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-