two phases, separated by a definite boundary. From the more concentrated phase (α phase) Cs evaporates as atoms while from the dilute β phase Cs evaporates as ions; both of these rates being equal to the rate of arrival from the vapor phase. At a given filament temperature there is only one pressure p_0 at which these two phases can coexist. If the pressure is changed to p_1, the phase boundary moves with a definite velocity v along the length of the filament, causing either one or the other phase to disappear.

At the phase boundary there is a sharp concentration gradient. The resulting surface migration is balanced by differences between the rates of evaporation into and arrival from the vapor. The rates of evaporation of atoms and ions, ν_a and ν_p, both depend on T and σ, but the rate of condensation μ is fixed by the Cs vapor pressure. The total evaporation rate $\nu = \nu_a + \nu_p$ rises from 0 at $\sigma = 0$ to a maximum at about $\sigma = 7 \times 10^{12}$, falls to a minimum at 43×10^{12} and then rises indefinitely. The curve $\nu - \mu$ as a function of σ thus intersects the σ axis at three points and forms two closed areas A_1 and A_2, enclosed by the curve and the σ axis. A recent article [I. Langmuir, J. Am. Chem. Soc. **54,** 1252 (1932)], gives data from which such curves can be prepared. Mathematical analysis shows that the condition for a stationary phase boundary is that $A_1 = A_2$.

If at any temperature the rate of arrival of Cs is changed from μ_0 to μ_1, the velocity of the movement of the boundary is given by

$$v = (D/2A)^{1/2}(\mu_1 - \mu_0).$$

This was derived on the assumption that D is independent of σ and that v is small.

The experiments show in fact that $A_1 = A_2$ and that v varies in proportion to $\mu_1 - \mu_0$. From measurements at 967°K a value of $D = 6 \times 10^{-4}$ was obtained. The concentration of the α phase was 7.3×10^{13}. From Eq. (1) for this temperature we calculate $D = 1.1 \times 10^{-4}$. The higher concentration is the probable reason for the higher observed value of D by this method.

The strong repulsive forces between the adatoms explains the variation of D with σ. It is planned to develop a quantitative theory of this effect. The coefficient of the last term of Eq. (1) corresponds to an activation energy for diffusion amounting to 0.61 volts. The atoms are normally held in definite positions with respect to the underlying tungsten lattice, but by acquiring thermal energy of agitation of 0.61 volts or more, may hop into adjacent vacant spaces. With definite knowledge of the lattice and the forces acting on the atom, it is hoped that the average life τ in each elementary space may be determined.

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Relative Abundance of H^1 and H^2 in Natural Hydrogen

Urey, Brickwedde and Murphy[1] have shown that an isotope of hydrogen of atomic weight 2 exists in ordinary hydrogen and that its abundance relative to H^1 is increased in liquid hydrogen by fractional distillation of liquid hydrogen near its triple point. By using the relative exposure times required to record the Balmer lines with a grating the relative atomic abundances were estimated as 1:4000 in natural hydrogen and 1:800 (or more) in the concentrated samples. Bleakney[2] found that the relative abundance in one of the same concentrated samples was 1:1100 ± 10 percent using a mass spectrograph method. The abundance as estimated by the relative exposure times agreed as closely with this as could be expected considering the approximate character of this method as compared with that used by Bleakney. However his estimate of the abundance in ordinary hydrogen reported at the Boston meeting, of 1:30,000 is in very marked disagreement with that given by Urey, Brickwedde and Murphy. Moreover Kallman and Lasareff[3] also using a mass spectrograph method conclude that H^2 must be less abundant than 1:40,000.

In order to explain these discrepancies we have searched for possible sources of error in the spectrographic estimates. The change of intensity of the H^2 Balmer lines relative to the H^1 Balmer lines depending upon whether the ordinary hydrogen or concentrated samples

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[1] Urey, Brickwedde and Murphy, Phys. Rev. **39,** 164 (1932); **40,** 1 (1932).

[2] W. Bleakney, Phys. Rev. **39,** 536 (1932).

[3] Kallman and Lasareff, Naturwiss. **12,** 206 (1932).

were used showed that the H^2 lines observed in the concentrated samples could not be due entirely to chance coincidence with ghosts, but this did not eliminate the possibility that most of the intensity of the H^2 lines in ordinary hydrogen was due to such ghosts. We have used the He 5016A 2^1S-3^1P line to eliminate this possibility. An exposure of this line gave no ghost of the required intensity anywhere near the position required if the H^2 Balmer lines from ordinary hydrogen were to be explained in this way. The intensity of the $H^2\beta$ line from ordinary hydrogen in the second order appears to be about the same as that of the second order symmetrical ghosts and the exposure times were controlled so as to make these second order ghosts easily visible. We conclude that our H^2 lines from ordinary hydrogen are not due to imperfections in the grating.

It is well known that the relative intensities of emission lines may be changed by reabsorption in the emitting gas. The stronger lines will be decreased in intensity relative to the weaker lines if this is the case. The discharge tube used was about 40 cm long, 8 mm inside diameter and carried a current of about 1 ampere. Under these conditions there might be enough atoms in the second state to absorb the Balmer lines considerably. This would cause us to overestimate the abundance of H^2. To test this possibility we photographed the spectrum from the side of the discharge tube and found that the intensity of $H^2\beta$ lines relative to the second order ghost of $H^1\beta$ was distinctly decreased. We then decreased the current in the discharge tube to about $\frac{1}{2}$ ampere and found that the intensity was further decreased. In the first case the exposure time required to bring out the second order ghosts was increased from 10 minutes to 3 hours and in the second case to 10 hours and thus the absorbing layer of atoms in the second state should have been markedly decreased in these experiments. We conclude that the discharge tube was well designed for discovering a very rare isotope, but that the estimates of relative abundance based on these exposure times are not trustworthy and are too high.

The authors previously estimated that as a result of the fractional distillation of four liters of liquid hydrogen near the triple point, the concentration of H^2 was increased by a factor of 5, which is in marked disagreement with the calculated factor of 100. Bleakney's estimates indicate an increase of about 27 which agrees much better with the calculated factor. The small concentration of H^2 in ordinary hydrogen makes the failure of Stern and Volmer[4] to detect the isotope after their attempts to concentrate it by a diffusion method understandable.

Before the discovery of the H^2 isotope of hydrogen, Birge and Menzel[5] pointed out that the discrepancy which exists between the atomic weights of hydrogen as determined chemically and by Aston using the mass spectrograph, when reduced to the same basis, might be explained by the existence of an isotope of hydrogen with mass number 2 present to the extent of 1:4500. If the estimates of the concentration of H^2 in ordinary hydrogen as given by Bleakney, by Kallman and Lasareff, and by Stern and Volmer are correct as to order of magnitude, this discrepancy must be accounted for in some other way.

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[4] Stern and Volmer, Ann. d. Physik (4) **59**, 225 (1919).

[5] Birge and Menzel, Phys. Rev. **37**, 1669 (1931).

Ultraviolet Bands of Silicon Monoxide

The writer has measured certain bands in the ultraviolet band system of silicon monoxide (SiO) and from these measurements has made a rotational analysis of the 0,1 and 0,2 bands, with heads at 2413.8A and 2486.8A, respectively. The transition to which the bands are due was found to be $^1\pi\rightarrow{}^1\Sigma$ as was expected by analogy with the fourth positive bands of CO. By the results of the analysis of the bands just mentioned calculation showed $B_0'=0.6265$, $B_1''=0.7189$, $B_2''=0.7138$.

The writer is doing further work on the rotational analysis of this band system.

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