heavy nuclei in terms of the "collective" model of Bohr and Mottelson. (11) Fission Radiochemistry (Low Energy Fission), by L. E. Glendenin and E. P. Steinberg, containing the experimental results since 1949 on problems relating to the mass distribution in low energy fission. (12) Theories of Photonuclear Reactions, by J. S. Levinger, a review and comparison of various models, all more or less successful (even though they are based on rather different and even contradictory assumptions) in describing the main features of the observations.

Articles on applied radioactivity: (13) Stable Isotope Dilution as an Analytical Tool, by M. G. Inghram, concerning a new technique of great promise. (14) Standardization of Radioactive Sources, by G. G. Manov, a survey of available standards and of the progress and remaining problems in extending the range and number of standard sources. (15) Radioactivity in Geology and Cosmology, by T. P. Kohman and N. Saito, a complete and thoroughly documented summary of the various techniques of geological and anthropological dating. (16) Biochemical Effects of Radiation, by K. P. DuBois and D. F. Peterson; and (17) Vertebrate Radiobiology (Lethal Actions and Associated Effects), by J. F. Thomson, two views of a field in which there are now many data, often contradictory, but in which there are still lacking the guiding principles which can lead to the understanding of the data.

The Development of the Concept of Electric Charge. Electricity from the Greeks to Coulomb. By Duane Roller and Duane H. D. Roller. 97 pp. Harvard University Press, Cambridge, Mass., 1954. Paperbound $1.60. *Reviewed by P. Morrison, Cornell University.*

This little book, with nearly a dozen cuts of the instruments of the antique electric art, is good reading for any physicist, and should be at hand for students from high school to the institute. The present reviewer can claim no historiographic competence, but the many citations and the care of the exposition convince him that here is a succinct and accurate history of ideas during what we may call the prehistory of the study of electricity.

The method of the study is this: the authors present the work of a major author or two in each of their chapters, with a brief sketch of the historical background, and plenty of small-print citations from the work itself. Then they seek to elucidate the meaning of the observations and comments reported, writing from the point of view, not really of detailed modern knowledge, but from that of common-sense hindsight, from knowing how it all came out. The work is simple enough for young students, and will yet prove novel, if I am not much mistaken, to the most sophisticated physicist who has not read the cited works. The classical period, and indeed all the history up to the time of Gilbert and Galileo is perhaps slighted, but it can be complemented by the same authors' fine paper in the *American Journal of Physics*, in 1953.

It is certainly illuminating to read of the efforts of the men of the Renaissance and of the Enlightenment to make sense out of the still uncertain behavior of glass rod, cat fur, gold leaf, and silk thread in a humid climate. Stephen Gray established the transfer of "electric virtue" over a line of thread from the high window of a noble Kentish country house 650 feet into the fields, where he found that rubbing the glass tube at the low end of the line caused a brass leaf to be attracted to an ivory ball at the high end, fastened to the window by a silk insulating cord. "At length the dew began to fall . . . and the attraction ceased." But Gray rather thinks it was caused by his being very hot, and not the dew. Such was the first transmission line.

The doughty van Musschenbroek of Leyden recounted in 1746 how he drew a violent discharge from a flask filled with water, set on a metal stand, and charged from a spinning glass globe. ". . . in a word, I thought it was all up with me . . . ," he writes. Thus was capacitance discovered. Now, in the full flush of the Enlightenment, electricity was so much a cynosure that the people flocked to the regular college lectures, often "crowding the students out of their seats." And in colonial Philadelphia, a well-to-do-publisher, the ebullient Franklin, began his wonderful work with the "electrical fire".

The book ends with the account of the experiments of Charles Coulomb, who established his famous and fundamental law both statically, using a torsion balance consisting of two pith balls on a waxed thread, and dynamically, using a torsion pendulum whose period he measured. A metal sphere about baseball size served him to demonstrate that such a charged sphere behaved like a point of charge at its center, and that the inverse square law held both in attraction and in repulsion.

As a work of history, the book seems wholly satisfactory for its modest scope. But as a means of instruction (as a case history for the tactics and strategy of science) I must own to grave doubt. What will all this careful account of one and two fluids, of induction, of the effect of points, and the disproved hypothesis of an effect of the color of charged bodies tell the student of physics today? It is true and to the credit of the method that on this qualitative level he will be able with some effort to understand the novel ideas behind the halting experiments of those times, but he can gain no feeling for the actualities of our present theory, for its power, for its beauty and diversity, above all for the unified picture of the world which it provides. Key ideas, like potential or field lines, nowhere appear. The physics is lost in something a little like antiquarianism. The Enlightenment workers had as their guide the brilliant and quantitative success of Newton and Halley and Euler in mechanics. They worked with electricity, not to putter among glass tubes and thick sparks, but in the conviction that the same unity would here be found. Our present powers attest to the truth of their faith. But to go back to those groping days, and then to study not the full success of "mechanics of the vacuum," which is admittedly hard, but rather—because it is easy—the feeble infancy of the theory of the electromagnetic field is to give up the task of making physics meaningful to the literate man of today It is an attractive notion, and it may work in some less mature fields of science, but in Case History 8 it does not come off. The epilogue of two pages, in which the modern unity of the one- and two-field theories into ionic and electronic conduction is sketched, ought to be a prologue, a prologue to the victories of the time since Coulomb, the battles of Laplace, Gauss, Faraday, Maxwell, Rowland, Hertz, Lorentz, and Dirac. This story is *Hamlet* without the Danish prince.

High Energy Radiation. Volume I of Radiation Biology. Parts I and II. Edited by Alexander Hollaender, with the cooperation of Austin M. Brues, Hermann J. Muller, Berwind P. Kaufmann, and Lauriston S. Taylor. 1265 pp. McGraw-Hill Book Company, Inc., New York, 1954. $17.50 (not sold separately). *Reviewed by Joseph G. Hoffman, Roswell Park Memorial Institute.*

This is the first volume of a projected three volume series on the general subject of radiation biology. It is printed in two parts and deals with high energy radiation: the designation "high" being in reference to the lower energy ultraviolet radiations which according to the jacket will be taken up in Volume II, and light radiations in Volume III. The present volume deals with a rapidly expanding subject inasmuch as x-rays and nuclear radiations are becoming more and more part of industrial and scientific activity. It is therefore necessary to note that all of the eighteen chapters were closed by December 1952.

This promises to be an important volume in the history of radiobiology. Its magnitude alone would bear this out: Part I has 626 pages and includes the first 8 chapters, the remaining 10 chapters are in Part II which has 640 pages. In the total of 1265 pages there is treated a wide diversity of aspects of radiation biology by twenty different essayists. The first 3 chapters are devoted to the fundamental physics involved in radiobiology. The first chapter deals with radiological physics which includes a concise evaluation of target theory. The second deals with methods of measuring ionizing radiations for biological purposes; and the third reviews physical principles underlying photochemical, radiation-chemical, and radiobiological reactions.

The next 3 chapters describe the basic processes set in motion when radiations are absorbed in living systems. Chapter 4 deals with mechanisms in radiation biochemistry, and Chapter 5 with the effects of x-rays on systems of biological importance. The role played by linear energy transfer is discussed in Chapter 6. One high-light of this section is found in Zirkle's single table 15 pages long which summarizes much literature on linear energy transfer and relative biological effectiveness. Thus, the first 6 chapters of this volume provide a broad review of basic knowledge of physical and chemical phenomena. These alone form an essential addition to the biophysicist's library.

The remaining 12 chapters are devoted to the description of biological effects produced by penetrating radiations. In broad outlines these center about genetic changes, mutations, chromosomal aberrations in plant and in animal cells, effects on the division, morphology, and viability of cells, disturbances of mammalian prenatal development, radiation injury in mammals, hematologic effects, histological changes, and carcinogenesis. Each of these major subjects of radiobiology is reviewed in detail. For instance, there are 3 chapters on genetic effects, 2 chapters on chromosome aberrations, and 2 chapters on pathological physiology of radiation injury.

The jacket points out that this volume is a work of reference. Accordingly each chapter is thoroughly documented with an extensive bibliography. These necessary references occasionally trip the flow of the text. Nevertheless, the contributors have succeeded in providing a very readable and stimulating account. In this connection must be mentioned the two chapters written by H. J. Muller. The titles of the chapters are indicative of their material. Chapter 7 is "The Nature of the Genetic Effects Produced by Radiation"; and Chapter 8, by the same author, is "The Manner of Production of Mutations by Radiation". The two chapters are classic. They cover 275 pages, and in them Muller elucidates clearly many ideas about the genetic substance which must be of fundamental interest to physicists, chemists, and biologists alike.

The chapters on genetics, along with the two on chromosome aberrations, provide reviews of material which can be especially pointed out to biophysicists. The mechanical maneuverings of chromosomes during cell division or in the process of crossing-over during meiosis present many intriguing problems for the physicist to contemplate. The two chapters on chromosome aberrations show very well how radiation has been employed as a tool for the study of the behavior of chromosomes.

A major portion of the second part is devoted to a description of injuries produced by radiation. The last 6 chapters taken together compromise a review of this subject which is a matter of interest to everyone ranging from the abstract scientist to the practicing physician and even to the nontechnical public. It is a noteworthy feature that for the first time there is gathered in a single reference text so much material on so many different aspects of injury reactions.

This volume is highly recommendable. It is a compendium of radiobiology in the form of timely reviews. Each contributor has without doubt performed here a worthwhile service to the subject of radiobiology. The text is supported by an ample number of diagrams and photographs, along with a generous supply of data in the many tables. The format and type are excellent.