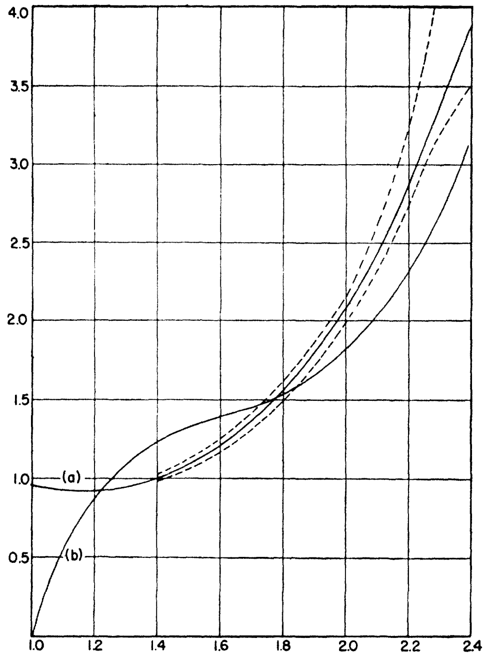

FIG. 2. Correction factors for Cl^{36} electrons. The area between the dashed curves represents the experimental data. Curve (*a*) is for the combination (2*S*, 2*T*), or (approximately) for the combination (2*A*, 2*V*). Curve (*b*) is the closest fit for the combination (2*S*, 2*A*).

Summing the results, it seems that the forbidden spectrum of Cl^{36} cannot be explained by any single type of interaction and spin change of two. It can be interpreted by three of the combinations of interactions; namely, (2*S*, 2*T*), (2*V*, 2*T*), (2*V*, 2*A*), but not by the combination (2*S*, 2*A*). Moreover, these combinations of interactions give agreement with the observed spectra for Y^{91}, Y^{90}, Sr^{90}, Sr^{89}, and Cs^{137}.

The authors are indebted to Professors R. E. Marshak, G. E. Uhlenbeck, and E. P. Wigner for their valuable discussions and suggestions throughout this investigation and to Mrs. Zelda Droshnicop for her greatly appreciated assistance with the numerical calculations.

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Beta-Spectrum of Y^{91}

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THE beta-spectrum of Cl^{36}[1] was observed to be radically different from allowed shape or the forbidden type exhibited by RaE. An attempt was made to fit it with an $(p^2+q^2)^{\frac{1}{2}}$[2] correction factor. This unique correction factor is the same as the one for transitions of $\Delta J=\pm 2$, (yes) as in Y^{91}, Y^{90}, Sr^{89}, Sr^{90}, etc. However, the difference between the two curves is quite pronounced. In order to check the distinctiveness of these two forbidden shapes, the beta-spectrum of Y^{91} was investigated in the solenoid magnetic spectrometer under conditions identical with those for the investigation of Cl^{36}, except that the thickness of the Y^{91} source was less than 100 mg/cm². Baffle systems of resolution of 2.5 percent and 4 percent both were used and yielded identical results.

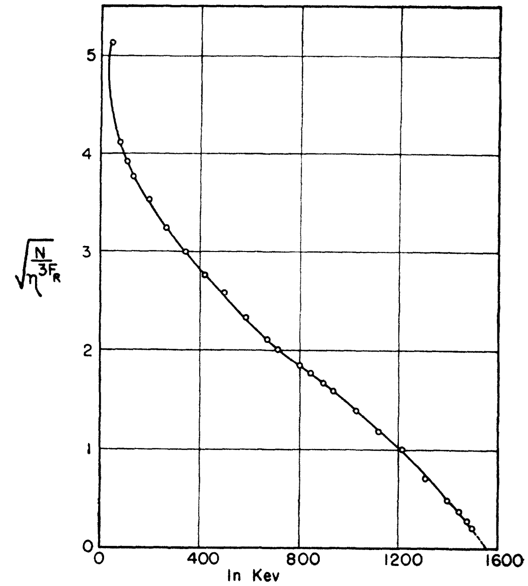

FIG. 1. Conventional Fermi plot for Y^{91} beta-spectrum.

Figure 1 is a Fermi plot of the Y^{91} beta-spectrum treated as an allowed transition. This curve shows a definite inversion point around the energy region of 500 kev as expected from the $(p^2+q^2)^{\frac{1}{2}}$ correction factor, but the concavity of the curve at the high energy region is much less pronounced than in the case of Cl^{36}.

When each point of the curve in Fig. 1 is divided by its corresponding $(p^2+q^2)^{\frac{1}{2}}$ correction factor all the points thus calculated fit a straight line, as shown in Fig. 2, from the upper energy limit

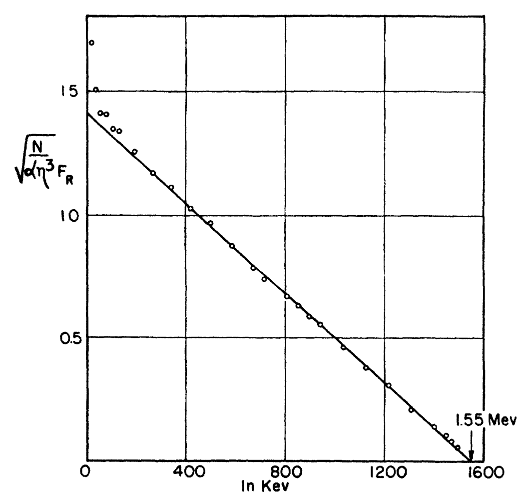

FIG. 2. Fermi plot of Y^{91} corrected by $(\alpha)^{\frac{1}{2}}\sim[(\epsilon^2-1)+(\epsilon_0-\epsilon)^2]^{\frac{1}{2}}$.

to about 200 kev. Even below 200 kev, the deviation from the straight line is very small. The upper energy limit determined from the forbidden Fermi plot is 1.55±0.01 Mev and is in good agreement with the result of Langer and Price.[3]

This investigation demonstrated the distinct difference between Cl^{36} and Y^{91} spectra. It is also interesting to observe that two completely different types of spectrometers and one spectrometer using two different resolutions can reproduce a forbidden spectrum such as that of Y^{91} in complete detail.[3]

The theoretical interpretation of the forbidden spectrum of Y^{91} is based on Feenberg and Hammack's analysis[4] of the shell structure in nuclei and was presented in detail in the Letter to the Editor by Langer and Price.[3] However, in view of the findings in the case of Cl^{36}, it would be highly desirable to have the spin of Y^{91} actually determined experimentally.

We wish to thank Dr. W. W. Havens, Jr., Dr. L. J. Rainwater, and Professor J. R. Dunning for the kind interest and valuable help rendered to us throughout this work. To Dr. C. Longmire, his enlightening discussions are deeply appreciated.

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Interpretation of Beta-Spectra from Thick Sources*

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It has been demonstrated[1] in the past that the beta-spectrum of an allowed transition as obtained from a thick source shows definite deviation from the expected straight line on the Fermi plot. The effect of the source thickness is to shift the energy of some of the electrons to lower values and to give an increased (energy dependent) back scattering effect. Therefore, a thick source invariably distorts an allowed straight Fermi plot to a convex curve toward the energy axis; its exact curvature depending on the upper energy limit, shape of the spectrum and the thickness of the source.

By this reasoning, one would therefore conclude that when a spectrum obtained from a thick source shows an allowed distribution, it is most likely that the Fermi plot of the true distribution is actually a concave curve towards the energy axis, at least in the high energy region.

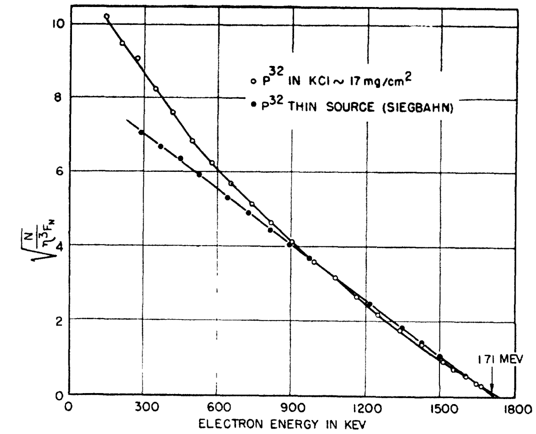

Fig. 2. Kurie plots of P^{32} from thin and thick sources. The thick source is in KCl of 17 mg/cm².

We have investigated the spectrum of three beta-emitters having radically different spectrum shapes, under exactly the same experimental conditions except for the thickness of the source. The same diluting material (KCl) was used in all cases to increase the thickness of the source.

In our investigation, the beta-spectra of Y^{91}, P^{32} and RaE were used. The upper energy limit of these three spectra are 1.55, 1.71 and 1.17 Mev respectively. Small amounts (less than 100 μg/cm²) of each of these radioactive substances are mixed thoroughly with inactive KCl to make sources of thickness around 15–20 mg/cm². While the thin source of Y^{91} gives a spectrum[2] according to the $(p^2+q^2)^{\frac{1}{2}}$ correction factors, a source of ~20 mg/cm² exhibits straight Fermi plot to 600 kev (Fig. 1). The P^{32} is known to show straight Fermi plot,[3] but a thick source of 17 mg/cm² distorted the spectrum to a convex curve (Fig. 2). The spectrum obtained from a thick source of RaE~22 mg/cm² also shows much greater curvature than that[4] of the thin sources (Fig. 3).

It is interesting to observe that the effect of the source thickness has definitely demonstrated the tendency to increase the second derivative of the conventional Fermi plot and therefore strongly supports the reasoning outlined above.

In view of this conclusion, it is interesting to reexamine the results recently reported by Alburger[5] on the beta-ray spectrum of K^{40}. The average thickness of the source used is around 18.5 mg/cm². The Fermi plot is straight from the upper energy limit 1.40 Mev to 450 kev. In view of the findings presented above, it seems reasonable to conclude that the true distribution of the

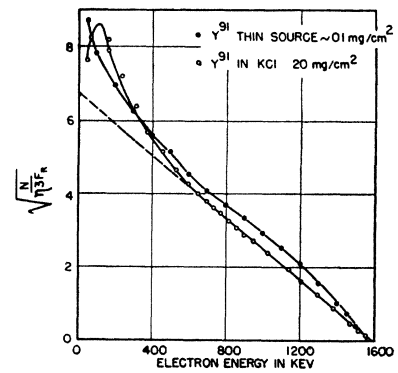

Fig. 1. Kurie plots of Y^{91} from thin and thick sources. The thin source is less than 0.1 mg/cm². The thick source is in KCl of 20 mg/cm².

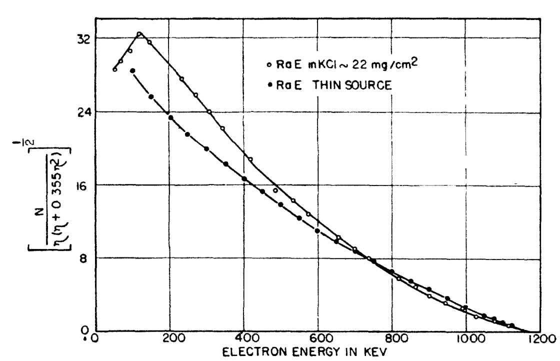

Fig. 3. Kurie plots of RaE from thin and thick sources. The thin source is in <0.1 mg/cm². The thick source is KCl of 22 mg/cm².