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Book Reviews

The Classical Atom. By F. L. Friedman and L. Sartori, Addison-Wesley, Reading Mass. (1965). 118 pages, paperback.

This is an interesting little book, the first volume in a projected series on the Origins of Quantum Physics. It is not a textbook in the usual sense, nor an historical development of the subject, but it does contain a large amount of historical material beginning with the concept of the atom and ending with the Rutherford nuclear atom. Those already familiar with atomic physics will find perusal of specific topics an interesting way of using this book. For example, Chap. 3 contains a very extensive account of the Thomson atom, much more than is available in most texts on atomic physics. There are a few direct quotations from writings by J. J. Thomson, and one from a book by Sir Oliver Lodge published in 1906. This last quotation contains a discussion of five possible views on the structure of the hydrogen atom. I will quote just one sentence from this: "A fifth view of the atom would regard it as a central 'sun' of extremely concentrated positive electricity at the center, with a multitude of electrons revolving in astronomical orbits, like asteroids, within its range of attraction."

There are three chapters in the book. The first is a short one which discusses very briefly the determination of the electronic charge by Millikan, and the determination of the Avogadro number by J. Perrin through his experiments on Brownian motion. The second chapter, "Some Successes and Failures of Nineteenth Century Atomism," treats some special topics in statistical mechanics. The mathematical level is higher in this chapter than in the two other chapters. It contains a derivation of the equation-of-state of an ideal gas by the use of virial theorems, a discussion of random walks, fluctuation phenomena, and a nice derivation of the Maxwell-Boltzmann distribution law with a description of an experimental verification of such a distribution. There is also a discussion of the equipartition theorem and its application to the specific heats of gases and solids. Some of the successes of this theorem are discussed, as well as its limitations.

The third chapter, on "Atomic Constituents and Atomic Nuclei," contains material on the determination of e/m for electrons by J. J. Thomson and the beginnings of discussions on the structure of the atom. There is a brief discussion of mass spectrometry beginning with the discovery of canal rays and ending with a modern table of masses of isotopes using ^{12}C as the standard. This chapter contains an extensive discussion of the work of Rutherford's group on the single scattering of alpha particles that led to the Rutherford theory of the nuclear atom. The equations for the scattering of alpha particles are derived in a short Appendix.

There is a list of references, mostly to original papers, at the end of each chapter. Some of these references go back more than a century (1860 is the earliest). There are some challenging problems at the ends of Chaps. 2 and 3.

Such important topics as x rays, photoelectric effect, and atomic spectra receive only very brief mention, but perhaps more extensive treatments will appear in succeeding volumes.

This book is a worthwhile addition to one's library; it will also be found very useful as a supplementary text in an undergraduate course in atomic physics. It is well written and attractively produced.

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February 4, 1966

About the Reviewer: Henry Semat has been a member of the Physics Department at The City College for many years and is, in fact, also an alumnus. He did his graduate studies at Columbia University in x-ray spectroscopy. But, basically, Professor Semat is a teacher, as attested by the achievements of his many former students now prominent in physics. He is also the author of widely used texts for introductory and advanced courses.

Chemical Effects of Nuclear Transformations. The proceedings of a symposium held in Vienna, 7–11 December, 1964, organized by the International Atomic Energy Agency in collaboration with the International Union of Pure and Applied Chemistry. Published by the IAEA in Vienna (1965), 2 volumes, Vol. I., pp. 442, \$9.00; Vol. II., pp. 558, \$11.00.

An earlier symposium on this subject took place in Prague in 1960 (IAEA, STI/PUB 34). In these two volumes, the proceedings of the second symposium (some 64 papers) are recorded; thus, clearly this has been a very active corner of science in recent years.

By requiring the contributors to submit their papers in a standardized form and to complete any corrections to their text at the symposium, the IAEA has been able to publish the proceedings with commendable speed. Contributions to the discussions were recorded and are published after each group of papers. It is true that neither authors nor speakers had the opportunity to proofread their contributions, but such sacrifices seem justifiable in the interests of speed of publication of this kind of material. Certainly, the density of typographical errors in the text is not noticeably higher than usual.

Perusing these volumes, the reader gains an accurate and up-to-date impression of the subject. He soon realizes that the contributors are pursuing a number of very different physico-chemical objectives but that they find common ground in their interest in the primary physical processes and, very often, in the experimental techniques employed. The study of the correlation of the primary physical processes with their immediate chemical effects is best conducted on gaseous systems. Mass-spectrometric techniques applied to such systems have yielded valuable information. Only three papers were devoted to this part of the subject.

Three branches of the subject are especially active: the physical and chemical behavior of epithermal atoms produced by nuclear transformations; the roles of hot reaction processes, diffusion-controlled thermal processes, and, possibly, ion–molecule reactions that follow nuclear transformations in liquids; and the effects of nuclear changes in solids. These nuclear changes in solids are considered as a variety of radiation damage.

The first of these fields is the veritable hot atom chemistry. Nuclear transformations provide the best means of producing highly energetic T, ^{11}C, ^{18}F, and other atoms. These nascent species generally become neutral before they are involved in chemical reactions in gaseous systems. By the use of moderators and scavengers, the reactions of the hot species can be distinguished from the purely thermal reactions, which are the fate of those atoms that fail to react in the epithermal region. These studies, pursued especially by Rowlands, Wolf, and Wolfgang and their collaborators, are rapidly mapping a new area of physical chemistry. The theoretical kinetic analysis of the data from these experiments, developed by Estrup and Wolfgang, has now been tested more extensively. However, the papers presented show that the precise limitations of the theory and the significance of the parameters evaluated cannot yet be considered established.

Although liquid systems were among the first to be studied, even the effects of thermal-neutron capture in the organic halogen compounds are not yet completely understood. As Willard asks, in a review contribution, "does radical formation occur by impact of neutral atoms on molecules of the medium, or by ion molecule reactions, or by neutralization of a solvent envelope that has been charged by charge transfer to the recoil atom following a vacancy cascade in the latter, or by the radiolytic effects of conversion electrons and Auger electrons or by the billiard-ball mechanism of impact with individual atoms?" Can liquids be treated using the Estrup–Wolfgang analysis or are they better interpreted using the thermal spike model that is useful with solids? Contributions, from several parts of the world, try to answer some of these questions. Nesmeyanov and Dzantiev and their collaborators investigated the departures from additivity of effects in two-component liquid mixtures.

A large part of the second volume deals with the effects in solids. Some 13 papers treat the primary effects, and another 13 cover post-irradiation phenomena. The irradiated solids behave as a matrix containing reactive species, possibly in many cases radicals. The results obtained are closely related to other studies on frozen free radicals, matrix systems, and the annealing of conventional radiation damage. Throughout these papers, one feels that something really important is just round the corner but is still managing to elude the investigators. The extension of these studies to include the behavior of ^{35}S in neutron-irradiated alkali chlorides, solids for which a wealth of physical data are available, may be a pointer as to the direction in which progress may be made.

Perhaps the most exciting contributions were the three papers dealing with the application of Mössbauer spectroscopy. This technique is clearly destined to provide very direct and important evidence on the chemical effects of nuclear transformations. Five of the last six papers are concerned with the chemical effects of beta decay. They provide a valuable addition to our knowledge of a part of this subject that has been neglected for several years. The final paper, from the USSR, introduces an entirely new and very interesting topic—the possibility of exploring fast chemical reactions by studying the behavior of muonium pseudo atoms in the system.

This collection of papers gives an accurate reflection of the state of worldwide activity in this branch of physical chemistry.

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About the Reviewer: Alfred Gavin Maddock, Reader in Radiochemistry at Cambridge University and Fellow of St. Catharine's College, graduated at Imperial College, London, where his research was supervised by H. J. Emeléus. Sometime after completing his thesis, he was attached to the British equivalent of the Manhattan Project. After nearly four years in Canada, and participation in the founding of the Chalk River and, later, the Harwell laboratories, he returned to Cambridge University. His principal research interests revolve around the chemical effects of nuclear transformation, radiation damage in solids, and the chemistry of the heavy elements, especially protactinium.

The Physics of Elementary Particles. By H. Muirhead, Nuclear Physics Research Laboratory, Liverpool University. Pergamon Press, Long Island City, N. Y. (1965). 718 pp. $20.00

Today, the theory of elementary particles seems to be in a state similar to that of quantum theory in the early '20s. If one is ingenious in following the logic of field theory just far enough, and in departing from it at just the right points, he can calculate some numbers with very great accuracy, and others with fair accuracy, whereas still others either come out all wrong, or are not derivable at all. Theoreticians are displaying vast erudition and sagacity in proposing programs for developing a new theory; but all the programs published hitherto seem to fail somewhere, and one does not know whether any of them may eventually produce a complete and accurate theory. Furthermore, perhaps recalling the birth of quantum mechanics or of relativity, physicists sometimes predict that the theory of particles will not reach a satisfactory state until some radically new ideas have been introduced into it.

Meanwhile, students must understand particles by means of the theoretical ideas that are now available, and experimenters must know the predictions of existing theories, so they will appreciate how various future data may fit into, or alter, our present picture of the world. Muirhead has undertaken the difficult and necessary task of acquainting these people with the current data and theories on elementary particles.

In view of the complexity of his subject and its present tendency to change rapidly, he succeeds admirably in his exposition. Not only does he fully summarize the experimental data through 1963 (and mentions in a footnote the two-pion decay of K_2° that, in 1964, first threw doubt on CP invariance), he also does remarkably well in covering the vast body of relevant theoretical publications. After a brief