LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

On the Existence of H^3

Several attempts have been made in the last few years to find a stable isotope of hydrogen of mass three in the natural state. The only experiments[1, 2, 3] which gave some positive evidence for H^3 were not very conclusive. The work of Smith[4] showed that a primary ion made up of three hydrogen atoms may be produced in hydrocarbons by single electron impact. This discovery offers a possible, though somewhat improbable, interpretation of the results[1] of the mass spectrograph.

Some months ago the problem was reexamined. The purest heavy water available[3] was decomposed on hot tungsten filaments in an evacuated system consisting of twenty-nine glass diffusion pumps[5] of the Hertz type. Samples were taken of the gas before the pumps were operated and also samples were withdrawn from the light and heavy ends after equilibrium had been established. Analyses, made with the same instrument and by the same method previously used,[1] of the untreated gas confirmed in general the earlier results, namely the production of a primary ion of mass 5. Gas extracted from the light reservoir contained about ten percent protium and ninety percent deuterium but other impurities were extremely minute. This pure sample gave a peak at mass 5 whose relative size vanished when extrapolated to zero pressure. This result, we believe, shows that the mass spectrograph was working properly. The gas from the heavy end contained many impurities and gave a much larger peak at mass 5 although light hydrogen molecules were presumably eliminated.

Another sample was collected at the heavy reservoir after some of the heavy gas had been discarded. Since the pumps separate other gases from hydrogen very efficiently this procedure practically eliminated all heavier compounds. Calculations supported by measurements on various hydrogen gases convinced us that if mass 5 molecules were present at all there would still be a considerable enrichment in this sample over the untreated gas. The analysis showed this sample to be one of the purest of deuterium we have ever tested. The ratio of mass 5 to mass 4 was 3×10^{-7}, too small to make the regular pressure run. From this result we conclude that we have no evidence for H^3 and that the former interpretation of similar data was in error. The occurrence of the primary mass 5 ion in unpurified samples is not understood at present.

Estimating the total enrichment to be expected both from electrolysis and diffusion our results indicate that the abundance of H^3 in ordinary hydrogen is less than 1 in 10^{12}. We believe this test is a more drastic one than that reported by Rutherford[6] and it is in line with the suggestion of Bonner[7] that H^3 may be unstable. In the light of these results it may be of interest to repeat the experiment of Tuve, Hafstad and Dahl.[2]

Rubby Sherr
Lincoln G. Smith
Walker Bleakney

Palmer Physical Laboratory,
Princeton University,
Princeton, New Jersey,
August 12, 1938.

[1] Lozier, Smith and Bleakney, Phys. Rev. **45**, 655 (1934).
[2] Tuve, Hafstad and Dahl, Phys. Rev. **45**, 840 (1934).
[3] Selwood, Taylor, Lozier and Bleakney, J. Am. Chem. Soc. **57**, 780 (1935).
[4] L. G. Smith, Phys. Rev. **51**, 263 (1937).
[5] Sherr, J. Chem. Phys. **6**, 251 (1938).
[6] Rutherford, Nature **140**, 303 (1937).
[7] Bonner, Phys. Rev. **53**, 711 (1938).

The Atomic Vibrations of a Zinc-Copper Alloy

A paper of the above title by Robert A. Howard[1] has led to the preparation of this note. Howard has proposed and experimentally verified the idea that in hexagonal close-packed crystals the atomic vibrations are greatest along the C axis of the crystal in case the axial ratio is greater than 1.633 and least when the axial ratio is less than 1.633. The axial ratio 1.633 is the ratio which would obtain in the hexagonal close-packing of spheres. The literature is cited for the cases of zinc and cadmium with axial ratios greater than 1.633 and the epsilon phase of the copper-zinc alloy system is the experimental basis for the case of an axial ratio less than 1.633.

It has occurred to the writer that the change in crystal lattice dimensions accompanying the variation of the composition of the eta and epsilon copper-zinc phases is in experimental support, or at least, experimental analogy to the work of Howard. The eta phase is the solid solution of copper in zinc, having at all compositions axial ratios greater than 1.633. The epsilon phase is an intermediate phase, also hexagonal close-packed, but with axial ratios less than 1.633. Fig. 1 portrays the rate of change of atomic spacings with change of composition for these two phases.

An increase in copper content of eta causes an increase in atomic spacing in a direction perpendicular to the C axis and a very large decrease parallel thereto; whereas in epsilon, the spacing perpendicular to the C axis undergoes a decrease while the direction parallel to the C axis changes very little. The increase in copper content (or the decrease