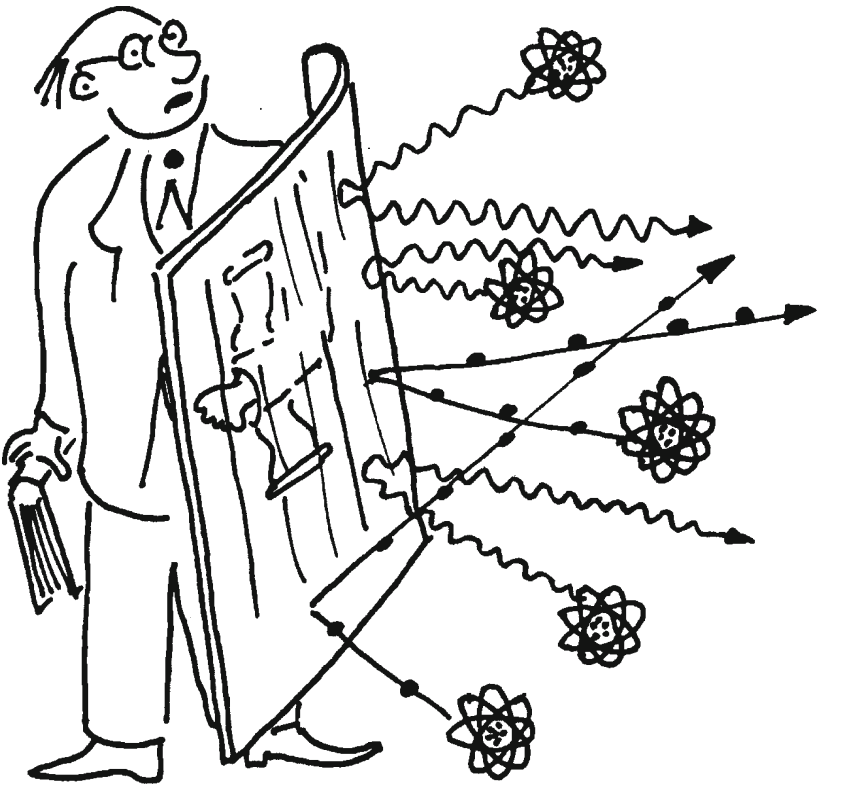
Radioactivity and Radiation



"Radiation Protection"

Claus Grupen · Mark Rodgers

Radioactivity and Radiation

What They Are, What They Do, and How to Harness Them

Springer

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Disclaimer

This book provides an overview of radiation physics. It is intended for members of the general public who are interested in radioactivity and radiation, and also science enthusiasts more generally. We have tried to keep the information correct and up-to-date. However, any reliance on such information is strictly at your own risk. This refers to the availability of the commercial products shown and also to those places where web sites are given. Web addresses can change quite rapidly, but we have made sure that the sites given in the text are available at the time of printing of this book. These web sites are not under our control. We have also tried to get written permission for the use of all pictures (relating to radiation detection, radiation instruments and other topics) which are shown in this book. Not in all cases did the companies providing such instruments or information respond to our request for permission to show their products. If any material in this book is being described or referred to improperly or incompletely, we would be grateful to be informed so that we can consider this for future editions of the book.

Claus Grupen
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Preface

Like taxes, radioactivity has long been with us and in increasing amounts; it is not to be hated and feared, but accepted and controlled. Radiation is dangerous, let there be no mistake about that – but the modern world abounds in dangerous substances and situations too numerous to mention, ... Consider radiation as something to be treated with respect, avoided when practicable, and accepted when inevitable.

Ralph Lapp 1917–2004

Radiation is everywhere. In this book, we are concerned with ionising radiation, i.e. radiation that can ionise ordinary atoms, such as the rays which come from radioactive decay. Almost everything is radioactive. Radiation emerges from the soil, it is in the air, and our planet is continuously being bombarded with energetic cosmic radiation. Even the human body is radioactive: about 9000 decays of unstable nuclei occur per second in a normal human body. In the early days of the Earth, when our planet formed from the debris of the early solar system, the radiation level was much higher. It is possible that the origin, development and biodiversity of life have been positively influenced by ionising radiation.

Since the early twentieth century, mankind has been able to artificially create radioactive nuclei: particularly so since the discovery of nuclear fission in the late 1930s. As early as 1905, Pierre Curie remarked that radium in the hands of criminals could be a disaster. Also, Louis de Broglie noted in his Nobel lecture in 1927 that he did not know whether science in the hands of humans is a good or a bad thing. The bombing of Hiroshima and Nagasaki in 1945 with nuclear weapons clearly demonstrated the disastrous effect of ionising radiation. The Nobel laureate for medicine, Maurice H.F. Wilkins, said contemplatively: “We have now reached the point where it is an open question as to whether doing more science is a good thing”. The nuclear accidents near Harrisburg at the Three Mile Island reactor (1979), in Chernobyl (1986), Tokaimura (1999) and Fukushima (2011) clearly demonstrated that nuclear fission requires high-quality safety systems.

It is in the nature of humans to try to further our understanding of the world around us. No law will stop people undertaking research which might carry them into new domains, and there will always be a risk that a new technology will be misused. Therefore, it is important to understand the results of research and to explain the advantages and possible risks to everybody who is interested. There are of course great benefits to be gained from nuclear energy and ionising radiation, particularly in (fission) power plants and in nuclear medicine (both diagnosis and therapy). Also nuclear fusion, the energy source of the stars, may well solve all of mankind's energy problems in less than a century.

The use and abuse of radiation concerns, among others, physicists, engineers, lawyers and healthcare professionals, as well as the general public. Everyone should be able to judge on the application of radioactivity in various fields himself without referring to experts.

This book was originally published as a longer, more technical volume called Introduction to Radiation Protection. That book itself originated from a series of lectures that one of the authors (C.G.) gave over a period of more than 40 years. The text was first published in German by Vieweg and updated later in editions by Springer. It has also been translated into English and Japanese. A translation into Turkish is in preparation.

This book would not have been possible without the help of a large number of people. In particular, the help of Dr. Tilo Stroh and Dr. Ulrich Werthenbach was invaluable in the creation of the earlier versions. We thank Dr. Cornelius Grupen for injecting ideas for the book, particularly on the structure of the material. In addition, M.R. would like to thank his wife Clare for her help and encouragement, and C.G. wants to thank his wife Heidemarie for her continuous support and patience.

The aim of this more accessible book is to simplify the complicated physics and mathematics of the original version so that interested members of the public will be able to judge on possible dangers of ionising radiation. There is often an antipathy and distrust when ionising radiation is discussed. Occasionally this distrust is justified, especially when irresponsible discharges of radioactive waste into the environment are concerned. However, we are surrounded by radiation from many different sources, especially from the natural environment: the food that we eat and the air that we breathe are to a certain extent radioactive. This unavoidable radiation serves as a good starting point for comparison when discussing additional radiation from technical installations, and we can keep in mind that most of the additional radiation results from diagnostics and therapy in medicine.

We have tried to make the field of radioactivity accessible to the layman with illustrations and examples that hopefully appeal to general experience. The aim of this book is to improve the understanding of the basics of radioactivity and to assess the radiation risks in comparison to the risks that we are used to taking every day without any consideration.

Claus Grupen (Siegen, Germany)
and Mark Rodgers (Leeds, UK), October 2016

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