An Actinide Element

Physico-Chimie du Protactinium. Colloque International du Centre National de la Recherche Scientifique, No. 154, held at Orsay, France, July 1965. Editions du Centre National de la Recherche Scientifique, Paris, 1966. 351 pp., illus. F. 56.

Only 10 years ago it could be said that protactinium was the least understood of the actinide elements. Today the situation is very different, and, as A. G. Maddock pointed out in his concluding remarks to this conference, we can look forward in a short time, at present rates of progress, to knowing more about the chemistry of protactinium than we do about that of niobium and tantalum. This surprising development is due primarily to the enterprise and fortitude of Harwell chemists who separated and purified more than 100 grams of protactinium from natural sources. This protactinium was made widely available to other investigators, and a large-scale, intensive attack on the chemistry of this previously intractable element thus became possible. The present volume embodies much of the results of these researches.

The 38 papers cover all aspects of protactinium chemistry: atomic and nuclear properties; preparation and properties of protactinium metal; oxides and other solid-state compounds; halides; protactinium in solution; and the separation of protactinium from both natural and synthetic sources. The papers generally have an unmistakable air of authority and together constitute the best single source of information on the properties of this element and its compounds. Not only will chemists interested in the actinide elements find this volume useful, but inorganic chemists generally will find it an excellent example of modern methods brought to bear on an important problem.

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Particles as Composite Systems

The Analytic S Matrix. A Basis for Nuclear Democracy. GEOFFREY F. CHEW. Benjamin, New York, 1966. 115 pp., illus. $7.50.

The art of writing monographs with an unashamedly personal bias appears to be a lost one. There are, fortunately, some few practitioners of the art still left among us, and these include Geoffrey Chew. The monograph under review has evolved from two earlier sets of Chew's lecture notes, *The S-Matrix Theory of Strong Interactions* (Benjamin, 1961) and "Nuclear Democracy and Bootstrap Dynamics" (in Jacob and Chew's *Strong Interaction Physics*, Benjamin, 1964). These lecture notes were influential in making Chew's ideas widely known; a number of these ideas have received almost universal recognition. This monograph does not add anything substantially new either to the viewpoint or to the techniques; it restates, with Chew's accustomed verve, his thesis that no particle in nature is more elementary than any other—certainly so far as the strongly interacting particles are concerned. This is the concept of nuclear democracy, in which all particles are composite systems made up of one another. The relative couplings, and indeed the ratios, of the masses are all a result of a consistent "bootstrap" mechanism which holds the whole edifice up. The bootstrap hypothesis is expressed formally through the statement that all strongly interacting particles lie on Regge trajectories. The greater part of the monograph is devoted to a discussion of this hypothesis and a presentation of the mathematical machinery to implement it in practice. It is perhaps fair to say that the hypothesis is qualitatively attractive but its quantitative successes do not quite match up to its esthetic appeal.

Chew recognizes that there are two places where this view of nature might be seriously challenged: First, the existence and interactions of leptons, and the weak, electromagnetic and the gravitational forces, which cannot be fitted into the scheme he presents. This results in strong-interaction physics becoming divorced from the rest of particle physics. Second, the internal symmetry concepts, particularly the rival hypothesis that all particles may be composites of quarks. Quarks are a (so far) hypothetical triplet of objects; if one assumes that all strongly interacting particles one observes may be made out of just these three building blocks, one immediately gets an understanding of the fairly successful symmetry schemes such as SU(3), SU(6), and U(6) × U(6). If these symmetries—and particularly SU(3)—have anything basic and fundamental about them, the quark hypothesis, totally irreconcilable with Chew's bootstrap hypothesis, seems the simplest (though by no means the only) way to build symmetry into physics. Chew dismisses symmetry physics with the remark that a number of approximate symmetries of a nonfundamental kind are known to exist in nuclear physics—for example, shell structure, which corresponds to the grouping of certain nucleons into multiplets. In nuclear physics these symmetries are dynamical accidents arising from a special situation-dependent interplay of nuclear forces. The same, in his view, might well be true of SU(3). One may disagree profoundly with Chew's views, but one cannot but admire the complete suspension of disbelief with which he can approach his view of physical reality.

It is somewhat unfortunate that this monograph was written just shortly before a strong revival of the Regge pole theory came about. After years in the wilderness it seems that a number of predictions of the theory—so much a cornerstone of Chew's work—are experimentally verified. The monograph would have been richer for a critical review of these developments.

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Polymers

Conformations of Macromolecules. T. M. BIRSHTEIN and O. B PTITSYN. Translated from the Russian by Serge N. Timasheff and Marina J. Timasheff. Interscience (Wiley), New York, 1966. 364 pp., illus. $14.50.

For a long time polymer chemistry has been a branch of chemistry seemingly detached from the rest of chemistry. Because of the tremendous complexity of these huge molecules a study on an atomic scale of the interaction between them and other molecules seemed a hopeless task. It is now becoming clear, however, that many important physical properties can be understood from a knowledge of the restriction to rotation of the single bonds making up the chain.

Birshtein and Ptitsyn deal thoroughly with the calculation of average physical properties, such as dimensions and dipole moments, on the basis of chain conformations and their energy differences. Their discussion in chapters 2 and 3 of internal rotation in small molecules and the semi-empirical ways of calculating barriers to rotation is in-

valuable. The great number of parameters that have to be used gives one a somewhat uneasy feeling. However, the criteria for choosing these parameters are well discussed, and the results obtained for polymer molecules are rather impressive. The chapters (5, 6, and 7) dealing with the calculation of average mean-square dipole moments and end-to-end distances are well written and should be highly useful to anyone interested in the calculation of these important properties. Although the literature is covered only up to 1963 and important later contributions are therefore not cited, the basic principles, which are the main subject of the book, remain valid. Especially worth mentioning is chapter 4, in which the relation between Ising models and Markoff chains is explained. This problem is well expounded and clearly discussed. Chapters 9, 10, and 11 deal with polypeptides and polynucleotides. These chapters should be highly valuable to biochemists who want to get an insight into the fundamental ideas behind phase transition in biopolymers.

Written on an advanced level, the book assumes a knowledge of matrix algebra. It is clearly written and the subject matter is well explained. The translation is excellent. In summary, nobody interested in the relation between chain structure and physical properties of polymer chains can afford to be without this book.

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Principles of Taxonomy

Phylogenetic Systematics. WILLI HENNIG. Translated from the German by D. Dwight Davis and Rainer Zangerl. University of Illinois Press, Urbana, 1966. 271 pp., illus. $12.50.

Here finally is an opportunity for English-speaking biologists to become acquainted in detail with the views of Willi Hennig, the eminent German systematist. His thoughts have greatly influenced the activities of continental taxonomists, and a study of his writings will enable English-speaking workers to understand the philosophy underlying some of the European taxonomic literature of the last decade.

Following a general introduction concerning the nature of systematics, its special tasks, and the position of phylogenetic systematics (read "cladistics") in relation to other schools of systematics, Hennig discusses problems of taxonomy of the lower categories, that is, of the species, and at the supraspecific level. The book concludes with a discussion of the principles and problems of phylogeny. Throughout the text Hennig maintains a consistently cladistic viewpoint which has considerable esthetic appeal but which is very difficult to maintain in practical systematic work. Although this reviewer disagrees with many of the conclusions that Hennig reaches from his evidence, a book review is not the place to debate the relative merits of different schools of systematics.

Had Hennig's *Grundzüge einer Theorie der Phylogenetischen Systematik* been translated during the early or middle 1950's, its effect on the development of systematic theory in the English-speaking world would have been very great. Hennig's clarity of thought, consistent phylogenetic philosophy, and profundity of insight and analysis would have won many adherents to his views. At the very least, those not agreeing with his philosophy would have had to meet his weighty arguments. Published in 1966, however, this book, although still impressive and important, is no longer as relevant to current issues of systematics as in the days of the original German edition published in 1950. While Hennig's arguments continue to have considerable validity and force, he apparently has not kept up with the rapid and numerous changes in systematics during the past decade. To cite but a single example, the revolutionary findings of modern genetics have not been dealt with at all.

The terse preface assures us that this volume is a translation not of the original German edition but of a reworked manuscript (of unstated date). It is true that references to some recent papers can be found and that various sections have been modified and updated to some extent. Nevertheless, the fundamental arrangement of the earlier work has been maintained and very large portions of the book are essentially straight translations from the previous text. Only 34 percent of its references are dated 1950 or later, as contrasted with 60 percent for Simpson's *Principles of Animal Taxonomy*, published in 1961, and 70 and 75 percent, respectively, for Davis and Heywood's *Principles of Angiosperm Taxonomy* and Sokal and Sneath's *Principles of Numerical Taxonomy*, both published in 1963. Hennig cites only one reference later than 1960. Not even Simpson's book is referred to, an incomprehensible omission. The main use of the bibliography will be as an invaluable entrée into the voluminous German literature on systematics.

The translators have done a conscientious but unimaginative job of rendering Hennig's extremely involved and philosophical German style into English. Long sentences of crypto-Germanic construction abound, as does difficult and unfamiliar terminology, of which *semaphoront, holomorph, tokogenetics,* and *vicariance* are but a sample. A glossary or an index leading to clear definitions of the various terms would have been a great help. Even supposedly familiar terms such as "genetic" have unconventional meanings in the text. By contrast, many conventional terms of modern systematics are omitted. Those familiar with the German edition, which lacked an index, will be gratified by the presence of a subject index; the addition of an author index would have been equally helpful.

In spite of the shortcomings of the book, English-speaking systematists should be glad to have an opportunity to be exposed to the views of the foremost proponent of the cladistic school. Indeed, no thinking systematist can afford not to have read this volume.

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Books Received

Absorption in Gas-Liquid Dispersions: Some Aspects of Bubble Technology. F. H. H. Valentin. Spon, London; Barnes and Noble, New York, 1967. 232 pp. Illus. $10.

Airborne Microbes. A symposium of the Society for General Microbiology (London), April 1967. P. H. Gregory and J. L. Monteith, Eds. Cambridge Univ. Press, New York, 1967. 397 pp. Illus. $13.50. Sixteen papers.

Algae and Fungi. C. J. Alexopoulos and H. C. Bold. Macmillan, New York, 1967. 143 pp. Illus. Paper, $2.25. Current Concepts in Biology Series.

Algebra. Saunders MacLane and Garrett Birkhoff. Macmillan, New York, 1967. 620 pp. Illus. $11.95.

An Atlas of Mammalian Chromosomes. vol. 1. T. C. Hsu and Kurt Benirschke. Springer-Verlag, New York, 1967. Unpaged. $9.40. Consists of 50 folios.

Atlas stereotaxique du cerveau de brebis: Prealpes du Sud. P. Richard. Institut national de la Recherche agronomique, Versailles, 1967. Unpaged. Illus. Paper, F. 50.

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