

experienced a particularly high rate of commercial development and production during the last 15 years. He gives special attention to amino acids, amides, nitriles, and amines. This chapter, which contains many reactions, tables of physical and chemical properties, and methods of preparation, also outlines industrial applications and production.

Dr. Markley, Research Consultant, Vegetable Oil Industry, Rio de Janeiro, Brazil, discusses the complicated subject of the organic sulfur derivatives, mainly the mono-, di-, and trithioacids, the sulfonic acids, and the sulfuric acid esters. Several other addition products and derivatives are covered briefly, such as sulfur chloride, thiocyanogen and thiophene additives, the sulfones, and thiuronium and mercaptoacetic acid derivatives.

Dr. Markley devotes a significant portion of this volume to chemical synthesis of fatty acids. Many methods and reactions are described for the synthesis of a wide variety of fatty acids.

Dr. Woodbine of the University of Nottingham, England, gives a historical perspective on the biosynthesis of fatty acids. He discusses progressive concepts since 1929, and develops the latest theories of biosynthesis dependent on the roles of "active" acetate and malonic acid. Mechanisms for the biosynthesis of unsaturated fatty acids are also presented.

Very thorough treatment is given to the techniques of separation. Since 1935 new and more efficient procedures for separating fatty acid mixtures have been developed, so that knowledge of the composition of fats and oils is more exact. Dr. Markley discusses the classical methods of separation by distillation, salt solubility, and low temperature crystallization. The techniques and principles of liquid chromatography are discussed by Professor Schlenk of the University of Minnesota. The newer technique of gas-liquid chromatography as applied to fatty acids is presented by Dr. Woodford, University of Leiden, The Netherlands. Dr. Scholfield of the U. S. Department of Agriculture describes the principles of countercurrent distribution. Equipment, operations, and mathematical treatment are discussed. Dr. Swern, also of the U. S. Department of Agriculture, reviews the subject of urea complexes, their properties and uses for purposes of separation.

Part 3 of "Fatty Acids" presents a broad survey of recent research. It is well edited and thoroughly documented. Special care has been taken to select references from sources that are readily available. Research workers in the field of fatty acid products and workers in related industries will find this volume an important source of information and a guide to significant references.

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Spectroscopy and Photochemistry of Uranyl Compounds. By EUGENE RABINOWITCH, Department of Botany, University of Illinois, and R. LINN BELFORD, Department of Chemistry, University of Illinois, Urbana, Ill. The Macmillan Co., 60 Fifth Ave., New York, N. Y. 1964. x + 370 pp. 14.5 × 22.5 cm. \$12.50.

This book is lucid and informative. Anyone concerned with the spectroscopy and/or photochemistry of uranyl compounds would do well to have it on his bookshelf.

The book is simply a review of the literature on the effects of electromagnetic radiation on uranyl compounds. Particular attention is devoted to the history of the subject, and indeed this is one of the more delightful aspects of the whole treatment. The green luminescence of uranyl ion, observed as early as 1833, is a topic of intense interest even today; in consequence, the discussion of uranyl luminescence, spanning as it does the classical and quantum mechanical eras, provides a unique insight into changing ideas and attitudes.

Chapter 3, concerned with uranyl luminescence intensity and decay, provides an entertaining discussion of whether the uranyl luminescence is a "fluorescence" or "phosphorescence." Unfortunately, the authors seem to have cut their teeth on inorganic solid-state luminescence, and fail to appreciate that molecular luminescers, such as uranyl ion, might require a different terminology. To be specific, the literature of molecular luminescence of the last four years is rife with terms such as "delayed fluorescence," "slow fluorescence," "E-type fluorescence," "P-type fluorescence," "annihilative fluorescence," "delayed excimer fluorescence," etc.; these luminescences would have to be classified

as phosphorescences if we are to accept the definitions of Rabinowitch and Belford (R and B). Furthermore, consistent adherence to the definitions of R and B would force us to designate the triplet → singlet ($T_1 \rightarrow S_0$) emission of an organic molecule as a *phosphorescence* if excited by $S_1 \leftarrow S_0$ (or $S_1 \leftarrow S_0$) absorption and as a *fluorescence* if excited by $T_1 \leftarrow S_0$ absorption. It appears that regardless of excitation method, current practice dictates designation of $T_1 \rightarrow S_0$ luminescence as phosphorescence and $S_1 \rightarrow S_0$ luminescence as fluorescence. In this context, the question of the name to be used for the uranyl luminescence is still open and hinges not upon metastability or otherwise of the emitting level, but rather on its Russell-Saunders spin multiplicity.

Chapter 4 discusses the photochemistry of uranyl compounds and manages to induce some order in an otherwise confused topic. This chapter is also characterized by a willingness to criticize and to evaluate the work of others.

Chapter 5 is disappointing, not through any fault of the authors, but rather because our knowledge of the electronic states of the uranyl ion is so very poor.

The worth of this book lies in its careful delineation of what is known and what is not known. It could be considered a primer for research in uranyl spectroscopy and photochemistry. It is four years out of date, but nonetheless it should prove indispensable to the research worker interested in this area.

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Introduction to the Atomic Nucleus. By J. G. CUNINGHAME, Atomic Energy Research Establishment, Harwell, Didcot, Berks, Great Britain. American Elsevier Publishing Co., Inc., 52 Vanderbilt Ave., New York, N. Y. 1964. xi + 220 pp. 14 × 22 cm. \$9.00.

"Introduction to the Atomic Nucleus" is intended as a survey of the characteristics of the nucleus for the scientific reader who is neither a nuclear physicist nor a nuclear chemist. After two introductory chapters concerned briefly with history, general definitions, and properties of radioactive materials, there are chapters dealing with nuclear forces, stable nuclides, unstable nuclides (radioactivity), nuclear models, nuclear reactions, fission, α -decay, β -decay, γ -emission, and interaction of particles with matter. Essential mathematical relations are given and explained, but not derived. The material has been carefully selected and is very well illustrated, as evidenced by 58 figures distributed rather uniformly over the 200-odd pages. Numerous references to the literature, including well-chosen reviews, are given for the benefit of those who wish to delve further into a particular topic.

The author has produced a lucid and readable monograph that meets the needs of the chemist, biochemist, biologist, etc., desiring a concise treatment of the subject.

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Chelating Agents and Metal Chelates. Edited by F. P. DWYER, Australian National University, Canberra, A.C.T., Australia, and D. P. MELLOR, University of New South Wales, Kensington, N.S.W., Australia. Academic Press Inc., 111 Fifth Ave., New York, N. Y. 1964. 530 pp. 15.5 × 22.5 cm. \$18.00.

This discussion of metal chelate compounds is a collection of chapters on topics which reflect the main interests of the contributors. The variation in scope of these subjects is considerable, with one chapter, for example, dealing with the general subject of metal chelates in biological systems, while others are restricted to such topics as bidentate ligands, and the tetrapyrrole pigments. While the book offers interesting information on many phases of the subject that have not been brought together previously, it does not, nor do the authors intend that it should, provide coverage of all aspects of the chemistry of the metal chelate compounds. It also suffers from a common defect of multiple authorship, in that the various parts of the book are only loosely tied together and, in some cases, not at all.

The first chapter, by Professor D. P. Mellor, is a survey of historical developments, definitions of terms, and general properties of metal chelates. There is a short section which interprets stabilities of metal chelates in terms of the properties of the ligands,

reminiscent of a similar treatment given in Martell and Calvin. Some recent developments in the field of metal chelates, such as hydrolysis, polynuclear chelate formation, and the formation of mixed ligand chelates, are not discussed.

Chapter 2, on the nature of the metal-ligand bond, by D. P. Craig and R. S. Nyholm, is an excellent description of the various kinds of coordinate bonds found in complexes, and interprets bond type on the basis of the properties of the atomic orbitals involved in bond formation. One might wish that additional space had been allotted to this chapter for the introduction of a larger number of examples and for a description of the application of the ligand field theory to coordinate bonding of transition metal ions. Special bonding effects observed in chelate compounds are not described.

Chapters 3, 4, and 7 constitute a review of various metal chelate types from the point of view of the number of chelate rings formed and the arrangement of donor groups in the coordination sphere. An attempt has been made to completely cover the literature, and many references are cited; however, the treatment is frequently only qualitative and the discussion is often reduced to whether a complex does or does not form. Chapter 3, by C. M. Harris and S. E. Livingstone, is a description of chelates of bidentate ligands, classified according to the nature of the donor atoms of the ligand. Metal chelates of multidentate ligands, arranged on the basis of the number of chelate rings formed per ligand, are described by H. A. Goodwin in Chapter 4. The properties, bonding, and isomerism of chelates of EDTA, and of a few related ligands, are described in Chapter 7, by F. L. Garvan. The treatment on EDTA is subdivided in terms of the group of the periodic table to which the metal ion belongs. There is a brief section on the synthesis of EDTA-type ligands, a subject that has not been treated previously in the many monographs now available on chelate compounds.

Chapter 5, on optical rotatory dispersion and optical isomerism of metal chelates, is perhaps the best one in the book. The treatment is thorough, perceptive, and up to date. There is an excellent description of optical rotatory dispersion, and recent work on the absolute configuration of optically active chelates is given. The author takes the trouble to set the record straight on some of the misconceptions about stereospecificity of metal chelates of optically active ligands that have appeared in the literature and in some monographs.

The oxidation-reduction reactions of metal chelates are described by D. A. Buckingham and A. M. Sargeson in Chapter 7. This subject has not been set forth in such detail in any other book.

The remainder of the book is mostly concerned with biological systems. Chapter 8, by F. P. Dwyer, is entitled "Enzyme-Metal Ion Activation and Catalytic Phenomena with Metal Complexes." The subject of metal-enzyme activation is treated very briefly; it may be found in greater depth elsewhere. The rest of the chapter is an interesting review of metal ion catalysis and reactions of coordinated ligands. Chapter 9, by A. Shulman and F. P. Dwyer, has the general title, "Metal Chelates in Biological Systems," but seems to be restricted to the research interests of the authors, *i.e.*, metal chelates in physiological systems, with emphasis on the

effects of *o*-phenanthroline and bipyridine chelates of iron(II) and ruthenium(II). The last chapter is the most specialized of all, dealing with the chemistry of the tetrapyrrole pigments. It is a good, well-annotated discussion of this restricted topic.

This book is recommended as a reference in the areas that are represented by the chapter headings. It cannot be a general reference on metal chelates since it omits some important aspects of the subject, such as the kinetics and mechanism of metal chelate formation and substitution reactions; new developments in infrared, n.m.r., and e.p.r. spectroscopy; interpretations of stabilities and other properties of transition metal chelates based on ligand field theory; and the insights into bonding and stability afforded by the large body of thermodynamic data now available. The book seems particularly well suited to chemists and biochemists interested in the functions of metal chelates in biological systems.

The book seems to have been delayed somewhat in editing or production, since with the exception of Chapter 2, most of the references cut off at 1961. This is not surprising in view of the unfortunate and untimely death of one of the editors.

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