significant figures where errors of the order of 10 per cent or more are expected; the insertion of occasional cautioning statements or the possible convenience for numerical work do not seem adequate justifications.

The book contributes to pure as well as to applied physics through very extensive and laborious new calculations on the distribution of radiation energy throughout matter. The author's emphasis on recognizing and analyzing the role played by secondary electrons in this process represents an important advance. As stated in the appendix, the calculations are based on somewhat tentative theoretical assumptions; the eventual influence of these assumptions should be estimated when utilizing the numerical results. The author emphasizes that the energy of photo- and recoil-electrons released by x rays of 10–100 KeV is far from proportional to the x-ray voltage; however, what is important for application is the apportionment of the total x-ray energy among electrons of different energies rather than the apportionment of all the electrons among different energy ranges. The latter is represented by the "mean energy" given in Table 3 of the book. The former is represented by a "weighted mean energy" calculated by giving each electron a "weight" proportional to its energy and is much more closely related to the x-ray voltage.

This book is timely, useful, and important and is recommended for widest circulation; judgment should be exercised, however, in utilizing its content.

The book was completed in the middle of 1944 and became available in England early in 1946. Commercial arrangements prevented its distribution in America until a year later. While the former delay may be charged to war conditions, the latter is highly regrettable.

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Fisica nucleare: dalla pila di Volta alla pila atomica. Plinius Campi and Aldo Rusconi. Milan: Ulrico Hoepli, 1946. Pp. viii + 215. (Illustrated.) Lire 400.

This book covers more ground than the title suggests, since it represents a general survey of the advances of atomic physics from the advent of relativity and the quantum theory to the utilization of nuclear energy.

Chapter 1 includes a condensed account of the structure of matter, ions and electrons, Bohr's atomic model, isotopes, radioactivity, and Planck's quantum hypothesis. Chapter 2, bearing the title "Space, Time, and Causality," gives an elementary account of restricted relativity and of the failure of the principle of causality in quantum physics as expressed by Heisenberg's uncertainty relations. The authors take the occasion for setting forth certain views of their own on the structure of the geometrical continuum. In the reviewer's opinion, whatever the value of such theories may be, discussion of them should be reserved for papers of a technical character and is rather out of place in a book of this type. Chapter 3 is a discussion of the wave properties of material particles as expressed by Schrödinger's equation. Chapter 4 includes an account of radioactivity, artificial disintegration of nuclei, neutrons, and the conditions which determine nuclear stability. Chapter 5 discusses the fission of heavy elements and the utilization of nuclear energy.

The book does not require from the reader more than a general knowledge of elementary physics and mathematics, and the difficult task of popularizing such a vast amount of material is, for the most part, well done. Perhaps the account of the principles of restricted relativity and of quantum mechanics contains some obscurities that might have been avoided. Inaccuracies are few and unimportant.

This book will be particularly useful to readers of a scientific mind, such as chemists, engineers, biologists, etc., who, not being physicists, are not familiar with the more technical accounts of atomic physics and look for an elementary but accurate résumé of the subject.

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Relaxation methods in theoretical physics. R. V. Southwell. Oxford, Engl.: Clarendon Press, 1946. Pp. vi + 248. (Illustrated.)

This volume, a continuation of the author's earlier monograph on *Relaxation methods in engineering science* (1940), constitutes an extremely important contribution to the literature of applied physics. It shows that almost any boundary-value problem in two dimensions for which one can write down the partial differential equations, and the solution of which one desires badly enough, can be solved by a sort of brute-force, cut-and-try numerical method of attack. It should go far toward dispelling the common idea that there is nothing that can be done about a two-dimensional problem for which an analytical solution has not or cannot be found, except perhaps to look for a physical analogue which is capable of experimental evaluation.

Southwell, in this volume, shows solutions of problems in torsion of solid and hollow cylindrical shafts, magnetic fields in regions containing iron, conformal transformation, capacity of cables, torsion of shafts of circular section but nonuniform diameter, torsion of tores, temperature distribution, shear stress trajectories, oil pressure and temperature distribution in bearings, flow of gas through convergent-divergent nozzles, plastic torsion, percolation, and shapes of free liquid jets.

The versatility of his methods is perhaps best illustrated by these last examples, in which the hydrodynamic equations are solved for free jets whose very shape is unknown at the start, and by H. W. Emmons' successful application (*N. A. C. A. Tech. Notes*, 1944, No. 932; 1946, No. 1003) of these methods to compressible-fluid-flow problems involving shock waves whose positions are initially unknown.

The relaxation procedure starts by replacing the two-dimensional continuum by a 'net' of points and the partial differential equation by a difference equation relating the function value at a given net point to its values at neighboring points. The finer the net, the closer is the approach of the solution of this difference problem on the net to that of the differential problem in the continuum. A trial-function value is estimated at each net point, and in terms of this trial function a 'residual' is computed, this being the amount by which the difference equation fails to be satisfied at each point. The residuals are then 'relaxed' to zero, or worked out to the boundary where they disappear, by successive and repeated changes in the function values at the various points, chosen at the discretion of the computer in such a way as eventually to make all the residuals vanish. The changes in the various residuals which occur with each change in a function value are made immediately on the net diagram.

Southwell's exposition of the actual computational procedure will be confused for many readers by his insistence on a mechanical analogy in which everything is expressed in terms of 'externally applied loads,' 'string tensions,' 'residual forces,' and the like. For such readers an excellent exposition of the procedure by Emmons (*Quart. appl. Math.*, 1944, **2,** 173) will be useful.

The very power of Southwell's method for handling problems *of whatever type* lies in the fact that *no* definite procedure is given for relaxing the residuals—one is only sure that if by hook or by crook he can get them relaxed, he has solved the problem. It is comfortable and convenient to have a definite procedure for 'relaxing the residuals' such as is given by the 'iteration' procedure, which has seen considerable development in recent years, but only for certain classes of linear, elliptic, partial differential equations. (See G. Shortly, R. Weller, P. Darby, and E. H. Gamble. *J. appl. Phys.*, 1947, **18,** 116, and earlier papers referred to therein. It is pointed out that the 'difference function,' the function 'relaxed' by the iteration procedure of these authors, is closely related to, although not identical with, Southwell's 'residual.') Southwell makes no comment on this procedure, but Emmons does, and it seems appropriate in a review of Southwell's book that some comparison be made for cases where the iteration procedure has been developed. Emmons gives a time comparison in which he says that a certain simple heat-conduction problem on a coarse, 19-point net took him 1.75 hours to solve by the relaxation procedure and the fantastic time of 11 hours "by the method of Shortley and Weller. . .with the use of a calculating machine" (*Trans. A.S.M.E.*, 1943, **65,** 607). The reviewer can only assert that the same problem took him exactly 26 minutes to solve by the last-named method, starting with the same plane trial function as Emmons and without the use of a calculating machine. It is his opinion that the 'iteration' procedure is certainly more convenient and probably more rapid than the 'relaxation' procedure in cases to which it has been applied.

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Elementary theory of gas turbines and jet propulsion. J. G. Keenan. London: Oxford Univ. Press, 1946. Pp. viii+261. (Illustrated.)

The title of this book is aptly chosen. Volumes could be written on the theory of gas turbines and jet propulsion, but the author has produced a work for the benefit of the average scientific reader. The book will appeal to those who wish to become somewhat acquainted with the theory but who lack the mathematical and thermodynamic background necessary for a more rigorous treatment. With this clientele in mind, the author has avoided the concept of entropy and has based the theory entirely on pressure-volume relations.

By way of introduction the early history of the gas turbine is reviewed. Various components, such as nozzles, combustion chambers, diffusers, etc., are treated individually. The author has effectively arranged the material by first defining such technical terms as are pertinent to the discussion and then applying these concepts to the various types of turbines, compressors, and jets.

The centrifugal and axial-flow compressors are discussed with reference to velocity diagrams, work per stage, losses, efficiency, intercooling, and compressor characteristics. The impulse and reaction turbines are discussed very briefly under similar headings. A chapter is given to heat transfer, since that topic is so intimately associated with gas turbine and jet engine development.

Actual data on performance of this type of equipment are rather meager; however, graphical material is given to show the effect of pressure ratios, reheating, and compounding, and to show the thermodynamic limitations as well as the present stage of development. The various types of jet motors are pictured with their operating cycles shown on pressure-volume axes. The effect of such variables as altitude and air density on performance is given. The last chapter describes installations in which the various forms of turbines and jet motors have found application.

The book is well illustrated and is easily followed. It will fill a present-day need as envisioned by the author.

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La scissione nucleare dell'uranio: fenomenologia generale. Emidio Prata. Milan: Ulrico Hoepli, 1946. Pp. 160. (Illustrated.) Lire 250.

After a few pages of introduction on nuclear reactions, the author describes the experiments that led to the discovery of fission (Chap. 1). Chapter 2 lists the identified fission products; Chapters 3 and 4, the mass distribution of fission fragments and their ranges in gases. Chapter 5 includes a detailed discussion of the stability of the nucleus against fission, the treatment following essentially the well-known papers of Bohr and Wheeler. Chapter 6 is a discussion of the instantaneous and delayed neutron emission in fission, from both theoretical and experimental standpoints. There follows a discussion of various cross sections for nuclear reactions (Chap. 7) and of the time within which fission occurs (Chap. 8). The conditions for a self-sustaining chain reaction and details on the chain-reacting pile as given in the Smyth report are given in Chapter 9. A complete bibliography of publications on fission from 1934 to 1943, including 325 titles, is given at the end of the volume.

The book constitutes a practically complete résumé of all the work on fission published in scientific periodicals up to 1943, plus a brief summary of additional information released by the Manhattan District after the war. The subject is competently treated, and apparently no essential data available at the time of publication are omitted. The book is evidently intended primarily for the physicist who is not a specialist in nuclear problems and who wishes to become acquainted with the essentials of the fission process. At the same time, it can be used profitably as a reference work by the nuclear physicist himself, the complete bibliography making it particularly valuable in this respect.

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