Reviews of Books

Pigments (10 lectures presented at a summer school on the Chemistry and Technology of Pigments at Leeds University). Ed. D. PATTERSON. (Elsevier Publishing Co., Ltd., Amsterdam, London and New York, 1967.) Pp. xii + 210. Price 65s.

The pigment technologist like many other specialists in the applied sciences requires a detailed background on certain aspects of physical chemistry, surface and colloid science and physics. Dr. Patterson's work in bringing together under one cover material from a wide spectrum is commendable, and the book should be of use to a group much wider than pigment technologists alone.

The first two chapters on the theory of coloured substances provide a useful introduction to the general theory of light absorption of organic and inorganic substances and quantum energy levels. General references to more extensive treatments would have been helpful. The third chapter is a particularly useful one and deals with the absorption, scattering and reflecting properties of a dispersed material. The treatment of Kubelka-Munk equation is good but discussion might have usefully included the difficulties encountered in its application. The fourth chapter on photoconduction and degradation of organic molecules covers the situations of light changing the nature and properties of the material it strikes—all too often assumed to be unaffected. Photoconductive processes are described in some detail. Chap. 5 and 6 on particle growth and particle size measurement should be helpful to the technologist particularly because the methods of specifying "mean diameter" have been set out clearly in a table.

Chap. 7 and 8 provide a survey on instrumentation and methods of colour measurement. The second gives just prominence to the very difficult subject of colour matching and visual response. Finally two chap. 9 and 10, cover the surface-active and dispersion properties that are required to make a pigment stable in its liquid carrier medium. These two chapters could have been combined so as to avoid, for instance, the section on the Derjaguin-Landau-Verwey-Overbeek theory of colloidal stability being repeated, more fully in chap. 10, with very similar diagrams. Triboelectric charging of pigments is not treated. However, the criticisms are mainly minor and the book without doubt provides a physico-chemical background to the study of pigment systems at a reasonable price.

J. F. PADDAY

Received 30*th October*, 1967

Annual Reviews of Biochemistry, Vol. 36 Part I and II. (Annual Reviews Inc., Palo Alto, 1967.) Pp. vii+757+80. Price 96s.

Anyone, like the reviewer, who uses physical chemistry to solve biochemical problems, must be even more indebted than others to the authors who survey these fields in the respective annual review volumes. The terms of reference of the authors of the individual chapters are to prepare a selective critical survey of their field. In consequence we get in any one year a lucid, albeit, biased account of an area, the bias being overcome by integration of the opinions expressed in a number of successive volumes. This approach is much more stimulating than a flat recital of published "facts".

The menu offered in 1967 is full of interesting information and clear presentation of problems of many areas of biochemistry which would be well served by more attention for sympathetic and suitably educated physical chemists. Some chapters are entirely devoted to topics of interest to physical chemists: Enzyme Kinetics, Conformation of Proteins, Electron Transfer, Physical & Chemical Properties of Nucleic Acids, X-ray Diffraction studies, Active Transport. Many of the other chapters on groups of enzymes or metabolic pathways contain sufficient chemical information to interest those concerned with mechanisms rather than the descriptive aspects of biochemistry. The chapters are uniformly well written and the Editors are to be congratulated on their choice of contributors.

H. GUTFREUND

Received 31*st October*, 1967

Topics in Phosphorus Chemistry. Vol. 4. Ed. MARTIN GRAYSON and EDWARD J. GRIFFITH. (John Wiley & Sons Ltd., New York, London and Sydney, 1967.) Pp. vii+529. Price 200s.

This fourth volume of a series which is, in fact, annual, contains a real medley of review articles, viz. The Structure and Reactions of Cyclopolyphosphines, by A. H. Cowley and R. P. Pinnell (22 pp.,

54 ref.); The Natural Occurrence of Compounds with the Carbon-Phosphorus Bond, by L. D. Quin (26 pp., 45 ref.); Photochemical and Radiation-Induced Reactions of Phosphorus Compounds, by M. Halmann (36 pp., 137 ref.); The Chemistry of Phosphorus Halides, by D. S. Payne (71 pp., 417 ref.); Progress in the Chemistry of Fertilizer and Soil Phosphorus, by G. E. G. Mattingly and O. Talibudeen (134 pp., 415 ref.); Phosphorus-Nitrogen Chemistry, by E. Fluck (191 pp., 442 ref.). The two articles, the fourth and sixth, which most interested the reviewer, are of high quality and provide full and valuable reviews of their subjects and the same is, no doubt, true of the other four articles in this volume. But what reader is really going to be interested in such a mixed bag and is he likely to be willing to pay £10 for it? It seems to the reviewer that each article in this volume would have a better chance of reaching the audiences it deserves if it had appeared together with others on more closely related topics. This circumstance, together with what really is a very high price, seems likely to determine that the fate of this volume will be to adorn only the shelves of major chemical libraries, which is, perhaps, a pity.

H. N. RYDON

Received 1st November, 1967

Reactivity of the Photoexcited Organic Molecule. (Proceedings of 13th Conference on Chemistry at the University of Brussels, October, 1965.) (Interscience Publishers, London, New York and Sydney, 1967.) Pp. ix + 350. Price 126s.

The 1965 Solvay chemistry conference was devoted to organic photochemistry. Nine expert rapporteurs presented surveys of different aspects to a select audience of 50, including 25 invited members and a similar number of Belgian chemists. The Solvay conferences played an important role in the development of science earlier in the century, when many outstanding questions were thrashed out at these meetings of " great minds ". The subsequent vast expansion of the scientific community has generated many much larger national and international gatherings, some of which function more usefully as social and labour exchanges than as scientific meetings. Smaller specialist symposia are more valuable to those privileged to attend, but their impact on the scientific world at large depends on the dissemination of the emergent knowledge and ideas. The publication of the 1965 Solvay conference proceedings is therefore to be welcomed by all those interested in the photophysics, photochemistry and photobiology of organic molecules. The two year time lapse is to be regretted, not least by some of the participants who might prefer with hindsight to revise their contributions. However, the discriminating reader should have little difficulty in separating the 95 % " wheat ", the material of more permanent value, from the 5 % " chaff ", the ideas with a half-life of less than two years, including a few which did not even survive the duration of the conference.

The proceedings include reports by C. A. Coulson on Theoretical Aspects of Electronic Excitation in Molecules, R. Daudel on The Quantum Theory of the Chemical Reactivity of the Excited States of Conjugated Molecules, G. Porter on Reactivity, Radiationless Conversion and Electron Distribution in the Excited State, G. S. Hammond on Energy Transfer in Organic Photochemistry, N. C. Yang on Photochemical Reactions of Ketones in Solution, the Hydrogen Transfer Reaction, W. G. Dauben on The Photochemistry of Conjugated Dienes, E. Havinga on Heterocyclic Photosubstitution Reactions in Aromatic Compounds, and G. M. J. Schmidt on The Photochemistry of the Solid State. The discussions on these and on an unpublished report by G. O. Schenck include contributions from D. H. R. Barton, D. P. Craig, J. H. de Boer, P. de Mayo, L. d'Or, J. Duchesne, D. Elad, Th. Förster, P. Goldfinger, C. A. Hutchinson, Jr., E. L. Mackor, R. Martin, J. E. Mayer, R. S. Mulliken, C. A. Parker, J. N. Pitts, Jr., G. Quinckert, J. Rigaudy, S. A. Rice, K. Schaffner, A. R. Ubbelohde, A. Van Dormael and the rapporteurs.

Among such a distinguished assembly few controversial points escaped critical discussion. Nevertheless the proceedings revealed the unfortunate communication gap between the theoretical and physical chemists, interested in relatively simple molecules, and the organic chemists, interested in relatively complex reactions. The gap might have been somewhat narrowed by a consideration of excimers (only referred to *en passant* by Coulson), which are amenable to the methods of theoretical and physical chemistry and which involve steric factors related to the photodimerization reactions of organic chemistry. The study of excimers and exciplexes (photo-excited complexes dissociated in the ground state) may provide a " missing link " in our knowledge of " the reactivity of the photo-excited organic molecule ".

J. B. BIRKS

Received 2nd November, 1967

The Mathematical Principles of Quantum Mechanics. By DEREK F. LAWDEN. (Methuen and Co. Ltd., London, Barnes and Noble Inc., New York, 1967.) Pp. xiv+280. Price 50s.

In this book quantum mechanics is developed with the emphasis on the mathematical structure of the theory rather than on its applications to physical problems. To a scientist this emphasis appears to be misplaced; quantum mechanics is a physical theory, and consequently the results of its applications to real problems involving atoms or molecules are of prime importance. Without such applications, the purpose of quantum mechanics, and the reason for its invention are obscured. But chemists and physicists can still learn a lot from this book because Professor Lawden establishes the mathematical structure of the theory in a systematic way from the basic quantum principles, and he does so with great clarity.

The subject is developed by first introducing N-dimensional vectors to represent quantum states, and $N \times N$ Hermitian matrices to represent observables. This formalism is applied in chap. 2 to the spin states of an electron. The generalization $N \to \infty$, which leads to wave functions, operators and Schrödinger's equation, is made in chap. 3, and both Schrödinger's and Heisenberg's forms for the equations of motion are developed in chap. 4. The chief contents of the remaining three chapters (a third of the book) are conventional accounts of the properties of angular momentum, the motion of an electron in a central field of force, perturbation theory (including simple radiation theory), and Dirac's theory of the electron.

Students of quantum chemistry who are familiar only with Schrödinger's representation will find much to interest then in the first four chapters, and anyone who works through the 109 exercises at the end of the book will acquire a sound knowledge of the basic mathematics of quantum mechanics. Unfortunately, not even the students of applied mathematics, to whom this book is directed, will learn very much from it about atoms, molecules and radiation.

T. B. GRIMLEY

Received 3rd November, 1967

An Introduction to Non-electrolyte Solutions. By A. G. WILLIAMSON. (Oliver and Boyd Ltd., Edinburgh and London, 1967.) Pp. ix+188. Price 21s. (paperback), 32s. (hardback).

This is the third of the series of University Chemical Texts which are intended for undergraduates. In a note by the editor of the series it is stated that each book resembles a chapter in a larger book rather than a separate monograph. However, there are in fact no references to either of the previous volumes in the series and one can safely consider this book as one which " stands on its own feet ".

The main chapters of the book deal with the following. (*a*) Observed behaviour of mixtures and solutes (39 pages). This is largely concerned with the types of phase diagram which are found, although there is also a small, but good, section on heats of mixing.

(*b*) Thermodynamics. This is an excellent chapter. It is long (54 pages), but contains much important material and is clearly written. Inevitably for a discussion in this degree of detail, the average undergraduate will find some parts difficult, but none of it should be beyond him and the effort expended should be well worthwhile.

(*c*) Experimental methods (29 pages). This gives good accounts of selected, modern methods of carrying out the most frequently required types of measurement. Students will find this pleasant reading after the challenges of the previous section.

(*d*) Theory (40 pages). This is essentially concerned with the interpretation of the experimental results in terms of molecular properties. Hildebrand's solubility parameter, Guggenheim's quasi-chemical, and corresponding states treatments take up most of the chapter; the cell model is summarily dismissed with a reference. The section on corresponding states theories could profitably have been enlarged. For example, one would have liked to see some data showing the extent to which dissimilarity of the molecules leads to departures from the theorem.

The price is reasonable, and the printing and illustrations are clear and well laid out. This book can be recommended as one which it would be useful for students to have in their possession.

N. G. PARSONAGE

Received 3rd November, 1967

Proceedings of the British Ceramic Society, No. 9. July 1967. Point Defects in Non-Metallic Solids, Part 2. (British Ceramic Society, Stoke-on-Trent.) Pp. 286. Price £3 15s.

This volume contains 24 papers presented at a meeting of the Basic Science Section of the British Ceramic Society, held in September 1966. The papers are divided into 5 groups. The first group, dealing with the nature and concentration of point defects, is introduced by Lidiard and includes

papers on relaxation processes, optical absorption, Faraday rotation and uniaxial stress spectroscopy. In the second section of three papers the rôle which point defects play in mechanical deformation is touched upon, whilst the third section deals in a more detailed way with recent studies of a classical kind on ionic conduction and diffusion. Sherwood contributes a review of point defects in molecular crystals and the volume concludes with papers on rare-gas diffusion (emanation) in radiation-damaged crystals.

This is a most useful volume. One imagines that some of the articles, particularly those by Hughes, Anderson and Kemp *et al.*, will serve as stimulating introductions to these subjects for many readers.

D. A. YOUNG

Received 6th November, 1967

Die Reduktion der Eisenerze. By LUDWIG VON BOGDANDY and HANS-JÜRGEN ENGELL. (Springer-Verlag, Berlin, Verlag Stahleisen mbH., Düsseldorf, 1967.) Pp. xv+539. Price DM 135.00, U.S. $33.75.

This book was written by Prof. von Bogdandy of the Hüttenwerk Oberhausen and Prof. Engell of the Max Planck Institut, Stuttgart—indeed, a powerful team combining the Stranski and Wagner schools. Engell is responsible for the first two chapters on the kinetic and thermodynamic fundamentals of the reduction of iron ores, von Bogdandy for chap. 3 to 5 on the technical execution. It is not quite clear why the book has not been presented in two separate volumes.

The iron and steel industry in various countries, including Great Britain, have always been willing pioneers in applying fundamental physical chemistry to practical problems. The present volume bears witness to this. It contains so much basic as well as practical information that it is not possible in a review to mention more than a selection of its contents.

The first part deals with such major items as the thermodynamic equilibria involving the iron oxides including defect equilibria in " FeO ", the mechanisms of nucleation, oxidation and reduction, transport reactions (diffusion) in solids, and experimental results pertaining to reduction kinetics. The interplay between diffusion and phase boundary reactions is being discussed.

One awkward mistake in the thermochemical tables is the value for the heat of formation of silica which is given as −205 kcal/mole. The many faulty calculations involving this important substance based on the earlier heat of formation have initiated several re-determinations several years ago. The authors are urged to correct the value in their tables at the earliest opportunity, namely to −217 kcal/mole, and consequently also the free energies.

Although the bulk of the world's iron is produced in the blast furnace, von Bogdandy devotes over a hundred welcome pages to the technical aspects of iron-ore reduction other than by blast furnace. 160 pages are devoted to the latter. In each case, the fundamentals are discussed and compared with experimental studies before turning to the technical performance. Some statistical information on the iron and steel industry is supplied and various plants are presented schematically.

This is a very important book for those concerned with the production of metals, in particular iron.

O. KUBASCHEWSKI

Received 6th November, 1967

Organic Reaction Mechanisms 1966. By B. CAPON, M. J. PERKINS and C. W. REES. (Interscience Publishers (John Wiley & Sons Ltd.) London, New York, Sydney, 1967.) Pp. viii+480. Price 84s.

For the second time the energetic authors of this volume have produced a literature survey of papers dealing with mechanistic and kinetic aspects of organic chemistry. Their latest one covers the period December 1964-November 1965 and clearly has been based on a thorough card index. The style of presentation is that which older chemists used to find in the Annual Reports of the Chemical Society and now miss with regret, but the very size of this volume shows that there is a present need for sectionalized reports that are comprehensive rather than selective, and so annual issues of this type are welcome. This book is a thoroughly good piece of work.

Organic reactions have been grouped, conventionally following modern textbooks, into 14 chapters and adequate space has been devoted to all. Particularly good reports are given of the classical–non-classical ion controversy, nucleophilic aliphatic and aromatic substitutions, molecular rearrangements and reactions of free radicals—subjects which have in recent years been unduly cramped in *Ann. Reports*.

Both the authors and the printers deserve particular praise for the clarity and abundance of their diagrams. I have never seen a book in which the stereochemical features of compounds and of

reaction mechanisms have been better displayed. By using thin-lined diagrams it has been possible to show in quite a small scale, the intricacies of structures of non-classical ions and of reactions involving neighbouring group participation so that the lettering (C, H, O etc.) in the formulae fits in naturally and yet matches the remainder of the typescript. As a result, a book which one expects to use mainly for reference has become one which can be read throughout with interest.

W. A. WATERS

Received 13*th November*, 1967

Absorption in Gas-liquid Dispersions: Some Aspects of Bubble Technology. By F. H. H. VALENTIN. (SPON: Chemical Engineering, 1967.) Pp. 212. Price £4 15s.

From the sparkle in champagne to the ductility of rimming steel, we owe a great deal to the behaviour of bubbles. Even when fringe activities are omitted, Dr. Valentin set himself no mean task in his attempt to collate the extensive and diverse literature on this subject. As might be expected the book starts with the behaviour of bubbles formed at single orifices. This is followed with a survey on bubble swarms and on bubbles rising in deep pools which covers problems of coalescence and of gas phase mixing. The chapter on mass and heat transfer presents, without derivation many of the basic theories and deals with the problems of mass transfer in the presence of chemical reactions. The last three chapters are concerned with plate columns, agitated tanks and industrial applications including the absorption of CO_2 and the production of nitric acid.

Only in comparatively simple cases is the theory adequate to express the dynamics or mass transfer characteristics of a rising bubble. Real processes are more complex and considerable simplifications of questionable validity must be introduced to make the problems at all tractable. Inevitably this results in a vast array of semi-empirical equations or dimensionless correlations. Moreover, each new investigation brings forth fresh relationships so that the situation is, to borrow an expression from the author, " extremely fluid ". This inadequacy of basic theory prevents a completely logical development of bubble behaviour based on first principles. For this reason the book is more suited to the expert than to the novice. It has been alleged with reference to the nature of turbulence that the ultimate mystery will only be revealed in heaven. I fear the same will be true for the behaviour of rising bubbles. Nevertheless, this book will be invaluable for those engaged in research and development work on dynamics and mass transfer of bubble agitated systems. The extensive bibliography will help considerably in unearthing previous work. Moreover sufficient description is nearly always available in the text for the investigator to ascertain the relevance of a particular reference to his own problem.

Unfortunately there is a number of printing errors, especially in the references to equations and to figures and even in the equations themselves, starting with the definition of Reynolds number in the list of symbols.

A. V. BRADSHAW

Received 14*th November*, 1967

Thermodynamics of Ceramic Systems. (Proceedings of the British Ceramic Society, no. 8.) (British Ceramic Society, Stoke-on-Trent.) Pp. 257. Price 70s.

This volume contains 19 papers presented at a meeting of the Society's Basic Science section, 19-21 April, 1966. The papers describe recent developments in the techniques of measuring thermodynamic properties as well as the results obtained from studies of particular systems. Interesting developments in technique include Kleppa's high-temperature solution calorimeter, using $PbO+CdO+B_2O_3$ melts as a solvent, and in Gross, Hayman and Stuart's halogen-combustion calorimeter. New developments in galvanic cells and gas equilibration techniques are described by Markin, Bones and Wheeler. The remainder of the papers deal primarily with the measurement of thermodynamic properties of specific phases together with some experimental detail. Carbides, ferrites, uranium compounds and ternary oxides having the CaF_2 structure are representative of the materials examined. The term " ceramics " is thus used in its broadest sense.

The collection of papers, while not meant to be representative of all developments in the field, nevertheless illustrates some general trends in applied thermodynamics. First, new experimental techniques are being developed to measure the properties of materials which are difficult to handle by conventional techniques. Secondly, ceramists are studying systems of increasing complexity: Muan's report of activity-composition relations in some oxide+silicate systems is an example.

Thirdly, thermodynamicists are becoming increasingly aware of the relevance of the large number of phase-equilibrium and crystallochemical studies which are already in the literature. One still encounters a few puzzling statements, such as the conclusion (p. 37) that mullite contains 3/4Si and 5/4Al in random distribution " per one mole of mullite ". The reviewer is also unable to follow the phase-equilibrium argument (p. 118) used to prove that solid solution of excess Al_2O_3 in $CaO \cdot 2Al_2O_3$ is impossible.

The book will appeal mainly to those interested in applied thermodynamics. Ceramists also who have discounted thermodynamics as a useful working tool might be interested in having a fresh look at the " state of the art ". The price—70s. for a paperback—will hardly encourage the casual buyer.

F. P. GLASSER

Received 14*th November*, 1967

Heat and Mass Transfer in Process Metallurgy. (Proc. Symposium by the John Percy Research Group in Process Metallurgy, Imperial College, London, April, 1966.) (Institution of Mining and Metallurgy, London, 1967.) Pp. 244. Price £3.

Although the writer attended the Symposium of which this book is the record, the significance and importance of the occasion is even more apparent now in retrospect than was obvious at the time. It is true to say that this publication marks a change in emphasis and approach to the subject of process metallurgy which places it on an equal footing in this respect with the now classic *Disc. Faraday Society* 1948, **4**, dealing with the Physical Chemistry of Process Metallurgy, which has been reprinted even in recent years. Since that time a greatly improved understanding of existing processes on a physiochemical basis has been achieved, but the design of new processes and improved control of existing techniques, on other than a purely empirical basis, has been hampered by insufficient knowledge of and data on the mass and heat transfer processes involved. The rate-controlling steps in a reaction can frequently not be quantitatively assessed other than, where suitable, through the statistical treatment of empirical results. This new volume reflects a widespread movement to the study and teaching of process kinetics in metallurgy in addition to the thermodynamic background now standard.

Two authors, A. Poos (C.N.R.M. Belgium) on blast furnace theory and practice and H. W. Meyer *et al.* (Jones and Laughlin Steel Corporation, U.S.A.) on process analysis and control in LD converters, describe efforts being made on full scale plant to analyze and control these two major units in the production of steel. J. Szekely considers problems relevant to the evergreen subject of the possibility of continuous steelmaking and leaves no doubt as to the uncertainty of the outcome, and in this his approach and treatment is more acceptable than in papers by other authors recently. In a somewhat unfortunate mistake on p. 141 the spray refining process is attributed to the British Non-Ferrous Metals Research Association instead of B.I.S.R.A. The origins of the process may not have been entirely with B.I.S.R.A. but B.N.F.M.R.A. have certainly not been involved.

The remainder of the papers are based on research interests within the John Percy Group. A. W. D. Hills considers the role of heat and mass transfer in gas-solid reactions involving two solid phases and with M. R. Moore also describes the use of integral-profile methods to treat heat transfer during solidification, solutions at present being limited to cases approximating to one-dimensional heat conduction and involving solidification at a single temperature or over a narrow temperature range.

The two research papers concerning the movement and interaction of bubbles and jets in liquids are of particular interest as regards definition of the mass transfer processes occurring. In the paper by W. F. Porter, F. D. Richardson and K. N. Subramanian on Mass Transfer across Interfaces agitated by Bubbles, the conclusions that bubble impingement on an interface from above is less effective in mass transfer than upward bubble movement from below the interface and that the disturbances radiating from the point of movement through the interface contribute more to mass transfer than the bubble itself, are particularly important. The interaction of both bubbles and gas jets with liquids is considered in a final paper by W. G. Davenport, D. H. Wakelin and A. V. Bradshaw using various models for practical study.

Although this book cannot be considered as a final work, it is important in the approach to current problems which it presents and is thoroughly recommended to all with an interest in both the practice and teaching of process metallurgy.

J. A. CHARLES

Received 15*th November*, 1967

Inorganic Glass-Forming Systems. By H. RAWSON. (Academic Press, London and New York, 1967.) Pp. xii + 317. Price 80s.

The title is slightly misleading in that not only does the book describe the systems in which glass formation can occur, but also it discusses this glass formation in terms of the various theoretical treatments of the structures of glasses and of metastable phase separation, devitrification and melting. The number of textbooks on the physical chemistry of glasses, as distinct from glass technology, is very few and the present one fills an obvious gap. The first half of the book provides a clear summary of the present understanding of the glassy state and its relation to solids and liquids and applies this to a discussion of vitreous silica, silicate and borate glasses.

The second half deals with glass formation in simple inorganic systems other than those containing the oxides of boron or silicon. A chapter each is devoted to phosphate and germanate glasses, both of which have interesting similarities in structure to silicates and significant differences. Four chapters deal with other oxide systems, including the interesting nitrate glasses, and the difficulties of explaining their structure in terms of Zachariasen-Warren network theory. A chapter deals with halide glasses and the model relationships of BeF_2 to SiO_2 as a network former in fluorberyllate glasses. Another chapter discusses chalcogenide glasses (based on sulphur, selenium or tellurium) whose structure is polymeric.

It is hardly surprising that in a relatively short book it is possible to pick on apparent omissions, such as the work of Meadowcroft and Richardson on the structure and thermodynamics of phosphate glasses published in the *Transactions*, and the relegation to a footnote of the ideas of Porai-Koshits on the micro-heterogeneity of many glasses. The author has, however, gathered together a large quantity of information from the diverse literature on glasses into a very readable book. This information is presented in a way which stimulates constructive thought and should therefore be read by all who are interested in the glassy state.

P. S. ROGERS

Received 29th November, 1967

Quantum Theory and Reality, Vol. 2 of Studies in the Foundations, Methodology and Philosophy of Science. Ed. M. BUNGE. (Springer-Verlag, Berlin, Heidelberg and New York, 1967.) Pp. 117. Price DM 29.60.

This is a series of seven papers prepared for an International Symposium on the Foundations of Physics at Oberwolfach in July 1966. All are in English, and deal with fundamental problems in the interpretation of modern quantum theory.

For a long time it has been recognized that all is not well with quantum theory. When a measurement is made on some physical system, does it merely discover for us the state in which the system was before the measurement, or does it so influence the measurement that much of its prior history is effectively obliterated? More embarrassingly, is there an objective reality which functions according to knowable laws even if no measurement is made on it? The philosophers' worry about the reality of the "tree in the quad" when unobserved, is more serious to the physicist. Is it true that the theoretical physicist must resign himself, in Kantian acceptance, to never knowing things-in-themselves, and interpreting his theory as simply a theory of measurement? And, as if to emphasize the depth of our ignorance, does the wave function ψ refer to one system, with complementary uncertainties in measurement, or to an ensemble of systems; i.e., are our statements that follow the calculation of ψ statistical statements, or are they statements about one particle (or one system) to which the Heisenberg Uncertainty Principle might not apply?

These are the questions with which this book is concerned. After a lively introduction by the editor who clearly believes that the tide is turning against the Copenhagen doctrine of Niels Bohr and his school, we have the main set of papers, some discursive, others mathematical and symbolic. The authors are distinguished people, and include one or two real scientists. It is not always clear whether all of the others have much sympathy with science. The prime example of this is a testy chapter—also the longest—by Karl Popper, whose main concern is polemic, against Heisenberg, Born and Bohr, and in favour of the author. This particular chapter is written for the hustings, full of italic type to emphasize its points, so that at the end one expects to hear the final shout: "Vote for Popper". Other chapters are less polemical, but not always so lively. It is a pity, all the same, that more of their authors did not stop, before writing, to ask what a modern theoretical physicist means by a particle. It would have saved a good deal of confusion about the interpretation of the Uncertainty Principle, if they had.

For those who like to shake the foundations of a building which is very strong and solid, but whose true function is not quite clear, this is a jolly book!

C. A. COULSON

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