And if past experience is any basis for judging, most of these efforts are destined to a quick and merciful oblivion.

It is therefore refreshing to read this unusual book by N. J. Berrill, who is Strathcona Professor of Zoology at McGill University and the author of a number of books and articles. In this volume Berrill's ostensible purpose is to extrapolate to other worlds what is known about life on earth and to speculate about the possible existence and nature of extraterrestrial life. In a kind of rambling discursive style, which has some of the attributes of free association, the author examines some of the components of the solar system, the nature and diversity of life from the viewpoint of a classical biologist, and finally the problems and prospects of space communication and travel.

The real intent of the writer, however, soon reveals itself, if the reader has not already guessed it by scanning the table of contents. The titles of some of the chapters are "Moonstruck"; "Out of their minds"; "Landed gentry"; and "Is sex necessary?" The overall impression left with the reader is that of a tongue-in-cheek discussion of "exobiology." By far the best part of the book is that which deals with the subject that the author knows best—the overwhelming variety of the earth's ecology and the questions raised about the nature of life itself. There is, however, some implied teleology in certain involved sentences—for example, "So what we see when we look at a horse is what a horse has to be if it is to be as big as it is and run as well as a dog" (p. 98). The author makes no significant reference to the key discoveries of modern genetics.

The book is also marred by a number of inaccuracies; for example, in describing the Martian dark areas Berrill says: "Often the colors become brownish, reddish, black, or even a moss green" (p. 55). But there exists substantial evidence suggesting that these colors are the result of an optical illusion arising from the contrast against the bright areas of the planet. Certain sweeping statements—for example, "Taken altogether, the evidence makes the existence of life on Mars almost a certainty" (p. 57) and the statement denying that relativistic time dilation applies to biological systems (p. 217)—are, to say the least, unwarranted. Anthropomorphisms of the type found on page 71—"Jupiter . . . turns on its axis in less than ten hours, blowing and rumbling as it spins around"—whether intentional or not, seem flippant rather than witty.

Perhaps the author's main contribution has been to provide an enjoyable and quite readable alternative to the plethora of space books that suffer from exaggerated optimism and labored enthusiasm.

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## Organic Chemistry Series

**Carbene Chemistry**. Wolfgang Kirmse. With a chapter by H. M. Frey and one by P. P. Gaspar and G. S. Hammond. Academic Press, New York, 1964. vii + 302 pp. $9.50.

During the last decade or so, at least four areas of organic chemistry have emerged from a position of relative obscurity to one of permanent importance in the field. One of these areas is the subject of this monograph, the first in a new series edited by Alfred T. Blomquist of Cornell University.

The chemistry of carbenes covers a rapidly growing class of highly reactive divalent derivatives of carbon, the central significance of which lies in its relevance to the fundamentally organic chemical problem of transforming one covalent bond into another. During the past 50 years it has been found that the great bulk of organic chemical reactions involve three classes of highly reactive trivalent intermediates—the positively charged carbonium ions, the neutral free radicals, and the negatively charged carbanions. Divalent carbon, which has now been established as a fourth class of reactive intermediates, has given rise to a host of novel chemical transformations.

The story of these intermediates is told simply and clearly by Kirmse in an orderly sequence, beginning with the parent unsubstituted methylene and proceeding chapter by chapter through carbenes substituted by alkyl groups, double and triple bonds, aromatic rings, the ester grouping, ketones, halogens, and miscellaneous types. Within each chapter emphasis is placed on methods of preparation of the divalent intermediates and on the chemical reactions to which they give rise. The presentation of these more classical aspects represents an impressively successful effort to cover a rapidly growing literature in complete form.

The fascinating mechanistic aspects of the field are woven into the formal development skillfully and with a fine sense of relevance. It is particularly in these sections that Kirmse's long experience as an imaginative contributor to the chemistry of carbenes, his command of the current theory of organic chemistry, and his inately critical and analytical mind have combined to lift this monograph far above the level of the customary review.

Two features in the chemistry of carbenes are of particular interest to physical organic chemists. One involves the behavior of the so-called "hot" molecules that are formed with abnormally high energies as the initial product of gas-phase reactions of methylene; the other concerns the calculation and establishment of the electronic spin states of carbenes. These subjects are expertly handled by Frey (University of Southampton) and Hammond (California Institute of Technology) and Gaspar (Washington University, St. Louis).

Because it was mainly written by one good man, this book achieves a coherence that is a most welcome change from the more customary collection of chapters written by several authors of disparate points of view and abilities. It is well indexed and free of serious errors; I recommend it highly for those whose background permits them to indulge their interest in the exciting events at the frontier of organic chemistry.

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## Plasma Physics

**Dynamics of Charged Particles**. Bo Lehnert. North-Holland, Amsterdam; Interscience (Wiley), New York, 1964. 310 pp. Illus. $11.50.

The subject of plasma physics is studied by scientists in a variety of disciplines, partly because of its intrinsic complexity and partly because of its appeal in diverse applied areas. A division exists between the particle approach and the gas dynamic approach; the present text follows the former choice. In this plan, it becomes a major addition to the field. A basic

objective is not only to bring together a mass of research literature into a single volume but to clarify conceptual difficulties, reduce certain of the more intuitive arguments to rigorous deductions, and tie together the considerable diversity of theoretical and experimental work into an integrated whole. In the process, the author brings new approaches into the textbook field and presents experiments, some of them his own, which are not widely known in the United States.

I regard the early introduction of Hamiltonian and Hamilton-Jacobi procedures for later use as a tool that provides a powerful, unifying approach to plasma particle dynamics. The chapters on relativistic plasmas and on radiation interactions are also strong and relatively new offerings. The author himself is the first to disavow originality in these efforts and is generous in citing references. The clarified and integrated presentation, however, merits comment. I particularly like the chapters on magnetic compression and on confinement of charged particles (the latter chapter contains some of the author's own work referred to above).

For use as a textbook, *Dynamics of Charged Particles* is more advanced than Rose and Clark's *Plasmas and Controlled Fusion* (1961) and requires a greater background knowledge and familiarity with experimental and instrumental developments in the field. The presentations are sometimes lengthy and seemingly intricate but may in time become accepted as the standard, rigorous proofs of basic theorems.

The author gained much of his experience in the Department of Electronics at the Royal Institute of Technology in Stockholm. He served as editor of the International Astronomical Union's symposium volume *Electromagnetic Phenomena in Cosmical Physics,* thereby adding breadth to his first-hand knowledge of experimental plasma physics. The present work, in contrast with recent books written from backgrounds of thermonuclear studies, of microwave discharges, or of aerodynamic plasmas, is based on this background of astrophysical interests.

At its level, the book should command a wide and appreciative student audience and serve as a standard reference for more advanced users.

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## For Laboratory Scientists

**Statistics in Physical Sciences.** Estimation, hypothesis testing, and least squares. Walter Clark Hamilton. Ronald, New York, 1964. xii + 230 pp. Illus. $10.

In the preface of this book the author sets forth quite clearly his reasons for writing this text. "The writing . . . was motivated by the need for a comprehensive treatment of the methods of least squares, linear hypothesis testing, and multivariate analysis in a form easily assimilated and put to use by the laboratory scientist. Although the emphasis is on least squares and associated techniques, it is hoped that the introductory sections are so complete that the mathematically mature scientist with little experience in statistical problems will become familiar enough with the concepts of elementary statistical estimation to be able to apply the methods with confidence and to read the more specialized statistical texts for treatment of the problems with which we do not deal here." A brief and excellent summary of each chapter is also presented in the preface.

The basic ideas of probability and statistics used in subsequent chapters are introduced in chapter 1. The concepts of probability distributions, expected values and moments, statistical estimation, and hypothesis testing are discussed at length, and the theory of matrices and linear equations without which a discussion of multivariate least-squares techniques becomes unnecessarily cumbersome are treated briefly.

In chapter 2, Hamilton discusses the estimation of parameters from univariate populations and introduces the basic distributions in common use: the normal, Student's, chi-square, and the variance ratio F; in chapter 3, he treats briefly the classical methods of the analysis of variance: the estimation of population means and their differences from several samples. Chapter 4, in which he presents the theory of linear least-squares adjustments, the error distribution of quadratic forms, and the theory of linear hypothesis tests, is in his own words, the "real heart of the book."

Discussions of a number of miscellaneous statistical problems, most of which are related to the applications of the least-squares method, are presented in chapter 5. Because some of the problems considered—for example, nonlinear least-squares and hypothesis tests and optimum experimental design—are the subjects of vigorous work by statisticians at the present time, the discussions are necessarily incomplete and perhaps speculative. Hamilton writes that "In this connection, it might be remarked that physical data and experimentation rarely conform in every respect to the idealized conditions implicit in every rigorous statistical test, and the scientist must therefore be prepared to use approximate methods and tests, realizing that his statements regarding probability of error are often more qualitative than they might appear." In chapter 6 the author presents more extended numerical examples of the least-squares method than was possible in chapter 4. "In particular, application to crystallography, radiochemistry, and infrared spectroscopy are illustrated."

Least squares is a very important topic for any scientist who is interested in the construction of mathematical models, curve fitting, and other similar topics. Since the community of physical scientists makes great use of these techniques, it is desirable for them to have a better understanding of the mathematical structure and background of the subjects. This well-written book, which will provide a good beginning toward such a goal, requires only an understanding of calculus and matrix algebra. In fact, what is generally taught in the sophomore year in college calculus will be sufficient for that subject. A course in matrix algebra is desirable, but those who have a working knowledge of the elementary concepts of the arithmetic of matrices and have done some work in the solution of systems of linear equations should encounter no unusual difficulty in this book. Although the book seems to be essentially self-contained, one or two courses in statistics would probably be most useful to the reader. I consider the book a contribution to the teaching literature for the engineer and others in the physical sciences and believe that the author has achieved his objectives.

The following are typical among the errors and misprints noted—[p. 9, 8(a)] the statement "P(A) is a *positive* real number not greater than 1" should read "a *non-negative* real number not greater than 1"; [p. 20, in the last formula on the page] the exponent 2 should be a negative 2 in the exponent; [p. 38, line 6 from the top] unbiasedness is not necessarily a stronger property than