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COMPILED BY VIRGINIA GRECO, CERN

Relativity Matters: From Einstein's EMC2 to Laser Particle Acceleration and Quark-Gluon Plasma

By Johann Rafelski

Springer

Also available at the CERN bookshop

This monograph on special relativity (SR) is presented in a form accessible to a broad readership, from pre-university level to undergraduate and graduate students. At the same time, it will also be of great interest to professional physicists.

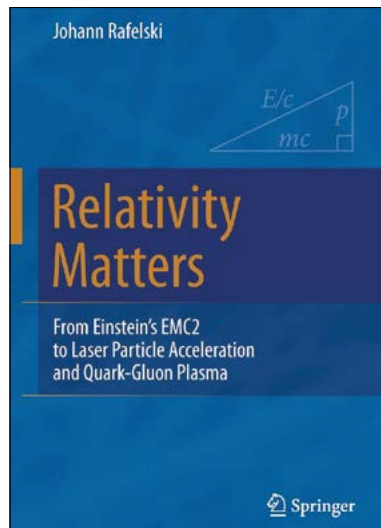
Relativity Matters has all the hallmarks of becoming a classic with further editions, and appears to have no counterpart in the literature. It is particularly useful because at present SR has become a basic part not only of particle and space physics, but also of many other branches of physics and technology, such as lasers. The book has 29 chapters organised in 11 parts, which cover topics from the basics of four-vectors, space-time, Lorentz transformations, mass, energy and momentum, to particle collisions and decay, the motion of charged particles, covariance and dynamics.

The first half of the book derives basic consequences of the SR assumptions with a minimum of mathematical tools. It concentrates on the explanation of apparently paradoxical results, presenting and refuting counterarguments as well as debunking various incorrect statements in elementary textbooks. This is done by cleverly exploiting the Galilean method of a dialogue between a professor, his assistant and a student, to bring out questions and objections.

The importance of correctly analysing the consequences for extended and accelerating bodies is clearly presented. Among the many "paradoxes", one notes the accelerating rocket problem that the late John Bell used to tease many of the world's most prominent physicists with. Few of them provided a perfectly satisfactory answer.

The second half of the book, starting from part VII, covers the usual textbook material and techniques at graduate level, illustrated with examples from the research frontier. The introductions to the various chapters and subsections are still enjoyable for a broader readership, requiring little mathematics. The author does not avoid technicalities such as vector and matrix algebra and symmetries, but keeps them to a minimum. However, in the parts dealing with electromagnetism, the reader is assumed to be reasonably familiar with Maxwell's equations.

There are copious concrete exercises and solutions. Throughout the book, indeed, every



chapter is complemented by a rich variety of problems that are fully worked out. These are often used to illustrate quantitatively intriguing topics, from space travel to the laser acceleration of charged particles.

An interesting afterword concluding the book discusses how very strong acceleration becomes a modern limiting frontier, beyond which SR in classical physics becomes invalid. The magnitude of the critical accelerations and critical electric and magnetic fields are qualitatively discussed. It also briefly analyses attempts by well-known physicists to side-step the problems that arise as a consequence.

Relativity Matters is excellent as an undergraduate and graduate textbook, and should be a useful reference for professional physicists and technical engineers. The many non-specialist sections will also be enjoyed by the general, science-interested public.

• Torleif Ericson, CERN

The Standard Theory of Particle Physics: Essays to Celebrate CERN's 60th Anniversary

By Luciano Maiani and Luigi Rolandi (eds.)

World Scientific

Also available at the CERN bookshop

This book is a collection of articles dedicated to topics within the field of Standard Model physics, authored by some of the main players in both its theory and experimental development. It is edited by Luciano Maiani and Luigi Rolandi, two well-known figures in high-energy physics.

The volume has 21 chapters, most of them

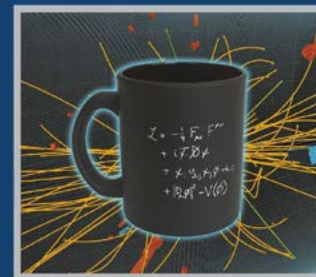
Advanced Series on
Directions in High Energy Physics — Vol. 29

THE STANDARD THEORY OF PARTICLE PHYSICS

Essays to Celebrate CERN's 60th Anniversary

Editors

Luciano Maiani and Luigi Rolandi



devoted to very specific subjects. The first chapters take the reader through a fascinating tour of the history of the field, starting from the earliest days, around the time when CERN was established. I particularly enjoyed reading some recollections of Gerard 't Hooft, such as: "Asymptotic freedom was discovered three times before 1973 (when Politzer, Gross and Wilczek published their results), but not recognised as a new discovery. This is just one of those cases of miscommunication. The 'experts' were so sure that asymptotic freedom was impossible, that signals to the contrary were not heard, let alone believed. In turn, when I did the calculation, I found it difficult to believe that the result was still not known."

In chapter three, K Ellis reviews the evolution of our understanding of quantum chromodynamics (QCD) and deep-inelastic scattering. Among many things, he shows how the beta function depends on the strong coupling constant, α_s , and explains why many perturbative calculations can be made in QCD, when the interactions take place at high-enough energies. At the hadronic scale, however, α_s is too large and the perturbative expansion tool no longer works, so alternative methods have to be used. Many non-perturbative effects can be studied with the lattice QCD approach, which is addressed in chapter five. The experimental status regarding α_s is reviewed in the following chapter, where G Dissertori shows the remarkable progress in measurement precision (with LHC values reaching per-cent level uncertainties and

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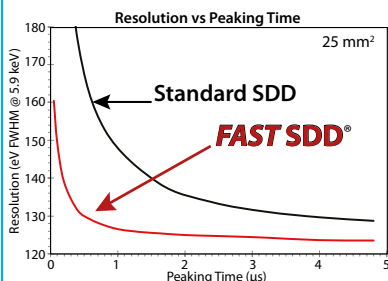
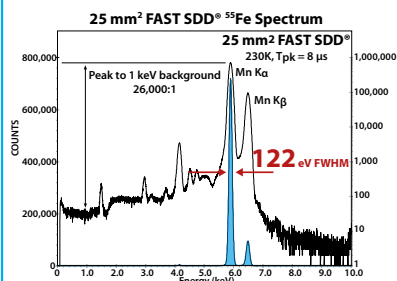
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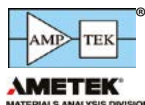


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covering an unprecedented energy range), and how the data is in excellent agreement with the theoretical expectations.

Through the other chapters we can find a large diversity of topics, including a review of global fits of electroweak observables, presently aimed at probing the internal consistency of the Standard Model and constraining its possible extensions given the measured masses of the Higgs boson and of the top quark. Two chapters focus specifically on the W-boson and top-quark masses. Also discussed in detail are flavour physics, rare decays, neutrino masses and oscillations, as is the production of W and Z bosons, in particular in a chapter by M Mangano.

The Higgs boson is featured in many pages: after a chapter by J Ellis, M Gaillard and D Nanopoulos covering its history (and pre-history), its experimental discovery and the measurement of its properties fill two further chapters. An impressive amount of information is condensed in these pages, which are packed with many numbers and (multi-panel) figures. Unfortunately, the figures are printed in black and white (with only two exceptions), which severely affects the clarity of many of them. A book of this importance deserved a more colourful destiny.

The editors make a good point in claiming the time has come to upgrade the Standard Model into the “Standard Theory” of particle physics, and I think this book deserves a place in the bookshelves of a broad community, both by the scientists and engineers who contributed to the progress of high-energy physics to younger physicists, eager to learn and enjoy the corresponding inside stories.

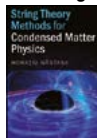
• Carlos Lourenço, CERN

Books received

String Theory Methods for Condensed Matter Physics

Horatiu Nastase

Cambridge University Press



This book provides an introduction to various methods developed in string theory to tackle problems in condensed-matter physics. This is the field where string theory has been most largely applied, thanks to the use of the correspondence between anti-de Sitter spaces (AdS) and conformal field theories (CFT). Formulated as a conjecture 20 years ago by Juan Maldacena of the Institute for Advanced Study, the AdS/CFT correspondence relates string theory, usually in its low-energy version of supergravity and in a curved background space–time, to field theory in a flat space–time of fewer dimensions.

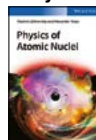
This correspondence is holographic, which means in some sense that the physics in the higher dimension is projected onto a flat surface without losing information.

The book is articulated in four parts. In the first, the author introduces modern topics in condensed-matter physics from the perspective of a string theorist. Part two gives a basic review of general relativity and string theory, in an attempt to make the book as self-consistent as possible. The other two parts focus on the applications of string theory to condensed-matter problems, with the aim of providing the reader with the tools and methods available in the field. Going into more detail, part three is dedicated to methods already considered as standard – such as the pp-wave correspondence, spin chains and integrability, AdS/CFT phenomenology and the fluid-gravity correspondence – while part four deals with more advanced topics that are still in development, including Fermi and non-Fermi liquids, the quantum Hall effect and non-standard statistics.

Aimed at graduate students, this book assumes a good knowledge of quantum field theory and solid-state physics, as well as familiarity with general relativity.

Physics of Atomic Nuclei

By Vladimir Zelevinsky and Alexander Volya
Wiley



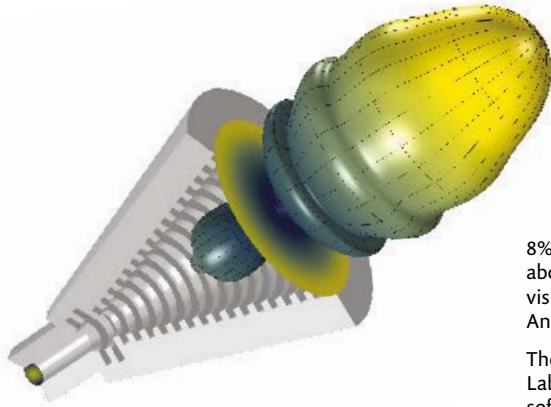
This new textbook of nuclear physics aims to provide a review of the foundations of this branch of physics as well as to present more modern topics, including the important developments

of the last 20 years. Even though well-established textbooks exist in this field, the authors propose a more comprehensive essay for students who want to go deeper both in understanding the basic principles of nuclear physics and in learning about the problems that researchers are currently addressing. Indeed, a renewed interest has lately revitalised this field, following the availability of new experimental facilities and increased computational resources.

Another objective of this book, which is based on the lectures and teaching experience of the authors, is to clarify, at each step, the relationship between theoretical equations and experimental observables, as well as to highlight useful methods and algorithms from computational physics.

The last few chapters cover topics not normally included in standard courses of nuclear physics, and reflect the scientific interests – and occasionally the point of view – of the authors. Many problems are also provided at the end of each chapter, and some of them are fully solved.

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