Preface

In 1912, Victor Hess discovered cosmic rays. His discovery opened the skies in many regards: for detecting extraterrestrial particles, for making energies beyond the MeV scale of nuclear physics accessible, for interpreting all kind of astrophysical data in terms of cosmic messenger particles, and finally, for giving cosmology an empirical basis. In the 1920s, it turned out that the so-called *Höhenstrahlung* has an extraterrestrial origin and contains charged particles such as the electron. The discovery of the positron in 1932 inaugurated the detection of a plethora of new subatomic particles. With the rise of the big particle accelerators in the early 1960s, cosmic ray studies shifted from particle physics to astrophysics. The cosmic microwave background discovered in 1965 gave support to the *big bang* model of cosmology and made cosmology an empirical science. In the late 1980s, with the experiments that measured the solar neutrino flux, part of the particle physics community moved back to cosmic ray studies and astroparticle physics began. The experiments of astroparticle physics use particle detectors arranged to telescopes. Hence, astroparticle physics is doing particle physics by means of telescopes, and vice versa, doing astrophysics by means of particle detectors. Cosmic rays are messenger particles that carry information about exploding and collapsing stars (in particular, supernovae, their remnants, and black holes), the large-scale structure of the universe, and the microwave afterglow of the *big bang*. Their investigation is one of the most fascinating fields of modern physics.

This book may be read on its own as an introduction to a fascinating multi-faceted field of research, but also used in addition to undergraduate or graduate lectures in astroparticle physics. It covers the historical experiments and lines of thought to which lectures cannot give sufficient attention. The material presented here makes the bridge from the beginnings of radioactivity research, particle physics, astrophysics, and cosmology in the early days of quantum theory and relativity, to the current foundations of physical knowledge, and to the questions and methods of a future physics. It shows that fundamental research is fascinating and of great importance, and that it seems worth tremendous efforts to the physicists.

At the centenary of the pioneering phenomenon found by Victor Hess, we present a historical introduction into astroparticle physics here. We think that the historical

approach is a good thread for understanding the many experimental methods, phenomena, and models employed in astroparticle physics, the ways in which they are linked to each other, as well as their relations to their neighboring disciplines of particle physics, astrophysics, and cosmology. Each of these fields on its own is highly complex, and to learn a mixture of them before getting to the bottom of any may be confusing for beginners. We hope that this complex body of knowledge is made more transparent by a historical account of the different research traditions which come together in current astroparticle physics.

Astroparticle physics has emerged from several distinct fields of research. Indeed, these fields have not completely grown together as long as physics does not dispose of a unified "theory of everything". Nevertheless the models and experiments of astroparticle physics are much more than provisional or piece-meal physics. They are no less and no more than surveys and maps of our knowledge of the universe at a small scale and at a large scale. On the way in *terra incognita*, careful cartography of the details is indispensable. Indeed astroparticle physics aims at establishing as many experimental details as possible about cosmic rays, their particle nature, their spectrum, their astrophysical sources, and the mechanisms of their acceleration. But in distinction to other scientific disciplines, this gathering of details does not give rise to increasing specialization. Quite to the contrary, the history of the different branches of physics grown together in astroparticle physics shows the merging of very distinct scientific traditions.

The book is addressed to undergraduate and graduate students of physics and to their teachers. It may serve as background material for lectures. It mays also serve the students and teachers of other faculties, in particular philosophers and historians of science, and everybody interested in a fascinating field of research in physics. To historians and philosophers of science it gives an overview as well as detailed information of a new sub-discipline of physics that has not been studied yet as a whole, but only in partial approaches to the history of particle physics, cosmology, etc., and to their epistemological aspects. Historians of science will read the book as a history written by the physicists, with all the advantages and disadvantages of objective expert knowledge combined with subjective memory. Philosophers of science will find in the book a lot of epistemological material, most of which has been neglected by a philosophy of physics that has traditionally been focusing on the theories rather than the phenomena of physics, even though the latter are most important constraints of the former. The history, the current shape, and the goals of astroparticle physics raise deep epistemological questions about the grounds of a discipline grown together from distinct scientific traditions in search for unified knowledge. But these philosophical questions are kept apart here. They will be discussed in a follower volume on the question of what kind of knowledge astroparticle physics gathers about particles from cosmic sources.

The authors of the book reflect the various approaches to astroparticle physics. All of them substantially contributed to developing the many-faceted methods and to the results of this field of research. We should add that the collection of subjects presented here is far from being complete. We thank to the authors and we apologize for all neglected subjects and all the colleagues and their merits which could not be included in the book.

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