of additional dimensions of space-time. Since no higher mathematical or physics expertise

is required, the book is also suitable for college and university students at the beginning of their studies. Hobby astronomers and other science enthusiasts seeking a deeper insight than can be found in popular treatments will also appreciate this unique book.
This well-known introductory textbook gives a uniform presentation of nuclear and particle physics from an experimental point of view. The first part, Analysis, is devoted to disentangling the substructure of matter. This part shows that experiments designed to uncover the substructures of nuclei and nucleons have a similar conceptual basis, and lead to the present picture of all matter being constructed from a small number of elementary building blocks and a small number of fundamental interactions. The second part, Synthesis, shows how the elementary particles may be combined to build hadrons and nuclei. The fundamental interactions, which are responsible for the forces in all systems, become less and less evident in increasingly complex systems. Such systems are in fact dominated by many-body phenomena. A section on neutrino oscillations and one on nuclear matter at high temperatures bridge the field of "nuclear and particle physics" and "modem astrophysics and cosmology. The seventh revised and extended edition includes new material, in particular the experimental verification of the Higgs particle at the LHC, recent results in neutrino physics, the violation of CP-symmetry in the decay of neutral B-mesons, the experimental investigations of the nucleon's spin structure and outstanding results of the HERA experiments in deep-inelastic electron- and positron-proton scattering. The concise text is based on lectures held at the University of Heidelberg and includes numerous exercises with worked answers. It has been translated into several languages and has become a standard reference for advanced undergraduate and graduate courses.
This books aims at giving an overview over theoretical and phenomenological aspects of particle astrophysics and particle cosmology. To be of interest for both students and researchers in neighboring fields of physics, it keeps a balance between well established foundations that will not significantly change in the future and a more in-depth treatment of selected subfields in which significant new developments have been taking place recently. These include high energy particle astrophysics, such as cosmic high energy neutrinos, the interplay between detection techniques of dark matter in the laboratory and in high energy cosmic radiation, axion-like particles, and relics of the early Universe such as primordial magnetic fields and gravitational waves. It also contains exercises and thus will be suitable for both introductory and advanced courses in astroparticle physics.
A Simple Guide - Synopsis. One of the most brilliant and well-known scientists of all time, Albert Einstein, said, "If you can't explain it simply, you don't understand it well enough." Tony Harris proves with this concise guide that he does understand his subject matter very well indeed. The book he has written will inspire a whole new generation of scientists - a generation that will span all age groups.A Simple Guide to Popular Physics does exactly what the title promises - it delves into the mind-boggling world of particles, quantum physics and cosmology in a clear and user-friendly way. Inspired by Professor Brian Cox's statement that his simple action of rubbing a diamond between his hands had altered every electron in the entire universe, Tony Harris took it upon himself to delve further into the subject, exploring Pauli's Exclusion Principle - the principle

that no two electrons can be in the same quantum state in atoms - that Professor Cox had been introducing to the millions of people watching his TV presentation. Intrigued and, by his own admission, more than a little sceptical, Tony researched the principle and revised his own understanding of it, realising that by questioning Professor Cox's statement, he had increased his knowledge base substantially. And that is what led to this book.Have you ever asked yourself why, if the atoms that make up all matter consist mainly of empty space, structures don't collapse and you don't fall through your living room floor? Are you fascinated by the relativity between time and space? Perhaps you've wondered whether antimatter really exists, and if so, where is it? Where does it come from? Is it capable of existance as we understand the word? Is our reality even real?Tony Harris answers these questions and many more with this book, breaking concepts down into simple components and explaining each in user-friendly terms. Whatever your age, this concise guide will provide you with the background and the confidence you need to find out more, whether it be about the very tiny - particle physics and quantum mechanics - or the unimaginable massive, such as cosmology and the Big Bang.A Simple Guide is here to whet your appetite. It aims to give you a broad overview of the basics of particles, quantum physics and cosmology, introducing you to experiments conducted by some of the greatest scientists the world has known along with the work they have done. Armed with this solid grounding, you will then be in a good position to expand your knowledge, just like Tony did himself, and maybe even conduct the experiments yourself to observe the results first hand.The wonderful world of science is accessible to everyone. A Simple Guide provides the grounding; all you need to add is an enquiring mind.

The book discusses, based on a series of lectures given by the authors at the Universidad Autonoma of Madrid discusses the relation between cosmology and particle physics at a pedagogical level. The topics covered contain much valuable introductory materials. Very useful as a text for graduate students in this field.

"Neutrinos in Particle Physics, Astronomy and Cosmology" provides a comprehensive and up-to-date introduction to neutrino physics, neutrino astronomy and neutrino cosmology. The intrinsic properties and fundamental interactions of neutrinos are described, as is the phenomenology of lepton flavor mixing, seesaw mechanisms and neutrino oscillations. The cosmic neutrino background, stellar neutrinos, supernova neutrinos and ultrahigh-energy cosmic neutrinos, together with the cosmological matter-antimatter asymmetry and other roles of massive neutrinos in cosmology, are discussed in detail. This book is intended for researchers and graduate students in the fields of particle physics, particle astrophysics and cosmology. Dr. Zhizhong Xing is a professor at the Institute of High Energy Physics, Chinese Academy of Sciences, China; Dr. Shun Zhou is currently a postdoctoral fellow at the Max Planck Institute for Physics, Germany.

The second edition of this successful textbook is fully updated to include the

discovery of the Higgs boson and other recent developments, providing undergraduate students with complete coverage of the basic elements of the standard model of particle physics for the first time. Physics is emphasised over mathematical rigour, making the material accessible to students with no previous knowledge of elementary particles. Important experiments and the theory linked to them are highlighted, helping students appreciate how key ideas were developed. The chapter on neutrino physics has been completely revised, and the final chapter summarises the limits of the standard model and introduces students to what lies beyond. Over 250 problems, including sixty that are new to this edition, encourage students to apply the theory themselves. Partial solutions to selected problems appear in the book, with full solutions and slides of all figures available at www.cambridge.org/9781107050402.

This readable introduction to particle physics and cosmology discusses the interaction of these two fundamental branches of physics and considers recent advances beyond the standard models. Eight chapters comprise a brief introduction to the gauge theories of the strong and the electroweak interactions, the so-called grand unified theories, and general relativity. Ten more chapters address recent concepts such as composite fermions and bosons, supersymmetry, quantum gravity, supergravity, and strings theories, and relate them to modern cosmology and experimental astronomy.

This text gives an introduction to particle physics at a level accessible to advanced undergraduate students. It is based on 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 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 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 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 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 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 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: https://pplhcera.physics.ox.ac.uk/

This book contains the proceedings of the Fifth International Conference on Physics Beyond the Standard Models of Particle Physics, Cosmology and Astrophysics. It presents a brilliant overview of the status and future potential and trends in experimental and theoretical particle physics, cosmology and astrophysics, in the complimentary sectors of accelerator, non-accelerator and space physics.

What is the dark matter that fills the Universe and binds together galaxies? How was it produced? What are its interactions and particle properties? The paradigm of dark matter is one of the key developments at the interface of cosmology and elementary particle physics. It is also one of the foundations of the standard cosmological model. This book presents the state of the art in building and testing particle models for dark matter. Each chapter gives an analysis of questions, research directions, and methods within the field. More than 200 problems are included to challenge and stimulate the reader's knowledge and provide guidance in the practical implementation of the numerous "tools of the trade" presented. Appendices summarize the basics of cosmology and particle physics needed for any quantitative understanding of particle models for dark matter. This interdisciplinary textbook is essential reading for anyone interested in the microscopic nature of dark matter as it manifests itself in particle physics experiments, cosmological observations, and high-energy astrophysical phenomena: from graduate students and advanced undergraduates to cosmologists and astrophysicists interested in particle models for dark matter and particle physicists interested in early-universe cosmology and high-energy astrophysics. Request Inspection Copy

Cosmic inflation and dark energy hold the key to the origin and the eventual fate of the Universe. Despite the increasing prominence of these subjects in research and teaching over the past decade or more, no introductory textbook dedicated to these topics has been previously published. Dr. Konstantinos Dimopoulos is a highly regarded expert in the field, and an experienced communicator of the subject to students. In this book, he provides advanced undergraduate and early graduate students with an accessible introduction and equips them with the tools they need to understand the cosmology of cosmic inflation and dark energy. Features: Provides a concise, pedagogical "crash course" in big bang cosmology, focusing on the dynamics and the history of the Universe, with an emphasis on the role of dark energy Chapters contain questions and problems for readers to test their understanding The first book to make cosmic inflation and dark energy accessible to students

This book is an introduction to “multi-messenger” astrophysics. It covers the many different aspects connecting particle physics with astrophysics and cosmology and introduces astrophysics using numerous experimental findings recently obtained through the study of high-energy particles. Taking a systematic approach, it comprehensively presents experimental aspects from the most advanced laboratories and detectors, as well as the theoretical background. The book is aimed at graduate students and post-graduate researchers with a basic understanding of particle and nuclear physics. It will also be of interest to particle physicists working in accelerator/collider physics who are keen to understand the mechanisms of the largest accelerators in the Universe. The book draws on the extensive lecturing

experience of Professor Maurizio Spurio from the University of Bologna.

This book introduces the basic concepts of particle cosmology and covers all the main aspects of the Big Bang Model (expansion of the Universe, Big Bang Nucleosynthesis, Cosmic Microwave Background, large scale structures) and the search for new physics (inflation, baryogenesis, dark matter, dark energy). It also includes the majority of recent discoveries, such as the precise determination of cosmological parameters using experiments like WMAP and Planck, the discovery of the Higgs boson at LHC, the non-discovery to date of supersymmetric particles, and the search for the imprint of gravitational waves on the CMB polarization by Planck and BICEP. This textbook is based on the authors' courses on Cosmology, and aims at introducing Particle Cosmology to senior undergraduate and graduate students. It has been especially written to be accessible even for those students who do not have a strong background in General Relativity and quantum field theory. The content of this book is organized in an easy-to-use style and students will find it a helpful research guide.

An introduction to modern particle physics includes all the recent developments in elementary particle physics, as well as its connections with cosmology and astrophysics.

The book provides a comprehensive account of particle physics linking various aspects of particle physics in a coherent manner. This self-contained book not only cover basic concepts and recent developments but also overlaps between Astrophysics, Cosmology and Particle Physics, known as astroparticle physics. Several appendices are included to make the book self-contained.

For graduate students unfamiliar with particle physics, An Introductory Course of Particle Physics teaches the basic techniques and fundamental theories related to the subject. It gives students the competence to work out various properties of fundamental particles, such as scattering cross-section and lifetime. The book also gives a lucid summary of the main ideas involved. In giving students a taste of fundamental interactions among elementary particles, the author does not assume any prior knowledge of quantum field theory. He presents a brief introduction that supplies students with the necessary tools without seriously getting into the nitty-gritty of quantum field theory, and then explores advanced topics in detail. The book then discusses group theory, and in this case the author assumes that students are familiar with the basic definitions and properties of a group, and even SU(2) and its representations. With this foundation established, he goes on to discuss representations of continuous groups bigger than SU(2) in detail. The material is presented at a level that M.Sc. and Ph.D. students can understand, with exercises throughout the text at points at which performing the exercises would be most beneficial. Anyone teaching a one-semester course will probably have to choose from the topics covered, because this text also contains advanced material that might not be covered within a semester due to lack of time. Thus it provides the teaching tool with the flexibility to customize the course to suit your needs.

The Fourth Edition of Introduction to Cosmology provides a concise, authoritative study of cosmology at an introductory level. Starting from elementary principles and the early history of cosmology, the text carefully guides the student on to curved spacetimes, special and general relativity, gravitational lensing, the thermal history of the Universe, and cosmological models, including extended gravity models, black holes and Hawking's recent conjectures on the not-so-black holes. Introduction to Cosmology, Fourth Edition includes: New theoretical approaches and in-depth material on observational astrophysics and expanded sections on astrophysical phenomena Illustrations throughout and comprehensive references with problems at the end of each chapter and a rich index at the end of the book Latest observational results from WMAP9, ACT, and

Planck, and all cosmological parameters have been brought up to date. This text is invaluable for undergraduate students in physics and astrophysics taking a first course in cosmology. Extensively revised, this latest edition extends the chapter on cosmic inflation to the recent schism on eternal inflation and multiverses. Dark matter is discussed on galaxy and cluster scales, and dark matter candidates are presented, some requiring a five-dimensional universe and several representing various types of exotica. In the context of cosmic structures the cold dark matter paradigm is described. Dark energy models include the cosmological constant, quintessence and other single field models, f(R) models and models requiring extra dimensions.

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This book presents more than 200 problems, with detailed guided solutions, spanning key areas of particle physics and astrophysics. The selected examples enable students to gain a deeper understanding of these fields and also offer valuable support in the preparation for written examinations. The book is an ideal companion to Introduction to Particle and Astroparticle Physics: Multimessenger Astronomy and its Particle Physics Foundations, written by Alessandro De Angelis and Mário Pimenta and published in its second edition in Springer's Undergraduate Lecture Notes in Physics series in 2018. It can, however, also be used independently. The present book is organized into 11 chapters that match exactly those in the companion textbook, and each of the exercises is given a title to facilitate identification of the subject within that book. Some new exercises have been added because they are considered helpful on the basis of the experience gained by teachers while using the textbook. Beyond students on relevant courses, exercises and solutions in particle and astroparticle physics are of value for physics teachers and to all who seek aid to self-training.

Introduces the fundamentals of particle physics with a focus on modern developments and an intuitive physical interpretation of results.

The topic of the CVIII session of the Ecole de Physique des Houches, held in July 2017, was Effective Field Theory in Particle Physics and Cosmology. Effective Field Theory (EFT) is a general method for describing quantum systems with multiple length scales in a tractable fashion. It allows to perform precise calculations in established models (such as the Standard Models of particle physics and cosmology), as well as to concisely parametrise possible effects from physics beyond the Standard Models. The goal of this school was to offer a broad introduction to the foundations and modern applications of Effective Field Theory in many of its incarnations. This is all the more important as there are preciously few textbooks covering the subject, none of them in a complete way. In this book, the lecturers present the concepts in a pedagogical way so that readers can adapt some of the latest developments to their own problems. The chapters cover almost all the lectures given at the school and will serve as an introduction to the topic and as a reference manual to students and researchers.

Beginning with basic facts about the observable universe, this book reviews the complete range of topics that make up a degree course in cosmology and particle astrophysics. The book is self-contained - no specialised knowledge is required on the part of the reader, apart from undergraduate math and physics. This paperback edition targets students of physics, astrophysics and cosmology from advanced undergraduate to early graduate level.

Describes the branch of astronomy in which processes in the universe are investigated with experimental methods employed in particle-physics experiments. After a historical introduction the basics of elementary particles, Explains particle interactions and the relevant detection techniques, while modern aspects of astroparticle physics are described in a chapter on cosmology. Provides an orientation in the field of astroparticle physics that many beginners might seek and appreciate because the underlying physics fundamentals are presented with little mathematics, and the results are illustrated by many diagrams. Readers have a chance to enter this field of astronomy with a book that closes the gap between expert and popular level.