in table 1 are briefly illustrated, allowing rapid comprehension by the reader and perhaps implying, without justification, a unity of evidence.

The first of the three chapters in the book sets the stage for its main contribution—the presentation of evidence for protein phosphorylation that is dependent on cyclic adenosine monophosphate (cyclic AMP) and of evidence concerning the nature of the substrate proteins phosphorylated. The presence and distribution of cyclic AMP-dependent proteins are briefly discussed, and the possible participation of specific protein kinases in a general mechanism for the expression of hormonally initiated biological events is outlined. Cyclic AMP-dependent dissociation of these kinases into regulatory and catalytic subunits is introduced as a likely mechanism for all of the cyclic AMP-mediated metabolic and physiological effects.

The main emphasis is on the evidence for a functional complex, localized in the postsynaptic membrane, which links receptors, adenylate cyclases, cyclic AMP-dependent kinases, protein substrates for the kinases, and specific phosphatases for dephosphorylating the resultant phosphoproteins. In this model the specificity of the system is inherent in the altered biological effects of the specific protein phosphorylated, which for events in the postsynaptic neuronal membrane is proposed to result in a change in membrane potential. Evidence is presented indicating that all of the components mentioned above are present in the postsynaptic membrane. A protein, designated protein I, is shown to be present only in neuronal synaptic membranes and synaptic vesicles, to appear simultaneously with synapse formation during development, and to be a substrate for a membrane-bound protein kinase and protein phosphatase. This protein specifically undergoes phosphorylation in the presence of cyclic AMP. In brain slices conditions that lead to depolarization and elevation of cyclic AMP also result in phosphorylation of protein I. Presumably protein I may be related to an intrinsic protein such as an ion channel or an electrogenic pump. As the author points out, there is no direct evidence that protein I is the hypothetical phosphoprotein that mediates the effect of cyclic AMP on the postsynaptic permeability change. However, the attractiveness of the system has stimulated major research interest in many laboratories.

A model system that is similar but more amenable to investigation, the avian erythrocyte, exhibits hormonally sensitive cyclic AMP-dependent changes in ion permeability. In this system hormones stimulate both changes in ion permeability and cyclic AMP-dependent phosphorylation of a specific protein. The phosphorylation of this protein, not of protein I, appears to be correlated with the influx of sodium ions into the cell. Similar experimental results have been obtained for the isoproterenol-stimulated phosphorylation of a protein and the influx of potassium ions in the plasma membrane of turkey erythrocytes.

A book of this character, based upon a lecture, cannot possibly serve as a technically complete or unbiased reference work. However, as an up-to-date primer for persons both within and outside of this multidisciplinary field, it does reflect the excitement and dynamic possibilities of neuroscience in particular and the physiological sciences in general. Furthermore, the book provides a wealth of current references to key research reports and reviews and will be an invaluable aid to neuroscientists.

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Nuclear Physics

Ions Lourds et Mésons en Physique Nucléaire. Nuclear Physics with Heavy Ions and Mesons. Papers from a summer school, 1977. ROGER BALIAN, MANNQUE RHO, and GEORGES RIPKA, Eds. North-Holland, Amsterdam, 1978 (U.S. distributor, Elsevier, New York). In two volumes. 1x, 1018 pp., illus. $133.25. Les Houches, Session 30.

During the 1960's the nuclear physics community enjoyed the considerable (and immensely useful) luxury of looking forward each year to a new crop of review articles generated by the advanced summer schools of Brandeis University, the University of Colorado, and Les Houches in France and the Enrico Fermi School of Physics in Varenna. With the 1970's came troubles for science funding in the United States, and the U.S. schools fell by the wayside, leaving the torch in the hands of the French and Italians, who themselves have only intermittently dedicated their annual efforts to nuclear physics. The summer of 1977 was one of these occasions, and these two volumes provide the welcome fruits of the efforts of ten experts (nine theorists and one intrepid experimentalist), whose reflections should provide food for thought to a wide variety of nuclear physicists.

The choice of topics for this 30th session of the Les Houches seminars was a felicitous one, for the summer was devoted to two of the most rapidly growing subfields of nuclear physics, heavy-ion and intermediate-energy physics. Though young, these two subfields are already becoming increasingly specialized and are rapidly growing apart. The summer school was a valiant attempt to stave off a further split by pointing out how many concepts and techniques the two subfields have in common.

The two volumes are themselves dedicated, separately, to heavy-ion and meson-nucleus problems. The volume on heavy ions begins with lectures by David M. Brink that deal with applications of multiple-turning-point JWKB (Jordan-Wentzel-Kramers-Brillouin) methods to elastic scattering and summarize ℓ-space parametrizations that have been employed for elastic angular distributions. This theme is followed by Richard Schaeffer, who provides an introduction to the use of semiclassical methods for elastic heavy-ion scattering, with primary emphasis on the concept of "complex trajectories," that is, radial JWKB turning points at complex r (equivalently, complex impact parameter) as a means of describing refraction and diffraction in the same formalism. George F. Bertsch concentrates on the transport theory of deep inelastic collisions. He employs the density-matrix formulation in terms of the Wigner distribution function, supplemented by semiclassical approximations that reduce the Liouville equation to the more tractable Vlasov equation. Drawing on the extensive scrutiny to which the equation in this form has been subjected in the field of plasma physics, Bertsch is able to indicate the extent to which analytic solutions can be expected, and, failing analytic solutions, he is able to obtain conservation laws and a consistent treatment of small-amplitude density oscillations.

With the appearance of heavy-ion beams, high ($\ell \leq 25\ \hbar$) angular momentum states have become accessible to intense experimental scrutiny. Zdzislaw Szymański provides a theoretical survey within the Hartree-Fock-Bogolyubov model, with primary emphasis on the "backbending" of rotational bands as they cross.

Finally, Herman Feshbach addresses the problem of relativistic heavy-ion col-

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