responsible for the Coulomb degeneracy. His last review article in 1964 is a brief and very elegant discussion of variational methods in two-electron problems.

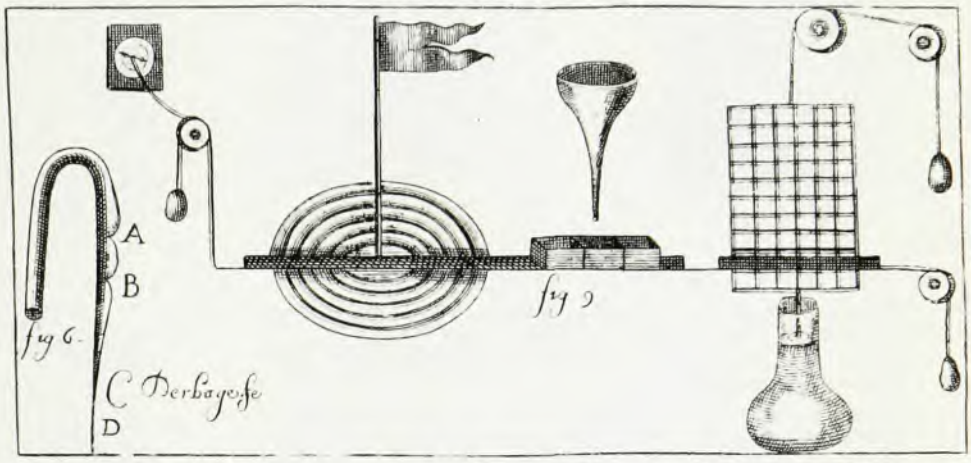
The impact of these collected papers is amplified by one particular memoir (*Rev. Mod. Phys.* **35**, 421 1963) that gives us great additional insight both into Hylleraas and into the way physicists work. There he deals with the early history of quantum theory, as seen by him as a young man. It should be compulsory reading for students and young physicists today. He shows a university life quite different from the present day. As a student "we could do what we chose to do, and nobody had a responsibility for the result, except ourselves . . . The top aim of our learning usually was to become useful teachers in our high schools, and none of us, or at least very few, would hit upon the idea of becoming scientists by profession."

On the research side, in Göttingen, he shows the presence of a well tempered competition and a great deal of discussion. A most interesting part deals with his gradual understanding and development of the approximation theory, which led to the calculation of the helium ground-state energy. This is a beautiful documentation on the growth of an idea nursed along by insight, discussions, persistence and luck.

NANDOR L. BALAZS
Professor of Physics
State University of New York, Stony Brook

Invention of the Meteorological Instruments

By W. E. Knowles Middleton
362 pp. Johns Hopkins, Baltimore, Maryland, 1969. $12.00



Sir Christopher Wren's weather-measuring device, sketched by Balthasar de Monconys.

An oral examination question attributed to Enrico Fermi is "How much energy is dissipated in a bolt of lightning?" The reaction of most examinees would be stark panic because most physics students learn little or nothing about the physics of their environment.

This is particularly sad because many advances in physics were intimately connected with the development of meteorological instruments. As far as we know the use of meteorological instruments goes back to the fourth century BC where weather-watchers in India tried to measure rainfall. But the real introduction of the instruments began in the flowering period of science during the 17th and 18th centuries.

W. E. Knowles Middleton is retired from the National Research Council of Canada and now lives in Vancouver, B.C., where he is associated with the department of the history of medicine and science at the University of British Columbia. He is a well known authority on the history of meteorology having written *A History of the Thermometer and Its Use in Meteorology* and *The History of the Barometer* and other excellent books. In the present work he treats the barometer, the thermometer, instruments for measuring humidity, duration of sunshine, the rain gauge and atmometer, the windvane and the anemometer, instruments for measurement of the upper winds and the height and motion of clouds, upper-air soundings, and concludes with telemeteorology and the radiosonde.

Middleton has traveled extensively to gather the data for this work. He has shown extreme care in preserving and presenting his historical data, not only in excellent bibliographical notes, but also in the 224 illustrations, many of them photographs of the ancient instruments and papers he discusses in the text.

FRED L. WILSON
Associate Professor
National Technical Institute for the Deaf
Rochester Institute of Technology

X-Ray Diffraction

By B. E. Warren
381 pp. Addison-Wesley, Reading, Mass., 1969. $15.00

Every once in a while a book appears that contains much of the author's creative life. This text by B.E. Warren, well known for his research and teaching, is just such a work. Intended for seniors and graduate students in physics and metallurgy, it provides both an introduction to the basics of x-ray diffraction and to advanced topics primarily in nonstructural problems. It is *the* primer for anyone intending to do research in the latter field. As is obvious, diffraction studies have contributed immensely to solid-state physics, and Warren's text covers several fields that are currently of research interest. Today, x-ray diffraction has even entered the area of Fermi-surface investigations.

About one third of the book covers introductory x-ray diffraction theory and practice; this section existed for many years as mimeographed notes and was referenced by A.H. Compton and S.K. Allison (1935). Then follow four long chapters that are the heart of the book: "Scattering by Non-Crystalline Forms of Matter," "The Effect of Temperature Vibration on X-Ray Diffraction," "X-Ray Studies of Order–Disorder" and "Diffraction by Imperfect Crystals." In each of these areas, Warren and his students have made original and significant contributions. Finally there is a full chap-

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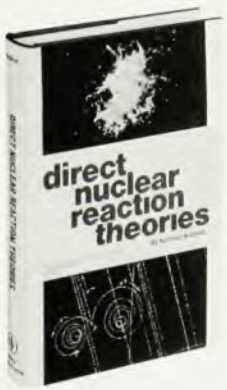

A guide to modern research in direct nuclear reaction theories, this book evaluates and classifies published research reports and explores the background and practical development of this field. Direct reactions are discussed as a special case of nuclear structure theory. Students preparing for work in theoretical or experimental nuclear physics, as well as active researchers in this field will benefit from this systematic approach to the vast amount of published research articles.

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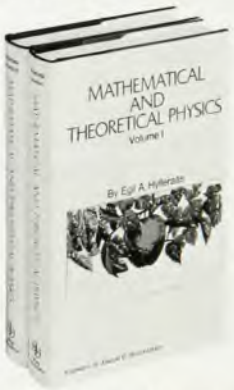

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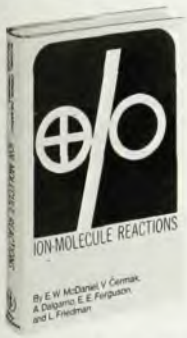

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COSMIC RAY PHYSICS

Nuclear and Astrophysical Aspects

By SATIO HAYAKAWA, *Nagoya University, Japan*

A volume in the *Monographs and Texts in Physics and Astronomy* series, edited by R. E. Marshak

The author discusses the astrophysical and nuclear-physical aspects of cosmic rays taking into consideration kinematics in collisions and decays and the results of cascade theory. An introduction to the general topic of cosmic rays is presented and the interactions of high-energy particles with matter are considered. The morphology of cosmic rays on earth is described and the origin of cosmic rays is examined.

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By G. N. RAMACHANDRAN, *Indian Institute of Science* and R. SRINIVASAN, *University of Madras*

A volume in the *Wiley Monographs in Crystallography,* edited by M. J. Buerger

A treatise on theoretical methods for transforming the data of x-ray diffraction by a periodic crystal into the electron density distribution in the crystal, this monograph is particularly concerned with procedures for deriving the structure via Fourier methods applied directly to x-ray intensities. The authors have been involved in this process for more than a decade. This volume is essentially an account of their procedures for deriving a structure, together with a discussion of related topics and extensions of their procedures. In addition, isomorphous replacement and anomalous dispersion are discussed in detail, with special reference to their application in the solution of the phase problem.

Just published 256 pages (approx.) $15.95

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WARREN

ter on perfect crystal theory; although no work in this field has come from MIT, several members of the Warren "school" have made contributions to this important subject.

Structural crystallography is introduced but not covered fully, small-angle scattering is not treated and details of apparatus and procedures are not included. However, there is enough on techniques so that one can learn how data are obtained and related to theory.

This book is notable for its exceptional clarity. It begins at the beginning with free-electron scattering and proceeds with a rigorous development of basic diffraction theory. As we might expect from someone who has attracted and taught two generations of students, there are numerous simplified retreatments of theory that are pedagogically very satisfying. Theoretical derivations are carried far enough to relate to experimental quantities. Such relations are necessary for students to appreciate the real world; all too often they are given highly sophisticated treatments that appear to have little relevance to actual experiments. In the chapter on noncrystalline scattering both approximate and exact theories are given; this again makes good pedagogical sense.

Much data and many results of significance are to be found, and some case studies are very detailed. For example, long- and short-range order studies are discussed with respect to acquisition of data and how they are treated to minimize errors. (By the way, most of us refer to short-range order coefficients as Warren coefficients; Warren, however, refers to them as Cowley parameters.) An example of the useful and practical information included is the treatment of termination effects in Fourier inversion.

There is a good selection of nontrivial problems, many of which are drawn from actual research questions. Each chapter has numerous references, some to other texts but most to papers in the research literature. A few tables are appended to provide ready reference to wavelengths, absorption coefficients, atomic scattering factors, dispersion corrections and Compton scattering intensities.

In summary it may be said that Warren has produced the expected and long-awaited book and the scientific world welcomes it as an important and unique contribution.

LEONARD MULDAWER
Professor of Physics
Temple University

Monte Carlo Principles and Neutron Transport Problems

By Jerome Spanier, Ely M. Gelbard
234 pp. Addison-Wesley, Reading, Mass., 1969. $14.95

In many complicated problems of particle transport, the numerical simulation of particle histories is a powerful tool for obtaining solutions. Because the histories are constructed by a more or less random sampling of possible histories, these techniques are called "Monte Carlo" methods for the solution of particle-transport problems.

Such Monte Carlo methods have proved useful in designing radiation shields and nuclear reactors and in studying cascade reactions. Often, one seeks to determine the probability of a rare event, such as the penetration of a particle through a shield. Then the central problem is to construct a biased simulation in which interesting histories are sampled preferentially while the probability of the rare event is still estimated in an unbiased manner. These are called "variance reducing simulations."

The present book is concerned with such methods and their application to practical problems of neutron transport in reactors. The authors are experts in their field; Jerome Spanier has helped to give the methods a firm mathematical foundation, and Ely Gelbard has pioneered in their application to selected reactor-design problems. The book reflects this expertise. The first half is a fairly rigorous and systematic presentation of the principles (without use of measure theory). Following a general introduction, emphasis is placed on methods for variance reduction and the techniques of importance sampling, correlated sampling, use of expected values, splitting, and Russian Roulette are explained.

In the second half, two neutron-transport problems arising in reactor design are considered, namely the absorption of thermal neutrons and resonance capture in cell geometry. Their solution using general Monte Carlo methods together with superposition principles and adjoint equations is explained in some detail, and serves to introduce the reader to the subtlety and diversity of techniques that are likely to be embodied in a numerical Monte Carlo program.

The exposition of Monte Carlo methods is a difficult task, for although many of the principles are