going research laboratories, and not prescribing any particular course of experimental work... because... you do not teach physics in practical work.... The only way you can do this is to throw away the routine experiments, throw away the laboratory manual..." (S. C. Brown coauthored the *Taylor Manual of Advanced Undergraduate Experiments in Physics,* sponsored by AAPT in 1959.)

E. Mendoza (University College of North Wales): "Contact with staff merely by mixing with their research group is haphazard. What we are trying to do is deliberately to teach how to design apparatus, how to be critical of apparatus, and how to organize a primary research project. ... It is a terrible criticism of us who teach science in the universities that graduates in English literature or history are found to have more logical and analytical minds than scientists."

(d) N. Clarke (Institute of Mathematics and its Applications, England): "The term 'sandwich course' is intended to indicate a course where periods of study in a university or college, extending over weeks or months, alternate with periods in industry or a government laboratory.... One of the requirements is that the student shall be engaged in industry on work which is relevant to his studies and which will help him to see the significance of them. A second essential requirement is that during the six months in industry the student shall be able to maintain appropriate contacts with the college.... A further feature.... is that the experimental work in the college, especially in the last year, has taken the form of projects. This is perhaps the feature more than any other in which the colleges have been pioneers in the United Kingdom."

(e) G. S. Bosworth (English Electric Co. Ltd.): "A physicist taking a post other than in a research laboratory will inevitably become a technologist. Unfortunately, the feeling seems to exist in the U.K. that technologists are second class scientists, if not second class citizens. The process of analysis is more highly regarded than the process of creation, but knowledge and understanding have little purpose if they are not used. Scientific knowledge can only be of lasting value if it is used in the constant struggle by mankind to dominate his environment. Man from the earliest times has been a technologist, and we in industry welcome especially the scientist who wishes to use his knowledge in creating the means whereby this can be accomplished."

All participants in the Conference are identified and a nine-page listing of their mailing addresses is given. It would have been helpful if addresses had also been given for sources of the films and film loops assembled by G. R. Noakes (pages 98–125).

Anyone interested in the education of physicists and the role of physics in society should find in this book some arresting new ideas and perhaps challenges to his present beliefs and practice.

* * *

Robert L. Weber is the author of a number of physics textbooks. He is an associate professor at The Pennsylvania State University.

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Evolution of ideas

THE CONCEPTUAL DEVELOPMENT OF QUANTUM MECHANICS. By Max Jammer. 390 pp. McGraw-Hill, New York, 1966. $10.50

by Eugen Merzbacher

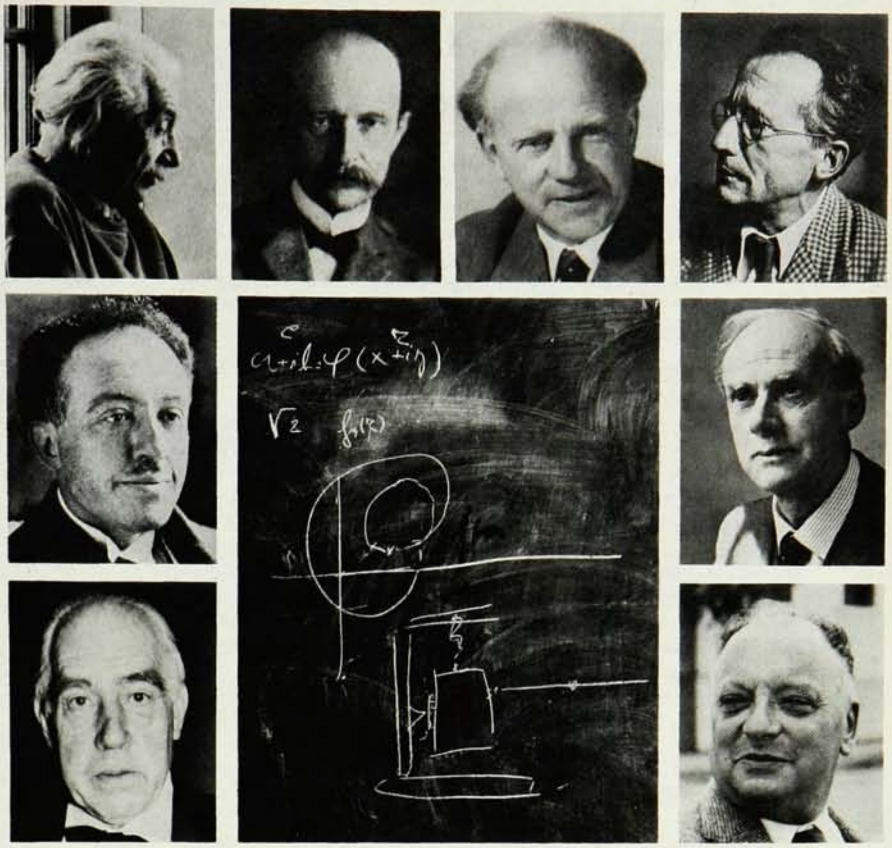
Most physicists who are active today studied quantum mechanics after World War II when it had already become a textbook subject, codified in terms of a set of consistent physical principles and mathematical techniques, and taught efficiently by a hardened pedagogic approach pioneered by Pauli (in his *Handbuch* article) and Dirac (in his *Principles of Quantum Mechanics*). We are fortunate that now an author of Max Jammer's ability and experience has provided us with a thorough and readable account of the genesis of the structure of quantum mechanics. The appearance of his *Conceptual Development of Quantum Mechanics* is an important publishing event in physics, and the book is a fitting addition to its publisher's distinguished green International Series in Pure and Applied Physics.

This is a study primarily of the evolution of ideas and knowledge that in the mid-twenties culminated in the formulation of quantum mechanics as we know it. As such it is a significant contribution to the literature in the history of physics, but it is not, nor does it claim to be, a full history of quantum physics. Such a history, when it is written, will be a more comprehensive work and will be based in large measure on the spadework done by Jammer and embodied in a most impressive array of footnotes throughout this book. Indeed, it is a pleasure to peruse these footnotes which, often in the original language, have been edited painstakingly.

The body of the text is thus unencumbered by detail not directly germane to the author's theme: the tracing of the concepts of quantum mechanics from their origins, not only in physics and mathematics but in philosophical and psychological thought patterns of the past, and a sharp and clear exposition of the conceptual change brought about by quantum mechanics as it emphasizes the notions of states of a system and of interactions in place of the concepts of properties and attributes of particles, which played a dominant role in classical physics.

Jammer's thesis is so well defined and his style so lucid that he is able to compress within less than 400 pages his explanation of much of the physics accomplished in the unbelievably productive period from 1900 to 1930. His historical erudition—especially evident in his illuminating discourses on the background of some of our routine mathematical methods—is matched by his professional handling of intricate physical problems. At the risk of exposing his own ignorance, this reviewer gladly confesses that every page in the book either contained information new to him or served to illuminate that which he already knew.

Without question, much of the value of Jammer's new book lies in the author's scrupulous objectivity as he carefully substantiates his arguments. In writing *The Conceptual Development of Quantum Mechanics* he was able to draw on a number of sources previously not accessible. Among these were the personal papers of Einstein. Even more informative, excerpts from interviews with Dirac and Heisenberg, among others, preserved in the new Archive for the History of Quantum Physics, add spontaneity to Jammer's documentation.



DEVELOPERS OF QUANTUM PHYSICS. The blackboard is Bohr's, who wrote the inscription on the night before he died: at the top a singularity of the nonuniform function $z^{1/2}$; underneath it the "Einstein box." The people are (CW from lower left) Bohr, de Broglie, Einstein, Planck, Heisenberg, Schrödinger, Dirac, Pauli.

While describing the attitudes of the founders of quantum mechanics toward the physical interpretation of the theory with uncommon clarity and brevity (and only with a slight loss of depth), Jammer refrains from taking sides in the continuing debate over the problem of measurement in quantum mechanics. This is proper, but one may question the virtue of an excessive neutrality with regard to some of the past and present controversies that surround quantum mechanics. Fairness to all participants in an intellectual dispute is of course welcome, but on occasion Jammer shows an unwillingness to evaluate that renders his analysis less useful than it might have been.

Yet, on balance one is grateful that he has erred on the side of caution, for even when he is too mild in his criticism he always confines himself with good judgment to the description of work that is relevant in the context. By exhibiting the variety of approaches applied by "the questioners" to problems that by training and habit we ordinarily examine from but one canonical point of view, Jammer uses history in a productive manner—as a means for showing us our science as a living and growing body of physical insights rather than the fixed orderly doctrine that we teach our students. Progress toward the next stage of physical theory depends on the development of new concepts and on our ability to discriminate between false starts and constructive innovations. It is therefore well that we have before us this fascinating account of the most

Physics today Outstanding ne

BERKELEY PHYSICS COURSE: VOLUMES 1, 2 and 3; and BERKELEY PHYSICS LABORATORY.

This course, when complete, will comprise five volumes. The texts were planned as a three- or four-semester sequence in physics for engineering and science students, by an inter-university steering committee which met in May 1962 at the University of California, Berkeley.

The specific objectives are to introduce coherently into an elementary curriculum the ideas of special relativity, quantum physics, and statistical physics. The course is designed for all who have had a high school physics course and are taking calculus concurrently.

BERKELEY PHYSICS COURSE: **VOLUME 1—MECHANICS.**
By CHARLES KITTEL and WALTER D. KNIGHT, both of the University of California, Berkeley; and MALVIN A. RUDERMAN, New York University. 502 pp., 594 line drawings, 40 halftones; $5.50.

This completely modern, stimulating text differs from others in its detailed development of the consequences of the special theory of relativity; emphasis on the motion of charged particles in electric and magnetic fields; and the presentation of elementary mechanics so that paths lead to other parts of physics, astronomy, geophysics, and in part to chemistry and biophysics.

Vectors, the conservation laws, the harmonic oscillator, elementary rigid body dynamics, and the inverse-square-law force are treated in the first part of the book. The other half of the book is largely a clear, complete exposition of the special theory of relativity, ending with chapters on the equivalence principle and the particles of modern physics. A Solutions Manual is available.

BERKELEY PHYSICS COURSE: **VOLUME 2—ELECTRICITY AND MAGNETISM.**
By EDWARD M. PURCELL, Harvard University. 479 pp., 470 line drawings, 2 halftones; $5.50.

This book develops the fundamental principles of classical electricity and magnetism, drawing on the background in mechanics and relativity provided in Volume I: MECHANICS.

Like Volume 1, this volume departs from traditional presentation. It treats the electric and magnetic fields of moving charges and the transformation laws for the magnetic field as manifestations of relativity and invariance of electric charge. Frequent use is made of symmetry considerations, superposition, and physical phenomena seen from different frames of reference. The book emphasizes the nature of atomic and molecular dipoles, both electric and magnetic, using a "microscopic approach."

Problems extend the discussion or introduce related material. A Solutions Manual is available.

BERKELEY PHYSICS COURSE: **VOLUME 3** (Preliminary Edition)—**WAVES AND OSCILLATIONS.**
By FRANK S. CRAWFORD, JR., University of California, Berkeley. 480 pp., $4.50 (soft cover).

The preliminary edition of this important volume is available in limited quantities. As it deals with revolutionary concepts, the author wishes to avail himself of the comments of his colleagues and to have the benefit of classroom-testing as the definitive edition is being readied for publication. The preliminary edition is produced at this time in response to very real and substantial demand from schools throughout the country.

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By EYVIND H. WICHMANN, University of California, Berkeley. 579 pp., 83 line drawings $4.50 (soft cover).

VOLUME 5—STATISTICAL PHYSICS.
By F. REIF, University of California, Berkeley. Approx. 425 pp., 276 line drawings; $5.50.

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recent heroic effort, the discovery of the quantum of action and the subsequent invention of quantum mechanics.

* * *

Eugen Merzbacher, a professor at the University of North Carolina, is the author of a textbook of quantum mechanics.

Fission-product dynamics

PHYSICS OF NUCLEAR KINETICS. By G. Robert Keepin. 435 pp. Addison-Wesley, Reading, Mass., 1965. $12.50

by Alvin M. Weinberg

Keepin interprets the "physics of nuclear kinetics" broadly. In the first half of his book he reviews and compiles data on prompt neutrons and gamma rays from fission, as well as on the energy release and the mass and charge distribution in fission. One particularly welcome and germane chapter reviews our knowledge of delayed gamma rays from fission, and the yields of photoneutrons induced in beryllium and deuterium moderators by fission and fission-product gamma rays.

The most important chapter—the fourth—reviews in painstaking detail most of what was known about delayed neutrons up to 1964. To this task Keepin brings his own extensive experience in measuring the yields of delayed neutrons. His comprehensive review is a model of patient scholarship, and his tabulations of the yields and periods of the delayed neutrons, and particularly of the derived inhour relations giving reactor periods as a function of reactivity will be very useful to reactor physicists and engineers working on reactor kinetics.

The second half of the book is concerned largely with the theory of reactor kinetics. Most of the exposition is confined to linear theory, and includes outlines of the various static and dynamic methods for determining the reactivity of a reactor. The final two chapters cover matters directly concerned with assessing the safety of a reactor: the transfer function and nonlinear reactor dynamics.

Thus the book is in a way two books: the first half a painstaking re-