Book Reviews

Electrons* (+ *and* −), *protons, photons, neutrons, mesotrons, and cosmic rays. (Rev. ed.) Robert A. Millikan. Chicago: Univ. Chicago Press, 1947. Pp. x + 642. (Illustrated.) $6.00.

Robert A. Millikan's new book on the electrons and other particles of modern physics is not so much a revision of the earlier editions as a reprinting with a supplement. The first 10 chapters are almost identical with the 1924 revision of the original book, called *The electron*, which was published in 1917. The next 5 chapters were added in the 1935 edition, and the last 5 are new.

As is explained in the Introduction, the book is devoted mainly to the researches of Millikan himself and his associates. However, the background and theoretical implications of the experiments are given in such detail, and Millikan's work has involved so many fields of physics, that the book amounts to a fairly complete review of atomic physics in the 20th Century.

It begins with the history of the atomistic concept of electricity, which culminates in Millikan's famous oil-drop experiment to measure the electronic charge. Following this, the problem of the nature of radiant energy provides background for Millikan's photoelectric experiments, which verified the crucial Einstein equation. Then the experiments of Bowen and Millikan in spectroscopy shed new light on the structure of atoms and led to the discovery of the spin of the electron. Finally we come to the work of Millikan and his associates on cosmic rays and nuclear physics—work which has been responsible for much of our present-day understanding of these subjects.

The new chapters may be summarized briefly as follows: One chapter explains how nuclear energy is released and discusses the practicality of commercial use of nuclear energy as a source of power. It seems to this reviewer that the chapter is not very well written or very scientific in the manner of drawing political, economic, and social conclusions from incomplete data.

A second chapter summarizes in detail the geomagnetic studies of cosmic rays made by Millikan, Bowen, and Neher in the years 1920–36. An explanation is also given of Millikan and Cameron's failure, in 1926, in their first effort to find a geomagnetic effect.

The third of the new chapters relates the history of the discovery of the mesotron and describes the properties of this particle. It is shown how the existence of such a particle was indicated by the high-altitude surveys made by Millikan, Bowen, and Neher and conclusively proved by the cloud-chamber data of Anderson and Neddermeyer.

The last two chapters are devoted to the nature of the primary cosmic rays and particularly to Millikan's hypothesis concerning the origin of these rays through the process of annihilation of atoms in interstellar space.

Any reader of the book who is not a learned physicist should be warned of the following: (1) Although the early chapters have been touched up slightly in an effort to modernize them, the effort has not been completely successful. Thus, the picture of the atom and its nucleus presented by Millikan in Chapter IX is definitely a 1924 painting with a few daubs of 1935 and 1946 paint; a 1946 picture would be somewhat different. Similarly, the first chapters on cosmic rays constitute a 1935 picture. (2) Over the years between editions of this book, common usage has changed with regard to the meanings of a few of the words. As a result, Millikan's book is not entirely consistent in word meanings, either within itself or as compared with other modern texts. For instance, his "positive electrons" may be either protons or positrons, and his "fast electrons" may be mesotrons or high-energy protons, positrons, or electrons. (3) Not all of the declarations made by Millikan meet with agreement among other prominent and competent physicists. In particular, many physicists feel that the evidence in favor of Millikan's hypothesis regarding the origin of cosmic rays is not as strong as one would gather from the book. (4) As a survey of modern physics, the book is far from impartial. The scientific world here presented has its center obviously in the Norman Bridge Laboratory at the California Institute of Technology.

KENNETH GREISEN
Department of Physics, Cornell University

Bioelectric fields and growth. E. J. Lund and collaborators. Austin, Texas: Univ. Texas Press, 1947. Pp. vii+391. Illustrated.) $6.00.

This important experimental contribution to the literature of biophysics supports the senior author's thesis that continuous, self-generated electrical fields operate as primary correlating mechanisms in living systems lacking nervous and circulatory devices, e.g. in the control of embryonic growth pattern.

About one-fifth of the space is devoted to the effects of externally applied electric fields upon polar growth in the onion root, *Avena* coleoptile, and reassociated cell masses of *Obelia*. The remainder is concerned with (1) measurement of the distribution of potential differences in space and time and in relation to environmental factors in *Pithophora* (a linear cell aggregate), the mantle of *Anadonta* and *Unio*, the onion root, and the coleoptile of *Avena*; (2) the counter-EMF developed in the onion root by applied currents in relation to intensity, duration and direction of current, region of the root, and effects of oxygen and cyanide; and (3) the capacity of frog's skin to perform electrical work and the efficiency of the process. The importance of these last three types of data cannot be overemphasized, for understanding of the control exerted by external electric fields rests upon knowledge of their effects upon the fundamental physiological properties of the growing systems. Extrapolation of such knowledge to the morphogenetic fields operating in normal development demands, in addition, complete information of the spatial and temporal distribution of the self-generated electrical potentials and the patterns and limits of internal electrical energy expenditure.

A valuable addition is the beautifully cross-indexed bibliography of 1406 titles on continuous bioelectric currents and bioelectric fields, by H. F. Rosene.

GORDON MARSH
Department of Zoology, The State University of Iowa