N atoms per cm^2, we find, for example, the following averages

$$\cos\theta = \left(1+\frac{\rho^2}{k^2}\right)^{-2\pi k^2 N},$$

$$P_2(\cos\theta) = \left(1+\frac{\rho^2}{k^2}\right)^{-6\pi k^2 N} e^{+6\pi k^2 N}.$$

In these expressions ρ is the cut-off radius of the Coulomb field and $k^2 = Z^2e^4(1-\beta^2)/m^2c^4\beta^4$. The exponent is usually quite small and hence the result is very insensitive to a change in ρ. For example, for 200 kev electrons passing through 1 mil of Al, we have $k=5.4\times10^{-12}$ and $N=1.5\times10^{20}$. This gives for the angle θ corresponding to the average cosine a variation of only from 41° to 47° while ρ changes by a factor of 10 from 10^{-9} to 10^{-8} cm. For 1 Mev electrons the corresponding variation is from 12° to 14° for the same range of ρ.

A very rough approximation for small angles gives the same Gaussian distribution as the diffusion treatment of multiple scattering of Bothe.[2] A slightly better approximation for small angles is

$$F(\theta)d\theta = 2\pi \sin\theta f(\theta)d\theta = \tfrac{1}{2}\lambda \exp(-\lambda \sin^2\theta/2)\sin\theta d\theta,$$

where

$$1/\lambda = 2\pi k^2 N \log \rho/k.$$

Further details of the calculations and results will be published later. We acknowledge the support of this work provided by the Horace H. Rackham Fund.

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[1] L. S. Ornstein, Proc. Amsterdam **XL**, 464 (1937).
[2] W. Bothe, Zeits. f. Physik **4**, 300 (1921).

The Existence of Radioactive Al^{29}

The bombardment of magnesium with α-particles produces two well-known radioactive bodies. They are Al^{28} and Si^{27} produced by the reactions Mg^{25} (α, p) Al^{28} and Mg^{24} (α, n) Si^{27}. The half-lives are 2.3 minutes[1] and 6.7 minutes,[2] respectively. In addition to these two it has been reported[1] that a third radioactive isotope is produced. It was assumed to be Al^{29} formed from the third magnesium isotope by the reaction Mg^{26} (α, p) Al^{29}. The activity produced with an α-particle source of 100 millicuries of radon was not sufficient for analysis and the half-life was estimated as 11 minutes.

The same sample has now been bombarded with the 16 million volt α-particles from the cyclotron and with the increased intensity the long period is found to be 4.0 hours. However, another sample of very pure magnesium supplied by the Dow Chemical Company does not show this activity. The decay curve found with the pure sample is shown in Fig. 1. It can be entirely explained by the existence of two radioactive bodies. The curve gives a half-life at 6.4±0.1 minutes for Si^{27} and by subtraction the half-life of Al^{28} is found to be 2.3 minutes.

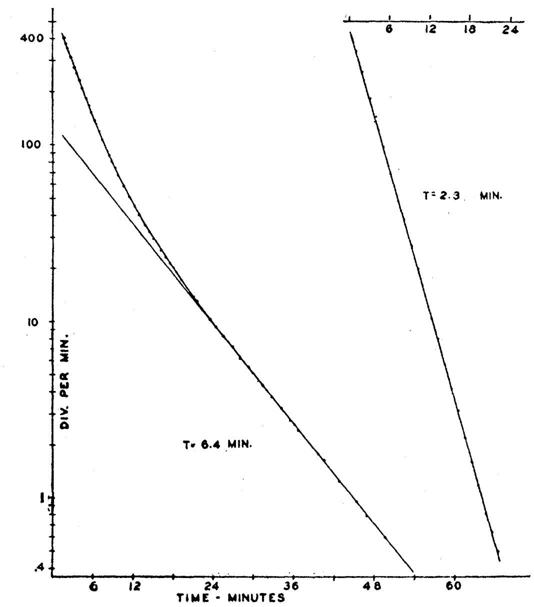

FIG. 1. Decay of magnesium + alpha-particles.

The third activity observed on the original sample must be due to an impurity. A likely impurity in magnesium is calcium and it is known that α-particles produce from calcium radioactive Sc^{43} with a half-life of 4 hours. With a pure calcium target the 4.0-hour activity is found to be about 300 times stronger than that observed with the impure magnesium sample. An impurity of 0.33 percent of calcium in the target would therefore explain our results. We conclude that the reaction Mg^{26} (α, p) Al^{29} does not occur to any appreciable extent.

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[1] Ellis and Henderson, Proc. Roy. Soc. **156**, 358 (1936).
[2] Fahlenbrach, Zeits, f. Physik **96**, 503 (1936).

Transitions Between Glow and Arc Discharge

The experiments on this subject recently described by Mr. Fan[1] were performed under conditions such that high frequency glow-arc transitions might in some cases have been expected. Just thirty years ago G. W. Vinal and I[2] described transitions somewhat similar to Fan's, using various metals as electrodes, in air or nitrogen. Discontinuous changes from one type of discharge to the other occurred every second or so, the intervals being considerably shorter than in Fan's experiments. But we found that at currents of about 0.1 amp., and with very short gaps, several thousand transitions occurred each second. In illuminating gas or a mixture of hydrogen and acetone vapor, with a d.c. supply voltage from 400 to 1000, and with a circuit having no large inductances or resistances