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Preface to the First Edition

The material in this book, which is the result of a 10-year experience obtained in teaching courses related to radiation measurements at the University of Missouri-Rolla, is intended to provide an introductory text on the subject. It includes not only what I believe the beginner ought to be taught but also some of the background material that people involved in radiation measurements should have. The subject matter is addressed to upper-level undergraduates and first-year graduate students. It is assumed that the students have had courses in calculus and differential equations and in basic atomic and nuclear physics. The book should be useful to students in nuclear, mechanical, and electrical engineering, physics, chemistry (for radiochemistry), nuclear medicine, and health physics; to engineers and scientists in laboratories using radiation sources; and to personnel in nuclear power plants.

The structure and the contents of the book are such that the person who masters the material will be able to

1. Select the proper detector given the energy and type of particle to be counted and the purpose of the measurement.
2. Analyze the results of counting experiments, that is, calculate errors, smooth results, unfold energy spectra, fit results with a function, etc.
3. Perform radiation measurements following proper health physics procedures.

Chapter 1 defines the energy range of the different types of radiation for which instruments and methods of measurement are considered; it gives a brief discussion of errors that emphasizes their importance; and, finally, it presents a very general description of the components of a counting system. This last part of the chapter is necessary because a course on radiation measurements involves laboratory work, and for this reason the students should be familiar from the very beginning with the general features and functions of radiation instruments.

Chapter 2 addresses the very important subject of errors. Since all experimental results have errors, and results reported without their corresponding errors are meaningless, this chapter is fundamental for a book such as this one. Further discussion of errors caused by the analysis of the results is presented in Chapter 11.

Chapters 3 and 4 constitute a quick review of material that should have been covered in previous courses. My experience has been that students need this review of atomic and nuclear physics and of penetration of radiation through matter. These two chapters can be omitted if the instructor feels that the students know the subject.

Chapters 5–7 describe the different types of radiation detectors. Full chapters have been devoted to gas-filled counters, scintillation detectors, and semiconductor detectors. Detectors with "special" functions are discussed in Chapter 17.

The subject of relative and absolute measurements is presented in Chapter 8. The solid angle (geometry factor) between source and detector and effects due to the source and the detector, such as efficiency, backscattering, and source self-absorption are all discussed in detail.

Chapter 9 is an introduction to spectroscopy. It introduces and defines the concepts used in the next four chapters. Chapter 10 discusses the features of the electronic components of a counting system that are important in spectroscopy. Its objective is not to make the reader an expert in electronics but to show how the characteristics of the instruments may influence the measurements.

Chapter 11 presents methods of analysis of experimental data. Methods of curve fitting, of interpolation, and of least-squares fitting are discussed concisely but clearly. A general discussion of folding, unfolding, and data smoothing, which are necessary tools in analysis of spectroscopic measurements, occupies the second half of this chapter. Special methods of unfolding for photons, charged particles, and neutrons are further discussed in Chapters 12 through 14, which also cover spectroscopy. Individual chapters are devoted to photons, charged particles, and neutrons. All the factors that affect spectroscopic measurements and the methods of analysis of the results are discussed in detail.

Chapter 15 is devoted to activation analysis, a field with wide-ranging applications. Health physics is discussed in Chapter 16. I feel that every person who handles radiation should know at least something about the effects of radiation, radiation units, and regulations related to radiation protection. This chapter may be omitted if the reader has already studied the subject.

Chapter 17 deals with special detectors and spectrometers that have found applications in many different fields but do not fit in any of the previous chapters. Examples are the self-powered