Additional Evidence for an Isotope of Hydrogen of Mass 2

The discovery of an isotope of hydrogen of mass 2 by Urey, Brickwedde and Murphy[1] has been confirmed by a study of the isotopic molecular ion $(H^1H^2)^+$ of mass 3 with a mass spectrograph. At first sight it might seem hopeless to attack the problem from this angle because of the high probability for the formation of the triatomic ion $(H^1H^1H^1)^+$, also of mass 3, a process which is well known to occur in experiments of this kind. It is assumed that such an ion is a secondary product and hence proportional to the square of the pressure if the pressure is low. Such an assumption is in accord with all the experimental facts.[2] The isotopic molecular ion $(H^1H^2)^+$, however, should be formed directly from the normal (H^1H^2) molecule and should therefore vary in intensity as the first power of the pressure. Hence if the pressure is small enough the intensity of the $(H^1H^1H^1)^+$ ion relative to the $(H^1H^2)^+$ ion will be reduced to such an extent that the latter will become distinguishable with a sensitive apparatus.

A mass spectrograph was constructed, not primarily with the anticipation of working on this particular problem, but with the expectation of studying gaseous ions at very low pressures. The design is somewhat after the style of one previously built by the author.[3] In this case however a much larger solenoid was available making it possible to use the semi-circular type of analyzer. With this type of apparatus good intensity may be achieved at pressures ranging from 10^{-5} to 10^{-6} mm Hg.

Through the kindness of Professor Urey a sample of the residue of hydrogen which had been evaporated near the triple point by Dr. Brickwedde was placed at the disposal of the author. Two runs were made studying the intensity of the ions of mass 3 as a function of pressure, the first with ordinary hydrogen and the second with Brickwedde's concen-

trated sample. The hydrogen was allowed to leak through a fine capillary and flow continuously through the tube. The relative pressures were measured by using the tube as an ionization gauge.

The results of these two runs showed a marked increase in the number of ions of mass 3 in the concentrated sample as compared to the number in ordinary hydrogen, amounting, at some pressures, to as much as tenfold. The difference between the two curves was a linear function of the pressure and represents, it is believed, the increase in the relative numbers of (H^1H^2) due to the concentration process. If this is true then the measurements indicate a value for the abundance of (H^1H^2) as compared to (H^1H^1), as they existed in the concentrated sample under the conditions of the experiment, of 1/550 or an atomic ratio of 1/1100. The error in this value is probably not greater than 10 percent. In arriving at this figure it is assumed that the probabilities of ionization for the two diatomic molecules are the same.

The author is particularly grateful to Dr. Brickwedde of the Bureau of Standards for the preparation of the sample of hydrogen which made this investigation possible.

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[1] H. C. Urey, F. G. Brickwedde and G. M. Murphy, Bull. Amer. Phys. Soc. New Orleans Meeting, December 1931.

[2] H. D. Smyth, Revs. Mod. Phys. **3**, 357 (1931).

[3] W. Bleakney, Phys. Rev. **34**, 157 (1929); **35**, 139 (1930).

A New X-Ray Non-Diagram Line

Duane (Phys. Rev. **37**, 1017, 1931) mentions the existence of a very faint unidentified line between γ and β found in some of his long exposure photographs of the molybdenum K spectrum.

During a study of the δ and γ lines with a new type of double-crystal x-ray spectrometer a very faint line lying roughly midway between the γ and β_1 lines was found in the spectra of molybdenum, rhodium, palladium and silver. For convenience in this letter I

shall call this line β_4. Its position checked, in molybdenum, with Duane's faint line as nearly as could be measured on a photograph which he had kindly sent me.

By interpolation, with I.C.T. values of $K\beta_1$ and $K\gamma$ the values of λ and ν for β_4 given in the tables below were obtained. It at once became evident that β_4 must originate in a transition from either M_{33} or M_{32} to K. No other upper level would even approximately satisfy the conditions.