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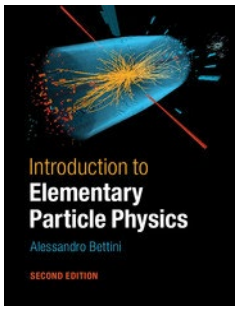

A. Bettini

Introduction to Elementary Particle Physics
2nd Edition

Cambridge University Press, 2014

pp. 489, $ 75.00

ISBN: 978-1-107-05040-2

In 2008 I had the pleasure to review the first edition of Bettini's textbook (Il Nuovo Saggiatore, vol. 24, n. 3-4, p. 98, see: `http://prometeo.sif.it:8080/papers/online/sag/024/03-04/pdf/08.pdf`). Here comes a new edition, revised and updated after Brout-Englert-Higgs boson discovery at CERN in 2012.

The conclusion of my 2008 review was: "*... Bettini provides the reader with a deep insight of the main steps which have brought to the present formulation of the Standard Model, with its essential ingredients, its limits and open questions. With the eyes of a highly skilful and cultured experimentalist, the accurate selection of subjects he presents to us denotes his passion for subnuclear physics, the beauty of which he never fails to point out. We should simply wait for a second volume*".

For this second volume, as a second edition of the first one, the main design principles remain the same. The book is meant to be a presentation at introductory level of subnuclear physics to undergraduate physics students, not necessarily to those specialising in the field. The reader is assumed to have already taken special relativity, quantum mechanics (including Dirac equation) and nuclear physics at introductory level. No prior knowledge of elementary particles neither of quantum field theories is assumed. Therefore the book may also be of interest for non-specialist readers.

The book presents the basic ideas of the Standard Model at an elementary level, it includes only experimentally well-established results, showing how the theoretical building blocks are supported by experimental evidence. To this purpose the author takes care of the crucial experimental aspects, describing detectors and their limitations, and nicely seeks for balance between historical perspective and simplicity. A very important element of the Standard Model, the "origin" of all the masses, has been experimentally proven by the time of this second edition with the recent discovery of the so-desired Brout-Englert-Higgs boson and has thus been included.

In particular, this new edition contains an exhaustive description of the ATLAS and CMS experiments at LHC which have led to the Brout-Englert-Higgs boson discovery and a deeper treatment of the spontaneously symmetry-breaking mechanism based on:

- a more complete discussion of the different types of symmetries (local *vs.* global) and of their breaking mechanisms;
- the chiral symmetry of the strong interaction Lagrangian, which is both explicitly and spontaneously broken;
- the gauge invariance of classical electrodynamics.

The contents of the book have been subject to an overall update. More specific changes with respect to the first edition concern:

- neutrino physics, where the established new results have been included:
  i) the measurement of θ_{13} mixing angle,
  ii) the first direct evidence for appearance of electron neutrinos (ν_e) in the T2K experiment and tau neutrinos (ν_τ) in the OPERA experiment,
  iii) the indirect upper limit on the sum of neutrino masses from cosmology by the PLANCK experiment,
- the running of quark masses, which is especially relevant since normally only the running of the "charges", *i.e.* of the "coupling constants", is described in textbooks;
- the detailed kinematics of scattering experiments.

Finally a new chapter at the end of the volume contains a short discussion on the limits of the Standard Model and on facts beyond it, on what is commonly called "physics beyond the Standard Model": neutrino mass, dark matter, dark energy, the problem of the vacuum energy, grand unification, SUSY (Super Symmetry), gravitation, absence of antimatter in the Universe, strong *CP* violation, and other fascinating theoretical problems.

On top of all this, the volume is complemented by an exhaustive online material on the Cambridge University Press website, addressed and reserved to physics teachers: solutions of all the problems and exercises appearing throughout the volume (only one third of these solutions are present in the printed version), and a series of colourful Powerpoint slides for each chapter, containing key figures and basic plots. This novel feature of the second edition makes it even more attractive.

My only objection concerns the novelty with respect to the first edition of the "physical" presentation of the volume, namely its new cover showing one of the first, celebrated Brout-Englert-Higgs candidate events detected by CMS experiment at LHC: déjà vu!

Otherwise this textbook indeed deserves to be more and more widely adopted in all our universities.

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