Book Reviews

Field Theory and Fundamental Dynamics

Mathematical Theory of Elementary Particles. Proceedings of a conference held in Dedham, Mass., September 1965. ROE GOODMAN and IRVING SEGAL, Eds. M.I.T. Press, Cambridge, Mass., 1966. 198 pp., illus. $6.

The perplexing problems that face elementary-particle physics have given rise to widely diverse "schools" of approach. The book under review presents conference papers by members of the school that seeks a workable mathematical foundation prior to an application to the real world. In some ways there is as much diversity of approach within this school as between schools, and such a conference serves the double purpose of exposing the contributors' research to each other as well as to the outside world.

The frustration that has for over 30 years met attempts to find an adequate formulation of fundamental dynamics through quantum field theory has spawned several heretical approaches to these problems. Notable for his ingenuity is the conference coorganizer, I. Segal, and his contribution to the present volume, although confined to a potent analysis of classical scattering theory, is ultimately to be applied to his own particular approach to nonlinear quantum field theory. We may cast the contribution of Greenberg on parafields in the category of unusual approaches that may illuminate elementary-particle theory; and in a short contribution D. Ruelle analyzes for pedagogical purposes a simple axiom system akin to that of quantum field theory. A number of contributions (notably those by A. Jaffe, E. Nelson, and A. Visconti) reexamine, with the use of careful and precise mathematical language, prescriptions that were developed in a heuristic manner during the "revolutionary period" between 1949 and 1955. While it is true that many precise statements fully in accord with physical intuition can be obtained for butchered theories (for example, by putting the system in a box, introducing a momentum space cutoff, or regularization of divergent integrals), the ultimate questions as to existence, uniqueness, and specific properties of the solutions of the nonbutchered theories remain virtually as elusive as they were in the revolutionary period. At the present stage axiomatic field theory, as the approach of the present school is often called, is at its best in establishing very general properties, such as the connection of spin and statistics and the so-called *TCP* theorem, and in disproving a number of the intriguing speculations that abound in this field of interest. The contributions of S. Coleman on the attempts to obtain meaningful relativistic symmetries of the U(6) variety, the nonexistence proof for a cutoff $\lambda\phi^3$ theory by A. Jaffe, and to a lesser extent the contribution of R. F. Streater on spontaneous breakdown of symmetry fall into these categories. Models and methods previously employed in statistical mechanics are profitably used by K. Symanzik in his analysis of Euclidean quantum field theory in a space-time having a positive definite metric. Analyticity aspects are exploited by J. Tarski in his analysis of the special problems peculiar to zero-mass particles in a space-time of two dimensions, and in the structure analysis of the holomorphy envelopes of multiple field expectation values by G. Källén. The contributions of algebraic topology, especially that of homology theory, to the analysis of singularities of Feynman integrals are outlined by M. Froissart. It is to be regretted that the contributions of some of the other speakers with novel approaches to these problems were not included in this volume.

The last paper in the book, which actually corresponds to the opening address of the conference, is an assessment of present-day axiomatic field theory by A. Wightman, who stresses the hope shared by all devotees of this school that real insight into the dynamical consequences of fundamental particles might best be gained through the techniques of field theory and that these techniques as elucidated by the powerful methods of modern mathematics may conceivably be on the verge of giving us certain truths about specific theories. Whether research of a mathematical nature will ultimately provide the road to a better understanding of elementary-particle physics is, of course, a subject of much controversy. Nevertheless, it is a comforting thing to read reports where the conclusions are at least a logical consequence of the assumptions. The co-editors are to be complimented on their undertaking and execution of a topical conference of this nature.

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Microscopy

Advances in Optical and Electron Microscopy. Vol. 1. R. BARER and V. E. COSSLETT, Eds. Academic Press, New York, 1966. 293 pp., illus. $11.50.

Optical and electron microscopes are surely the most common instruments now used by the tens of thousands of workers concerned with microstructures or morphology. Papers on instrument developments and techniques are numerous and widely scattered, a condition which has stimulated publication of various cross-indexed bibliographies. Comprehensive review articles are even more useful, and several outstanding examples have appeared in the *Advances in Electronics* series and elsewhere. R. Barer, a biologist, and V. E. Cosslett, a physicist, have now launched a new *Advances* series specifically committed to reviews on microscopy. The editors point out, however, that the articles will not conform to a set pattern and may range from very objective, critical reviews to frank expressions of personal points of view. The six articles in the first issue illustrate the promised variety.

P. A. G. Monro deals exclusively with measurement under the microscope of the velocity of moving particles—blood cells moving in living

tissue. The complexities of making such measurements and the results obtained are fascinating even to someone who feels slightly faint at the sight of blood. Methods of determining the light optical properties of very small crystals are described in considerable detail by C. P. Saylor. This reader finished the article feeling that he could go down to the laboratory and carry out successful measurements, although illustrations of the procedures with an actual example would have added to the interest of the article. The third article on optical microscopy, by R. D. Allen, J. S. Brault, and R. M. Zeh, deals with image contrast and phase-modulated light methods in polarization and interference microscopy. This article begins with a fairly complete discussion of the physical basis of polarizing and interference microscopy, but unfortunately it finishes with a series of photographs of the semicommercial equipment constructed in the authors' laboratory. Not a single micrograph or any other experimental data obtained with this technique are included. Thus readers not familiar with the technique will spot little to attract their interest as they browse through this section of the book.

The resolution limit of the transmission electron microscope is the subject of a long review by E. Ruska, one of the inventors of this instrument. He begins by pointing out that the original estimate of 2.2 Å given in 1932 for the resolution of the electron microscope was very close to the values predicted today because, except for the introduction of astigmators to correct for mechanical asymmetry, modern lenses are essentially no better than the original ones. Ruska then goes on to present a quantitative analysis of all the factors affecting the resolution of both nonperiodic structures and crystal lattice images. Methods largely developed at the Fritz-Haber Institute to overcome the specimen-contamination problem receive considerable attention. Many readers would get more from this article if the various analytical expressions relating to resolution were also presented in graphical form. Probably the most interesting review is that by R. C. Valentine on the response of photographic emulsions to electrons. This short article contains a great deal of information on optimum exposure and development of practical interest to all electron microscopists. The one surprising omission is any reference to the exposure of color film by electrons. I had hoped to find the explanation of rather puzzling observations obtained with color film. The final article, entitled "The struggle to overcome spherical aberration in electron optics," is by Albert Septier, who makes it very clear that the struggle has been and continues to be a difficult one.

This first volume is a very promising beginning to what could become the standard vehicle for reviews on microscopy. The burden of its success will rest with the editors. In the present volume the interval between the completion of the manuscripts (late in 1964 or early in 1965) and the general availability of the published volume seems somewhat longer than necessary, and one hopes it will be shorter in future volumes.

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Heterocyclic Compounds

The Acridines. Their Preparation, Physical, Chemical, and Biological Properties and Uses. ADRIEN ALBERT. St. Martin's Press, New York, 2nd ed., 1966. 616 pp., illus. $32.50.

Here is a book written by a man with an obvious love and enthusiasm for his work. The style of writing is pleasant and the range of topics broad enough to provide something of interest for all chemists. Unfortunately the price, which seems excessive, will discourage the book's entrance into most personal libraries.

Albert begins with a discussion of the ready interconvertibility of the acridines, acridones, and acridans and then considers in detail the many general and specialized methods for preparing compounds in these three oxidation states. He concludes this part of the book with a very practical discussion of how to choose good synthetic methods and gives "hints on the manipulation and purification of acridines."

As a physical chemist, I found the second part of the book of special interest. Albert's principal topics are surface properties, ionization, dipole moments, and spectral properties of acridines. His discussions are on the usual level found in organic chemistry textbooks, and in general he tries to give the reader some insight into the basis of the various physical properties by presenting many examples, with occasional generalizations to summarize the facts. The ionization of acridines is covered in considerably more detail than one might have expected, but their state of ionization plays a crucial role in their important bacteriostatic properties. Spectra are discussed in terms of Platt's notation, and the application of electronic spectra to structure determination is emphasized. A 15-page table and some 20 spectra summarize the electronic spectra of acridines up to 1965. The third part of the book deals with the chemical properties of the ring systems whose preparations were described in the first chapters.

The next section is devoted to the biological properties and uses of the acridines. It contains chapters on clinical properties, relationships between physicochemical and biological properties, acridine-nucleic-acid complexes, pharmacology, and toxicology. Albert's history of the development and use of these drugs make fascinating reading, but I think the clinical discussions (which even include detailed prescriptions) should have been condensed. In fact the entire section on the biological properties (about one-sixth of the book) should perhaps have been made into a separate monograph. In spite of Albert's quite successful (and always interesting) attempts to relate the biological and chemical properties of the acridines, I believe the biological and chemical portions of the book will generally appeal to distinctly different classes of readers. The fifth and final section of this monograph is entitled Dyes and Reagents, but it is also a catchall for many miscellaneous topics —for example, chemiluminescence and solar energy cells.

I was pleased to see that this edition of *The Acridines*, unlike the first, uses Graebe's numbering system (which is also used by *Chemical Abstracts*)—it must have been a difficult change for the author to make. Albert's comments on the various numbering systems (pp. xi–xii), and in particular on those for the benzacridines, point up the desirability of a nomenclature which incorporates chemistry as well as geometry.

In general I would recommend this book (or books, since it is almost two in one) for browsing to all chemists with an interest in biochemistry or heterocyclic organic chemistry. It presents a vast amount of interesting miscellaneous information concerning acridines, as well as valuable generalizations based on Albert's many years