The Revolution in Physics

In his historical essays Niels Bohr repeatedly stressed the complex nature of the development of quantum physics, describing it as having taken "the combined effort of a whole generation of physicists" and having led eventually to nothing less than "a new outlook regarding the comprehension of physical experience." Max Jammer's **The Conceptual Development of Quantum Mechanics** (McGraw-Hill, New York, 1966. 413 pp., illus. $10.50) is the first serious attempt to deal with the history of this revolutionary change in physical thought. Jammer has written directly from the primary sources, and must have worked his way through a quarter of a century of extensive and difficult periodical literature. He has supplemented this with a study of the recorded interviews with some of the survivors from the heroic age (interviews we owe to the project "Sources for History of Quantum Physics") and with an examination of the scientific correspondence of a number of the leading physicists of the period. The result is a book that treats the period from Max Planck's introduction of energy quanta in 1900 through the formulation of the Copenhagen interpretation in 1927, and treats it thoroughly and with assurance. Jammer is at home in the language of theoretical physics, and he has carefully discussed and analyzed a good many of the major and minor papers to show how the arguments he selects were originally presented. His previous work on the history of some of the key concepts in physics is also reflected here as he suggests the philosophical background of Bohr's work [in Kierkegaard, Høffding, and William James (!)], traces the prior history of some of the mathematical techniques used in quantum mechanics, and follows the shifting arguments on several conceptual issues that have not been fully resolved. All future students of the history of quantum physics will gratefully begin their work with the aid of Jammer's book.

But having said this I must also say that Jammer has not written a completely satisfactory history. Even dealing with the history of a particular branch of science in the recent past, it would be wise to observe A. O. Lovejoy's remark that the historian "may not assume a priori that the major problems of the present were those of the past" and his suggestion that "the intellectual historian's selection . . . should be determined, not by what seems important to him, but by what seemed important to other men." Jammer has not always proceeded in this way. He actually begins his book by remarking that it was "unfortunate" that quantum theory arose from such a complex issue as the problem of black-body radiation! His readers will not learn, for example, that Planck's fundamental aim in the late 1890's was to provide an electromagnetic, nonstatistical derivation of the second law of thermodynamics, or that Planck's full confidence in the correctness of his energy quanta was based on his determination of the basic units of mass and electricity with the help of his radiation formula. The concerns that loomed large 50 or 60 years ago do not always control Jammer's account of the events of that time. Thus, by choosing to emphasize only Bohr's derivation of the hydrogen spectrum, which has "survived," Jammer gives a misleading picture of the purpose of Bohr's 1913 papers, which was the construction of a theory of atomic and molecular structure, with emphasis on the "permanent" states of such systems, in order to explain the chemical and physical properties of matter. This sort of failure of the historical sense is the major flaw in Jammer's book.

Robert Oppenheimer once commented that writing the history of quantum physics "would call for an art as high as the story of Oedipus or the story of Cromwell." Jammer's book lacks the "bravura adequate for this great hymn." He deserves all credit for having written the first word on his subject, but it is hardly the last.

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Marine Biology

Matter suspended in the water provides food for a very large number of marine organisms. In C. Barker Jørgensen's **Biology of Suspension Feeding** (Pergamon, New York, 1966. 373 pp., illus. $12.50), an outgrowth of a general survey of the topic that appeared in *Biological Reviews* some years ago, the various types of feeding structures that have developed to capture suspended material are described, and the organisms that subsist by such means are reviewed. Jørgensen then goes on to discuss the sources of suspended material, including phytoplankton and various "dissolved" and breakdown substances. The book is an excellent contribution to one of the most basic problems of marine biology in terms both of morphological and zoological summary and of the ecological aspects of the process. There are 144 pages of references and numerous illustrations of feeding or collecting structures. The illustrations have been copied from the literature and represent diverse drawing techniques. In some instances lines should have been strengthened or illustrations redrawn, but this is a comparatively minor defect in what is one of the best and most useful volumes of Pergamon's series of monographs in pure and applied biology.

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Laser Therapy

Leon Goldman, a dermatologist with extensive clinical experience, has been intensely interested and closely involved in the development of the laser as it relates to medical applications. He has written a short monograph, **Laser Cancer Research** (Springer-Verlag, New York, 1966. 73 pp., illus. $4), which in part justifies the enthusiasm with which his laser studies have been carried out. A carefully written introductory chapter on laser instrumentation details to the novice innumerable innovations that the engineers have offered the investigator interested in determining the role that the laser may play in the treatment of the cancer patient. The poorly understood safety hazards, which must be considered in every laser laboratory, are summarized in the second chapter, emphasis being placed on the all-important protection of the eye. The author's philosophy, that true advances in the biomedical laser art will be made in the human and not necessarily in the experimental laboratory, are reflected in four abbreviated chapters on laser reaction in normal and tumor tissue in animals and tissue cultures and the role of pigmentation in laser sensitivity. The concluding chapters outline the active role that the laser currently plays in the author's clinic. In the discussion of the laser treatment of melanoma, epithelioma, lymphoma, and other malignancies, encouragement is offered the therapist who is planning to include the laser in his cancer armamentarium.

The reader's optimism should, however, be tempered somewhat by a review of the bibliography. One quarter of the 99 references are to publications by the author, nearly all dealing with clinical experimentation. A review of many of the other references suggests that much is left to be learned before this innovation in biomedical research should be made available to every clinician who can afford to buy it.

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For Statisticians and Students

The **CRC Handbook of Tables for Probability and Statistics** (Chemical Rubber Company, Cleveland, Ohio, 1966), edited by William H. Beyer, appears in a "Professional Edition" (518 pp., illus. $15) and a "Student Edition" (378 pp., illus. $5).

The professional edition consists of 13 sections, the first section giving background material on probability and statistics, and the remaining sections containing 77 tables and charts under such headings as the normal distribution; chi-square, *t*, and *F* distributions; discrete distributions; order statistics; range; correlation coefficient; nonparametric statistics; quality control; and miscellany. The first section, which comprises more than one-fifth of the book, summarizes some of the basic concepts in probability and statistics and includes topics such as the general linear model, plans for design of experiments, and analysis-of-variance tables. Preceding almost every table is a brief introduction which defines and discusses the function being tabulated. This edition includes almost every table that a practicing statistician is likely to need in his daily work.

The student edition, which appears in a smaller page size, omits five of the tables and most of the background material included in the professional edition. Unfortunately, there is nothing on the title page of the student edition to distinguish it from the professional edition, and both have been given the same Library of Congress card number. Only in the publisher's advertisements does one find the labels "professional" and "student" editions.

Although this handbook contains a highly useful collection of tables, it has a number of shortcomings. In the preface it is stated that the tables "were collected from many sources, to which due credit is given." I noted, however, a number of omissions and one error in the acknowledgments. No credit, for example, is given to W. J. Dixon's article in *Biometrics* (1953) as the source of the table of critical values for testing outliers.

In checking some of the tables in this handbook against other published tables, I found a number of nontrivial errors. These will be listed in the errata section of the journal *Mathematics of Computation*. Three of the errors in the *t* table could have been avoided if the latest edition of *Statistical Tables for Biological, Agricultural and Medical Research* by Fisher and Yates had been consulted instead of the first (1938) edition. In the student edition the first few lines of the "general linear model" appear at the bottom of page 20, but the rest of this 21-page section was omitted. The introduction to the table of binomial coefficients tells how to obtain values missing from the table, but there is no remedy for the omission of a whole page from this table. The table gives $({}_nC_m)$ for $n \leqq 50$, with m covered only for $m \leqq 11$, whereas the source table covers $m \leqq 25$ and is thus complete.

In the table of critical values of Spearman's rank correlation coefficient, r_s, there is an unexpected lack of monotonicity in the column headed $\gamma = .01$. I found that this is due to the fact that most of the table is based on approximations, but no statement to this effect is given.

One thing lacking in the book is a bibliography of related tables to assist the reader who sometimes needs more extensive tables than those given here. The index is adequate except for being set in unusually small type.

These two books will be useful if the prospective user gets hold of the right edition and is aware of its shortcomings.

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Crystallography: Exploring Polytypism

Polymorphism and Polytypism in Crystals (Wiley, New York, 1966. 361 pp., illus. $12.75), by Ajit Ram Verma and P. Krishna, is the first book in Wiley's Monographs in Crystallography series, edited by Martin J. Buerger.

Polymorphism is the crystallization of the same chemical substance in more than one structure. Polytypism is a special case of polymorphism involving "the ability of a substance to crystallize into a number of different modifications, in all of which two dimensions of the unit cell are the same while the third is a variable integral multiple of a common unit." One would judge from the title of Verma and Krishna's book that an equally thorough treatment is afforded both subjects. However, polymorphism is treated "more to facilitate a fuller understanding of polytypism" and is discussed in two chapters (phase and structural aspects), whereas the more specialized topic occupies over 80 percent of the text. The authors discuss polytypism from its beginnings as a crystallographic curiosity in 1915 to its current recognition as a widespread phenomenon bearing on the fundamentals of crystal growth. The coverage includes a description of polytypic structures (especially SiC and CdI_2), polytype structure determination, dislocations and spiral growth, theories of polytypism, and recent observations. In weighing collected experimental data against the various postulated mechanisms, the authors dwell at length upon Frank's nonthermodynamic, screw-dislocation theory and Jagodzinski's thermodynamic, layer-transposition mechanism. Neither of these best-available theories, however, is completely satisfactory, and the dilemma of polytypism persists: what is the ordering mechanism in materials such as SiC (47 modifications; unit cells up to 594 layers, ~ 1500 Å) and CdI_2 (64 structures)?

There are a number of typographic and other errors and contradictions. The more important ones include: page 25, b.c.c.'s and f.c.c.'s are interchanged in the discussion on Fe (compare page 11); pages 81 and 93 are contradictory with respect to the natural occurrence of SiC (it *is* a mineral); pages 81 and 92 differ as to who first obtained SiC; entry 42 in Table 3, page 108, should be 123R;