

butions to analytic geometry were not printed during his lifetime; hence, it is difficult to estimate their influence. There was an essential difference of emphasis between the works of Fermat and Descartes: Descartes usually started with a locus problem and then obtained an equation of the locus; Fermat, conversely, had the habit of beginning with an equation from which he derived the properties of the curve.

Chapters VI ("The age of commentaries"), VII ("From Newton to Euler"), and VIII ("The definitive formulation," which leads into the second part of the 18th century), show how slow, relatively, the further progress in analytic geometry was: it was some time before negative abscissas were admitted, before two axes in the plane were systematically used, or before solid analytic geometry was developed. The author calls Euler's *Introductio in Analysin Infinitorum* (1748) the most influential textbook in modern times and, in particular, considers this work a turning point in the development of analytic geometry.

Finally, chapter IX, "The Golden Age," is devoted to the great and original advance in the first three-quarters of the 19th century. The remarkable contributions of the German mathematicians Möbius and Plücker and of the English mathematician Cayley, among others, are stressed: barycentric and homogeneous coordinates, symbolic notations, line coordinates and line geometry, the theory of algebraic curves, and the more dimensional analytic geometry. The last quarter of the 19th century and our 20th century are not taken into consideration by the author.

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Pion Physics. vol. 2 of *CERN Symposium on High Energy Accelerators and Pion Physics, Proceedings*. European Organization for Nuclear Research, Geneva, 1956. 444 pp. Illus. F. 40.

This is the second volume of the papers submitted to the European Organization for Nuclear Research (CERN) Conference, held at Geneva 11–23 June 1956. After the meeting, the proofs were checked by the editors against corrected preprints. In general, the speakers who took part in the discussions also had an opportunity to correct the text of their remarks.

There is a group of eight papers on bubble chambers, including a review of the field by Brown, Dodd, Glaser, and Perl (University of Michigan) and Rahm (Brookhaven), followed by a series of discussions of experimental work at the University of California, the

University of Chicago, Duke University, the U.S.S.R. Academy of Sciences, the University of Padova, the University of Pisa, and the Centre d'Etudes Nucleaires. The fact that bubble chambers are far from having taken over the fundamental particle experimental field from cloud chambers is shown by a series of five papers on more standard chambers, from sources almost equally well distributed geographically.

A group of nine papers on fast counting techniques, most of which are related to Cerenkov counters, includes one paper on neutron time of flight techniques in the 100 Mev region, by Stafford (Harwell). Two papers are included on antiproton physics, including reviews, by Segrè, of the Berkeley work and, by Amaldi, of cosmic-ray work. Papers on nucleon-nucleon scattering are presented, primarily from the U.S.S.R.

A group of papers on the theory of pion physics includes a review by Wick, an article on the generation of mesons in nucleon collisions by Blokhintsev, a discussion of radiation during the collision of pions and nuclei by Landau and Pomeranchuk, and a simple treatment of meson-nucleon scattering, using the Yukawa potential and the Born approximation, by Edwards and Matthews. Wick's review nicely points out that "features of meson theory included in the cut-off model have something to do with reality."

A paper by Källén discusses the mathematical consistency of quantum electrodynamics. Källén carefully points out that his ideas do not constitute mathematical proof but are intended to serve as a basis for further discussion.

Papers on pion nucleon scattering include a review by Yuan (Brookhaven); data at six energies from 200 to 300 Mev from the U.S.S.R.; data at 150, 170, and 220 Mev by Ashkin, Blaser, Feiner, and Stern (Carnegie Institute of Technology); data at 70 and 130 Mev by a group from Bologna; a discussion of phase shifts by Orear, at Columbia University; and two papers on the very low energies of 20 Mev and 18.7 Mev, respectively, from Liverpool and Chicago.

On the subject of photoproduction of pions there is a review by Bernardini (Illinois) and there are about ten papers, including photoproduction from bound nucleons and complex nuclei as well as from protons and deuterons. This section of the conference includes an announcement, by Pauli, of the telegram received, 15 June, from Reines and Cowan at Los Alamos, stating the detection of neutrinos in the inverse beta decay of protons.

A section on pion production by nucleons includes an introductory talk by Merrison (Liverpool) and a group of papers, including bombarding ener-

gies from 383 Mev at Liverpool, 600, 650, and 929 Mev at Birmingham, 660 Mev in the U.S.S.R., and various energies up to 2.75 Bev at Brookhaven.

A few papers on mesonic atoms were introduced, with a review by Roberts (Rochester). These include the beautiful proportional counter work of West and Bradley at Harwell, the absolute yields by the two Stearns at Carnegie Institute of Technology, and the work on the lifetime of muons by Lederman and Weinrich at Columbia.

This volume provides a useful review of the state of the art, both theoretical and experimental, in pion physics as of the time of the meeting. The authors and editors have done an excellent job in presenting up-to-date, accurate material in a form very useful for reference. The drawings of experimental equipment and the curves presented are remarkably clear and accurate for a publication of this nature.

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Handbuch der Physik. vol. XXI, *Gas Discharges I*; vol. XXII, *Gas Discharges II*. S. Flügge, Ed. Springer, Berlin, 1956. 683 pp.; 652 pp. Illus. DM. 105.50; DM. 128.

At certain epochs of advance in the field of physics, there have appeared in Germany notable *Handbücher*—or, better, encyclopedias—of physics. I gratefully recall Winckelman's *Handbuch*, which was so useful to me in my student days. Nearly coincident with the development of the modern outlook on physics—ushered in by the age of atomic structure and quantum mechanics in 1926—there appeared a truly monumental and invaluable work in 26 volumes, the famous Geiger and Scheel *Handbuch der Physik*, from the presses of Springer. Now, 30 years later, following the post-World War II advances, there appears, under the editorship of S. Flügge, the timely new *Encyclopedia of Physics* of international scope, from the same publishing house. Volumes XXI and XXII comprise summaries of most of the material in the fields of electronics and gaseous electronics. The increasing demands of an adequate modern knowledge of these fields, so vital to technologic and experimental advance, make the publication of these two volumes, by many authors, an invaluable addition to the modern literature, since the scope of recent advances makes it impossible for any one person to summarize expertly this material.

Flügge is to be congratulated on having secured contributions from a group of authors so competent in their respective

fields. These, written in the author's native language, have been admirably edited, printed, and bound. Although most of the articles in these two volumes are in English, the absence of serious typographic errors is remarkable. The prodigious labor and encyclopedic knowledge required of the editor in such a task indicate that future publishers and editors of encyclopedias of this nature should designate a senior subeditor of broad training and experience to be responsible for the volumes in a general field of interest, to edit and supervise the contributions to these volumes, and to insure an adequate and balanced coverage of the various fields by the specialist authors.

Volume XXI deals largely with basic processes of electronics and gaseous electronics, while volume XXII integrates these in relation to various breakdown mechanisms. Volume XXI is divided into nine chapters.

Chapter 1, "Thermionic emission," is written, in English, by one of the world's leading experts, Wayne B. Nottingham. Needless to say, it is comprehensive and well done, although one might wish that less time had been spent in trying to justify the author's theory of reflection at the interface, which, in the light of the recent work of H. Shelton, appears to be disproved.

Chapter 2, "Field emission," is written jointly by R. H. Good, Jr., and Erwin W. Muller. The theoretical aspects are presented by Good in an exceptionally clear and able fashion. Concerning the experimental contributions of the world's leading expert in this field, it is unnecessary to comment except to state that the article presents a good summary of all the recent contributions to the problem, including Muller's own remarkable work on positive-ion field emission and surface microscopy, using field ionization of inert gas atoms and making visible, for the first time, single-surface atoms.

Chapter 3, by Rudolph Kollath, in German, summarizes the present status of knowledge of secondary electron emission on electron bombardment—so essential to modern technology—in the comprehensive and excellent fashion to be expected from one of the world's leaders in this field.

Chapter 4, by Gerhard L. Weissler, in English, succeeds remarkably well in compressing into 60 pages the extensive work, theory, and experimental data on photoelectric ionization in gases and on photoelectric emission from solids to which he and his group have made prominent contributions. This recent compilation of data is indispensable for the interpretation of many currently studied breakdown phenomena.

Chapter 5, in English, represents the first attempt at a unified summary and presentation of the rapidly developing,

generalized kinetic theory concerning the motion of electrons and ions in gases. It was written by W. P. Allis, who is currently the world's leading expert in this field. Since this material has, in the past, been widely dispersed among authors and journals, and chronologically, in the literature, this concise, carefully coordinated, systematic presentation in terms of a consistent symbolism is of inestimable value as a background from which to follow the progress of the coming era of highly and otherwise ionized gases. It is, however, in connection with this article that lack of properly oriented editorship is to be noted, for there is omitted from this volume all mention of experimental techniques and data on drift velocities and energies, elasticities of impact, and mean free paths of the electrons in fields in gases. Likewise, all discussion of the experimental techniques, values, and data on ionic drift velocities in gases is lacking, as are the questions of ionic nature, complex molecule formation, clustering, and charge exchange, about which much is known today that should be made available.

Chapter 6, by L. B. Loeb, in English, deals with the formation and nature of negative ions in gases, including methods of study, energies of formation, experimental results, and interpretation. Some data on the appearance of negative ions from other sources in gases are included.

Chapter 7, by Loeb, considers the complicated variants of the analytically simple-appearing processes manifested under the general designation of recombination of ions. It presents experimental methods, their limitations, existing theory, and interpretation of existing data, including the anomalous values of the electron-ion coefficients around 10^{-10} observed in certain glows and arcs.

Chapter 8, by A. v. Engel, in English, deals with ionization by electrons in electric fields. Engel has written various articles in this field and is a veteran investigator, but this chapter, while perhaps adequate in coverage, is somewhat primitive and perhaps ill-advised in its handling of antiquated theory. It omits proper emphasis on the important, newer secondary ionization processes, such as the Hornbeck-Molnar process, the statistical fluctuations in the coefficient, and processes violating the similarity principle in which a/p is a function of distance of advance x and pressure p , as well as of E/p , and may show temporal lags and diffusion.

Chapter 9, in English, by P. F. Little (who is a relatively young newcomer to the field), is a thoroughly workmanlike and exceptionally complete presentation of the rapidly growing and complex field of secondary processes in gaseous breakdown. He presents the physical processes in the Townsend discharge, the measurements made by means of steady dis-

charges, the time-dependent studies of secondary mechanisms, measurements in nonuniform fields, and the relative importance of the mechanisms. Next he presents the mechanisms active in other discharges, such as in glows and arcs. The last section deals with direct measurements, such as those of emission by positive-ion bombardment, including Hagstrum's recent work and other processes.

All told, this volume, with the exceptions noted, presents a very complete coverage of the subject and is indispensable to the physicist engaged in this field as well as to many others who will find it useful as a reference book.

Volume XXII of the series is divided into seven chapters.

Chapter 1, "Ionization growth and breakdown," by F. Llewellyn Jones, in English, presents the concept of the electric breakdown of gases—in contrast to that of breakdown and spark discharge—as an extension of the work of the original Townsend school, in which the author participated. The article is devoted in large measure to a presentation of the extensive investigations of the author's group (reports of which are scattered widely through the literature) in which, using adequate pre-World War II techniques but failing to use the modern Alpert vacuum and fast-time resolutions observational techniques, they rediscover and establish in new fashion the secondary cathode mechanisms earlier reported by many workers outside the Townsend school. Aside from presenting these findings in a coordinated and collected form, the article is valuable, since it includes the very excellent theoretical analyses of P. M. Davidson for temporal growth of ionization in uniform fields, which are the best to date, and which were carried out in collaboration with this group.

Chapter 2, "The glow discharge at low pressure," by Gordon Francis, in English, is a complete and remarkably clean-cut critical evaluation and survey of the phenomena associated with the glow discharge by a relatively young investigator in the field. The literature coverage of old and new work is exceptionally full, and excellent judgment is shown in the choice of material presented. I know of no other recent article in this field that can furnish the reader with as useful and comprehensive a survey of this subject, on which probably more extensive research has been done than on any of the other topics.

Chapter 3, "Radiation from low pressure discharges," by Richard G. Fowler, in English, probably should have appeared in volume XXI, for it is properly an article on basic processes. However, it would be welcome wherever it might appear. Written by one of the younger but leading workers in the field, this

analysis and presentation of the basic atomic theory of general aspects of gas radiance, excitation, and depopulating processes, covering both theory and experiment, is exceptionally lucid, up to date, and, in fact, superb. It adds practical value and usefulness to the subject content of both volumes under review.

Chapter 4, "Electrical arcs and thermal plasmas," by W. Finkelburg and H. Maecker, in German, constitutes the *pièce de résistance* of this volume. It alone makes the purchase of this book imperative for the modern worker in gaseous electronics. In 1950, before publication of volume XXII, I asked Finkelburg to write a chapter on arcs for a contemplated and still only partially completed book on the electric breakdown of gases. He replied that he felt not enough was known about arcs for him to write such a chapter. After joining the group at the Sieman's Laboratory in Erlangen, Finkelburg and Maecker, with their able coworkers, cracked the mystifying cipher of the electric arc behavior. As a result of their modern and versatile experimental techniques and modern and sound, but often laborious, theoretical physical analyses, they are able to present, in this chapter, the most advanced and complete description yet given of that group of phenomena classified as arcs—a description which is physically sound and satisfying. Thanks to their activities, these phenomena are now perhaps the best understood of all the breakdown forms. Much work yet remains to be done, but with my past experience, I stand in awe of this achievement. For all those venturing into high temperature plasma work, a careful study of this chapter is imperative.

Chapter 5, "Electrical breakdown of gases with steady or direct current impulse potentials," by Loeb, starts with basic definitions of electric breakdown and spark breakdown in terms of current potential relations. Next, the temporal growth of the Townsend discharge is developed. This leads to the threshold equation and its implications. Then follows a treatment of statistical fluctuations in terms of theory and experiment, which leads to concepts of time lags. Breakdown in nonuniform fields at highly stressed anodes is discussed in terms of photoionization in gases, leading to the Geiger counter pulse and the streamer mechanism. Spark breakdown, through streamers, is related to the Townsend thresholds through time-lag studies of Fisher and Bandel. This is followed by an analysis of steady breakdown to Townsend discharge in coaxial cylindrical and point-to-plane gaps for various gas types, both from highly stressed anodes and cathodes.

Chapter 6, by Sanborn C. Brown, in English, deals with the breakdown in

gases in alternating and high-frequency fields. In his characteristic clear and concise style, this leading experimental investigator develops the basic concepts in an admirable fashion. The more esoteric theory based on the Boltzmann transport equation is then developed, and about it as a framework is developed the theory upon which interpretation and computed comparison with experiment is made. The work of the author's school is effectively collected and summarized in terms of solutions for various container forms with superimposed direct-current and magnetic fields. Further discussion covers electron attachment, controlled breakdown, and mobility controlled breakdown and introduces the amplitude oscillation limit concepts. The secondary electron resonance controlled breakdown is also treated. A notable omission is the lack of any discussion of the alternating-current breakdown for the low-frequency cases with external electrodes or internal electrodes, at frequencies much below 10^5 cycles—a field of current interest which merits the critical techniques and analyses of this excellent group of investigators.

Chapter 7, "The lightning discharge," by B. F. J. Schonland, in English, is a remarkably fine summary of this complicated phenomenon by the world's leading expert. It is beautifully written and (unlike his more popular booklet, *Flight of the Thunderbolts*) is a highly valuable, scientific, professional treatise on methods, results, and interpretation (as of 1956), and encompasses all important contributions, including his own.

In summarizing the contents of this volume, I can only say that the appearance of volume XXII has rendered unnecessary the completion of my own half-written volume on electric breakdown of gases and represents an essential addition to the library of all workers in the field.

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Solid State Physics. Advances in research and application. vol. III. Frederick Seitz and David Turnbull, Eds. Academic Press, New York, 1956. 588 pp. Illus. \$12.

This latest volume of comprehensive survey articles on various aspects of solid-state physics contains six articles. The first, by Welker and Weiss, is an almost encyclopedic account of present knowledge about III-V compounds. Extensive references are given to methods of preparation and to physical properties. The main body of the article discusses the electric, magnetic, and optical properties of both pure and doped materials.

The second article, by Eshelby, discusses the continuum theory of lattice defects. This theory is applicable to the study of the deformation and energy changes associated with the presence of defects. The formal theory is given in some detail, and applications to point defects and dislocations are discussed.

The third article, by Guttman, is on order-disorder phenomena in metal alloys. After a short but useful introduction to the subject, the author discusses the various types of short- and long-range order and their description. There are sections on thermodynamic and statistical treatments of the problem and on the kinetics of order-disorder transformations. Many references are given.

The primary purpose of David Turnbull's article on phase changes is to discuss the problem of the formation of one phase of a given substance in another phase of the same substance. The article gives ample references to the field and includes a review of the thermodynamics of phase changes, a discussion of phase stability, and the theory for phase-change kinetics. Nucleation and precipitation are discussed in detail.

In the article on imperfections in crystalline solids, Kroger and Vink consider vacant lattice sites, interstitial atoms, misplaced lattice atoms, foreign atoms, and electrons and holes. The main purpose of the article is to discuss the interdependence among the concentrations of the various types of imperfections, but, in so doing, it covers nearly the entire field of imperfection studies. More than 400 references are given.

The final paper, by Kittel and Galt, is on ferromagnetic domain theory. This is an excellent review of domain theory and its application to the understanding of the behavior of ferromagnetic materials. Many useful references are given.

The diverse subject matter of the review articles in this volume is probably unavoidable. With the present increase in specialization, the survey volume is becoming indispensable, and it is pleasing to see that the high standards for clarity of the first two volumes in this series are being maintained.

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The Encyclopedia of Chemistry. George L. Clark, Ed. Reinhold, New York; Chapman & Hall, London, 1957. 1037 pp. Illus. \$19.50.

This encyclopedia provides a thorough and timely coverage of at least 1000 chemical and physical terms, selected mainly, though not exclusively, on the basis of their importance to industrial chemistry. In addition, the work con-