

port theory and the theory and practice of Fermi-surface measurements. Entries ranged far beyond material in the text (which, perhaps, should be viewed not as I have done, but as a commentary on the bibliography) extending from the late 19th century into early 1965. I can only stand in awe before such a list. Some of my favorites are on it; some are not. Each reader must judge it for himself, because only extensive personal use will reveal how valuable a tool the book can be for scholarship and research.

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Neither a gas nor a crystal

THE STATISTICAL MECHANICS OF SIMPLE LIQUIDS. By S. A. Rice and Peter Gray. 582 pp. Interscience, New York, 1965. \$19.75

AN INTRODUCTION TO THE STATISTICAL THEORY OF CLASSICAL SIMPLE DENSE FLUIDS. By G. H. A. Cole. 284 pp. Pergamon Press, New York, 1967. \$12

by JOEL L. LEBOWITZ

The two books reviewed here are among a large number of books published in the past few years on the statistical-mechanical theory of fluids (that is, dense gases and liquids).

The difficulty in studying fluids is that one has no ideal state such as the ideal gas or harmonic crystal that can be used as a reference state, or zero-order approximation, for real systems. This is particularly true of the nonequilibrium properties of fluids (For equilibrium properties the "hard-sphere" fluid serves as some sort of reference system.) The best that can be said is (to paraphrase a somewhat optimistic statement from the preface of the book by Stuart Rice and Peter Gray): The kinetic theory of liquids is at a stage of development analogous to that of the mean-free-path theory of gases: All the important qualitative features of the physical problem are incorporated, and agreement between theory and experiment is meaningful.

Given this state of the theory, both books make a useful contribution to the field. The book by Rice and Gray is the larger (by a factor of two) and more advanced of the two. It is really an advanced treatise on the

present state of the art as seen by active workers in the field. As such books are apt to do, and perhaps ought to do, it emphasizes the authors' approach and contains some previously unpublished material. It is a book for researchers and those desiring to do research in this difficult but fascinating field. An important and useful feature of the book is its emphasis on comparison between theory and experiment. A somewhat discouraging feature, to the beginner at least, is the somewhat cursory and sometimes haphazard way in which the authors review well known material (well known to experts that is), such as the definition of ensembles and the derivation of the virial expansion. The uninitiated reader might feel that he is stupid not to follow the "obvious" when it is actually not obvious at all (witness equation 2.3.27). My advice to the reader is: Don't despair, persevere and you shall be rewarded.

The book by G. H. A. Cole is briefer and in general more elementary. Many of the more mathematical parts are put in the appendixes, which are placed at the end of the book. (This brevity is somewhat violated in chapter 6 where the author could not resist giving his own work in full, and

what is essentially one formula takes up 3 1/2 pages). In some cases, I would question the author's notion of what constitutes a "derivation," for example, the statistical derivation of the Boltzmann equation in section 8.2. The book is suitable for graduate students as auxiliary reading for a course in statistical mechanics.

Both books deal only with simple classical fluids, of which argon is the principle example. The book by Rice and Gray devotes about one quarter of its space to equilibrium properties, whereas the book by Cole is divided evenly between equilibrium and nonequilibrium results. In the study of equilibrium properties both books emphasize the central part played by the radial-distribution function and discuss in some detail the various approximate integral equations in current use for this function. In the discussion of nonequilibrium phenomena the book by Rice and Gray is much more detailed than the book by Cole. Neither contains any material on the currently active research areas of critical-point phenomena or of the so-called "exact results."

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Atoms and ions: A summary of experiments

METHODS OF EXPERIMENTAL PHYSICS, VOL. 4: ATOMIC AND ELECTRON PHYSICS, PART B: FREE ATOMS. Vernon W. Hughes, Howard L. Schultz, eds. Academic Press, New York, 1967. \$15.50

by WILLIAM LICHTEN

The title of this book is somewhat of a misnomer. In contrast to its sister volume, 4A, *Atomic Sources and Detectors*, volume 4B is more devoted to a summary of experiments and results than to experimental methods. The emphasis, as the title indicates, is on free atoms, although a rather lengthy treatment is given to free ions, including electrons and positrons.

The book should be viewed as a collection of review articles; thus a more accurate title might be "Progress in Atomic Physics" or "Reviews of Recent Experiments with Atoms and Atomic Particles."

If we accept the book on these terms, we can ask how well it achieves its purpose. As is often the case, the

level of the articles is somewhat uneven.

David T. Wilkinson's article, "Properties of Free Electrons and Positrons" is a fairly complete review of the experiments that have been conducted over the past century to measure the electron charge, mass, charge-to-mass ratio, magnetic moment and electric dipole moment. In addition, discussions are given of similar measurements on the positron, electron-positron mass or charge difference.

The article by K. G. Kessler and Henry M. Crosswaite on optical spectroscopy is severely dated, with practically all of its discussion limited to pre-World-War-II research. The work with lasers is essentially completely omitted.

H. E. Radford's extensive treatment of radio frequency and microwave spectroscopy is very much an updated version of Norman F. Ramsey's *Molecular Beams* (Oxford, 1956). All the references appear to be 1963 or

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earlier. In addition to molecular-beam experiments, a summary of radiooptical (optical pumping) and microwave absorption experiments is given.

The articles by Klaus Ziock on the lifetime of excited states and by Charles W. Drake on polarized-ion sources are fairly complete (as of 1966) reviews.

A brief section on basic techniques features articles on ultrahigh vacuum and methods of gas purifications, by G. E. Becker and R. M. Mobley, respectively. This appears to be the only part of the book that is concerned with methods, per se.

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Algebra of rotation

LIE THEORY AND SPECIAL FUNCTIONS. Willard Miller, Jr. 338 pp. Academic Press, New York, 1968. \$16.50

by HENRY S. VALK

In 1951 L. Infeld and T. E. Hull, in a paper in the *Reviews of Modern Physics* 23, 21 pointed out that particular classes of second-order differential operators could be factorized into the product of two first-order differential operators, and that these first-order operators could, in turn, give rise to recurrence relations connecting different eigenfunctions of the original second-order differential equation. The most common use of this procedure occurs in constructing eigenfunctions of the angular-momentum operator. In this case the second-order operator L^2 is expressed in terms of raising and lowering operators L_+ and L_- , and the z component of the angular momentum, L_z and the algebraic properties of these operators are then utilized to derive the desired results. At a time when the *gruppenpest* is rampant, most physicists will recognize that these algebraic properties follow from the fact that the operators L_+ , L_- and L_z form a representation of the Lie algebra of the rotation group. Less well known, however, is that the commutation relations of Lie algebras can be used in a general fashion to obtain recursion relations, generating functions and addition theorems for most of the common special functions of mathematical

physics. It is this second approach to special-function theory that is the subject of the book, *Lie Theory and Special Functions*. The current work is a direct outgrowth of an earlier memoir by the same author (*Memoirs of the American Mathematical Society*, no. 50, 1964), but expanded and redirected so as to be more accessible to an audience of physicists. In his preface the author, a mathematician from the University of Minnesota, expresses the hope that his book will help to bridge the gap between the pure and applied sciences. In my opinion, Miller has succeeded admirably. Any graduate student with a reasonable background in theoretical physics should find most of the book self-contained. The requisite mathematical concepts and results of Lie theory are surveyed in the first two chapters. The remainder of the book is concerned with developing a unified approach to the special functions within the context of Lie theory. The elegance of this approach will put the book on the required list of those readers who harbor an affection for the special functions; however, the volume makes valuable reading for any physicist, as it again demonstrates very clearly the intimate relationship that exists between the mathematical description of a physical problem and the symmetry that may be inherent in the problem.

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Survey of great experiments

MUONS. By A. W. Weissenberg. (Trans. from Russian). 347 pp. North-Holland, Amsterdam (Interscience, New York), 1967. \$19.50

by JOHN L. GAMMEL

This book is a translation of a book that was first published in the Russian language in 1964. It is mainly about experimental physics: Experimental apparatus and results are described in great detail. It is also historical in character: Early experiments and their results are treated in as much detail as the experiments that superseded them. The experiments described (such as that of Chien-Shiung Wu, Ernest Ambler, Raymond Hayward, Dale Hoppes and R. P. Hudson, which first exhibited nonconservation of parity; that of Richard

Garwin, Leon Lederman and Marcel Weinrich that exhibited nonconservation of parity in $\pi^- \mu^- e$ decay and resulted in the first experimental values of the magnetic moment of the muon; that of G. Charpak, F. J. M. Farley, Richard Garwin, T. Muller, J. C. Sens, Valentine Telegdi and A. Zichichi, which resulted in a precision value of the magnetic moment of the muon; that of G. T. Danby, J. M. Gaillard, K. Goulianos, Lederman, Nariman B. Mistry, Melvin Schwartz and Jack Steinberger, which first verified the two-neutrino hypothesis—and more) are comparable in importance to either experiments that revolutionized the conceptual basis of physics, such as the Michelson-Morley experiment, or great precision measurements, such as Robert A. Millikan's measurement of the charge on the electron. These research teams do not produce books like Arthur Compton's *X-Rays in Theory and Experiment*, or Ernest Rutherford, James Chadwick and Cecil Ellis's *Radiations from Radioactive Substances*. This book fills the gap that results. I view this book—as I view these other books—as historical documents that are not without merit as scientific treatises at any later date however remote. Like these other books, it might serve as a reference book for undergraduate surveys of great experiments.

It is possible to find fault with the book. This process may be begun by comparing it with a book edited by T. D. Lee entitled *Weak Interactions and High-Energy Neutrino Physics*, (Proceedings of the International School of Physics "Enrico Fermi", Varenna, Italy, course 32, 1964, Academic Press, New York, 1966). The description of experiments ($\gamma_\mu + \text{heavy nucleus} \rightarrow \mu^- + e^+ + \gamma_e + \text{heavy nucleus}$) that lead to the conclusion that the mass of the intermediate boson—if it exists—is greater than 2 Bev is mentioned on page 120 of Weissenberg's book, but no real account of them appears anywhere in the book—certainly not in Chapter I as asserted on page 120. Gilberto Bernardini describes the experiments in great detail in Lee's book, as does Lee himself but more sketchily.

From the theoretical side, this book is certainly much weaker than Lee's and at times appears wrong. (I do not understand the statement on page 88 that "No information is available at present about the absolute probability of these processes" ($\pi \rightarrow \mu +$