TABLE I. Classification of showers.

Origin of showers	Electron showers By I.P.	By N.P.	By unknown	Mixed showers By I.P.	By N.P.	By unknown
Plate 2	0	6	1	0	0	0
Plate 3	0	1	0	3	0	0
Plate 4	2	1	1	1	1	0
Plate 5	3	1	0	5	0	0
Plate 6	6	1	7	4	1	2
Plate 7	11	1	1	1	0	0
Plate 8	2	0	1	1	0	0
Total	24	11	11	15	2	2

much smaller than that by ionizing, penetrating particles. This result is to be expected if the two types of showers are produced mainly by protons of the primary cosmic rays or by ordinary mesons. Although the contribution to the electron showers by ordinary mesons may be quite considerable, it seems probable in view of other evidence that the mixed showers observed in this experiment were largely produced by primary protons. It may be mentioned that the relative contributions of the two types of producing particles depend presumably on the energy of the showers selected and hence, on the particular arrangement of the experiment.

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† Except the mixed shower produced in the 8th plate.

Coincidences Between Beta-Rays and Conversion Electrons in Europium

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IT has been shown that the long-lived (5–8 years) isotope of europium decays with the emission of beta-spectra of upper energies of the order of 0.6–0.7 Mev and 1 Mev,[1] respectively. Using a double focusing spectrometer, Shull[2] has found the ratio of the two components to be approximately 4 to 1. In addition he has found a large number of conversion lines, the highest corresponding to a gamma-ray energy of 412 kev.

We have measured the beta-conversion electron coincidence rate for europium as a function of the absorber thickness. The lower curve in Fig. 1 was obtained by placing equal absorbers between the source and each of the counters. The point at which this curve becomes zero gives the maximum energy of the conversion electrons. For europium this value is about 375 kev.

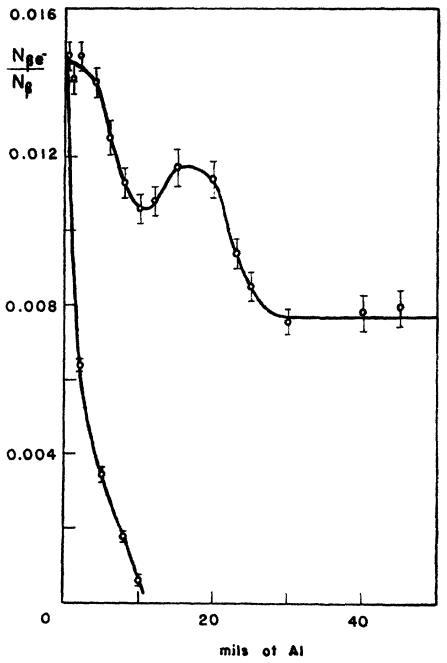

FIG. 1. Beta-conversion electron coincidence rate for europium. The lower curve was obtained by placing equal absorbers between the source and each counter. The upper curve was obtained by placing an absorber between the source and only one of the counters.

We have previously[3] published several curves obtained by placing an absorber between the source and only one of the counters. For cases of decay with the emission of a simple beta-spectrum a considerable amount of information can be obtained, including a fair estimate of the total conversion coefficient. The upper curve in Fig. 1 was obtained by this single absorber method. This curve is level at absorber thicknesses greater than 28 mils of aluminum at which point the lower energy beta-component has been completely absorbed. The equation for the curve beyond this point reduces to

$$R=\sigma_\beta \epsilon \sum_{K=1}^{n} \alpha_K,$$

in which σ_β is the fraction of the sphere subtended by the counter, ϵ is its efficiency, and $\sum_{K=1}^{n} \alpha_K$ the total conversion coefficient associated with the higher energy beta-rays. The value obtained for $\sum_{K=1}^{n} \alpha_K$ is 25 ± 5 percent. From the initial value of these curves and using a branching ratio of 4:1 one can give an estimate of 35 percent for the conversion coefficient of the gamma-rays following the lower energy beta-component. The peculiar shape of the curve appears to be real and is probably caused by the manner of absorption[3] of the many components involved in the coincidences.

[1] M. L. Wiedenbeck and K. Y. Chu, Phys. Rev. **72**, 1164 (1947).
[2] F. B. Shull, Doctorate Thesis, University of Michigan (1948).
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