



# Cosmic Radiations: From Astronomy to Particle Physics

Edited by

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# Cosmic Radiations From Astronomy To Particle Physics

**Brigitte Falkenburg, Wolfgang Rhode**



## **Cosmic Radiations From Astronomy To Particle Physics:**

*Cosmic Radiations: From Astronomy to Particle Physics* Giorgio Giacomelli, Maurizio Spurio, Jamal Eddine Derkaoui, 2001-11-30 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

**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** 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

**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

**High Energy Cosmic Rays** Todor Stanev,2010-03-10 Cosmic rays are an essential part of the universe Their origin is related to many important astrophysical processes such as star formation stellar evolution supernova explosions and the state of interstellar matter in the Galaxy Cosmic Ray Physics reviews our present knowledge of cosmic rays describing how they are born in a wide range of cosmic processes how they are accelerated and how they interact with matter magnetic fields and radiation during their journey across the Galaxy The book also describes the detection of cosmic rays and the processes which take place both at the top and within the Earth's atmosphere The author also describes the very important area of the underground detection of very high energy cosmic rays and particles such as neutrinos The book is divided into two parts the first describing the standard model of cosmic rays and contemporary challenges and the second part dealing with very high energy cosmic rays that cannot be detected directly in satellite and balloon experiments and with gamma ray and neutrino astronomy It is in this particular aspect of the book that the greatest developments have taken place during the 5 years since the first edition was completed Consequently it is in the chapters cosmic ray showers their spectrum on high energy neutrinos and on gamma ray astronomy of this revised and updated 2nd edition that a considerable amount of new material has been incorporated with more minor revisions and updating taking place in the first part of the book Students

and lecturers of advanced undergraduate courses on cosmic rays and astroparticle physics as well as post graduates and researchers will continue to find this book a valuable source of learning and reference

**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 multidisciplinary features of astroparticle physics clear

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

**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 time 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 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

**Cosmic Rays** Alessandro De Angelis, 2023-11-01 In recent years cosmic rays have become the protagonists of a new scientific revolution We are able today to film the Universe with telescopes of completely novel conception recording information from many different messengers and accessing previously unknown cosmic regions Written by a recognized authority in physics this book takes readers on a captivating journey through the world of cosmic rays their role in the revolutionary field of multi messenger astronomy their production from powerful accelerators close to the surfaces of black holes and compact objects reaching the highest levels of energy observed in nature and the implications this has for our understanding of the Universe Through the stories of pioneering scientists explorations of cutting edge technologies and simple explanations related to particle physics quantum mechanics and astrophysics the book provides an illuminating state of the art introduction to the current state of high energy astrophysics The book was written in straightforward yet rigorous language so as to be accessible to the greater public For those curious about the cosmos and cosmic gamma rays nuclei neutrinos and gravitational waves from casual observers to professional astronomers and physicists the book is a must read offering a thrilling adventure into the future of astronomy and particle physics

**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: radio astronomy, gamma ray astronomy, and gravitational wave astronomy. This volume includes also six short contributions presented as single talks during the EMA 2005: amplitudes 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. Physics and Astrophysics of Ultra High Energy Cosmic Rays M. Lemoine, G.

Sigl, 2014-01-15 *Early History of Cosmic Ray Studies* Yataro Sekido, Harry Elliot, 2012-12-06 On the occasion of the International Conference on Cosmic Rays held in Kyoto in August 1979, five aged members of the cosmic ray fraternity: H. Elliot, V. L. Ginzburg, B. Peters, Y. Sekido, and J. A. Simpson met together at a dinner party devoted to the enjoyment of Japanese cuisine and reminiscences of our younger days. This pleasant occasion called to mind of our own age as well as some eminent seniors not present at the time: the many friends of the conference whose recollections would have further enriched and enlivened our evening. By the time the dinner came to an end, we had agreed that the compilation of a more extensive collection of personal reminiscences would be an interesting and worthwhile undertaking. Accordingly, the next day we held an editorial meeting to draw up a list of potential authors, and two of us, the present editors, started work on the project. In putting the book together, our intention has been to try to capture and record through these personal accounts something of the atmosphere, the excitement, and the frustrations of research in cosmic rays as experienced at first hand by some of the practitioners in the field. It has never been our intention that it should comprise a systematic history of the subject. Neither unfortunately can it be a fully representative collection, since practical limits to the size of the volume alone would preclude that. **Gravitation, Cosmology, and Cosmic-Ray Physics** National Research Council, Board on Physics and

Astronomy, Physics Survey Committee, Panel on Gravitation, Cosmology, and Cosmic-Ray Physics, 1986-02-01 *Cosmic Ray Physics* Veronica Bindi, Mercedes Paniccia, Martin Pohl, 2023-03-23 This book introduces you to the physics of cosmic rays: charged particles which reach us from known and maybe unknown sources in the cosmos. Starting from a brief history of this

fascinating field it reviews what we know about the creation of elements in the Big Bang and inside stars It explains cosmic accelerators reaching fabulous energies It follows the life cycle of cosmic rays all the way from their sources to detection near on or below Earth The central three chapters cover what we know about them at the level of the solar system the Milky Way and the Universe at large Up to date experimental results are presented in detail showing how they are obtained and interpreted The book provides an accessible overview of this lively and diversified research field It will be of interest to undergraduate physics students beginning their studies on astronomy cosmology and particle physics It is also accessible to the general public by concentrating mathematical and technical detail into Focus Boxes Key features Complete introductory overview of cosmic ray physics Covers the origins acceleration transport mechanisms and detection of these particles Mathematical and technical detail is kept separate from the main text

**Messengers from the Cosmos** Francesco Riggi, 2023-03-30 This book provides a complete overview of the development of cosmic ray physics with historical and educational considerations from early evidence of the existence of extraterrestrial radiation up to the most recent applications of cosmic ray muons in different aspects of daily life Many of the original results that contributed to the study of cosmic radiation are presented and discussed accompanied by bibliographic references numerous in depth appendices about 200 illustrations and a large chapter dedicated to the overall impact of cosmic rays The book includes sections on among other topics the debate on the corpuscular or radiative nature of cosmic radiation the development of early techniques for detecting cosmic particles the properties and composition of primary and secondary radiation and the interaction of cosmic muons in matter and a long list of their recent applications ranging from the muon tomography techniques to the investigation of the stability of civil buildings The book is addressed to a wide audience and thus while it is used for introductory cosmic ray physics courses at the bachelor s or master s level high school students and teachers involved in educational projects around cosmic rays also benefit from its many historical and educational aspects

*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 yond 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

*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

*Astrophysics at Ultra-High Energies* Maurice Mandel Shapiro, Todor Stanev, J. P. Wefel, 2007 This book introduces young researchers to the exciting field of ultra high energy astrophysics including charged particles gamma rays and neutrinos At ultra high energy the radiation is produced by interactions of cosmic ray particles accelerated in explosive events such as supernovae or hypernovae black holes or possibly the big bang Through direct contact with senior scientists now actively planning the next generation of experiments models the excitement and motivation for research at ultra high energy was conveyed The underpinning of these fields is a synthesis of knowledge and techniques from nuclear and particle physics astronomy and cosmology Informing the participants of this background how it was derived and the new challenges for the future are the major goal Further the course has helped to foster new astrophysical research and promoted contacts which have resulted in new collaborations

Sample Chapter s Chapter 1 Gamma Ray Burst Discoveries With Swift 352 KB Contents Powerful Astrophysical Sources Gamma Ray Bursts Discoveries with Swift A Wells Gamma Ray Burst Phenomenology in the Swift Era P M r sziros The Nature of Dark Matter P L Biermann Cosmic Rays Particle Acceleration and Propagation in the Galaxy V S Ptuskin GRB as Sources of Ultra High Energy Particles P M r sziros The KASCADE Grande Experiment F Cossavella et al Gamma Ray and Neutrino Astronomy Study of Galactic Gamma Ray Sources with Milagro J Goodman The GLAST Mission and Observability of Supernovae Remnants O Tibolla First Results from AMANDA using TWR System A Silvestri and other papers Readership Academics in astrophysics high energy cosmology and earth science

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