The Fermi Proton Effect in Silver

IN the course of investigating the radioactivity induced by the neutron produced by the bombardment of diplogen with diplons, we observed that the yield of radio-element produced in silver increases by a factor of about ten when the sample of silver was surrounded by a layer of paraffin 3·5 cm. in thickness during the exposure, showing the Fermi proton effect. The decay curve obtained with the Geiger counter is shown in Fig. 1, which suggests the fact that it cannot be expressed by a single exponential curve. The apparent value of half-period is about 30 sec. at the beginning, becoming approximately 2 minutes at 4 minutes after the bombardment ceased.

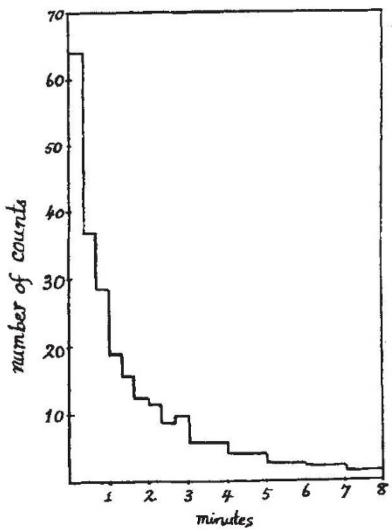

FIG. 1.

J. Bjerge and C. H. Westcott have reported that the ratio of the yield of radio-element produced in silver by beryllium-radon neutrons to that by the diplogen-diplon neutron is about 100 to 15. It is generally accepted that the mean energy of the neutron is greater in the former case. We have therefore two alternatives. In the first case we consider the beryllium-radon neutron to contain an appreciable amount of components softer than that of the diplogen-diplon neutron and these softer components were effective in the experiment of Bjerge and Westcott. In the second case, the yield of radio-element produced in silver is not a monotonic function of the energy of the neutron, decreasing with decreasing energy from the region of energy of the beryllium-radon neutron to that of the diplogen-diplon neutron, but below this value of energy it increases with decreasing energy. In this argument it is assumed that the Fermi proton effect is due to the decrease of energy of the neutron by its collision with protons.

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Radioactivity of Potassium

KLEMPERER[1] has recently shown that postulation of the existence of a radioactive isotope, $_{19}K^{40}$, with a large nuclear spin, affords the most likely explanation of the radioactivity of potassium. He appears, however, to have over-estimated the value of the nuclear spin ($i = 4$ or 5 units) necessary to obtain a sufficiently high half-value period for the isotope. Klemperer made use of a statement due to Gamow[2], which was based on theoretical reasoning. The latter author reached the conclusion that, if two radioactive elements possess the same upper velocity limit in their β-ray spectra, and if one of them suffers unit change in nuclear spin during decay while the other preserves its spin unchanged, then the ratio of their half-value periods is about 100.

However, if the value of 700 electron-kilovolts for the upper velocity limit of the β-particles emitted by potassium is inserted in the Sargent equations between decay-constant and energy (as given by Klemperer), 250 days is obtained for the half-value period on the assumption that $\Delta i = 1$, and 36 minutes on the assumption that $\Delta i = 0$ in the decay. These periods stand in the ratio of 10^4, and not 10^2. From the actual curves of Sargent[3], a value of about $10^{3 \cdot 3}$ is derived for the same ratio. These figures are considerably higher than that quoted by Gamow, and are probably more acceptable in view of the facts that the theory is only an approximate one and that Gamow states that the ratio may be considerably in excess of 100.

On the supposition that the half-value period is increased by a factor lying between $(2{,}000)^{\Delta i}$ and $(10{,}000)^{\Delta i}$ when the spin changes by Δi during the radioactive transformation, it is necessary to assign a spin of only 2 to 3 units to the nucleus of the hypothetical isotope in order to increase its half-value period to a reasonable figure.

In conclusion, it may be pointed out that Klemperer's views are supported by the fact that the isotope, $_{19}K^{42}$, the existence of which has been definitely established by Hevesy and Høffer-Jensen[4], is also a misfit as regards the Sargent relations. Here again, the existence of quite a small nuclear spin of this isotope would clear up the contradiction between β-velocity and life-time.

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[1] *Proc. Roy. Soc.*, **148**, 638; 1935.
[2] *Phys. Z.*, **35**, 540; 1934.
[3] *Proc. Roy. Soc.*, **139**, 659; 1932.
[4] NATURE, **135**, 96, Jan. 19, 1935.

Induced β-Radioactivity by α-Particle Bombardment

LORD RUTHERFORD's classical experiments showed that the emission of protons from the nuclei of the light elements, when these were bombarded with α-particles, was a fairly general phenomenon. No protons, however, were observed from helium, lithium, beryllium, carbon or oxygen. These results are significant, and suggest that $_2He^4$, $_6C^{12}$ and $_8O^{16}$ are very stable structures, probably consisting of close combinations of α-particles. The great stability of these isotopes is confirmed by Aston's work and by their behaviour under bombardment by high-speed ions. But both lithium and beryllium are