

THE PHYSICS OF RADIOLOGY BY JOHNS AND CUNNINGHAM A HISTORICAL PERSPECTIVE AND IMPACT ON THE PRACTICE OF MEDICAL PHYSICS

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Introduction

The book series, The Physics of Radiology by Harold Johns and Jack Cunningham, was, and continues to be, a major resource for educating medical physicists and related professionals and a reference for clinical practice, especially in radiation therapy. Over a period of 68 years five (5) editions were published. Each documented the state of the science/physics and technology that existed at that time. This establishes it as a valuable historical record of the development of medical physics and related clinical applications throughout that time. The first two editions were authored by Johns, the third and fourth editions by Johns and Cunningham, and the fifth edition by different authors.

For someone studying the history of radiation therapy, the book provides a remarkable record of how the field evolved from simple X-ray and radium treatments in the 1950s to today's computer-controlled, image-guided, and particle-beam therapies.

The Authors

Harold E. Johns, PhD, the first full-time cancer care-focused medical physicist in Canada, has been called the father of megavoltage radiation and the educator of generations of radiation oncologists, diagnostic radiologists, nuclear medicine physicians and medical physicists. (Ref. 1)

John Robert “Jack” Cunningham was a Canadian medical physicist best known as the co-author, with Harold E. Johns, of The Physics of Radiology and as a pioneer in computerized radiation-treatment planning. (Ref. 2, 3).

Their Relationship, as Reported by Cunningham

The Second Edition was prepared after Dr. Johns had moved to Toronto in the late 1950's. My role in working on this manuscript was mainly to act as a sounding board for some of the chapters, and to check the solutions to some of the problems that are found at the end of the chapters. I became a full co-author for the Third Edition, which was prepared during the years 1966-69. I was responsible for the initial drafts of some of the chapters on basic Radiation Physics.

For the Fourth Edition I played a much greater role. I wrote the first drafts for about half the chapters and set up most of the tabular data in the Appendix. For this latter task I wrote several computer programs and compiled and organized the data. I also calculated the data for several of the dose distributions that are included.

The Fourth Edition was first published in 1983 it takes two or three years of intense work to produce a textbook of this sort. The book sells for somewhat more than \$100 (US) per copy and the Royalties an approximately 5%, split between the two of us. Sales were a thousand or so copies, during the first year, tapering off considerably as the years go by. I have estimated that the income on an hourly basis would be well less than \$1.00 Clearly it is not the kind of activity one would undertake in the hopes of making money. That being said, I know both of us would say it was very worthwhile. It has established itself as the standard textbook in the radiological physics field and is used worldwide.

First Edition 1953

Established medical physics as a quantitative scientific discipline.

The first edition of the book was titled: *The Physics of Radiation Therapy* and was authored by Harold E. Johns. The origin and general content are described in the Preface by Dr. Johns.

From the Preface

This book is an expansion of a set of notes, *The Physical Basis of Radiotherapy*, which was printed privately and in limited numbers by the Saskatchewan Cancer Commission. It is written with the object of supplying students and physicians with the fundamental physical principles basic to an understanding of radiotherapy.

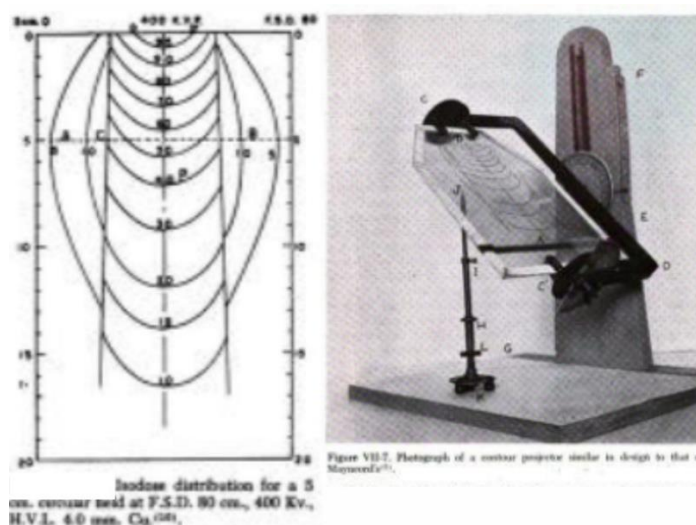
A detailed discussion of the methods by which an x-ray beam can give up its energy to tissue has been included. Special emphasis has been placed, throughout, on the concept of energy absorption in tissue, which I feel is fundamental. The nature of the distribution of radiation in space has been emphasized and a number of practical examples in radiotherapy have been included. The methods by which depth dose data and isodose distributions may be used in clinical work are indicated. In addition, a discussion of energy absorption in bone, fat and muscle has been included. Description of radium dosage has followed closely the Manchester system. A section on high energy devices (in particular, the betatron) and the use of radioactive isotopes has been added.

To increase the practical application of this book, I have added an appendix. This includes depth dose data based upon a comprehensive experimental survey of the depth dose which has been obtained from a variety of types of radiations. Great care has been taken in compiling this data to determine how the depth dose depends upon focal skin distance and area. A number of isodose distributions for the more commonly used types of radiation have been included. Experimentally determined spectral distributions of radiations are also presented.

Harold E. Johns.

The development of the book started in 1946 when W. V. Mayneword from England was in Canada participating in a program concerning the development of nuclear weapons. He was lecturing in Toronto and Harold Johns attended the lectures. Johns, who was a senior physicist, was designated to prepare the notes for the class. Using these notes, he continued to develop the text for the book. In 1948 Jack Cunningham was one of his students majoring in engineering and with experience in drafting was co-opted to produce some of the illustrations.

A major focus of the book was providing methods and data that could be used for planning radiation therapy procedures. This was with depth dose and isodose curves that were provided in the appendix. An example is shown here.



The book can be read at: [The physics of radiation therapy : Johns, Harold Elford. : Free Download, Borrow, and Streaming : Internet Archive](#)

Second Edition 1960s

Reflected rapid growth of cobalt therapy and radiation measurement.

The Second Edition, *The Physics of Radiology*, 767 pages, was also authored by Johns and was expanded to include the physics of medical imaging and more on radiation protection. The content of each chapter is based on many publications by other professionals and are referenced. This enhances its value to other researchers.

With its expansion beyond just the basic physics of radiation and the physics of radiation therapy, there was a considerable emphasis on the hazards of radiation. Some justification for this was said to be the many other sources of radiation beyond medicine that the public might be exposed to, including reactors and bombs. The chapter on Imaging opens with a discussion of the hazards of radiation and the statement that patients undergoing an examination is “also receiving a treatment”.

The book serves two major purposes, as an education resource and a reference and handbook for clinical practice.

Education

The series, and especially beginning with the Second Edition, was developed to be a major textbook for medical physicists and related medical professionals.

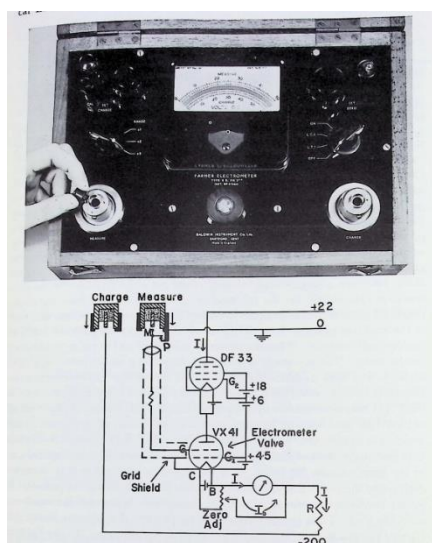
The comprehensive and detailed text with understandable explanations and the necessary quantitative and mathematical components was coupled with illustrations that connected the theory to practical applications.

This is an illustration that shows both the circuitry and use of the electrometer for charging and reading the small condenser chambers that were used to measure radiation exposure at that time.... bridging the theory to the practical applications.

Perhaps the content that stimulated learning was the set of questions at the end of each chapter. The correct answers were in a section near the end of the book.

At that time in history, many, including myself, were entering the field of medical physics not having graduated from medical physics programs. My graduate work was in nuclear physics with a good understanding of radiation interactions but not medical physics applications. For us, the Johns and Cunningham books were our introduction and continuing learning resource for medical physics.

An example is show here.



Clinical Practice of Medical Physics

Throughout the series, the physics of radiation therapy has been the major topic. It is the field that both Johns and Cunningham were major contributors to with their research and developments and used their knowledge and experience to support other physicists practicing in that field.

It was the time before the more contemporary treatment planning methods with computers was available and it was generally done manually with published tables and charts.

Third Edition 1970s

Added modern dosimetry and computer-assisted calculations.

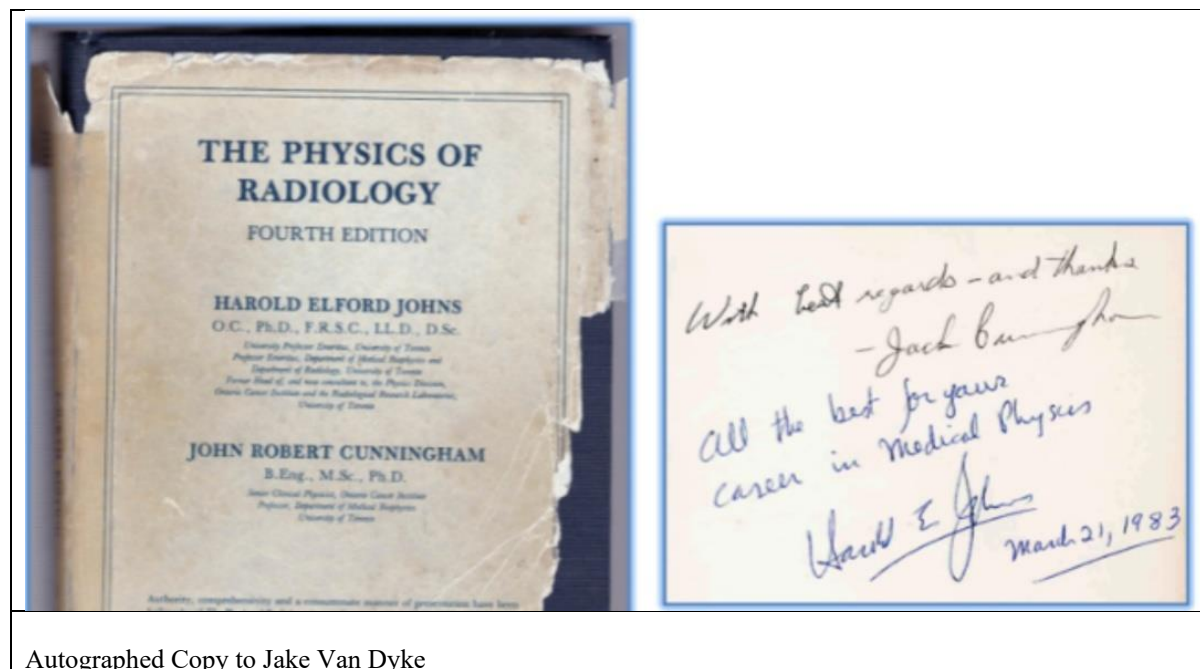
This was the first edition to be authored by both Johns and Cunningham. It added more on modern dosimetry and computer-assisted calculations that was Cunningham's specialization.

The Appendixes were updated. Appendix A. provided absorption coefficients and absorption data for a large range of photon energies. Appendix B provided depth dose data for the various radiation sources, field sizes, shapes, and distances that were being used at that time.

Fourth Edition 1983

Became the standard reference text for medical physics education worldwide.

It was the last to be authored by Johns and Cunningham and remained the standard version for almost four decades.



Autographed Copy to Jake Van Dyke

Fifth Edition 2021

Complete modernization while preserving the original educational style

The 5th edition was published in 2021 as Johns and Cunningham's Physics of Radiology but was not written by Johns and Cunningham themselves. It preserves their names in the title because the book continues the classic textbook tradition begun by Harold Elford Johns and John Robert Cunningham. The 5th edition authors are Eva Bezak, Alun H. Beddoe, Loredana G. Marcu, Martin Ebert, and Roger Price.

The 5th edition was important because it updated the classic 1983 fourth edition after nearly four decades. During that period, radiology and medical physics changed greatly with the growth of CT, MRI, PET, molecular imaging, digital x-ray detectors, modern radiation therapy planning, proton and heavy-ion therapy, molecular radiotherapy, and computer-based dose calculations.

Conclusions

The series of textbooks, four editions, published over a period of 30 years, authored by Harold Johns and Jack Cunningham, was a major educational resource for medical physicists and provided data for general medical physics applications and especially treatment planning in radiation therapy. The value of each edition was providing updates on current medical physics issues, like radiation quantities and units, and the clinical technology and methods being used at that time.

Acknowledgement

Jacob (Jake) Van Dyk, Professor Emeritus, Departments of Oncology and Medical Biophysics Western University, London, Ontario, Canada, has been a major resource providing detailed information for this article. He joined the staff with Johns and Cunningham in 1971 and was a colleague and friend throughout their lifetime.

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