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Maurizio Spurio



Particles and Astrophysics

A Multi-Messenger Approach



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**Roland Diehl,Dieter H.
Hartmann,Nikos Prantzos**



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Particles and Astrophysics Maurizio Spurio, 2014-10-06 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

The Multi-Messenger Approach to High-Energy Gamma-Ray Sources Josep M. Paredes, Olaf Reimer, Diego F. Torres, 2007-07-17 This book provides a theoretical and observational overview of the state of the art of gamma ray astrophysics and their impact and connection with the physics of cosmic rays and neutrinos With the aim of shedding new and fresh light on the problem of the nature of the gamma ray sources particularly those yet unidentified this book summarizes contributions to a workshop that continues with the series initiated by the meeting held at Tonantzintla in October 2000 and Hong Kong in May 2004

Probes of Multimessenger Astrophysics Maurizio Spurio, 2018-12-07 I have taught from and enjoyed the first edition of the book The selection of topics is the best I've seen Maurizio Spurio gives very clear presentations using a generous amount of observational data James Matthews Louisiana State University This is the second edition of an introduction to multi messenger astrophysics It covers the many different aspects connecting particle physics with astrophysics and cosmology and introduces high energy astrophysics using different probes the electromagnetic radiation with techniques developed by traditional astronomy charged cosmic rays gamma rays and neutrinos with methods developed in high energy laboratories and gravitational waves recently observed using laser interferometers The book offers a comprehensive and systematic approach to the theoretical background and the experimental aspects of the study of the high energy universe The breakthrough discovery of gravitational waves motivated this new edition of the book to offer a more global and multimessenger vision of high energy astrophysics This second edition is updated and enriched with substantial new materials also deriving from the results obtained at the LIGO Virgo observatories For the first time it is now possible to draw the connection between gravitational waves traditional astronomical observations and other probes in particular gamma rays and neutrinos The book draws on the extensive courses of Professor Maurizio Spurio at the University of Bologna and it 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

Introduction to Particle and Astroparticle Physics Alessandro De Angelis, Mário

Pimenta,2018-06-19 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

Astroparticle Physics Claus Grupen,2020-01-27 This second revised and thoroughly updated edition of the successful textbook by Claus Grupen describes the branch of astrophysics known as astroparticle physics Using experimental methods known from cosmic ray and particle physics astroparticle physics investigates processes of highest energies taking place in the universe The new edition reports on progress made by recent discoveries in gravitational wave astronomy and neutrino astronomy including all details needed to understand recent discoveries in multi messenger experiments and also astrobiology After a historical introduction to the basics of elementary particles the author describes their interactions and the relevant detection techniques The main body of the book concerns cosmic rays as well as particle processes in astrophysics and cosmology including the physics of the early universe The book provides an orientation in the field of astroparticle physics that many beginners might be looking for It also presents new sections exploring the interface between particle physics and cosmic radiation and illustrates the impact of particle physics discoveries to astroparticle physics The physics is presented using little mathematics and the results are illustrated by many diagrams and illustrative scientific cartoons which ease the reading of the book Closing the gap between expert and popular level the book is highly recommended for undergraduate students in physics or astronomy It also includes an extensive glossary and a detailed index

Particle and Astroparticle Physics Alessandro De Angelis,Mário Pimenta,Ruben Conceição,2021-05-27 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

Dissertation Abstracts International ,1988

Multiple Messengers and Challenges in Astroparticle Physics Roberto Aloisio,Eugenio Coccia,Francesco Vissani,2018-02-27 This book designed as a tool for young researchers and graduate students reviews the main open problems and research lines in various fields of astroparticle physics cosmic rays gamma rays neutrinos cosmology and gravitational physics The opening section discusses cosmic rays of both galactic and extragalactic origin examining experimental results theoretical models and possible future developments The basics of gamma ray astronomy are then described including the detection methods and techniques Galactic and extragalactic aspects of the field are addressed in the light of recent discoveries with space borne and ground based detectors The review of neutrinos outlines the status of the investigations of neutrino radiation and brings together relevant formulae estimations and background information Three complementary issues in cosmology are examined observable predictions of inflation in the early universe effects of dark energy modified gravity in the large scale structure of the universe and neutrinos in cosmology and large scale structures The closing section on gravitational physics reviews issues relating to quantum gravity atomic precision tests space based experiments the strong field regime gravitational waves multi messengers and alternative theories of gravity

Introduction to Particle and Astroparticle Physics Alessandro De Angelis,Mário João Martins Pimenta,2015-09-05 This book written by researchers who had been professionals in accelerator physics before becoming leaders of groups in astroparticle physics introduces both fields in a balanced and elementary way requiring only a basic knowledge of quantum mechanics on the part of the reader The new profile of scientists in fundamental physics ideally involves the merging of knowledge in astroparticle and particle physics but the duration of modern experiments is such that people cannot simultaneously be practitioners in both Introduction to Particle and Astroparticle Physics is designed to bridge the gap between the fields It can be used as a self training book a consultation book or a textbook providing a modern approach to particles and fundamental interactions

Introduction to Particle and Astroparticle Physics Alessandro De Angelis,Mário João Martins Pimenta,2015-11-17 This book written by researchers who had been professionals in accelerator physics before becoming leaders of groups in astroparticle physics introduces both fields in a balanced and elementary way requiring only a basic knowledge of quantum mechanics on the part of the reader The early history of particle physics cannot be distinguished from the history of cosmic rays With the advent of accelerators however the importance of cosmic rays in particle physics was lost This situation persisted until the 1990s when novel techniques allowed breakthrough discoveries and exploration of new physics scales now requires returning to cosmic rays The new profile of scientists in fundamental physics ideally involves the merging of knowledge in astroparticle and particle physics but the duration of modern experiments is such that people cannot simultaneously be practitioners in both

Introduction to Particle and Astroparticle Physics is designed to bridge the gap between the fields It can be used as a self training book a consultation book or a textbook providing a modern approach to particles and fundamental interactions

Particle Cosmology and Astrophysics Dan Hooper,2024-05-14 This textbook is a graduate level introduction to cosmology and particle astrophysics which will also serve as a useful reference for researchers working in and across these areas The book covers cosmology as well as a variety of other topics in high energy particle astrophysics such as cosmic ray acceleration neutrino astrophysics gamma ray astrophysics and gravitational waves In addition it discusses many modern topics including dark matter candidates and searches the cosmic microwave background and high energy multi messenger astrophysics It should serve graduate level courses in particle astrophysics high energy astrophysics or cosmology particularly the early universe Problems are featured as an essential part of each chapter **Cosmology and Particle**

Astrophysics Lars Bergström,Ariel Goobar,2006-05-26 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 **Principles of Multimessenger Astronomy** Miroslav D.. Filipović,Nicholas Francis Hugh Tothill,2021 Astronomy has traditionally relied on capturing photons from cosmic sources to be able to understand the Universe During the 20th and 21st centuries different messengers have been added to the astronomer s toolset cosmic rays neutrinos and most recently gravitational waves Each of these messengers opens a new window on the Universe and a modern astronomer must be familiar with them As multimessenger astronomy becomes part of the mainstream each messenger must be understood not only as its own astronomical domain but as part of a whole endeavour A broad understanding of these messengers and their relationship to each other is the main goal of this book The unique physics of each messenger is introduced as well as the physics of their detection and interpretation An additional focus is the discussion of techniques and topics that are common to more than one messenger Treatments of historical background the effect of the Earth s atmosphere the transfer of radiation and measurement techniques are aimed at giving the reader a broad understanding of this new way of observing the cosmos Principles of multimessenger astronomy is designed to be both an introduction and reference to modern astronomy Particle Astrophysics, Second Edition D.H. Perkins,2009 The close relation between particle interactions and large scale development of the cosmos is a constant theme in the text with emphasis on the interplay between experiment and theory Jacket **Particle Astrophysics** ,2006 *Astrophysics with Radioactive Isotopes* Roland Diehl,Dieter H.

Hartmann,Nikos Prantzos,2018-10-11 Dealing with astrophysics derived from the radiation emitted by radioactive atomic nuclei this book describes the different methods used to measure cosmic radio isotopes It demonstrates how this astronomical window has contributed to the understanding of the sources and the chemical evolution of cosmic gas

Reference materials and explanations are included for students in advanced stages of their education. Nuclear reactions in different sites across the universe lead to the production of stable and unstable nuclei. Their abundances can be measured through different methods allowing to study the various nuclear processes taking place in cosmic environments. Nucleosynthesis is the cosmic formation of new nuclear species starting from hydrogen and helium resulting from the big bang origins. Stars create and eject synthesized nuclei during their evolution and explosions. Incorporation of the new interstellar composition into next generation stars characterises the compositional chemical evolution of cosmic gas in and between galaxies. Radioactive species have unique messages about how this occurs. Since the first Edition of this book published in 2011 with the title *Astronomy with Radioactivities*, long awaited new direct observations of supernova radioactivity have been made and are now addressed in two updated chapters dealing with supernovae. In this second Edition the advances of recent years beyond one dimensional treatments of stellar structure and stellar explosions towards 3 dimensional models have been included and led to significant re-writings in Chapters 3-5. The sections on the Solar System origins have been re-written to account for new insights into the evolution of giant molecular clouds. The chapter on diffuse radioactivities now also includes material measurements of radioactivities in the current solar system and their interpretations for recent nucleosynthesis activity in our Galaxy. Significant new results on gamma rays from positron annihilations have been accounted for in that chapter and led to new links with nucleosynthesis sources as well as interstellar transport processes. A new chapter now provides a description of interstellar processes often called chemical evolution thus linking the creation of new nuclei to their abundance observations in gas and stars. The experimental instrumental chapters on nuclear reaction measurements on gamma ray telescopes and pre-solar grain laboratories have been updated. Moreover new windows of astronomy that have been opened up in recent years have been included in the discussions of the multi-messenger approach that broadens the basis for astrophysical insights.

Solar, Stellar and Galactic Connections between Particle Physics and Astrophysics Alberto Carramiñana, Francisco Siddharta Guzmán Murillo, Tonatiuh Matos, 2007-03-23. The very small and the very large are intimately connected in Nature. Particle physics and astrophysics meet in fundamental questions: the structure and evolution of stars, their end and how this is manifested, how we think galaxies are created from matter we have yet to discover, and why we believe the most energetic particles cannot come from the most distant universe. During the IV Escuela Mexicana de Astrofísica (EMA) 2005 held in the beautiful colonial city of Morelia between 18 and 23 July 2005, we reviewed and explored the numerous connections between astrophysics and particle physics. The core of the school program aimed to advanced postgraduate students and young researchers in physics and astrophysics was formed by half a dozen extended lecture courses delivered by recognized experts in their fields. The written versions of these courses became the main substance of this book. Three review talks were devoted to the techniques and results of novel astronomical windows of the XX and XXI centuries: radioastronomy, gamma ray astronomy and gravitational

wave astronomy This volume includes also six short contributions presented as single talks during the EMA 2005 amplexes of experimental and theoretical research work presently conducted in Mexico and Latin America This book is the final product of a two year process centered on the EMA 2005 We believe it will serve as a guide not just to the participants but also to the communities of all interrelated fields

Cosmology and Particle Astrophysics L. Bergstrom, A. Goobar, 1999 In recent years there has been an increasing realisation that there are important areas of common ground between modern particle physics and high energy astrophysics This book provides a much needed readable yet comprehensive overview of particle physics and emphasises the close links between particle physics and cosmology Beginning with some basic facts about the observable universe the authors consider in successive chapters special and general relativity gravitational lenses cosmological models particles and fields thermodynamics and phase transitions in the early universe The cosmic microwave background structure formation and dark matter the inflationary universe gamma rays cosmic rays neutrinos and gravitational wave detectors are then discussed Recent discoveries such as neutrino mass and oscillations and measurements of the universe using supernovae are treated in a pedagogical and non technical manner A feature of this book is that it is self contained in that no specialised knowledge is required on the part of the reader except basic undergraduate mathematics and physics In addition to the more descriptive sections where the reader is able to get the flavour of the subject without needing to follow every step involved some chapters contain optional more technical parts which may be skipped by less advanced readers By combining the expertise of both a leading experimentalist and foremost theorist this book includes important aspects of both observational cosmology as well as more theoretical concepts Readership Undergraduate and postgraduate students of astronomy astrophysics cosmology particle physics theoretical physics and mathematical physics and those carrying out research in these fields Lars Bergström is Associate Professor in the Department of Physics at Stockholm University He has authored or co authored over 100 technical articles and scientific papers on physics in general and particle physics in particular Ariel Goobar is Postdoctoral Research Fellow in Experimental Particle Astrophysics at FYSIKUM Stockholm University Sweden As active researchers in the subjects of high energy neutrino astrophysics and cosmology both authors are internationally respected authorities in the field of particle astrophysics

From Ultra Rays to Astroparticles Brigitte Falkenburg, Wolfgang Rhode, 2012-12-30 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

disciplinary features of astroparticle physics clear

Astrophysics at Very High Energies Felix Aharonian, Lars

Bergström, Charles Dermer, 2013-04-05 With the success of Cherenkov Astronomy and more recently with the launch of NASA's Fermi mission very high energy astrophysics has undergone a revolution in the last years This book provides three comprehensive and up to date reviews of the recent advances in gamma ray astrophysics and of multi messenger astronomy Felix Aharonian and Charles Dermer address our current knowledge on the sources of GeV and TeV photons gleaned from the precise measurements made by the new instrumentation Lars Bergström presents the challenges and prospects of astroparticle physics with a particular emphasis on the detection of dark matter candidates The topics covered by the 40th Saas Fee Course present the capabilities of current instrumentation and the physics at play in sources of very high energy radiation to students and researchers alike This book will encourage and prepare readers for using space and ground based gamma ray observatories as well as neutrino and other multi messenger detectors

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