

# Preface

It is now nearly half a century since the measurement of weak radioactivity emerged as a separate branch in radiometry — when elaborate measures were for the first time taken to achieve maximum signal and minimum background. The technique of low-level counting was invented and named by Williard F. Libby in the late 1940s when he, together with his collaborators, developed radiocarbon dating. The technique has since expanded from a single radioisotope to cover a large number of radioactive nuclides. The number of detectors has increased dramatically and the scope of applications has become highly varied, ranging from environmental control to cosmological problems.

This book on the measurement of weak radioactivity — on low-level counting — will hopefully help all those who are using the technique or are improving on it. The sources of background — environmental radioactivity and cosmic rays — and methods to suppress their effects are described. The basic principles of the detectors used are explained, systems with each of these detectors are described and their characteristic background effects discussed. Four of the most important application areas of the low-level technique are described. In order to make the book more self-contained, the basic principles of nuclear physics are also described — a brief description of the nucleus is given, radioactivity is discussed and the interaction of radiation with matter is explained in some detail.

As with all other modern measuring techniques, low-level counting has continuously been expanded and improved: new detectors have been added, older ones improved and their associated electronic equipment has kept pace with the revolutionary progress in the electronic technique. Some ten years ago, important developments were initiated to make possible studies of some rare radioactive processes of theoretical importance. Resources were made available for this work on a scale never seen before in low-level counting. This work has not only brought us greatly improved germanium spectrometers, but also a wealth of information vital to all sectors of low-level counting.

However, most of the low-level techniques were developed when the experimental methods and equipment were primitive compared to modern standards. For decades researchers had to be content with various recipes, which were not sufficiently supported experimentally, coming mainly from the early pioneers. Today, when it is much easier to study these recipes, many of them are still considered good enough. Now that we better understand the effects of the basic processes of the background and their impact on our measurements, the time is ripe for a critical review the whole field of low-level counting.

This book is not simply a review of the present state of the low-level counting technique,

it also includes an analysis of a large mass of scattered material that has been published since the birth of the technique and has appeared in many scientific journals, reports and conference proceedings. Information has been collected from various sources. By piecing it together we can frequently extract a more coherent picture of the phenomena of interest. Writing this book has therefore been like putting together a large jigsaw puzzle, where bits of information from a large number of articles and reports represent the pieces. Sometimes they fit well, sometimes only nearly, but frequently not at all; and a number of pieces are no doubt missing. The author is well aware that these pieces have not always been put together correctly. In some cases there has been doubt about how to interpret the results of certain measurements. I have preferred to do my best to give a plausible explanation, even though it may well be wrong, rather than leave the question open. This will hopefully urge others to find a better explanation.

We still have a good deal to learn about our low-level systems in order to be able to design still better ones. Most of the relevant studies are relatively easy to make, especially if they are carried out through a systematic collaborative effort of a number of laboratories.

Although the main source of information on which this book is based comes from the technical literature, a large number of colleagues have given me valuable information.

I gratefully acknowledge the invaluable help of Dr. Christopher Evans for reading over the manuscript, the efficient assistance of Sveinn B. Sigurdsson and the very thorough work of Gerlinde Xander.

Without the excellent service of the library of Risö National Laboratory this book could not have been written.

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Reykjavik, Iceland  
August 1996