from spin-spin interactions are by no means negligibly small compared with those from spin-orbit interactions. In some cases the former is even larger than the latter. Three examples are given in Table I.

The detailed report will shortly be published in *Progress of Theoretical Physics*.

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The Self-Diffusion Coefficient of Argon

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November 6, 1947

THE diffusion coefficient for the diffusion of A^{41} into normal argon (99.6 percent A^{40}) has been measured, using the beta- and gamma-radiation from A^{41} to determine the amount of that isotope diffused. This coefficient should be close to the self-diffusion coefficient of A^{40}.

The apparatus consists of two brass tubes 45 cm long and 1.2 cm i.d., mounted with their axes horizontal and in line with each other, and connected by a suitable valve.[1] One side was filled with argon containing A^{41} made by bombarding tank argon with deuterons, the other side with tank argon to the same pressure, and the gases allowed to interdiffuse for a known time through the valve. The radioactivity of the gas in either side could be determined by Lauritsen quartz fiber electroscopes, one mounted on each tube over a "window" made by thinning the tube wall to 0.005 cm. From measurements of the activities in both tubes before and after diffusion, properly corrected for A^{41} decay, the fraction of A^{41} transferred from one tube to the other by diffusion could be determined, and from this figure and the geometry the diffusion coefficient D could be calculated. The weighted mean of six runs gives

$$D=0.423\pm0.003 \text{ cm}^2/\text{sec.},$$

corrected to 32 cm Hg and 22°C. The error is the probable error calculated from the scatter of the data.

Kinetic theory gives the relation $\rho D=\epsilon\eta$, ρ being the gas density, η the viscosity, and ϵ a number which depends on the forces between two colliding molecules. Taking ρ of argon at 22°C, 32 cm Hg to be $(0.6947\pm0.0003)\times10^{-3}$ g/cm^3, η at 22°C to be $(0.225\pm0.001)\times10^{-3}$ poise, we find $\epsilon=1.31\pm0.01$. Assuming that the force between two molecules varies as r^{-n}, Chapman and Cowling[2] give a method of calculating a first approximation to ϵ. Fitting the calculated dependence of viscosity on temperature to the experimental data, they find $n=7.36$, which gives $\epsilon=1.47$. The discrepancy between this value and the experimental value is larger than can be accounted for by experimental error.

TABLE I. Reported values of ϵ.

Gas	Temp., °C	
H_2	20	1.37$_0$±0.003[4]
	−188	1.32 ±0.06[4]
	−252.8	1.28 ±0.02[4]
Ne	20	1.27$_5$±0.006[5]
A	22	1.31 ±0.01
Kr	20	1.30 ±0.06[6]
Xe	20	1.24 ±0.06[6]
CH_4	20	1.33[6]
UF_6	30	1.31[7]

Table I is a summary of measured values of ϵ collected from the literature. Amdur[3] has pointed out that knowing the value of ϵ will not permit an unambiguous determination of intermolecular forces. However, the small variation in ϵ shown in the table is rather unexpected, and must have some significance.

I would like to thank Professor E. C. Pollard for suggesting the problem and for many valuable discussions during the work.

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** Assisted in part by the Office of Naval Research under Contract N6ori-44.
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Precision Measurement of the Ratio of the Atomic 'g Values' in the $^2P_{3/2}$ and $^2P_{1/2}$ States of Gallium*

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November 3, 1947

THE measurement of the frequencies associated with the Zeeman splittings of the energy levels in two different atomic states in a constant magnetic field permits a determination of the ratio of the g_J values of the atomic states. This determination involves only an accurate measurement of the frequencies, and does not require a knowledge of the value of the constant magnetic field.

Using the atomic beam magnetic resonance technique we have measured six lines in the Zeeman spectrum of the $^2P_{1/2}$ state, and five lines of the $^2P_{3/2}$ state of gallium at a field strength of 380 gauss. The spectrum is, of course, complicated by the level splittings produced by the nuclear magnetic moments and electric quadrupole moments. At the field strength employed in this experiment the nuclear energy level pattern is of an intermediate Paschen-Back character.

The procedure employed in the observations was to make a series of alternate measurements of the frequencies of the lines in the $^2P_{1/2}$ and $^2P_{3/2}$ states. In this way the effect of a drift in magnetic field was minimized.

Becker and Kusch[1] have recently determined with high precision the nuclear magnetic moment and electric quadrupole moment coupling coefficients as well as the nuclear g values of Ga^{69} and Ga^{71} in both states. Their determinations are independent of any knowledge of g_J in either state.

Their results are consistent with the less accurate values obtained by Renzetti[2] by the zero moment deflection method.

With the constants given by Becker and Kusch and with assumed values for g_J it is possible to determine the magnetic field from the observed frequencies. The field values obtained from either of the groups of lines in the $^2P_{1/2}$ or the $^2P_{3/2}$ states are constant within the experimental uncertainty. What is more, there is excellent consistency of the results obtained from the data on the two isotopes. The mean value of magnetic field determined from the $^2P_{1/2}$ lines is less than the mean field value for the $^2P_{3/2}$ lines by 0.65 ± 0.02 gauss when the g_J values for the $^2P_{3/2}$ and $^2P_{1/2}$ states are taken to be 4/3 and 2/3, respectively. To remove this discrepancy we must assume for the ratio of the g_J values

$$\frac{g3/2}{g1/2}=2.00344\pm0.00012=2+\Delta.$$

If the electronic configuration in these states is accurately described by Russell-Saunders coupling the above discrepancy must be assigned to a change in the g value of the intrinsic moment of the electron or of the orbital moment from their accepted values. If the electron spin g value $g_S=2+\delta_S$ and the orbital g value $g_L=1+\delta_L$, then $\Delta=\frac{3}{2}\delta_S-3\delta_L$. Our present experiments, even assuming Russell-Saunders coupling, do not permit any evaluation of δ_S and δ_L. However, the discrepancy could be accounted for by taking $g_S=2.00229\pm0.00008$ and $g_L=1$, or alternatively $g_S=2$ and $g_L=0.99886\pm0.00004$.

The experiments reported in this note are of a preliminary nature. It is our intention to continue these studies with other atomic systems to clarify the role of the coupling in this phenomenon.

The authors are grateful to Professors G. Breit and I. I. Rabi for suggestions which stimulated these experiments.

* Publication assisted by the Ernest Kempton Adams Fund for Physical Research of Columbia University.

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On the Tripartition of Heavy Elements

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October 21, 1947

AFTER our experimental proof of the existence of tripartition and quadripartition of the compound nucleus of U^{236} by means of photographic emulsion,[1] I have discussed the mechanism of the first phenomenon and concluded, from the direction of the light third fragment, that the three fission fragments are emitted very probably in the same instant of separation.[2] This point of view is supported by other independent investigators.[3,4]

From the successively published results[1,4-9] on tripartition of Th^{233}, U^{236}, U^{239}, Pu^{240}, it is established that: (*A*) In 1–2 percent of all fissions, a light fragment is liberated in connection with the two heavy fragments, a part of them might be He^4. (*B*) These light fragments can be divided into two groups according to their range: the more frequent short range group ($L<3$ cm in air) exists in fissions of all elements, whereas the less frequent long range group (10 cm $<L<45$ cm) occurs only in the case of fissions by slow neutrons, its frequency varies with the element (that of U^{236} is twice that of Pu^{240}), and it depends probably on the degree of excitation of the compound nucleus, the low lying levels favoring this phenomenon. (*C*) The light fragment is emitted preferentially in a direction perpendicular to that of two main heavy fragments. Let α_1 be the angle made by the light fragment (M_3) with the heaviest fragment (M_1) and α_2 that with the lighter heavy fragment (M_2); in general, $\alpha_1>\alpha_2$, which means that M_1 takes more momentum than M_2. In the case of U^{236}, $\theta=\frac{1}{2}\Delta\alpha=\frac{1}{2}(\alpha_1-\alpha_2)$ has a value of 8° and 20° for the long and short range groups, respectively.

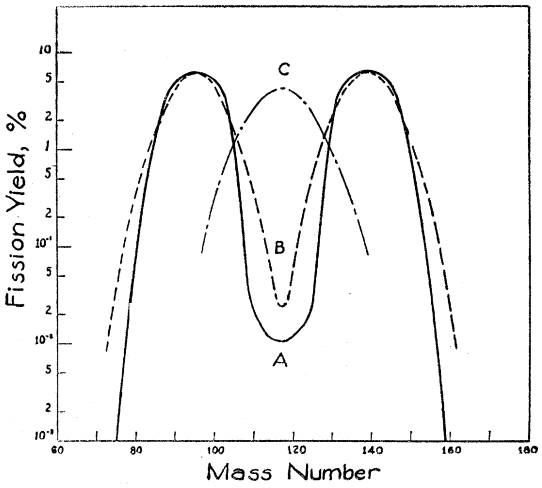

FIG. 1. The simplified model of tripartition. For the compound nucleus U^{236}, $R_1\sim8.4\times10^{-13}$ cm, $R_2\sim7.8\times10^{-13}$ cm, and $R_3\sim2\times10^{-13}$ cm, $Z_1\sim50$ and $Z_2\sim40$. In *A*, $H=6\times10^{-13}$ cm; in *B*, $H=0.1\times10^{-13}$ cm.

Let us take the simplified model of tripartition just before the moment of separation of 3 fragments (Fig. 1*A*, *B*),[2,10] one can calculate the direction and the velocity of M_3 as a function of time by taking into account the electrostatic repulsions due to M_1 and M_2. The result depends upon the choice of the value of nuclear radius R. It is well established that with $R\backsimeq1.5\times A^{\frac{1}{3}}\times10^{-13}$ cm, the deduced total kinetic energy of the two bipartition fragments ($\backsimeq$electrostatic potential energy just before the separation) is much higher than the experimental value,[11,12] while with the new value[13] of $R=(1.52\times A^{-\frac{1}{3}}+0.696)\times10^{-13}$ cm, the agreement between the theoretical and the maximum experimental values is satisfactory. By using the observed distribution of the total kinetic energy[14] of bipartition fragments of U^{236}, one can deduce the corresponding distribution of the nuclear radii $R'=KR$ (with the new value of R) of the heavy fragments in excited state, where K varies from 1 to 1.5 with the maximum frequency at 1.23.

(1) Assuming that the initial velocity of M_3 is zero (Fig. 1, *A*), for each value of A_3/Z_3, one can deduce the asymptotic velocity (V) and angle of emission (θ) of M_3