lisions, where the two topics of these volumes come closest to fusing into one. After an extensive survey of the relativistic data available in 1977, he provides summaries of selected models for both peripheral and central collisions, focusing mainly (as have the experiments) on the inclusive spectra of emitted light particles.

The volume on mesons comes down rather heavily on the side of exotic and, so far, conjectural phenomena such as "pion condensation"—a possible example of Bose-Einstein condensation (macroscopic occupation of the lowest quantum state) in which the bosons are pi-mesons. An exception to the exotic tendency is the lead paper, by Ernest J. Moniz, which makes fairly extensive contact with conventional pion-nucleus scattering data. After a review of the foundations of the pion-nucleus optical potential and the necessary multiple-scattering results, he provides an extended discussion of the isobar-doorway model for pion-nucleus scattering.

David K. Campbell provides two lecture series. The first is an extended review, geared to nuclear theorists, of Lagrangian field theory, weak interactions, chiral symmetry, and the σ model. It contains few quantitative results but does provide a useful idea of how pion-nucleus physics might be understood at a field-theoretic level. The second series gives further details of the σ model, including discussions of semiclassical methods (with instantons) and the way in which a Lee-Wick density isomer appears in the model.

Raymond F. Sawyer discusses pion condensation in infinite nuclear matter, showing clearly how it relates to properties of the pion-nucleus optical potential. Gordon Baym continues in this vein with an extended treatment of exotic nuclear phenomena that may occur in neutron stars at densities larger than those normal in nuclear matter: pion condensation in the σ model, and its possible effect on the cooling of neutron stars; the possibility of a solid core, and its relation to starquakes; quark matter at high density in the bag model and in quantum chromodynamics; and Lee-Wick density isomers in the σ model. The lectures provide an inspiring display of technical ambidexterity in treating a remarkable range of topics.

Finally, Denys H. Wilkinson closes the volume with a wide-ranging survey of symmetry principles whose conservation laws can be subjected to significant tests in nuclear physics experiments. The treatment provides many useful insights into the meaning of theoretical expressions and offers clear indications of where an improvement in experimental limits is useful or feasible.

The editors and the authors of these volumes have produced a welcome addition to the current review literature of nuclear physics.

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Organic Chemistry

Reactive Intermediates. A Serial Publication. Vol. 1. Maitland Jones, Jr., and Robert A. Moss, Eds. Wiley-Interscience, New York, 1978. xii, 350 pp., illus. $24.95.

Reactive intermediates, those chemical species that can be generated and then utilized in diverse chemical processes but that in many cases cannot be isolated, purified, bottled, and put on the shelf for the admiration of all, are the busy elves of chemistry. If properly understood and handled they do our bidding and help us to make all sorts of wonderful things in our flasks and kettles. Some, such as the carbanions, have been with us for a long time; others, such as the carbenes, nitrenes, and silylenes, have more recently been recognized and accepted.

The present book is the first volume of what is intended to be serial publication on reactive intermediates. The objective is "to carefully select and then evaluate those recent contributions that the authors believe require most urgent attention by students and researchers." In striving to be selective and critical, the authors in the present volume have gone a step further and in their already selective list of references have marked with an asterisk "those references that they consider most significant for detailed discussion, analysis, or rereading." In this volume the discussions have been focused on the literature of the period 1975–1976.

On the whole, the editors and authors have been quite successful, and one may hope that the intention of the editors to bring out further volumes will be realized.

In separate chapters *Reactive Intermediates* deals with seven such species. The book is aimed at the organic chemist and more particularly at the physical organic chemist. This does not, however, mean that the preparative organic chemist, or even the inorganic or organometallic chemist, cannot derive both stimulation and benefit from the various chapters.

The brief chapter on arynes by Ronald H. Levin treats *ortho*-, *meta*-, and *para*-benzyne, 1,8-naphthyne, norbornyne, 2,3-thiophyne, and cyclobuta[1,2-d]-benzyne, but it does so almost exclusively from the physical organic point of view. There is little here for the preparative chemist. W. J. le Noble's chapter on carbanions, on the other hand, will be stimulating to a broad range of readers. Carbanion chemistry is a field in ferment, and the writers of organic textbooks would be well advised to give this chapter a thorough reading. The advent of new and powerful donor solvents, the development of the concept of metal counterion complexation, especially with crown ethers and cryptands of ever-growing diversity, and the study of ion pairs and of charge distribution in carbanions by diverse experimental techniques all have contributed to the recent development of this field.

Moss and Jones do not disappoint the reader in their survey of carbenes and the generally less well defined "carbenoids." Their chapter is a thoughtful and critical analysis of divalent carbon chemistry, which is now in a "mature" stage after its almost explosive development following the discovery by Doering and Hoffmann in 1954 of a preparatively useful route to dichlorocarbene. The emphasis is on the more physical organic aspects, but the preparative chemist also will find much that is useful and stimulating concerning carbene generation and utilization.

Carbonium ions (or carbocations or carbenium ions, depending upon whose papers you read) have been known for a long time and by now represent a broad area of organic chemistry. D. Bethell, in his chapter, has wisely restricted himself to coverage of selected aspects of the subject. One of these is the nuclear magnetic resonance spectroscopy of carbonium ions—an important topic since application of this technique, especially of ^{13}C NMR spectroscopy, has yielded valuable information concerning the structure and bonding of positively charged organic species. The second aspect is the interactions of carbonium ions with solvent, a subject dear to the hearts of physical organic chemists, and the third and last section of the chapter deals with some selected types of carbocations—aryl cations and pentacoordinate carbocations. The latter are newcomers whose appearance on the scene was made possible in the gas phase by new

developments in mass spectroscopy and in solution by the advent of superacidic media. One might quarrel with the author about his choice of topics, but very few will fault him for omitting the subject of nonclassical carbonium ions.

The concept of free radicals dates back to the first half of the 19th century and gave birth in the investigations of Bunsen and Frankland to the field of organometallic chemistry and in those of Kolbe to organic electrochemistry. Gomberg's discovery of the triarylmethyl radicals and Paneth's pioneering work with free radicals in the gas phase put radical chemistry on a firm footing, and it has been an important aspect of organic chemistry ever since. Leonard Kaplan's chapter on free radicals makes instructive and entertaining reading as he leads us past the pitfalls that await the unwary. Examples of fuzzy thinking, of faulty technique, and of jumping to conclusions are held up to the light during discussions of the structure, energetics, and spectroscopy of free radicals, the experimental techniques used to study them, their generation and trapping, and their reactions. The chapter is one every organic graduate student should read.

The following chapter on nitrenes by Walter Lwowski is more standard fare, being simply an updating of nitrene chemistry from the time of the author's 1970 monograph on the subject. It touches all bases—the various types of nitrenes, their generation, and their reactions—and eschews controversy. Peter P. Gaspar too is an old hand at reviewing his subject, divalent silicon species, the silylenes, which are covered in the next chapter, and he does it well. During the past half-dozen or so years, progress in the study of reactive intermediates and hyper-reactive molecules has been fast and furious, and Gaspar has much to report. Most of those active in the field, this reviewer included, have been skimming off the cream, not analyzing the milk. Mechanistic problems abound and are discussed in detail by the author. In a sense, the field is young and many "mechanisms" have as their experimental basis only the identity of the products that were isolated. The state of our knowledge of mechanism is summarized nicely by Gaspar in his concluding section, and it is clear that much remains to be done. The chapter might well have included the other major facet of reactive silicon intermediate chemistry—the unsaturated silicon species with Si=C, Si=O, Si=Si, Si=N, and Si=S formal double bonds. These are very new on the scene, and their discovery has added a new and exciting dimension to organosilicon chemistry. Also missing from the chapter are the divalent germanium and tin intermediates, the germylenes and stannylenes. The former include transient species such as $(CH_3)_2Ge$ as well as isolable compounds such as GeI_2. Their chemistry has been developed chiefly in France, by J. Satgé and his coworkers, and in the Soviet Union, by the research groups of V. F. Mironov and O. M. Nefedov. In terms of preparative applicability and breadth, the chemistry of the germylenes at the present time is richer than that of the silylenes.

The final chapter in the book, by K. N. Houk, deals with the theory of reaction intermediates and reaction mechanisms. It covers a large diversity of topics and discusses critically the recent developments in computational organic chemistry.

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