NEW ATOMS FOR OLD

Mass Spectra and Isotopes

By Dr. F. W. Aston. Second edition. Pp. xii+276+12 plates. (London: Edward Arnold and Co., 1942.) 22s. 6d. net.

THE atomic theory of Dalton, accepted after many misgivings by nineteenth-century chemists, is now essentially discarded; Prout's hypothesis, rejected by Stas as "nothing but an illusion, a mere speculation definitely contradicted by experience", has returned to favour. One of the main factors in this transformation has been the discovery that the majority of the elements exist in two or more forms, which are chemically identical even though their atomic masses differ. These diverse species of the same element are known as isotopes, and when the word isotopes is mentioned one immediately thinks of Aston.

Although this welcome volume is announced as the second edition of "Mass Spectra and Isotopes", it constitutes in reality the fourth edition of Dr. Aston's pioneer monograph on "Isotopes", first issued in 1922. The change in title made in 1933 did not, as might appear to the casual eye, indicate a broadening of the ground covered. On the contrary, as the author himself specifically pointed out in his preface, the large development of the subject led him then to narrow the scope of the book a little—"it is now concerned less with general theory and more with experimental results, especially with those obtained by mass-spectrum analysis". The present edition very wisely continues this policy of restriction.

No doubt there will be readers who will regret that the book does not contain any discussion of induced radioactivity and artificial isotopes, but if Dr. Aston was justified in allotting a "somewhat disproportionately large space" to inactive isotopes twenty years ago in the hope that the inadequacy of his account of radioactive isotopes might stimulate the production of a separate volume dealing with this field, then it is obvious that it would be an impossible task nowadays to compress even a summary of all the important recent work on synthetic isotopes into a volume describing the stable isotopes in detail. One task at a time is prudent procedure, and Dr. Aston is entitled to feel a considerable amount of satisfaction in the fact that, in one important sense at least, the task to which he has devoted himself almost uninterruptedly for thirty years—the complete tabulation of the stable natural isotopes—has at length been triumphantly concluded. To quote his own words: "All the elements have now been analysed, and my main concern in writing this book is to tell how this has been done".

The tale is a thrilling one, and it is admirably told. The volume is indeed, in a fashion, a detective story of the very first class; Hercule Poirot or Lord Peter Wimsey would envy the skilful way in which one minute clue after another has been first distinguished and then relentlessly followed up until every atom of information has been drained out of it which might lead (and in every case, has led) to the identification of each individual connected with the mystery. No element possessed of a double, or multiple, personality has succeeded in concealing its duplicity, or multiplicity. "*Elementary*, my dear Watson!" might well be the motto on the title-page.

The experimental work involved, bristling with

fresh difficulties at each forward step, has been meticulously careful from the very start, and has now attained an almost incredible order of accuracy. A most valuable feature of this edition is the inclusion of an entirely new chapter recording the remarkable recent advances in design of mass spectrographs, particularly the double-focusing types. The increase in exactness obtained by the employment of these formidable instruments may be recognized, in a very simple manner, by a comparison of Aston's original packing fraction curve (p. 81) with Dempster's 1938 model (p. 108). The atomic masses of all the significant natural isotopes of every element and their relative abundance have now been established with such certainty as to warrant the astounding statement (p. 216) that were the vast accumulations of chemical data comprising the grand total of direct atomic weight determinations lost, the table of atomic weights could be reconstructed to-day, entirely from mass spectrum evidence, as complete and, with the possible single exception of the element copper, as accurate as the table we now have.

Especially interesting in this connexion is the history of hydrogen, since it was an infinitesimal disagreement between the chemical and mass-spectrograph atomic weight values for this element that first led Birge and Menzel in 1931 to point out that, to bring the results into accord, hydrogen must contain heavier isotopes. Here the amusing case of a false clue leading to a correct deduction, rare in detective novels but still rarer in scientific work (Prout's hypothesis is an apposite example), is beautifully exemplified. "Fortunately unaware that, as we now know, the error in *each* of the estimates concerned was greater than the *total* discrepancy he was seeking to explain, Urey started his famous painstaking search which resulted in the remarkable discovery of heavy hydrogen, and for which he received the well-merited award of the Nobel Prize in 1934."

The fact that there are still plenty of unsolved problems in the general theory of the subject is well illustrated in Chapter 13, which deals with "Isotope Statistics". A number of interesting rules are cited, but their basis is admittedly still obscure in most instances. For example, why should elements of odd atomic number never have more than two stable isotopes, while elements of even atomic number may have up to nine or ten (p. 204)? Why should elements of even atomic number predominate to a very marked extent not only in the earth's crust, but also in such extra-terrestrial matter as meteorites (p. 207)? And why should there be so little apparent rhyme or reason in the relative abundance of isotopes (p. 210)?

Dr. C. P. Snow has made an excellent revision of the two chapters on the isotope effect in molecular and atomic spectra, which he wrote for the previous edition. In the whole book, I have detected only one error, namely the statement (pp. 259-60) that Lewis and Macdonald's partial separation of the isotopes of lithium was founded upon "the difference in the free migration velocities of ions"; it depended, in fact, upon a difference in their electrode potentials. In return, however, I am prepared to admit that I have corrected quite a number of false impressions in my own mind through the perusal of the volume, and have acquired a veritable mass of new knowledge. I venture to advise all my chemical and physical colleagues to go and do likewise.

JAMES KENDALL.