

chapter, but merely remark that these eleven chapters whet one's curiosity as to what comment the author would make upon the view of Sir J. J. Thomson ("Recollections and Reflections," pp. 368-9) that "the mass, momentum and energy of a charged sphere are distributed throughout the medium around it and not in the sphere itself."

When the present administration has completed its investigation of the methods of the American Telephone and Telegraph Company it is to be hoped that they will find both reason and space for commending the policy of any corporation which has the wisdom, foresight and ability to maintain a research staff of the caliber of the men now at the Bell Telephone Laboratories and of their late director, to whom the book is so appropriately dedicated.

HENRY CREW

NUCLEAR PHYSICS

An Introduction to Nuclear Physics. By N. FEATHER. x+213 pp. 21 figs. 3 plates. New York: The Macmillan Company; Cambridge: The University Press. 1936. \$3.00.

RADIOACTIVITY was discovered in 1896 by Becquerel in connection with studies concerning the nature of fluorescence. Later developments, coming as a result of this discovery, have been of benefit both to the medical profession and to physicists and chemists wishing to gain an insight into the fundamental properties of matter. Alpha-particles, obtained from radioactive elements, were the tools with which Lord Rutherford was able to perform his scattering experiments, the results of which led to the famous nuclear atom (1911). This hypothesis was the foundation stone upon which Bohr was able to build his theory of the hydrogen atom. The tremendous developments brought about in physics, chemistry and astronomy as a consequence of Bohr's theory are now known to every one.

While rapid strides were being made in understanding the outer structure of the atom, steady progress was also being made in our knowledge of the nucleus, albeit this work was somewhat eclipsed by the great volume of papers in the other field. Since the discovery of the positron, the neutron, artificial radioactivity and transmutations by high velocity particles, the amount of work being published on nuclear physics is beginning to rival that produced during the atomic structure "boom" of the 1920's. The author of the present volume has made very notable contributions to the study of nuclear physics.

With experimentation in nuclear physics going forward at such a terrific rate, one would have a certain feeling of futility in attempting to write a book on the subject, since it would be supposed that the book

would be out of date before it could possibly be published. It takes rare skill on the part of the author to choose material which will be fundamental and at the same time up to date, and a considerable amount of speed on the part of the publisher to get the book off the press and distributed in a very short length of time. This rare feat has been accomplished in a singularly successful manner by Dr. Feather and the Cambridge University Press.

The book is divided into four parts, the first of which is introductory in character, giving the necessary background for an understanding of the subject. The next three parts treat in turn stable nuclei, unstable nuclei and transformations produced by fast-moving particles and by radiation.

The superbly written introductory chapters give an excellent description of the development of atomic and nuclear physics during the last forty years. At the outset the author describes in detail the types of measurements made in experiments on nuclear physics, showing clearly the relation of the quantities measured to our well-known standards of length and mass. In these introductory chapters all branches of physics having to do with the study of the nucleus are concisely discussed, the essential points being introduced in such a way that the fundamentals are clearly before the reader at all times. After a discussion of the important experiments on radioactivity and scattering of alpha-particles, the results are considered in the light of the classical theory—including also the Bohr theory. The shortcomings of the classical theory in accounting for certain experiments in nuclear physics are pointed out and the wave mechanics is then introduced from an experimental point of view, without recourse to mathematics. The general results of the theory are given and the uranium paradox, resonance capture, and the scattering of identical particles are treated. The closing chapter of Part I, entitled "Elementary Particles: Nuclear Structure," contains an account of the various suppositions made as to the constitution of nuclei, the laws of force between elementary particles, and a particularly enlightening discussion of the nature of the Heisenberg-Majorana exchange force.

Part II deals with the measurement of nuclear masses by means of the mass spectrograph and by optical methods, together with a discussion of the determination of masses by means of the energy balance in disintegration experiments. The chapter on nuclear spins and moments is somewhat inadequate, but gives the main results obtained in this field, together with a table of nuclear spins and moments.

Part III deals with the emission of alpha-particles, of electrons, positive and negative, and of gamma rays. Since other treatises exist in which the subject of the emission of alpha-particles and gamma rays is

treated in great detail, the present section merely states the main experimental facts and brings the material up to date. The chapter on the emission of positive and negative electrons completes the usual discussion of beta-ray spectra by the inclusion of data on the emission of positrons and electrons from light elements made radioactive by bombardment. The foundations and results of Fermi's theory of beta particle disintegration are clearly discussed and the connection between this theory and Sargent's curves is pointed out. The recent experiments concerning the existence (or perhaps non-existence) of the neutrino are described.

The final section of the book—Part IV—deals with transformations produced by high energy particles and light quanta. The effects produced by alpha-particles, neutrons, accelerated particles and quanta are described in turn. The discussion is well ordered and entirely free from the confusion with which one

is confronted if one has to go to the original sources for information. The usefulness of these sections is enhanced considerably by the inclusion of a section entitled "collected results" at the end of each chapter. These sections contain in tabular form all the useful information which has been accumulated to date on induced disintegration.

The book contains an unusually complete list of references. In fact, references to papers published in this country as late as July, 1936, and to English papers published after the book was printed are to be found. The theoretical discussions are treated mostly from the physical standpoint without the use of mathematics. The book should be of great interest both to the specialist in nuclear physics and to one who merely wishes to find out what the nuclear physicist is doing.

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SPECIAL ARTICLES

VITAMIN B₁ AND THE GROWTH OF EXCISED TOMATO ROOTS

IN 1922 one of the authors¹ reported a method of cultivating excised root tips under sterile conditions, and found the growth of excised roots of corn (*Zea mays* L.) to be limited in extent in a modified Pfeffer's solution containing dextrose. As a working hypothesis it was assumed that oxygen, the mineral salts of Pfeffer's solution, glucose and water were insufficient for the continued growth of excised corn roots. In the same year Robbins² reported the beneficial effects of autolyzed yeast on the growth under sterile conditions of the excised root tips of corn. Various evidences were presented and discussed, indicating that the yeast was effective by furnishing some accessory growth factor or factors originally supplied to the root tip from the grain but fractionated in subculturing the root tips. The same hypothesis was considered in later papers. However, it was not possible at that time definitely to determine in what the effectiveness of the yeast consisted.

White³ demonstrated potentially unlimited growth for excised root tips of tomato (*Lycopersicon esculentum* L.) in a solution containing mineral salts, cane sugar and yeast.

Since September, 1935, we have cultivated excised tomato root tips in White's solution, thus confirming his original report of the possibility of unlimited growth of the root tips of this plant. We have found that excised tomato root tips which have been subcul-

tured for some time will not grow in White's solution if the mineral salts are omitted, leaving the cane sugar and yeast only. They will not grow if the cane sugar is omitted; nor will they grow if the yeast is omitted and only cane sugar and mineral salts are present.

The effective materials in the dried yeast are not soluble in absolute ethyl alcohol but are soluble in 80 per cent. alcohol. The residue left after extraction with absolute and 80 per cent. ethyl alcohol is ineffective. The beneficial action of the yeast is not eliminated by autoclaving for 12 hours at 120° C. at pH 9.0. Yeast ash prepared by ashing at low red heat in a muffle furnace will not replace the yeast.⁴ However, we have found excised tomato roots to grow in White's solution in which the yeast is replaced by natural crystalline vitamin B₁ Merck or by synthetic vitamin B₁ Merck.⁵ The vitamin is effective at great dilution. Growth of root fragments has been secured in 50 cc of White's solution without yeast to which $1 \times 10^{-4}\gamma$ of natural crystalline vitamin B₁ Merck was added. No growth was secured in the same solution lacking both yeast and the vitamin. The vitamin in this solution was present at a concentration of 1 part in 5×10^{11} parts of liquid or $2 \times 10^{-6}\gamma$ per cc, a dilution of the same order as that found by Kögl⁶ to be effective for

⁴ The authors are indebted to F. Kavanaugh for the preparation of the yeast fractions and for other assistance.

⁵ The authors express their appreciation of the assistance of R. R. Williams in securing this material and to Merck and Company for the gift of the synthetic vitamin B₁.

⁶ Fritz Kögl, and Benno Tönnis, Hoppe-Seyler's *Ztschr. f. physiolog. Chem.*, 242: 43-73, 1936.

¹ William J. Robbins, *Bot. Gaz.*, 73: 367-390, 1922.

² *Idem.*, *Bot. Gaz.*, 74: 59-79, 1922.

³ P. R. White, *Plant Physiol.*, 9: 585-599, 1934.