Books

Nuclear Moments (English version prepared from 2nd German edition by E. E. Schneider). Vol. 2 of Pure & Applied Physics. By Hans Kopfermann. 505 pp. Academic Press Inc., New York, 1958. $13.00. *Reviewed by William F. Meggers, National Bureau of Standards.*

The second German edition of Kopfermann's *Kernmomente* was published in 1956 by Akademische Verlagsgesellschaft, Frankfurt, and reviewed by F. Bloch.[1] That book was a vast improvement over the first edition which appeared 15 years earlier when the study of nuclear moments was practically a specialized branch of optical spectroscopy limited to interferometric resolution of hyperfine structures and isotope shifts.

Optical interference spectroscopy is still the most versatile method for the study of nuclear moments, and isotope shifts in atomic spectra remain its exclusive domain, as stated in the second edition of Kopfermann's *Kernmomente*. But the recent development of radio-frequency methods has greatly increased the precision of magnetic and electric moments, and stimulated searches for a successful nuclear model. Consequently the second German edition had four large chapters dealing with the nuclear moments in free atoms, in free molecules, in liquids and crystals, and nuclear models. Radio-frequency spectroscopy of atomic and molecular beams was introduced in the first chapter, magnetic and electric molecular beam radio-frequency spectroscopy in the second, the third dealt with nuclear magnetic resonance, nuclear quadrupole resonance, and paramagnetic resonance, and the fourth dealt mainly with a comparison of the nuclear shell model with experimental results. In preparing the present English edition of Kopfermann's *Kernmomente* the translator has closely followed the experiments, physical arguments, and mathematical derivations of the German edition, but has occasionally deviated from a literal interpretation to make the text more acceptable to English and American readers. Substantial amendments and additions have added about 40 pages, partly to include new experimental data from May 1955 to May 1957, and partly to provide extra conveniences, including a 6-page explanation of symbols, a 2-page element index, a 10-page author index, a greatly extended subject index, and 15 pages of literature references as compared with 9. These important improvements will appeal to all spectroscopists and nuclear physicists, even those who read German as easily as English. Incidentally this English edition is printed on matte paper which seems easier to read than the German edition printed on glaring glossy paper. Without doubt, this timely and useful book on *Nuclear Moments* will achieve popularity both on account of its interesting content and its excellent typography.

[1] Bloch, F., *Science* **124**, 1152 (1956).

The Neutrino. No. 5 of Investigations in Physics. By James S. Allen. 168 pp. Princeton U. Press, Princeton, N.J., 1958. $4.50. *Reviewed by Arthur H. Snell, Oak Ridge National Laboratory.*

All physicists recognize as one of the absorbing aspects of their science the crossing and interlocking of its many threads, the appearance of basic principles in various forms when varying subjects are under scrutiny, and the diverse viewpoints from which sets of phenomena can be assessed. Take the subject of beta decay. The classical expositionary approach has been based upon the Fermi theory, with emphasis on the shape of the continuous spectrum, the allowed and forbidden transitions, the *ft* values, and so on, and indeed the remarkable developments of the last two or three years can be incorporated as capstones upon a structure of this kind. In Dr. Allen's book he has shown that the story can also be developed with emphasis upon the neutrino, and that such a development can be given sweep and vigor. A sense of drama accompanies this approach; suspense and triumph have lived with our growth of knowledge of this gentle particle since its invention in 1933. Since then, it has developed from a seemingly artificial concept demanded for the salvation of the conservation laws to a familiar body that has been detected in the free state, and with which we are sufficiently acquainted even to know that a neutrino twists to the left in flight, while an antineutrino twists to the right. There is indeed a story in physics to be told here, sharpened by the philosophic interest that many feel in something that is so very close to nothing. Yet Dr. Allen's treatment retains the physics of the many aspects of beta decay; the shape of the continuous spectrum (especially near its end point), angular correlations in the three-body breakup, double beta decay, decay of polarized nuclei, meson decay, helicity experiments, the nature of the basic interactions, and the universal Fermi interaction all receive discussion. Late developments have been incorporated as notes added in proof, and although this device has unavoidable awkwardnesses, nevertheless we can be thankful in this case that it was possible. Publication a few months earlier would have meant the total omission of a climax as important as the helicity experiment of Goldhaber, Grodzins, and Sunyar!

Despite the impact of the subject matter as a chapter in physics, the language of the book is sober and factual. There is sufficient theory to give unity and a feeling for the objectives sought by all of the investigations, but the text is at its best when it deals with the experiments. As one reads successively about the various measurements that have informed us about the neutrino, one cannot avoid being struck by the ingenuity

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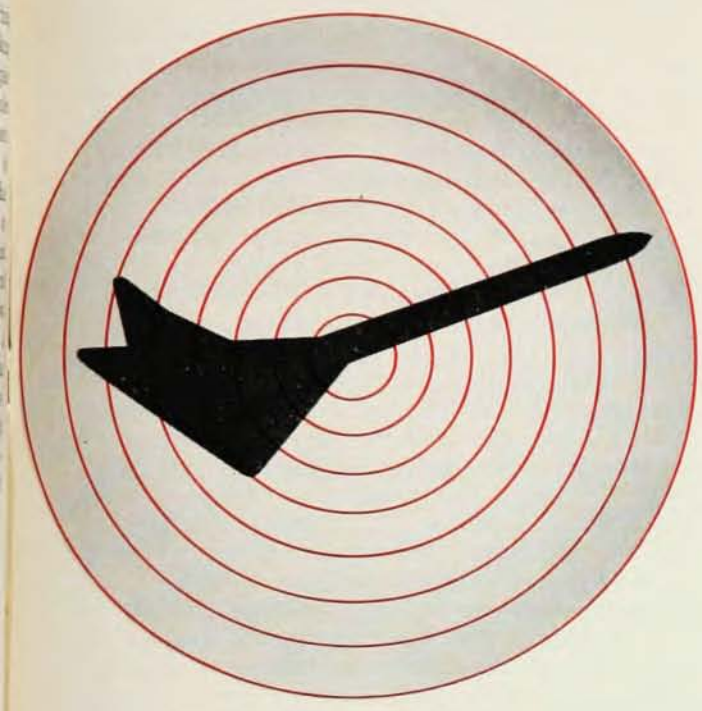

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that has been shown. The account is in a way an incidental history of the development of laboratory skills, exemplified in the progressively increasing specificity of the experiments. The latter have been notoriously difficult, for sundry reasons: the measurements of the upper end of the tritium spectrum were difficult because of the low energy of the particles and the fact that they vanish in intensity in the region of interest, and yet they have told us that the rest mass is less than a thousandth of that of an electron; the experiments on nuclear recoil from electron capture have been difficult because of the low energy of the recoils, with the consequence that "vacuum" sources have to be used, and yet they have been forced to such detail as a revelation of the recoil line shapes; the experiments on beta particle-recoil nucleus angular correlations have been difficult for similar reasons, and yet they have informed us about the nature of the basic interactions; the experiments on double beta decay have been difficult because of the tantalizing infrequency of the events; the radiochemical experiments have demanded the application of the finest of technique, sometimes almost on a chemical engineering scale; and (most of all) the experiments on the detection of the free neutrino have been difficult because they demanded the measurement of interaction cross sections about 10^{12} times smaller than those that had previously been considered small. It is therefore fitting that the emphasis be experimental, as it is also fitting that the story be told by one who has contributed substantially to it.

A summarizing account such as Dr. Allen's gives the reader the impression that, at the age of twenty-five years, the neutrino has reached its majority. A new phase of the research is now to be entered, less exploratory and more mature. One wonders at the conclusion of Dr. Allen's book: what is next? There are one or two nails yet to be driven into the lid of the packing box, such as the time-reversal experiment in neutron decay (now in progress at Chalk River and the Argonne National Laboratory), but beyond that one can see only vaguely. That terrestrial neutrino physics is possible from an experimental standpoint has been demonstrated, although at present it is difficult, slow, and costly. One can see a need for the measurement of interaction cross sections, but perhaps the more interesting questions relate to the role of neutrinos in cosmology. Challenges still exist, both theoretical and experimental, and Dr. Allen's absorbing account of past accomplishment makes one feel confident that scientific ingenuity will rise to meet them.

Corpuscles and Radiation in Matter II. Vol. 34 of Handbuch der Physik. Edited by S. Flügge. 316 pp. Springer-Verlag, Berlin, Germany, 1958. DM 78.00 (subscription price DM 62.40). *Reviewed by L. Marton, National Bureau of Standards.*

The numbering of the volumes of the new encyclopedia of physics is somewhat confusing. Volume 33 is entitled *Optics of Corpuscles,* Volume 34 is called *Corpuscles and Radiation in Matter II.* The number II implies there is somewhere a number I, but I haven't seen any evidence of it.

However, this volume will have to be judged on its own merits. It consists of six chapters. The first chapter, written by R. Kollath, is entitled "Passage of Slow Electrons and Ions through Gases". The 50 pages of this chapter contain a summary of what is known about single collisions in a field-free space. Other topics which might have been considered under this title are discussed elsewhere. Impact phenomena in accelerating fields are treated in Volume 21, whereas excitation, ionization, and similar phenomena are part of Volume 36. The present treatment is, therefore, limited to the measurement of total cross sections for the elastic scattering of slow electrons and of ions as well as the scattering and charge exchange of slow ions.

The coverage of the material gives the impression of a more or less abandoned field of physics. Just for the fun of it, I made a histogram of the references given in this paper and found that the center of gravity is on 1930. This center of gravity is so marked that, for instance, all the references (books and papers) for the post-war period are less than two-thirds of the references given for the single year 1930. I don't believe I am mistaken in stating that the post-war work in this branch of physics is considerably more than the few papers quoted in the text. Thus I am forced to conclude that the presentation, with its emphasis on very early papers, is somewhat misleading.

The second chapter is by R. D. Birkhoff. It is entitled "The Passage of Fast Electrons through Matter". The first section of this chapter considers free electron collisions where only a small amount of energy is transferred. In the next section the theory of stopping power is reviewed and a brief discussion of the Cerenkov effect is given. This section is followed by one entitled "Collisions with the Conduction Electron Plasma". This is essentially a review of the theory and of experiments of characteristic energy losses (called discrete losses by Dr. Birkhoff). The presentation reflects the point of view of the earlier version of the collective oscillation theory of the free electron gas and doesn't consider later developments where effects of nonconduction electrons can be quite important or even predominate. This section is followed with the one on the "Distribution of Energy Losses—Straggling". This is essentially a more complete study of the average rate of energy losses which was first discussed in an earlier chapter. There is also a discussion of the effect which nuclear scattering has on the shape of the distribution. In the following section the deflection caused by single scattering and multiple scattering by nuclei is considered. Ample tabular material illustrates this chapter. The last part of the Birkhoff chapter is devoted to total-range considerations. The energy distribution of electron flux is calculated for an infinitely thick absorber.

The next contribution by Lenart Simons is on "Positronium". In 23 pages he discusses the formation, sta-