intensities is without significance; the agreement is as complete as the quality of the observations will permit. Conclusions about the relative merits of the two electron-stopping formulas would scarcely be warranted by these results since all the curves of Fig. 3 are separated by amounts less than their errors.

The present work needs to be extended in two directions: thick and thin target comparisons for other elements should be made, and the thin target characteristics should themselves be explained by fundamental atomic theory. The latter matter is discussed in a report[28] which is in press at this writing. The former will receive attention in a paper now in preparation on the characteristic radiations of copper and nickel.

[28] D. L. Webster, L. Pockman, P. Kirkpatrick, and K. Harworth, Phys. Rev. 71, 330 (1947).

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Range Measurements of Alpha-Particles from 94^{239} and 94^{238}†

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The ranges of alpha-particles from 94^{239} and 94^{238} have been measured by comparison with Po alphas, and are found to be 3.68 and 4.08 cm of air.

INTRODUCTION

To determine the ranges of alpha-particles from 94^{239} and 94^{238} with greater precision than previously reported,[1,2] a direct comparison of these ranges with the ranges of alpha-particles from Po was carried out.

EXPERIMENTAL METHOD

The samples of 94 were deposited on platinum by evaporation. They were separated from the bombarded uranium with a very small amount of carrier. The uranium sample was electroplated on a copper disk. The thinness of all these samples is borne out by the small values of the straggling coefficient observed, which is reported below.

The range of the alpha-particles were measured by comparison with a thin polonium standard. The samples were put in front of, and at a constant distance from, a shallow (0.23 cm) ionization chamber. The chamber and the sample were enclosed in a vessel, the pressure in which could be varied and the temperature measured. We plotted curves giving the counting rate of the samples, at a constant gain of the amplifier and registering circuit, as a function of the air density in the chamber.

The mean range was computed from the air density at which one obtained half the maximum counting rate according to the formula,

$$R = R_{\mathrm{Po}}(\delta/\delta_{\mathrm{Po}}), \tag{1}$$

in which R is the range of the alpha-particles of the substance under investigation, $R_{\mathrm{Po}} = 3.842$ cm (in air at 15°C and 760 mm of Hg)[3] and δ_{Po}, δ are respectively the densities of the air at which half the maximum counting rate is observed for δ_{Po} and for the substance under investigation. A small correction for varying pressure in the ionization chamber is discussed below. The ranges R obtained in this way are clearly mean ranges in air at 15° and 760 mm Hg.

Various runs for each substance were per-

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[1] J. W. Kennedy, G. T. Seaborg, E. Segrè, and A. C. Wahl, Phys. Rev. 70, 555 (1946).

[2] G. T. Seaborg, A. C. Wahl, and J. W. Kennedy, Phys. Rev. 69, 367 (1946).

TABLE I.

Element	Mean range	α
Po	3.842 cm	0.09 cm
94^{239}	3.68	0.11
94^{238}	4.08	0.12

formed in order to check the reproducibility of the positions in changing samples, and additional runs were made for studying the influence of the minute amounts of carrier contained in the samples of 94.

STRAGGLING

The total experimental straggling parameter,[3] α, obtained by taking $\alpha = 2s/\pi^{\frac{1}{2}}$ in which s is the difference between the extrapolated and mean range is reported in Table I together with the mean ranges.

Our straggling figures are higher than the ones obtained under the best possible conditions;[3] this is due to several factors, including the comparatively low specific activity of the substances studied which requires some sacrifice in the geometrical conditions to keep the counting time within reasonable limits.

[3] M. G. Holloway and M. S. Livingston, Phys. Rev. **54**, 18 (1938).

CORRECTION FOR DEPTH OF DETECTOR

Equation (1) is nearly exact if R is close to R_{Po}, otherwise it needs some small corrections because of the fact that varying the density of the air also produces a change in the residual range that the alpha-particle must spend in the shallow ionization chamber in order to trip the counter. If we call ϵ the minimum residual range at 760 mm of Hg and 15°C that an alpha-particle must spend in the chamber in order to produce enough ions to trip the counter, Eq. (1) must be replaced by

$$(R-\epsilon)/(R_{\text{Po}}-\epsilon) = \delta/\delta_{\text{Po}}. \tag{2}$$

In order to determine ϵ we reduced the air density in the chamber until only half of the polonium particles were counted. This occurred at a density of 0.20 of the density of air at 760 mm of Hg and 15°C. Under these conditions the alpha-particles reaching the chamber had a residual range of 2.8 cm and would produce approximately 3000 ion pairs per millimeter in air at 760 mm of Hg and 15°C or 1350 in our chamber with the air at $\frac{1}{5}$ the density. This number of ions corresponds to a residual range of 0.08 cm in air at 760 mm of Hg and 15°C. This was obtained from the curve of specific ionization *versus* range for a single alpha-particle as given by Holloway and Livingston.[3]