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.

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On the Tripartition of Heavy Elements

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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.

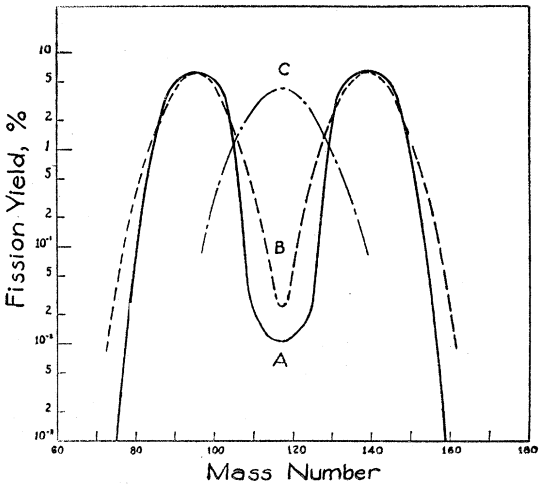

FIG. 1. The simplified model of tripartition. For the compound nucleus U^{236}, $R_1\sim8.4\times10^{-13}$ cm, $R_2\sim7.8\times10^{-13}$ cm, and $R_3\sim2\times10^{-13}$ cm, $Z_1\sim50$ and $Z_2\sim40$. In *A*, $H=6\times10^{-13}$ cm; in *B*, $H=0.1\times10^{-13}$ cm.

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

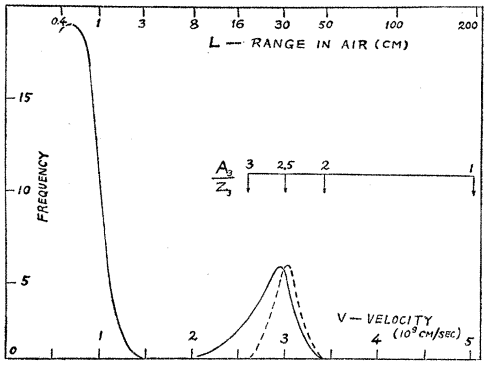

FIG. 2. Velocity distribution of M_3 of U^{236}. Full curve: experimental values. Dashed curve: theoretical velocity distribution of M_3 with $A_3/Z_3=2$ (position: Fig. 1, A), its maximum intensity is taken to be the same as the maximum of the experimental curve near $V\sim 3\times 10^9$ cm/sec. The arrows on the scale of A_3/Z_3 indicate the maximum velocity of M_3 for each value of A_3/Z_3.

for different values of K. The theoretical frequency-velocity curve of M_3 for $A_3/Z_3=2$ corresponding to the given distribution of K is shown in Fig. 2 (dashed curve), its maximum velocity, corresponding to a range about 47 cm in air, is in good agreement with the observation. For $A_3/Z_3=1$, 2.5, or 3, the maximum velocities are also indicated in Fig. 2, their absolute values are insensitive with respect to the mass value of M_3 (4 to 12). The comparison with the experimental curve (full curve) shows that A_3/Z_3 must be equal to or greater than 2 (therefore H^1 and He^3 are excluded). In combining the mass determination of M_3 in our experiments ($M_3=4\rightarrow 7$, except one case in which $M_3=32$),[6] one can conclude that the third fragment group is composed of He^4, Li^6, He^6, etc.

(2) The velocity and angle of emission vary with the position of M_3. An example of their relation with H (Fig. 1A, B) for $K=1$ and $A_3/Z_3=2$ is given in Fig. 3. The theoretical mean value of θ for the long range and short range groups is 6° and 19°, respectively, in good agreement with the experimental values: 8° and 20°. The spread of θ from the mean value is partly due to different mass and charge distributions of the two heavy fragments and partly due to the possibility that the third fragment is emitted a little later than the separation of the two main fragments.[10] Detailed calculations show that the upper limit of this delay is 10^{-21} sec.

(3) The short range group is connected with the case in which the three fragments are almost collinear at the moment of separation (Fig. 1, B) ($H<0.15\times 10^{-13}$ cm) while the long range group corresponds to the case in which the central third fragment shifts away from the axis of deformation (Fig. 1, A) (0.5×10^{-13} cm $<H<6\times 10^{-13}$ cm). When the compound nucleus is in a highly excited state, its lifetime is so short that the separation of the three fragments may take place immediately when the deformation reaches the form of 3 collinear droplets. But if the excitation of the compound nucleus is just sufficient to overcome the fission threshold, the lifetime is a little longer and there may be a certain possibility, due to asymmetric effect or strong vibration, that the third fragment shifts away from the axis of deformation before the separation of 3 fragments. Therefore one can conclude tentatively that the ratio of the frequency of tripartition to that of bipartition is nearly constant for all fissions (1–2 percent), but the percentage of tripartition with emission of a long range third fragment varies with the degree of excitation of the compound nucleus above the fission threshold, the lower the excitation, the greater the percentage.

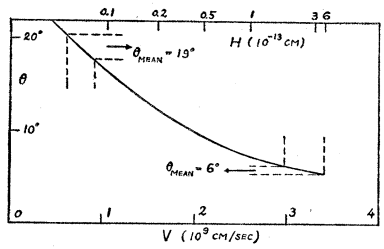

FIG. 3. The relations between the velocity V, the angle of emission θ, and the position H of M_3 (for $K=1$).

With the simplified model of tripartition, all the main experimental facts can be explained in a satisfactory way. The detailed discussions will be published shortly in the Journal de Physique et le Radium.[15]

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Preliminary Data on Absorption of High Energy Neutrons from the 184-Inch Cyclotron

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WHEN the 190-Mev deuterons produced in the 184-inch cyclotron strike the target they project forward a spray of fast neutrons with a maximum of intensity along an axis tangent to the deuteron orbit at the target. Helmholz, *et al.*,[1] have studied the angular distribution; Serber[2] has calculated a theoretical energy distribution of these neutrons giving a maximum at 95 Mev and a bell-shaped spread from about 30 to 160 Mev.

Early in the work it was desirable to study approximately the absorption of this high energy neutron beam in various materials, particularly in concrete, in order to judge shielding requirements.