



COSMIC RAYS
AND
PARTICLE PHYSICS
SECOND EDITION

Thomas K. Gaisser, Ralph Engel
and Elisa Resconi

Cosmic Rays And Particle Physics

P.K.F. Grieder



Cosmic Rays And Particle Physics:

Cosmic Rays and Particle Physics Thomas K. Gaisser, 1990 Over recent years there has been marked growth in interest in the study of techniques of cosmic ray physics by astrophysicists and particle physicists Cosmic radiation is important for the astrophysicist because in the farther reaches of the universe For particle physicists it provides the opportunity to study neutrinos and very high energy particles of galactic origin More importantly cosmic rays constitute the background and in some cases possibly the signal for the more exotic unconfirmed hypothesized particles such as monopoles and sparticles Concentrating on the highest energy cosmic rays this book describes where they originate acquire energy and interact in accreting neutron stars supernova remnants in large scale shock waves It also describes their interactions in the atmosphere and in the earth how they are studied in surface and very large underground detectors and what they tell us

Cosmic Rays and Particle Physics Thomas K. Gaisser, Ralph Engel, Elisa Resconi, 2016-06-02 Fully updated for the second edition this book introduces the growing and dynamic field of particle astrophysics It provides an overview of high energy nuclei photons and neutrinos including their origins their propagation in the cosmos their detection on Earth and their relation to each other Coverage is expanded to include new content on high energy physics the propagation of protons and nuclei in cosmic background radiation neutrino astronomy high energy and ultra high energy cosmic rays sources and acceleration mechanisms and atmospheric muons and neutrinos Readers are able to master the fundamentals of particle astrophysics within the context of the most recent developments in the field This book will benefit graduate students and established researchers alike equipping them with the knowledge and tools needed to design and interpret their own experiments and ultimately to address a number of questions concerning the nature and origins of cosmic particles that have arisen in recent research

Astroparticle Physics Claus Grupen, 2005-12-06 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

Cosmic Rays at Earth P.K.F. Grieder, 2001-07-27 In 1912 Victor Franz Hess made the revolutionary discovery that ionizing radiation is incident upon the Earth from outer space He showed with ground based and balloon borne detectors that the intensity of the radiation did not change significantly between day and night Consequently the sun could not be regarded as the sources of this radiation and the question of its origin remained unanswered Today almost one hundred years later the question of the origin of the cosmic radiation still remains a mystery Hess discovery has given an enormous impetus to large areas of science in particular to

physics and has played a major role in the formation of our current understanding of universal evolution. For example, the development of new fields of research such as elementary particle physics, modern astrophysics, and cosmology are direct consequences of this discovery. Over the years, the field of cosmic ray research has evolved in various directions. Firstly, the field of particle physics that was initiated by the discovery of many so-called elementary particles in the cosmic radiation. There is a strong trend from the accelerator physics community to reenter the field of cosmic ray physics now under the name of astroparticle physics. Secondly, an important branch of cosmic ray physics that has rapidly evolved in conjunction with space exploration concerns the low energy portion of the cosmic ray spectrum. Thirdly, the branch of research that is concerned with the origin, acceleration, and propagation of the cosmic radiation represents a great challenge for astrophysics, astronomy, and cosmology. Presently, very popular fields of research have rapidly evolved such as high energy gamma ray and neutrino astronomy. In addition, high energy neutrino astronomy may soon initiate as a likely spin-off, neutrino tomography of the Earth, and thus open a unique new branch of geophysical research of the interior of the Earth. Finally, of considerable interest are the biological and medical aspects of the cosmic radiation because of its ionizing character and the inevitable irradiation to which we are exposed. This book is a reference manual for researchers and students of cosmic ray physics and associated fields and phenomena. It is not intended to be a tutorial. However, the book contains an adequate amount of background materials that its content should be useful to a broad community of scientists and professionals. The present book contains chiefly a data collection in compact form that covers the cosmic radiation in the vicinity of the Earth in the Earth's atmosphere at sea level and underground. Included are predominantly experimental but also theoretical data. In addition, the book contains related data, definitions, and important relations. The aim of this book is to offer the reader in a single volume a readily available, comprehensive set of data that will save him the need of frequent time-consuming literature searches.

Cosmic Rays and Particle Physics T. K. Gaisser, 1979 **A Thin Cosmic Rain** Michael W. Friedlander, 2002-11-30

Enigmatic for many years, cosmic rays are now known to be not rays at all but particles, the nuclei of atoms raining down continually on the earth where they can be detected throughout the atmosphere and sometimes even thousands of feet underground. This book tells the long running detective story behind the discovery and study of cosmic rays, a story that stretches from the early days of subatomic particle physics in the 1890s to the frontiers of high energy astrophysics today. Writing for the amateur scientist and the educated general reader, Michael Friedlander, a cosmic ray researcher, relates the history of cosmic ray science from its accidental discovery to its present status. He explains how cosmic rays are identified and how their energies are measured, then surveys current knowledge and theories of thin cosmic rain. The most thorough up-to-date and readable account of these intriguing phenomena, his book makes us party to the search into the nature, behavior, and origins of cosmic rays and into the sources of their enormous energy, sometimes hundreds of millions of times greater than the energy achievable in the most powerful earthbound particle accelerators. As this search led unexpectedly to the discovery

of new particles such as the muon pion kaon and hyperon and as it reveals scenes of awesome violence in the cosmos and offers clues about black holes supernovas neutron stars quasars and neutrinos we see clearly why cosmic rays remain central to an astonishingly diverse range of research studies on scales infinitesimally small and large Attractively illustrated engagingly written this is a fascinating inside look at a science at the center of our understanding of our universe

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

Cosmic Rays and Astrophysics Carlos Javier Solano Salinas,Jose Bellido,David Wahl,Oscar Saavedra,2009-05-29 The purpose of the School was to promote cosmic ray physics and astrophysics within the Latin American community These proceedings aim to provide a comprehensive overview of the theoretical and experimental aspects of Cosmic Ray Physics and Astrophysics The list of lecture topics includes experimental techniques primary spectrum and composition of cosmic rays high energy interactions gamma ray astronomy and GRBs neutrino astrophysics cosmic ray detectors simulation solar modulation and present status of the development and results from several present day observations such as the Pierre Auger IceCube HESS KASCADE etc The proceedings will provide students with a common background and will give them an updated panorama

Cosmic Radiations: From Astronomy to Particle Physics Giorgio Giacomelli,Maurizio Spurio,Jamal Eddine Derkaoui,2012-12-06 Non accelerator particle physicists especially those studying neutrino oscillation experiments will read with profit the in depth discussions of new results and their interpretations new guidelines are also set out for new developments in this and related fields Discussions are presented of neutrino oscillations neutrino astronomy high energy cosmic rays gravitational waves magnetic monopoles and dark matter The future large scale research projects discussed include the experiments on long baseline neutrino beams from CERN to Gran Sasso and Fermilab to the Soudan mine large underwater and under ice experiments the highest energy cosmic rays gravitational waves and the search for new particles and new phenomena

Proceedings of the Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics Symposium on Cosmic Rays, Elementary Particle Physics and Astrophysics,1965

Proceedings on the Symposium on Cosmic Rays, Elementary Particle Physics and Astrophysics Symposium on Cosmic Rays, Elementary Particle Physics and Astrophysics,1966

Neutrinos, Dark Matter and Co. Claus Grupen,2021-06-07 In this essential Claus Grupen discusses astroparticle physics in a short historical outline and describes

the latest results without going into mathematical detail. As an introduction to this new field of research, he gives an overview of what happens in the sky between stars and between galaxies. By now, many things are quite well understood, but with every solution found, new questions arise. The author also deals with this spectrum of questions with some answers. Today, astroparticle physics is an active interdisciplinary field of research that includes and combines astronomy, cosmic rays, and elementary particle physics. This Springer essential is a translation of the original German 1st edition, *essentials Neutrinos Dunkle Materie und Co* by Claus Grupen, published by Springer Fachmedien Wiesbaden GmbH, part of Springer Nature, in 2021. The translation was done with the help of artificial intelligence machine translation by the service DeepL.com. A subsequent human revision was done primarily in terms of content so that the book will read stylistically differently from a conventional translation. Springer Nature works continuously to further the development of tools for the production of books and on the related technologies to support the authors.

Cosmic Rays in the Earth's Atmosphere and Underground

Lev I. Dorman, 2004-08-24. The present monograph, as well as the next one, Dorman M2005, is a result of more than 50 years working in cosmic ray (CR) research. After graduation in December 1950, Moscow Lomonosov State University Nuclear and Elementary Particle Physics Division, the Team of Theoretical Physics, my supervisor Professor D. I. Blokhintsev planned for me as a winner of a Red Diploma to continue my education as an aspirant, a graduate student, to prepare for Ph.D. in his very secret Object in the framework of what was in those times called the Atomic Problem. To my regret, the KGB withheld permission, and I together with other Jewish students who had graduated Nuclear Divisions of Moscow and Leningrad Universities and Institutes were faced with a real prospect of being without any work. It was our good fortune that at that time there was being brought into being the new Cosmic Ray Project, what at that time was also very secret but not as secret as the Atomic Problem, and after some time we were directed to work on this Project. It was organized and headed by Prof. S. N. Vernov, President of All Union Section of Cosmic Rays, and Prof. N. V. Pushkov, Director of IZMIRAN. Prof. E. L. Feinberg headed the theoretical part of the Project.

Cosmic Rays Steff Jaywan, Cosmic rays are an intriguing aspect of astrophysics originating from various sources in the universe such as supernovae, pulsars, and even black holes. They consist of charged particles accelerated to incredible energies, often far beyond what our most powerful particle accelerators on Earth can achieve. These particles, when they collide with the Earth's atmosphere, create secondary particles in a cascade of interactions leading to a fascinating array of phenomena. Studying cosmic rays provides valuable insights into the universe's most extreme environments and processes. They offer clues about the composition of cosmic objects, the nature of dark matter, and the magnetic fields permeating space. Moreover, understanding cosmic rays is crucial for space exploration as they pose radiation hazards to astronauts and spacecraft. Researchers use ground-based detectors, high-altitude balloons, and even satellites to study cosmic rays from different vantage points. By analyzing the energy spectrum, arrival directions, and particle types, scientists aim to unlock the mysteries surrounding these enigmatic messengers from the cosmos.

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

The Particle Odyssey Frank Close, Michael Marten, Christine Sutton, 2004-08-26 During the 20th century scientists discovered what the Universe is made of as the 21st century begins they are preparing experiments to find out how it came to be like this This great adventure which will involve a metaphorical journey back in time to within a billionth of a second of the Big Bang is the latest stage in the quest to understand the nature of the matter that makes our Universe and the forces that govern it The Particle Odyssey takes the reader on a spectacularly illustrated journey to the heart of matter In clear non technical language the authors describe the key experiments and fundamental discoveries which have led to our current understanding of the origins and nature of the material universe In this fascinating book you will find individual portraits of all the major subatomic particles from the electron to the top quark The authors describe the history of experimental particle physics its origins in the discovery of X rays in 1895 the dissection of the atom by Rutherford and others the unexpected revelations of the cosmic rays the explosion of new particles in the 1950s and 60s the discovery of quarks and the rise of the standard model in the last part of the 20th century And they also look at the great challenges that face physicists today where did antimatter go what is dark matter can there be a theory of everything and the experiments they are devising to explore them The Particle Odyssey brings together and presents with style over 100 of the best images of particle events mysterious abstract beautiful pictures of the tracks of subatomic particles as they speed curve dance or explode through cloud and bubble chambers stacks of photographic emulsion and the giant multi element detectors of modern experiments Here are spiralling electrons the tell tale vees of strange particles matter and antimatter born from raw energy energetic jets of particles spraying out from the decay points of quarks and gluons A further 250 pictures many taken specially for this book illustrate the laboratories experiments and personalities of over a century of particle physics This superb book is a testament to the work of big science and one of the great detective stories of our age *High Energy Cosmic Rays* Todor Stanev, 2012-03-01 Offers an accessible text and reference a cosmic ray manual for graduate students entering the field and

high energy astrophysicists will find this an accessible cosmic ray manual Easy to read for the general astronomer the first part describes the standard model of cosmic rays based on our understanding of modern particle physics Presents the acceleration scenario in some detail in supernovae explosions as well as in the passage of cosmic rays through the Galaxy Compares experimental data in the atmosphere as well as underground are compared with theoretical models *Physics and Astrophysics of Ultra High Energy Cosmic Rays* M. Lemoine, G. Sigl, 2001-12-14 The International School on Physics and Astrophysics of Ultra High Energy Cosmic Rays UHECR2000 was held at the Observatoire de Paris Meudon on June 26 29 2000 This was the rst international school speci cally dedicated to ultra high energy cosmic rays Its aim was to familiarize with and attract students physicists and astronomers into this quickly developing new research eld The mysterious and currently unknown origin of the most energetic particles observed in Nature has triggered in recent years theoretical speculations ranging from electromagnetic acceleration to as yet undiscovered physics beyond the Standard Model It has also lead to the development of several new detection concepts and experimental projects some of which are currently under construction By its nature the eld of ultra high energy cosmic rays is therefore highly interdisciplinary and borrows from astrophysics and cosmology via particle physics to experimental physics and observational astronomy One main aspect of the school was to emphasize and take advantage of this interdisciplinarity The lectures were grouped into subtopics and are reproduced in this volume in the following order After a general introductory lecture on cosmic rays follow two contributions on experimental detection techniques followed by three lectures on acceleration in astrophysical objects The next four contributions cover all major aspects of propagation and interactions of ultra high energy radiation including speculative issues such as new interactions *Cosmic Rays* A. M. Hillas, 2013-10-22 Cosmic Rays is a two part book that first elucidates the discovery nature and particles produced by cosmic rays This part also looks into the primary cosmic radiation radio waves from the galaxy extensive air showers origin of cosmic rays and other cosmic radiations Part 2 consists of reprinted papers involving cosmic rays Papers 1 to 10 treat the nature of the radiation arranged chronologically in Papers 11 to 16 the scene moves away from the Earth **Cosmic Rays for Particle and Astroparticle Physics** S. Giani, C. Leroy, P. G. Rancoita, 2011 The conference was aimed at promoting contacts between scientists involved in solar terrestrial physics space physics astroparticle physics and cosmology both from the theoretical and the experimental approach The conference was devoted to physics and physics requirements survey of theoretical models and performances of detectors employed or to be employed in experiments for fundamental physics astroparticle physics astrophysics research and space environment OCo including Earth magnetosphere and heliosphere and solar terrestrial physics Furthermore cosmic rays have been used to extend the scientific research experience to teachers and students with air shower arrays and other techniques Presentations included the following subjects advances in physics from present and next generation ground and space experiments dark matter double beta decay high energy astrophysics space environment trapped particles propagation of cosmic rays in the Earth

atmosphere Heliosphere Galaxy and broader impact activities in cosmic rays science The open and flexible format of the Conference was conducive to fruitful exchanges of points of view among participants and permitted the evaluation of the progresses made and indicated future research directions The participants were experienced researchers but also graduate students MSc and PhD and recent postdoctoral fellows

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