Letters to the Editor

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Distribution in Mass and Charge of Fission Products*

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IT is not well understood why the fission products are divided into two distinct mass groups separated by a marked minimum. This note makes a suggestion concerning this problem.

When a nucleus of U^{235} picks up a slow neutron it may become so distorted that ultimately it separates into two major fragments. It is reasonable to assume that this fission will occur in such a way as to produce fragments having the greatest ability to bind the excess neutrons which were present in the parent distorted nucleus. The ability of a nucleus to bind neutrons may be measured by $(A-Z)/Z$, so that isotopes of stable elements having particularly high values of $(A-Z)/Z$ may be expected to be prominent among the fission products. This hypothesis affords no criterion of the possibility of fission, but merely attempts to tell what the fragments will be if fission does occur.

A tabulation was made of values of $(A-Z)/Z$ for elements with Z lying between 10 and 80. The mass numbers used were the average mass numbers taken from Mattauch's *Nuclear Physics Tables*, and thus account was taken of the relative abundance of the various isotopes. These data are plotted in Fig. 1 (circles for even Z and crosses for odd), and it is seen that the values of $(A-Z)/Z$ for odd Z in the central region lie systematically below the values for even Z, corresponding to the systematic difference between even and odd nuclei. This difference is much more marked if the plot is made for stable isotopes of maximum A for each Z. According to the above hypothesis it would be expected therefore that all the initial fission products would be of even Z. This may well be the case, because it is probable that many of the initial fission products have not been listed yet on account of their short half-lives. Assuming then that the initial fission products are all of even Z, the probabilities of forming various pairs of initial products may be found by taking pairs of complementary values of Z, $(Z_1+Z_2=92)$, and adding together the corresponding values of $(A-Z)/Z$. These values are plotted in Fig. 2. A similar curve for initial fragments of odd Z is shown dotted in Fig. 2, and it is clear that fragments of odd Z are less likely to be formed than those of even Z in the central region of the figure. The scale of ordinates in Fig. 2 is presumably approximately exponential as regards percentages of the various fragments formed.

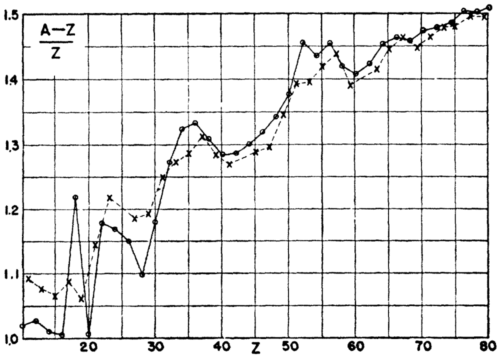

FIG. 1. Plot of $(A-Z)/Z$ as a function of Z. The circles are for even Z; crosses for odd Z.

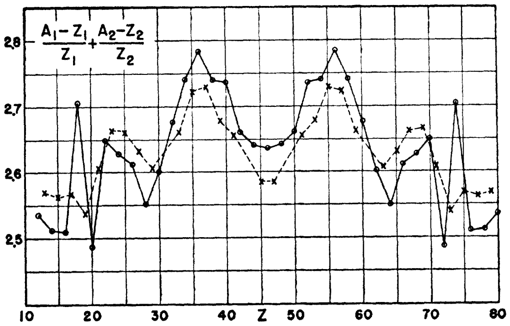

FIG. 2. Plot of $(A_1-Z_1)/Z_1+(A_2-Z_2)/Z_2$ as a function of Z, where Z_1+Z_2 equals 92.

The central part of the curve of Fig. 2 is strikingly similar to the well-known[1] curve showing percentage of fission products as a function of mass number. The change of abscissa from Z to A and the formation of various isotopes may well change the shape of Fig. 2 to that shown in the A curve.

The location of Fig. 2 on the Z axis is in reasonable agreement with the A curve. Figure 2 shows the central minimum at $Z=46$, which matches the minimum at 117 of the A curve fairly well. On the two wings of the A curve, abundances equal to the central minimum are reached at $A=77$ and 157, while on Fig. 2 the corresponding values of Z are about 32 and 60, in fair correspondence.

Figure 2 departs from the mass number curve of reference 1 in suggesting an appreciable possibility of fission into a very light and a very heavy fragment, especially for argon and tungsten.

The occurrence of the deep minimum in Fig. 2 implies that the incipient fission fragments have time to sort themselves out into the most stable possible pairs. If the fission act occurs so rapidly that complete "sorting" is not possible, the central minimum will be higher. This is presumably the cause of the less deep central minimum in fission by fast neutrons.

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* Based on Knolls Atomic Power Laboratory Report A-4271 dated September 8, 1947.

[1] J. Am. Chem. Soc. 68, 2411 (1946), see p. 2437.

Microwave Rotational Spectra and Structures of $\mathrm{GeH_3Cl}$, $\mathrm{SiH_3Cl}$, and $\mathrm{CH_3Cl}$*

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PURE rotational spectra due to the $J=2\rightarrow3$ transition of all ten isotopic combinations of $\mathrm{Ge^{70}}$, $\mathrm{Ge^{72}}$, $\mathrm{Ge^{73}}$, $\mathrm{Ge^{74}}$, $\mathrm{Ge^{76}}$, and $\mathrm{Cl^{35}}$ and $\mathrm{Cl^{37}}$ in $\mathrm{GeH_3Cl}$ have been observed. In addition, previously unreported lines corresponding to the $J=1\rightarrow2$ transition of the rarer isotopic species of chlorosilane, $\mathrm{Si^{29}H_3Cl^{35}}$, $\mathrm{Si^{29}H_3Cl^{37}}$, and $\mathrm{Si^{30}H_3Cl^{35}}$ and the $J=0\rightarrow1$ transition of $\mathrm{C^{13}H_3Cl^{35}}$ and $\mathrm{C^{13}H_3Cl^{37}}$ have been found. Rotational constants obtained from those lines that have been measured accurately are contained in Table I.