On the Intrinsic Moment of the Electron*

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In a previous letter[1] we have reported the observation that the ratio of the g_J values of the ${}^2P_{3/2}$ and ${}^2P_{1/2}$ states of gallium has the value 2.00344; the value 2 for this ratio follows from Russell-Saunders coupling and the conventional spin and orbital gyromagnetic ratios. If each of these states is exactly described by Russell-Saunders coupling, this observation can only be explained by setting $(\delta_S-2\delta_L)=0.00229\pm0.00008$, where the electron spin g value is $g_S=2+\delta_S$, and the orbital momentum g value is $g_L=1+\delta_L$. Since each of these atomic states may be separately subject to configuration interaction perturbations, the interpretation of this result was not entirely clear.

A determination has now been made of the ratio of the g_J values of Na in the ${}^2S_{1/2}$ state and of Ga in the ${}^2P_{1/2}$ state. The experimental procedure was similar to that previously described.[1] The known hyperfine interaction constants of gallium[2] and sodium[3] were employed in the analysis of the data. We find for this ratio the value 3.00732 ± 0.00018 instead of the value 3. This result can be explained by making $(\delta_S-2\delta_L)=0.00244\pm0.00006$.

The agreement between the values of $(\delta_S-2\delta_L)$ obtained by the two experiments makes it unlikely that one can account for the effect by perturbation of the states. The effect of configuration interaction on the g_J value of sodium is presumably negligible.[4] To explain our observed effect without modification of the conventional values of g_S or g_L introduces the rather unlikely requirement that both states of gallium be perturbed, and by amounts just great enough to give the agreement noted above.

From any experiment in which the ratio of the g_J values of atomic states is determined, it is possible to determine only the quantity $(\delta_S-2\delta_L)$. If, on the basis of the correspondence principle we set δ_L equal to zero, we may state the result of our first experiment as

$$g_S=2.00229\pm0.00008$$

and that of our recent experiment as

$$g_S=2.00244\pm0.00006.$$

It is not possible, at the present time, to state whether the apparent discrepancy between these values is real. It is conceivable that some small perturbation of the states would give rise to a discrepancy of the indicated magnitude.

These results are not in agreement with the recent suggestion by Breit[6] as to the magnitude of the intrinsic moment of the electron.

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[1] P. Kusch and H. M. Foley, Phys. Rev. **72**, 1256 (1947).
[2] G. E. Becker and P. Kusch, to be published.
[3] S. Millman and P. Kusch, Phys. Rev. **58**, 438 (1940).
[4] M. Phillips, Phys. Rev. **60**, 100 (1941).
[5] Dr. J. Schwinger has very kindly informed us in advance of publication of his conclusion from theoretical studies that δ_L is zero whereas δ_S may not vanish.
[6] G. Breit, Phys. Rev. **72**, 984 (1947).

The Thermal Diffusion Constant of Nitrogen

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It is the purpose of this note to report the results of some two-bulb thermal diffusion experiments that have been performed with neon, argon, and nitrogen. Previously, two-bulb thermal diffusion experiments with isotopic mixtures have been performed by Nier[1] (methane and neon) and by Stier[2] (neon and argon).

The value of the thermal diffusion constant, α, can be computed from the observed data by means of the equation

$$\alpha=\frac{C_2{}^0-C_2}{nC_1C_2}\cdot\frac{1+\beta+T_1/T_0}{(1+\beta/2)\ln T_1/T_0},\qquad(1)\dagger\dagger$$

where $C_2{}^0$ is the concentration of the heavy isotope in the cold bulb;
(C_1), C_2 is the concentration of the (light) heavy isotope in normal material;
n is the number of repeated runs;
T_0 and T_1 are the temperatures of the cold and hot bulbs, respectively;
$\beta\equiv T_1V_c/T_cV_1$, is a small correction for the gas in the connecting tube between the bulbs.

Since α is a temperature dependent quantity, it is customary to specify the temperature at which measurements are made by a criterion due to Brown,[3] namely,

$$T=(T_1T_0/T_1-T_0)\ln T_1/T_0,\qquad(2)$$

where T is the temperature assigned to a measured value of α and T_0 and T_1 signify as before.

It is also convenient to refer to R_T, where R_T is defined as the ratio of the experimentally determined value of α to the value of α predicted on the basis of the elastic sphere molecular model.

The apparatus used in the experiments reported here was similar to that described by Nier and Stier. The high temperature was obtained by a specially constructed regulated furnace and the low temperature by a constant temperature bath.

The gas samples from the thermal diffusion experiments were analyzed with a Nier-type mass spectrometer.[4] The procedure was as follows. Six determinations of the ratio of the intensity of the heavy isotope to the intensity of the light isotope were made on the normal material. Then six determinations of the same ratio were made on the sample collected from a thermal diffusion experiment. The average of the six values from the normal material was compared with the average of the six values from the sample to obtain the quantity $(C_2{}^0-C_2)/C_2$, which can be substituted directly into (1).

In the case of neon, there was no background behind either the Ne^{20} or the Ne^{22} peak, and the two peaks were completely resolved in the mass spectrometer. With argon, the A^{36} and A^{40} peaks were completely resolved, but it was necessary to make a small correction for the background behind the A^{36} peak. With nitrogen, there was a background of approximately 0.05 times the intensity of the $N^{14}N^{15}$ peak in the valley between $N^{14}N^{15}$ and $N_2{}^{14}$. It was also