

Comparison of (3) and (5) shows that:

$$f_D = - \left(\frac{qD}{\mu} \right) \frac{\nabla n}{n} \quad (6)$$

Substituting the Einstein equation into (6), we get:

$$f_D = - (kT) \frac{\nabla n}{n} \quad (7)$$

The assumed particle diffusion force f_D , as expressed in equation (7), does not depend on the particle charge, and conceivably would hold true whether or not there were other processes, if the Einstein relation were satisfied. The answer appears to be consistent with the fundamental property of diffusion that it is independent of the particle charge.

We shall next calculate the average energy W_D , gained by a particle, diffusing from a point A of high concentration n_a , to a point B of low concentration n_b . This energy would be:

$$W_D = \int_A^B f_D \cdot ds \quad (8)$$

where s is the particle path.

In view of equations (7), and (8), we have:

$$W_D = (kT) \ln \left(\frac{n_a}{n_b} \right) \quad (9)$$

which is independent of the path. This energy is the amount gained from the diffusion process alone.

The concept of a particle diffusion force suggested in this communication does not seem to be inconsistent with the well-established laws of Nature. In fact, the collective contribution of the particle diffusion force would, in some cases, give rise to the osmotic pressure discussed in Einstein's original paper¹. Furthermore, osmotic pressure effects are well-known observations.

Many processes and phenomena in the life, natural, and engineering sciences involve the diffusion process. It is probable that the particle diffusion force, and gained energy, might be useful, if not essential, for a better understanding of some of these processes and phenomena, wherever they may be, if the Einstein equation holds.

I thank Dr. C. W. Schultz for his comments.

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¹ Einstein, A., *Ann. Physik*, **17**, 549 (1905).

² Shockley, W., *Electrons and Holes in Semiconductors*, 299 (D. Van Nostrand Co., Inc., New York, 1950).

³ See ref. 2.

Absorption Spectrum of Gold Hydride in the Ultra-violet

THE absorption spectrum of gold hydride has been photographed in the region 2200–2900 Å.

Gold hydride has two known excited states, $A^1\Sigma^+$ at 27,340 cm^{-1} and $B^1\Sigma^+$ at 38,230 cm^{-1} above the ground-state $X^1\Sigma^+$. Transitions from several vibrational levels of A and from $B(v'=0)$ to X have been observed in emission^{1,2}. The 1–0 transition of $B-X$ has been observed in absorption³.

In the region 2200–2900 Å eleven bands were found, all shaded towards the red. Of these the band farthest to the ultra-violet (head at 43,846 cm^{-1}) was too weak and diffuse to be analysed, but it is too complex to be a $^1\Sigma^-1\Sigma$ transition. The bands are given in Table 1.

The B state dissociates very probably to $^2D_{3/2}$ (Au) + $^2S_{1/2}$ (H) and the A state (10,890 cm^{-1} below B) to $^2D_{5/2}$ (Au) + $^2S_{1/2}$ (H), where $^2D_{5/2}$ is 12,270 cm^{-1} below $^2D_{3/2}$ and 9,160 cm^{-1} above the $^2S_{1/2}$ ground state of gold.

The $C^1\Sigma^+ - X^1\Sigma^+$ transition shows broad lines increasing roughly linearly with J (width at $J=10 \sim 2 \text{ cm}^{-1}$). This indicates a predissociation of C , probably by an unstable Π -state.

The $^3\Pi$ state is inverted and the constants given are for $^3\Pi_1$. A $^3\Pi - ^1\Sigma$ transition should have 5 branches in Hund's

Table 1

No.	ν_0 (cm^{-1})	$v'-v''$	Transition
1	35,425.3	1-2	$B-X$
2	36,013.1	0-1	$B-X$
3	36,821.2	2-2	$B-X$
4	38,231.8	0-0	$B-X$
5	38,953.4	2-1	$B-X$
6	39,776.2	1-0	$B-X$
7	40,104.2	0-1	$a^3\Pi_1 - X^1\Sigma^+$
8	41,172.1	2-0	$B-X$
9	42,323.0	0-0	$a^3\Pi_1 - X^1\Sigma^+$
10	43,105.5	0-0	$C^1\Sigma^+ - X^1\Sigma^+$

Preliminary constants (cm^{-1}):				
	B_e or B_0	a	ω_e	$\omega_e x_e$
$B^1\Sigma^+$	5.849	0.187	1,693.1	74.3
$a^3\Pi_1$	5.464			
$C^1\Sigma^+$	5.79			

case (a) and 9 in Hund's case (b). For gold hydride 5 branches are observed at low J values. For higher J values extra branches appear, indicating a transition from case (a) to case (b). The 0^+ levels of $^3\Pi_0$ lie about 100 cm^{-1} below the 0^- levels owing to the strong perturbing influence of $C^1\Sigma^+$. This influence also shows up as a broadening of the R - and P -lines from $^3\Pi_0$.

It may be remarked that the notation used here may not be quite adequate, since for some of the states Hund's coupling (c) seems to be more appropriate. It is hoped that projected experiments with gold deuteride will elucidate further the problem.

Absorption spectra of silver hydride have also been taken for wave-lengths below 2700 Å. These show the existence of new Σ and Π states of silver hydride, but the analysis has not yet been completed.

This work was carried out, during June 1962, in the Physical Chemistry Department, University of Oxford.

A detailed account of the experiments on gold hydride and gold deuteride and, later, silver hydride, will be given in the Swedish journal *Arkiv för Fysik*.

Note added in proof. Analysis of gold deuteride has shown that the notation $^3\Pi$ is incorrect. The state labelled $^3\Pi_0^+$ is in reality a higher vibrational level of the B state and the other components of $^3\Pi$ are now labelled $0^-, 1, 2$, all dissociating to $^2D_{3/2}$ (Au) + $^2S_{1/2}$ (H).

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¹ Heimer, A., *Z. Physik*, **104**, 448 (1937).

² Imanishi, S., *Sci. Pap. Inst. Phys. Chem. Res. (Tokyo)*, **31**, 247 (1937).

³ Hulthén, E., and Zumstein, R. V., *Phys. Rev.*, **28**, 13 (1926).

Electron Spin Resonance in Neutron-irradiated Diamond

RECENT work has shown that the nature of the electron spin resonance spectrum observed in irradiated diamond depends on the type and amount of irradiation. Faulkner and Lomer¹ used comparatively heavy doses of 2-MeV electrons (up to 8×10^{19} electron cm^{-2}) and distinguished four systems, all of which show a g -value which is isotropic and equal to the free-spin value within 0.2 per cent: (a) a single line of width about 5 gauss; (b) a system of 24 lines with symmetry axes near the $\langle 221 \rangle$ directions, and a D -value of 0.14 cm^{-1} ; (c) a system of 6 lines with symmetry axes along the $\langle 100 \rangle$ directions and a D -value of 0.14 cm^{-1} ; (d) a broad absorption with a half-power width of about 70 gauss, showing a complicated anisotropic structure.

Baldwin², using a much lower effective dose (9×10^{17} electron cm^{-2} at 0.75 MeV), observed only the system (a), which was shown to be composed of at least three superimposed lines.

Here we give the results of room-temperature measurements at 9 kMc/s on four specimens of type IIa diamond which have been subjected to irradiation with fast neutrons at a temperature of about 50° C in the National Institute for Research in Nuclear Science irradiation facility in the Atomic Weapons Research Establishment *Herald* reactor. We find that the features of the spectrum