in the subject and yet everywhere empty. The total number of terms in the main dictionary is said to be more than 7000, and it would probably take an equal number of additional entries to reach the point where one would have difficulty finding terms not present. Yet the backbreaking labor on the part of the editors and publishers is apparent on every page. There are many fine articles carefully thought out and carefully written. What is lacking, and this is my principal criticism, is a clear picture of the use to which the dictionary can be put and of the class of people making such use. There are terms from the deep past such as "parallelepiped" which can be found in a conventional dictionary. There are also terms from the bright present such as "Moore-Smith convergence" whose definition would take a specialist in a sub-sub-field to interpret properly. Of course, the specialist doesn't really work with such a dictionary, and the mathematical typist who might benefit greatly by the spellings doesn't require the definitions. The successes of the present dictionary are, so to speak, "literary" and derive from the care which each contributing editor has devoted to his assigned terms. The failures must be seen against the backdrop of an increasingly critical problem: how and for whom should vast globs of fact be summarized?

Punched Cards: Their Application to Science and Industry (2nd Revised Ed.). Edited by Robert S. Casey, James W. Perry, Madeline Berry, Allen Kent. 697 pp. Reinhold Publishing Corp., New York, 1958. $15.00. *Reviewed by Robert E. Maizell, American Institute of Physics.*

ONE of the principal problems in the attempts to work with punched cards has been that the potential consumer has been dependent on what the manufacturer of the equipment tells him. This book will help to provide information so that the consumer may make a more intelligent decision as to what type of equipment, if any, may be most suited to his needs. The review of available equipment (as of October, 1958) is particularly useful. In this connection, the physicist should also be aware of the newly established clearing house known as the Research Information Center and Advisory Service on Information Processing. This clearing house has recently been established with aid from the National Science Foundation at the National Bureau of Standards.

Technical information retrieval rather than scientific computation is the subject of this book. Scientific computation and accounting applications are subjects all to themselves and would require books of approximately equal size. Consequently, the present volume is concerned principally with mechanized techniques for retrieval of information from the literature rather than with the solutions of equations, or the like. But the scope of this volume is not limited to punched cards; it extends to include chapters on coordinate indexing (on which full books have been written) and an excellent chapter on the design and use of such conventional information retrieval devices as the printed subject index. There is also a chapter on literature searching, but there are full books available on this topic also. Actual programming details for machine use are properly omitted. Also, although there is some discussion of theory, principal emphasis is placed on applications in the form of case histories by a variety of authors.

Punched cards have found major uses in chemistry, metallurgy, and biology. The work in metallurgy is particularly noteworthy. Under the sponsorship of the American Society for Metals, one of the authors of this book, J. W. Perry, is leading a full-scale experiment to test the feasibility of a centralized mechanized information searching service. The results of this work, being done at Western Reserve University, have been very encouraging.

In some branches of physics the subject matter is not so easily classified as in other fields of science and hence not as susceptible to punched-card treatment. It appears from this book that applications of punched cards to information retrieval in physics have not been extensive, with the exception of the coding of spectral data. It is known that punched cards have also been applied to the coding of nuclear data, but this application is not adequately covered in this book. In addition to spectral and nuclear data, it is believed by some that there may be possible application of punched cards in such fields as acoustics and optics, where subject matter may be more readily classified than in such fields as theoretical physics.

There is an extensive bibliography of some 400 references on the use of punched cards. The bibliography alone constitutes a valuable contribution.

Physicists interested in studying the application of punched cards to their particular problems should consult, in addition to this book, the following pamphlet: National Science Foundation, *Current Research and Development in Scientific Documentation*, No. 4 (1959). This valuable pamphlet is available from the Superintendent of Documents in Washington for 15 cents.

Linear Groups with an Exposition of the Galois Field Theory (Reprint of 1st Ed.). By Leonard Eugene Dickson. 312 pp. Dover Publications, Inc., New York, 1958. Paperbound $1.95. *Reviewed by J. Gillis, Weizmann Institute of Science.*

THE late Professor Dickson has been quoted for the opinion that every research mathematician has a debt to his subject of one work of erudition. He himself certainly paid that debt in full with his *History of the Theory of Numbers*. The work on *Linear Groups* is a rare combination of erudition with brilliant original research into the subject itself, and its appearance in 1900 marked an epoch in the history of Galois theory. Moreover, by clarifying the subject and its outstanding problems, it pointed the direction for much of the

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The presentation of Galois field theory in the first part of the book stands to this day as a model of lucid exposition; and very little would have to be added to bring it completely up to date. The second part of the book is taken up with an exposition of linear groups. Although Chevalley and others have since, indeed very recently, added considerably to our stock of such groups, it is interesting to note how nearly all the basic ideas are to be found in this work of nearly sixty years ago. And the abundance of skillfully selected exercises and worked examples can be a boon to student and teacher alike.

The publication of the book at a very moderate price will be welcomed by all who are interested in Galois theory.

On Numerical Approximation: Proc. of US Army Math. Research Center Symp. (U. of Wisc., Apr. 1958). Edited by Rudolph E. Langer. 462 pp. The U. of Wisconsin Press, Madison, Wisc., 1959. $4.50. *Reviewed by George Weiss, Institute for Fluid Dynamics and Applied Mathematics, University of Maryland.*

IN the very short time since the development of the digital computer, the subject of numerical analysis has become one of current and compelling interest. Although a knowledge of numerical analysis is not yet a required part of a physicist's education, there is no doubt that it is now of enough importance to attain that status. The fact that digital computation methods are of primary importance in the fields of reactor design, other neutron diffusion problems, and celestial mechanics should considerably stimulate the interests of physicists in the relatively unfamiliar methods of numerical approximation. The present volume contains a collection of papers on that subject, most of which are in the nature of review articles on current research.

As in most collections of review articles there is wide scatter in the level of sophistication required for the reading of the individual papers. Fortunately none of the papers in this volume have completely wandered off into abstract spaces, and most are intelligible to the physicist with a good background in general analysis and at least a passing acquaintance with the concepts of functional analysis.

The introductory article by Ostrowski, "On Trends and Problems in Numerical Approximation", is a well-written account of some challenging problems in the field. A long article by Golomb and Weinberger deals with the systematic development of error bounds for numerical approximations. Using quite elementary techniques in functional analysis these authors develop error estimates which are practical as well as elegant for numerical methods in boundary value problems, interpolation problems, quadrature problems, and other linear approximation procedures. A paper by Hammer serves to point out the present difficulties in the numerical evaluation of multiple integrals because of the inability to find a proper analogue to Gaussian integration in higher dimensions than one. The contribution by Davis presents results relating to the superiority of trapezoidal integration rules over Gaussian quadrature, when dealing with certain periodic functions. There are many other papers in this volume, all of more or less specialized mathematical interest, on asymptotic expansions, extremal polynomial approximations, interpolation procedures, and applications of the concepts of linear spaces to the problems of numerical approximation. It is probable that among them the nonnumerical analyist will find at least some of interest.

Atoms III—Molecules I. Vol. 37, Part 1 of Handbuch der Physik. Edited by S. Flügge. 439 pp. Springer-Verlag, Berlin, Germany, 1959. DM 120.00 (subscription price DM 96.00). *Reviewed by Stuart A. Rice, Institute for the Study of Metals, The University of Chicago.*

VOLUME 37 of the *Handbuch der Physik* contains but three articles, all in English. These deal respectively with atomic and molecular beam spectroscopy, vibration-rotation spectra of molecules, and collisions of electrons with molecules.

Molecular and atomic beam studies have provided the experimental basis for much of modern physics. Stern's early experiments demonstrating space quantization, the determination of the anomalous spin magnetic moment of the electron by Kusch, the measurement of molecular dipole moments as a function of vibrational state by electric resonance, etc., indicate the range and power of this general experimental technique.

The first article, by Kusch and Hughes, is a magnificent summary of the methodology of, general theory of, and experimental results obtained from molecular beam studies of atomic and molecular structure. The article is of necessity shorter than Ramsey's book, but nevertheless manages not to slight any of the three general subtopics mentioned. An excellent bibliography, ordered both by year and alphabetically, makes the article extraordinarily valuable in tracking down the literature. Approximately 150 references dating from 1955 may be considered to supplement those in Ramsey's text.

The article entitled "Vibration-Rotation Energies of Molecules and their Spectra in the Infra-red" by Nielsen is an excellent account with emphasis on the theoretical details of higher order analysis than the elemental harmonic oscillator-rigid rotor approximation. In view of the material and the volume for which the article was written, the subsection on the general formulation of quantum mechanics appears somewhat out of place.

Finally, while due credit has been given to the experimental technique of molecular beams in establishing some of the basic concepts of quantum theory, the Franck-Hertz experiment demonstrating discrete atomic states must not go unmentioned. The Franck-Hertz experiment was one of the earliest quantitative studies