

dinger, one peripheral, one a statement that Born's perturbation theory is equivalent to his (what hindsight!), and one to him as a precursor of von Neumann! I hope that Van der Waerden uses "quantum mechanics" as a synonym for "matrix mechanics" merely to stress that historically the term is Born's, not in order to prepare the ground for a new attempt to bypass Schroedinger. But we must wait for the second volume to see how wave mechanics is treated. Let us hope that it will include other neglected works, notably of Landé and of Milne, not to mention Heisenberg's 1927 paper on indeterminacy.

In this volume, Van der Waerden draws attention only to that part of Bohr's program which relates to the rise of matrix mechanics. And therefore, even though he tries hard to credit Bohr, he does not do justice to all of Bohr's remarkably detailed and suggestive ideas. He can still do so in his second volume.

Viewed as a program, Bohr's correspondence principle suffers from too much success. Viewed as a proposal for a solution to a problem, it must be seen as embedded in a wider problem, how to overcome the wave-particle duality. The duality problem was not solved but rather deepened by following the correspondence principle. Otherwise there would be no need for the uncertainty principle (nor would it be possible). Did that principle solve the problem satisfactorily? The answer to this question was given by Bohr in his discussions of complementarity: it was as satisfactory as possible. The complementarity principle thus came to replace the correspondence principle. Hence the lack of clarity about correspondence, and the injustice done to it, in subsequent literature, including Pasqual Jordan's *Physics of the Twentieth Century*.

Van der Waerden has rendered a valuable service by putting the correspondence principle back on the map, even though he appears thus far as an apologist of one party in the dispute—the majority—rather than as a dispassionate observer; however, he can still correct this impression. It would be easier for him to do so, I suggest, if he stressed more the role that problems play in the advancement of science.

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Continental Drift Revisited

The Origin of Continents and Oceans. ALFRED WEGENER. Translated from the fourth revised edition (Braunschweig, 1929) by John Biram. Dover, New York, 1967. 256 pp., illus. Paper, \$2.

Debate about the Earth. Approach to Geophysics through Analysis of Continental Drift. H. TAKEUCHI, S. UYEDA, and H. KANAMORI. Translated from the Japanese by Keiko Kanamori. Freeman, Cooper, San Francisco, 1967. 253 pp., illus. \$4.50.

The debate about continental drift has raged fiercely ever since Alfred Wegener advanced his concepts in 1912. Struck by the congruity of the South American east coast and the African west coast, Wegener had gathered relevant geological data which convinced him that indeed South America and Africa had once been together as a single continent. He further concluded that all the present land masses had once been united. Historically, Wegener's views received their widest distribution through translation into many languages of his third revised edition (1922) of *The Origin of Continents and Oceans* (English translation by J. G. A. Skerl, London, 1924). That edition has formed the basis for most English-language discussions. The fourth revised edition (1929), however, from which the present translation was made, presents Wegener's matured views and represents a revision over the third edition to the extent that 40 percent of the references and illustrations are new. This last edition is flawed by Wegener's justified but unfortunate acceptance of erroneous geodetic measurements which seemed proof of relative movements of Greenland and Europe. The revision is surprisingly modern and cogent in some sections but is archaic in others. The volume (despite the tedious prose) should be read by every serious student of continental drift.

H. Takeuchi, S. Uyeda, and H. Kanamori use the debate about continental drift to present a generalized discussion of the earth's structure and history. The geophysical principles are presented nonmathematically, but only magnetism and heat are treated in detail. The authors take the reader from A. Wegener's presentation (third edition) through the controversy and the critical American Association of Petroleum Geologists symposium on continental drift of 1928, critical because the embittered rejection of the theory of continental drift by the main body of

American geologists of that time can in part be tied to that symposium. The authors carry the discussion through the development of paleomagnetism into the modern oceanographic work and set the stage for the latest advance of the continental-drift theory, the hypothesis of sea-floor spreading, which has come on the scene since the book was written. A well-balanced account of the debate, which has itself been anything but well balanced, is presented. The authors provide many pieces of personal information which could not be gotten from the scientific literature and which help to bring the debate into its true historical perspective. A very strong emphasis is justifiably placed on the post-World-War-II development of paleomagnetism in the modern rebirth of the concept of continental drift. In this, however, the authors reflect the Japanese and European history rather than the U.S. history of rebirth. The rebirth in the U.S. came about through geological and geophysical studies in western North America and, especially, studies of the deep-sea floor. The large-scale yet simple geologic structures and geophysical properties of western North America and of ocean basins could only be explained in terms of a mobile earth, rather than the static one so long favored by most American geologists. The authors' treatment can be easily understood by the intelligent layman. It brings the reader up to the current scientific frontier while providing him with a good background. The book can profitably be read by any scientist concerned with the problem, if he is not put off by the simple treatment.

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Physics without Words

Basic Data of Plasma Physics, 1966. SANBORN C. BROWN. M.I.T. Press, Cambridge, Mass., ed. 2, 1967. 330 pp., illus. \$8.50.

This is a book essentially written by computer. It is a compilation of curves useful to those making calculations involving elastic and inelastic collision cross sections, charge exchange cross sections, mobility, diffusion, recombination, and secondary emission coefficients, as well as other atomic processes that occur in gaseous discharges. These data were searched out of the

listings of 25 physics journals programmed into the computer memory of the M.I.T. Technical Information Project. References from papers in these 25 journals raised to 850 the total number of journals available for citation.

Approximately 450 diagrams convey the essential information to the reader, with a minimum of distracting text. References to the original literature accompany each figure, making it easy to look up details concerning experimental methods if the reader so desires.

The present volume is a complete revision of Brown's 1959 volume of similar purpose, bringing the data up-to-date as of 1965. Most of the descriptive text in the earlier edition has been eliminated, leaving only the barest minimum of theory necessary to define the symbols used in the diagrams. Unfortunately, in the course of the revision a large number of typographical errors have crept in, making it necessary for the reader to verify each equation and numerical factor. Some of the sentences have been chopped so that one must guess at their meaning. There has been an apparent neglect of editing and proofreading at some stage in the manufacture of this book.

Reading a book like this makes me wonder if education by computer will leave the next generation of children indifferent to the beauties of English style and sentence construction. Or will we, as suggested in the recent science-fiction story "Babel-17," learn to think in computer language?

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Cellular Structures

Regulation of Metabolic Processes in Mitochondria. Proceedings of a symposium held in Bari, Italy, April-May 1965. J. M. TAGER, S. PAPA, E. QUAGLIARIELLO, and E. C. SLATER, Eds. Elsevier, New York, 1966. 594 pp., illus. \$27.50.

This collection of papers by European biochemists includes accounts of experimental work and discussions of most of the major known functions of mitochondria. The gathering together of a large number of papers in this field in a single volume not only serves to highlight areas in which there is es-

sential agreement among different investigators, but also reveals that in other areas there is a lack of unanimity and basic understanding of the mechanisms controlling metabolic reactions in mitochondria. The concluding panel discussions on selected topics are particularly valuable and should provide a stimulus to investigators in their search for new approaches and tools to resolve such problems as the mechanism of energy conservation, the nature of energy-rich intermediates of oxidative phosphorylation, and the metabolic significance of ion uptake and swelling in mitochondria.

Among the more interesting papers are P. Mitchell's defense of his recently developed chemi-osmotic theory of energy conservation against the more conventional chemical theory, and E. C. Slater's summary of evidence in favor of the existence of high-energy chemical compounds as intermediaries in respiratory-chain phosphorylation. Proposals for new mechanisms of fatty acid activation are presented by several authors, and concepts on the control of glutamate oxidation and competition between substrates for oxidation are also reported.

G. D. Greville presents a fine review of the control of utilization of substrates by mitochondria, which focuses attention on the multiplicity of possible control sites and their interaction. It reveals clearly that a deeper understanding of the intramitochondrial location of enzymes and permeability barriers to substrates and cofactors is necessary before observed metabolic events can be interpreted unambiguously. An experimental approach to this difficult problem is described by M. Klingenberg and E. Pfaff, who present data, based on analytical measurements principally of isotopic nucleotide exchange, that formalize functional compartments. V. P. Whitaker discusses the morphological compartments seen in the electron microscope. Once functional compartments are defined in relation to the mitochondrial ultrastructure, it may be expected that basic problems involving mitochondrial control mechanisms will be solved. This book provides examples of profitable, as well as unprofitable, approaches.

Although *Regulation of Metabolic Processes in Mitochondria* contains a large body of experimental facts, it would have been more authoritative had the editors been more selective. The impression exists that some of the

reported findings may be inconsequential, essentially unrelated to the broader issues of metabolic control. This may confuse the nonspecialist seeking a background in mitochondriology and makes the specialist pay an unnecessarily high price for the dozen or more excellent articles. A major defect in many of the papers themselves is an insufficiency of detail in the description of the experimental procedures. This makes it difficult to judge the data on such controversial subjects as the mechanism of action of atractyloside, carnitine, and thyroid hormone, where discrepancies between observations reported by various laboratories may, in large part, reside in the different experimental procedures used.

However, the extensive bibliographies, excellent indexing, and the presence of previously unpublished data in most of the contributions, make this volume a useful reference work well worth the initial investment.

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Physicochemical Phenomenon

Ion Exchange. A Series of Advances. Vol. 1. JACOB A. MARINSKY, Ed. Dekker, New York, 1966. 436 pp., illus. \$16.75.

This is the first volume of a series of Advances initiated, according to the editor, to satisfy the need "for examination and evaluation of ion-exchange theory and experiment as they evolve."

The first chapter, on transport processes in membranes (Caplan and Miclecky), stresses the application of nonequilibrium thermodynamics. I found the material quite difficult to follow, apparently as a result of the desire of these authors to present a complete and rather detailed treatment in a limited space. A review restricted to fewer phenomena and less detail would have made this section more useful. The treatment of ion-exchange kinetics (Helfferich) gives a good summary of recent experiments and results, followed by an excellent review of recent theoretical treatments, largely those of the author. The study of complex formation in ion exchangers (Y. Marcus) is detailed and complete, but of interest probably limited to those concerned with this rather narrow application. The chapter on theory and experi-