two-particle problem. Recent developments such as the existence of cuts are discussed and the effects of these, as well as other theoretically possible singularities in the angular momentum plane, on high-energy scattering. The possibility of "elementary particles" of conventional field theory being Regge poles is also treated.

The phenomenology of what the author cheerfully admits is the most naive application of the Regge pole hypothesis to high-energy scattering is described by B. M. Udgoankar (Tata Institute). The possibility of using Regge ideas in the low-energy pion-nucleon system is also discussed.

A detailed model for very high-energy reactions in which very many particles are produced is presented by S. Fubini (Università degli Studi di Padova). The relation between this approach and Regge ideas is explained.

What is perhaps the most elaborate dispersion theoretic attack extant on the low-energy pion-nucleon system is very coherently discussed by J. Hamilton (University College, London). All of the intricacies of this problem are carefully revealed, and the rug covering 10 years of dirt is raised.

One of the most appealing ideas to grow out of dispersion theory, although the idea is actually much older, is that all so-called elementary particles are composites of each other. This idea is refreshingly presented by F. Zachariasen (California Institute of Technology). The possibility of symmetries—for example, charge independence of strong interactions—emerging from self-consistency requirements is explained by simple, quantitatively unreliable, model calculations.

R. Blankenbecler (Princeton University) addresses himself to the problem of how one may hope to do actual computations in the real world of strongly interacting particles. He describes a formalism which is an elaboration of the so-called determinental approach to scattering problems. This D-(determinant) matrix theory has considerable formal beauty and is at least in theory free of some of the complications encountered in other current approaches.

After a slightly pretentious introduction, C. Lovelace (Imperial College, London) describes his own version of the theory of three-particle systems, based on the theory of Faddew who first attempted to give a rigorous formulation of the three-body system. The connection between various approximate treatments, in which the true three-particle states are roughly represented as one particle and a resonating pair treated as a particle, and the exact formulation is discussed. At the end of the article the reader is assigned a number of exercises which might be completed by the time of the next summer school session on the present topic.

This is a good and useful book for both students and advanced workers in the field.

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Organic Chemistry

Solvolysis Mechanisms. Edward R. Thornton. Ronald, New York, 1964. viii + 258 pp. Illus. $7.

The study of solvolysis reactions has received a great deal of attention from organic chemists in recent years. The mechanisms of these reactions, among the simplest we know about from a gross viewpoint, are exceedingly subtle when the fine points are critically examined. Classical organic techniques often prove inadequate and recently such approaches as investigations of linear free-energy relationships and isotope effects have been used to bring more evidence to bear on the subject. However, the story is far from complete, and the use of additional physical techniques, such as relaxation methods, will probably be required before the final answers are known.

Thornton's book, a volume in the "Modern Concepts in Chemistry" series, is not a review work but a discussion, and a rather successful one at that, of the important concepts generated by the investigation of simple solvolysis mechanisms. The various theoretical treatments involved are, in general, well integrated with the clear and quite readable qualitative discussions. The recent literature is used extensively, and particularly good lists of references, which are placed at the end of each chapter, give suggestions for further reading. Two chapters, one dealing with isotope effects and another with the more classical mechanistic aspects, are especially good, although it is regretable that a fuller discussion of nonclassical carbonium ions was not included. In another chapter the author gives a good discussion of linear free-energy relationships and other aspects of the study of reaction rates, and, in a fourth chapter, he deals with the theory of reaction rates and molecular orbital theory. This last chapter is the weakest portion of the book. Thornton introduces the theories at the simplest level, but then progresses rapidly to more advanced levels in a way that is not entirely satisfactory for the more advanced student or for the beginner. The portion on molecular orbital theory, although important to the subject of the book, seems out of place because very few results are ever discussed in terms of the theory.

The objections raised should not be considered particularly serious. The author obviously is well acquainted with the subject, and, in general, he presents the material very well. It is suggested in the preface that this book may be useful as an introduction to theoretical organic chemistry. Although I feel that there are better choices available for this purpose, Thornton's book is highly recommended as a perceptive discussion of the many aspects of physical organic chemistry involved in the study of solvolysis mechanisms.

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Statistics and Biology

Stochastic Models in Medicine and Biology. Proceedings of a symposium (Madison, Wisconsin), June 1963. John Gurland, Ed. University of Wisconsin Press, Madison, 1964. xvi + 393 pp. Illus. $6.

The inherent variability in almost all biological data strongly suggests that probabilistic techniques are required to derive the maximum information from them. Stochastic models are required for the elucidation of many phenomena in the life sciences, and indeed theoretical models seem to have appeared and proliferated with only the slenderest motivation from experiments. This volume, the proceedings of the Wisconsin symposium, is a good sample of current research; it illustrates not only the scope of such research, but also the large fluctuations in quality and relevance to the real world.

Many fields are represented by the papers in this volume. N. Arley discusses, perhaps too briefly, the results of his long collaboration with experimentalists in the field of carcinogenesis. J. Neyman and E. L. Scott describe a model for epidemics which takes into account spatial migration. Stochastic processes in genetics are discussed in papers by S. Wright, S. Karlin and J. McGregor, and by W. J. Schull and B. R. Levin. These papers range from a historical account by Wright and an account of the transition between discrete and continuous genetic models by Karlin and McGregor to a description of a simulation program by Schull and Levin. Other participants discuss statistical models for the evaluation of biological data, the application of game theory to certain psychological experiments, a possible mechanism for biological clock mechanisms, a historical account of early stochastic models in epidemic theory, an attempt at an abstract classification of catalytic processes, and a statistical study of arteriosclerosis.

It is probably too early to offer an evaluation of the place of stochastic methods for biological problems. Their role in genetics is certainly well established. However, it is usually orders of magnitude simpler to develop a mathematical model than to perform the experiments necessary to verify it. The work reported in this book should not be judged as pure mathematics, but rather as an attempted elucidation of natural phenomena. As such, much of the work seems very far from the goal.

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Analytical Techniques

Microwave Scanning Antennas. vol. 1, *Apertures*. R. C. Hansen, Ed. Academic Press, New York, 1964. xviii + 442 pp. Illus. $16.

The editor, Robert C. Hansen, has assembled outstanding contributors for his two-volume treatise **Microwave Scanning Antennas**. Volume 1, *Apertures*, the subject of this review, covers aperture theory (R. C. Hansen), reflecting systems (L. K. De Size and J. F. Ramsay), optical scanners (R. C. Johnson), radio telescope antennas (Hsien Ching Ko), and large radomes (J. A. Vitale).

A welcome feature of this new addition to the antenna literature is its devotion to the intensely practical without sacrifice of mathematical rigor. The extensive mathematical developments, however, belong to the engineer who desires to understand as well as to solve his antenna problems rather than to the scientist who is preoccupied with the theory of radiating systems. This emphasis on analytical techniques makes the volume a powerful tool for those working on new problems as well as for those interested in understanding the solution of past problems.

In developing their several subjects, the authors demonstrate that in recent years the antenna art has indeed become much more of a science—or perhaps that antenna science has been given more engineering effectiveness through analytical sophistication. In the chapter on optical scanners, for example, more than half of the references are to work done during the last 8 years. In many cases, however, the basic concepts date back to the inventive war years or earlier, sometimes predating the earliest reference in the text by 10 to 15 years or more.

Volume 1 represents the best and most complete treatment that I have seen on its subject. Thus, chapter 1 follows a general treatment of aperture theory with detailed treatments of aperture distributions and of pattern synthesis and supergain. Chapter 2 treats reflectors, feeds, and reflector-feed systems for a variety of purposes, beginning with Hertz and ending with space applications. Chapter 3 describes the many ingenious inventions that have resulted from the application of optical principles to achieve the scanning of directive beams, an uphill fight owing to the limited number of wavelengths in any reasonable microwave aperture. Chapter 4 deals with the functions of a radio telescope and the nature of its received signal, as well as with the means of achieving high-resolution steerable apertures, a variety of interferometer techniques, and possible designs of the future. Chapter 5 concerns itself with large radomes, their functions, a great variety of types, the effects on the characteristics of the enclosed antenna, environmental problems, and structural and electrical design. Volume 1 not only provides an adequate development of its subject, but prepares the way for volume 2, *Arrays*, which will treat aspects of the subject in which recent advances promise spectacular future accomplishments.

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Mathematics

The New Mathematics Dictionary and Handbook. Robert W. Marks. Bantam Books, New York, 1964. 186 pp. 95¢.

Inexpensive reference books in mathematics are certainly needed, but *The New Mathematics Dictionary and Handbook* almost completely disappoints the hopes raised by statements made on its cover and in its preface. The reader is promised answers to "every kind of question about mathematics . . . . explanations for all the puzzling terms . . . . practical working information . . . . the most advanced areas of the new mathematics . . . . biographies of the most important mathematicians from Euclid to Einstein. . . ." Instead he gets a hodgepodge of information and misinformation, obsolete terms (for example, *aliquot part*), incorrect definitions (for example, see the definition of asymptote), uneven coverage of both classical and "modern" terminology, and no coverage of nonelementary mathematics. Sciolism shades into quackery in the area of contemporary biography. Only one living mathematician is mentioned (Gödel), but three pages are devoted to the biography and alleged mathematical discoveries of the engineer R. Buckminster Fuller who has added nothing to mathematical knowledge and belongs in a list of what De Morgan called "paradoxers" rather than in one of mathematicians.

Since the author of this book is not one of them, mathematicians need feel responsible only for leaving such a gap in the literature. But this book will add nothing to the reputations of the publisher or of the two science editors whose endorsements were presumably written without sufficient examination.

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