# Preface

This textbook is based on my lectures for the undergraduate course of radiation detectors, in the School of Physics and Astronomy at Queen Mary University of London, given in the years 2012 and 2013.

The book provides an introduction to the field of radiation, to the mechanisms of interaction between radiation and matter, and to the exploitation of those mechanisms for the purpose of designing radiation detectors. Significant attention is paid to all of those aspects in equal measure, defining and explaining the language and the first principles with little assumption. The mathematical formalism is kept to a minimum, but simple derivations are presented in order to guide the reasoning and understanding of the physics principles. Detectors are introduced by both their general working design and by modern examples of devices currently operating around the world. There are over 140 original experimental figures, detector schematics, and photographs in this book, which help relate the material to the broader research context and can be used to find out more through the selected referenced documents.

Since interaction processes become more or less relevant depending on the energy, on the materials and the detection objectives, in this book the interaction mechanisms and the detectors are presented interleaved, and the description of a technology always follows the particular interaction mechanism which it exploits. For example, in describing the interaction of photons, the photoelectric effect is introduced first in Chap. 9 by only the details needed in the context of photomultipliers, then expanded in Chap. 10 together with Compton scattering and pair production which anticipate the discussion of electromagnetic showers and the technology of calorimeters. In other words, in organising the material in this book only the physics principles most relevant are presented first, clearly and extensively, just before describing a class of detectors.

The first five chapters are dedicated to *radiation*, as we understand it today based on subatomic physics, including the language in use, its metrics, and the most common natural and man-made forms of radiation. Realistic worked examples of the various types of radiation and its energy accompany the presentation. Dosimetry (Chap. 3) is presented from a modern, user-led point of view, and relativistic kinematics (Chap. 4) is introduced to give the basic knowledge needed to handle the more formal aspects of radiation dynamics and interaction. Part II is dedicated to the *interaction* between radiation and matter, and to *detectors*. The energy loss by ionisation (Chap. 6) is described in some detail, anticipating the principles of ionisation detectors (Chap. 7), semiconductor detectors (Chap. 8), and scintillation detectors (Chap. 9). The topics in Chap. 10 span several interaction mechanisms that underpin the phenomenology of showers and the design of calorimeters. Chapter 11 covers a number of additional phenomena including Cherenkov and transition radiation and the detection of neutrinos. Finally, a summary of statistics and probability distributions is presented in the Appendix.

Through this book, the reader is expected to acquire an awareness of how radiation and its exploitation are rapidly expanding to many diverse contexts in the modern world, including in medical physics. The reader will also acquire the preliminary broad knowledge needed if wishing to undertake advanced studies in one of the areas presented. The introductory level of the material makes the book of particular interest to undergraduate students, graduate students (for an introduction to radiation detectors or selected aspects of it), and lecturers as support for a one-semester undergraduate course on radiation detectors.

I am indebted to Anna Di Ciaccio at the Department of Physics of Rome Tor Vergata, and Jonathan Hays, Teppei Katori, and Jeanne Wilson at the School of Physics of Queen Mary University of London, for providing valuable feedback on earlier drafts of some of the chapters. For their support and feedback, I am grateful to the editorial team at Springer, particularly to Tom Spicer.

Every effort has been made to obtain the required permissions to reproduce copyrighted figures. Copyright information and acknowledgments are indicated in the respective captions and references.

Rome, Italy Lucio Cerrito

Springer

http://www.springer.com/978-3-319-53179-3

Radiation and Detectors
Introduction to the Physics of Radiation and Detection Devices
Cerrito, L.
2017, XIV, 210 p. 142 illus., 50 illus. in color., Hardcover
ISBN: 978-3-319-53179-3