
Books

Principles of Quantum Theory I. Vol. 5, Part 1 of *Handbuch der Physik*. Edited by S. Flügge. 376 pp. Springer-Verlag, Berlin, Germany, 1958. DM 90.00 (subscription price DM 72.00). *Reviewed by Freeman J. Dyson, Institute for Advanced Study.*

Volume 5 of the new *Handbuch der Physik* comes in two parts, one real and one imaginary (nomenclature due to Weisskopf). The real part, which is now before us, consists of Pauli's 1933 article on the general principles of quantum mechanics and a new article by Källén on quantum electrodynamics. The imaginary part will consist of an article on field theory by Schwinger.

Pauli's article has been reprinted without any important changes except that the last 28 pages have been amputated. Those pages dealt in a preliminary way with the quantization of the Maxwell field and are now superseded by Källén's fuller exposition. It is not necessary in a review to say much about Pauli's article. It remains as it was long ago described by Oppenheimer "the only adult introduction to quantum mechanics". It concentrates exclusively on the basic theoretical and conceptual framework, does not discuss examples or applications, and contains little that has become irrelevant or incorrect during the 25 years since it was written. The famous error in the 1933 article, in which Pauli derived the 2-component neutrino equation only to dismiss it with the remark "These wave-equations are not invariant under reflection and are therefore not applicable to physical reality," has been rectified by the omission of the last eight words.

Källén's article is written in a quite different style from Pauli's. It is much closer to standard textbook form, pedestrian in its full development of computational details, and suitable for students who are learning the subject for the first time. The subject matter is quantum electrodynamics in the narrow sense, that is to say, the study of radiation phenomena involving electrons, positrons, and photons alone. There is heavy emphasis on the applications of the formalism to specific problems by means of second-order perturbation theory. In particular, the shift in the fine structure of the hydrogen spectrum, which was discovered by Lamb in 1947 and which stimulated the modern development of quantum electrodynamics, is calculated in full detail.

Källén begins with the quantization of the Maxwell and Dirac fields without interaction, continues with the formal theory of the interacting fields, covariant perturbation theory, the calculation of radiative corrections to specific processes, the procedures of mass and charge

renormalization, and ends with a general discussion of the renormalization program. Most of this material is already to be found in various textbooks. Only the last section, containing Källén's proof that at least one of the renormalization constants must be infinite independently of any perturbation-theory approximations, appears for the first time between hard covers.

It is clear from the content of Källén's article that it must have been written and essentially completed in 1954 or 1955. Its publication was delayed by the editors of the *Handbuch* in a vain attempt to avoid the division of Volume 5 into two parts. The delay is not Källén's fault, but it is none the less regrettable. It has the effect of making the article look old-fashioned. Källén has been careful to revise his numerical results and to put in references to electrodynamic calculations published as recently as 1957. But the point of view of the article is still definitely 1954. Of the "New Look" which came into field theory after 1954, with various attempts to abandon altogether perturbation theory and the renormalization program, the article reflects no trace. While the recent attempts to rebuild the theory upon a more secure mathematical foundation have not been notably successful, still it is a disappointment not to find them subjected to Källén's critical scrutiny.

Astrophysics I: Stellar Surfaces—Binaries. Vol. 50 of *Handbuch der Physik*. Edited by S. Flügge. 458 pp. Springer-Verlag, Berlin, Germany, 1958. DM 98.00 (subscription price DM 78.40). *Reviewed by C. C. Kiess, National Bureau of Standards.*

This fiftieth volume of the *Encyclopedia of Physics* is the first of a series on astrophysics. The term "encyclopedia" gives promise of articles containing a comprehensive survey of the knowledge relating to the topics discussed, with ample references to the pertinent literature. This expectation is realized in all the articles except one. As indicated in the title, one set of articles deals with the surfaces of the stars, the other with binary stars.

The light from stars, revelatory of the physical state of their surfaces, is investigated best with photometers and spectroscopes. Early fruits of this work revealed that many stars can be assigned to a sequence of spectral classes in which temperature is the principal physical parameter. Later, when spectroscopic and photometric details became more abundant a second parameter, luminosity, was needed to mark subdivisions of the classes in a 2-dimensional scheme. More recently still, the distribution of energy in the continuous spectra of stars has led to a 3-dimensional classification. All these subjects are treated fully in the article in French, "The Spectral Classifications of Normal Stars", by Charles Fehrenbach, director of the Marseilles Observatory.

Not all stars, however, fit neatly into the normal systems of classification. The article "Stars with Peculiar Spectra" by Philip C. Keenan, astronomer at the Perkins Observatory, discusses groups of stars, usually



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small in number, whose spectra are related to the normal classes but exhibit some peculiarities. Although the basis for labelling a star "Pec" has shifted over the years, yet the designation carries with it recognition of abnormalities in the physical and chemical properties of the stars' atmospheres.

"The Spectra of the White Dwarfs" is the title of the article by Jesse L. Greenstein, professor of astrophysics, California Institute of Technology. White dwarfs are stars of low luminosity, of small volume and mass, but of exceedingly high density, which tells us that the material composing them is in a very unusual state. Although more than 200 of these objects are known, yet owing to their faintness, spectroscopic data are available for fewer than half of them. These have proved sufficient, however, to set up several classes with distinctive spectral features, and differing in temperature and color.

Tenuous clouds of gas surrounding very hot stars appear under telescopic scrutiny as disk-shaped or ring-shaped objects. This has led to their designation as planetary nebulae. Two articles in German, "The Spectra of the Planetary Nebulae" and "Theory of the Planetary Nebulae", by Karl Wurm, professor and observer in the Hamburg-Bergedorf Observatory, are devoted to them. Logically these thorough articles belong together and should be read together, but, for some reason not apparent, the editor has separated them by more than 200 pages.

The spectral features of stars with surface temperatures above 7000° are those of gases in the atomic state. At lower temperatures some atoms combine to form diatomic molecules, hydrides and oxides, and their spectra will appear together with the atomic spectra. In the atmospheres of the coolest stars these molecular features become so prominent that their strengths and chemical nature are criteria for the classification of the cool, red stars. These and related topics are fully discussed by P. Swings, professor in the University of Liège, in his article, written in French, "Molecular Bands in the Stellar Spectra".

The spectral features described in the foregoing articles are the consequences of the interaction between the energy generated in the stellar interiors and the matter in the outer gaseous layers. How does this interaction take place? The attempt to answer this question has led to a vast amount of theoretical work which is thoroughly presented in the article "General Theory of Stellar Atmospheres", written in French by Daniel Barbier, astronomer at the Paris Observatory.

The second group of articles, written in English, deals with the mechanical and physical properties of binary stars—pairs of stars that revolve around a common center of gravity. Some of these pairs are separated widely enough to be seen telescopically as double stars. The problems concerning them are treated in the article "Visual Binaries" by Peter van de Kamp, professor of astronomy, Swarthmore College. The subject of "Spectroscopic Binaries" and their problems are discussed by Otto Struve, professor of astrophysics, and

his colleague Su-Shu Huang, research fellow, in the Department of Astronomy, University of California. Both articles are comprehensive in content and provide ample references to pertinent literature for further study.

The article remaining for consideration is "The Eclipsing Binaries" by Sergei Gaposchkin, astronomer at the Harvard College Observatory. It is offered by him "in condensed form (as) a summary of the multifarious known data on eclipsing binaries". As such it lacks the comprehensiveness that should be the main attribute of an encyclopedic article. Although the authorities for the tabulated data are named, there are only seven specific citations to the extensive literature covering this subject, none of them, however, referring to the epoch-making work, at the Princeton Observatory, that initiated this branch of astrophysics more than four decades ago.

In composition, illustrations, and presentation of tabular matter, this book maintains the high standard for which the Springer-Verlag is noted. The trilingual indexes are detailed and run to nearly 40 pages. On the whole the standard set by the articles in this volume is high; and one hopes that it will be maintained in the succeeding volumes of the series.

Nuclear Reactions III. Vol. 42 of *Handbuch der Physik*. Edited by S. Flügge. 626 pp. Springer-Verlag, Berlin, Germany, 1957. DM 135.00 (subscription price DM 108.00). Reviewed by E. R. Rae, *A.E.R.E., Harwell, England*.

The latest volume of this well-known reference series contains six monographs on important topics in nuclear physics in a text of 610 pages, together with an English-German and German-English subject index. The articles included in the present volume are as follows:

(1) Nuclear Isomerism, by D. E. Alburger, 108 pages. The author starts with an account of the historical development of the idea of nuclear isomerism and proceeds to discuss the methods available for obtaining information about the isomeric states from their lifetimes and from the radiations emitted in the decay of those states. The account is followed by fifty pages of level diagrams and tables describing the present state of knowledge of isomeric states. The review is completed by a brief discussion of the systematics of the lifetimes of the isomeric states.

(2) Alpha Radioactivity, by I. Perlman and J. O. Rasmussen, 96 pages. This article considers first the systematics of alpha-decay energies, the type of spectra observed from even-even and from odd nuclei and the interpretation in terms of nuclear models. This is followed by a consideration of the theory of the lifetimes of alpha-emitters for even-even and odd nucleon types and the article is rounded off with some illustrative examples of individual decay schemes.

(3) The Transuranium Elements, by E. K. Hyde and G. T. Seaborg, 104 pages. The place of the heaviest