that $A_x(0)$ can be determined with comparable relative precision, the decay constant of the actinium can be found.

Differential measurement enjoys several advantages over separate measurement of standard and unknown: measuring the samples at the same time and interchanging them minimizes systematic errors; the readings on the difference of the two activities are always small and with ionization chambers are much more convenient to take than readings on the activities; it is practical to use considerably stronger samples than for single readings.

The differential chamber has been amply described by Segrè and Wiegand.[4]

Our measuring procedure was as follows. The actinium sample is placed in chamber 1 and the radium standard in chamber 2; the rate of drift of the galvanometer is then

$$p=A_x(t)S_1-A_r(t)S_2,$$

where S_1 and S_2 are the sensitivities of chambers 1 and 2, respectively, and are very nearly equal. When the samples are interchanged, the rate of drift becomes

$$q=A_r(t)S_1-A_x(t)S_2,$$

from which

$$p-q=[A_x(t)-A_r(t)](S_1+S_2)$$
$$\cong -2\delta(t)\cdot S$$
$$\delta(t)\cong -(p-q)/2S.$$

The initial rate of drift due to the actinium sample alone, $a(0)$, is then measured. Since $a(0)=A_x(0)\cdot S$,

$$A_x(0)=a(0)/S.$$

But we had from the decay law that

$$t_{\frac{1}{2}}=0.693A_x(0)\cdot t/\delta(t).$$

Substituting from above for $\delta(t)$ and $A_x(0)$, we obtain

$$t_{\frac{1}{2}}=-0.693\cdot a(0)/(p-q/2t).$$

We have measured $(p-q)$ over a period of about 100 days and have found $(p-q)/t$ to be -0.05916 ± 0.00020 (mm/sec.)/day. Also, the initial activity of the actinium sample, corrected for decay, was $a(0)=343.7\pm2.9$ mm/sec.

From these data, the half-life of actinium is calculated to be 22.0 ± 0.3 years, comparing favorably with the value offered by Curie and Bouissières.

We wish to thank Professors E. Segrè and I. Perlman for their helpful suggestions during the course of this experiment.

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Large Angle Scattering of π^--Mesons*

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An investigation is being made of the mean free path for large angle scattering and nuclear interaction of π^--mesons in G-5 emulsion. Mesons entering the edge of a plate with approximately 38-Mev energy are identified by measurement of grain density *versus* small angle scattering. These mesons are then followed for several millimeters until they leave the 600 μ-thick emulsion or reach an energy of 30 Mev. In a scan of 568 cm of meson track the scatters tabulated in Table I have been observed. There were also five cases in which an energetic meson produced a star, and two cases in which a meson ended abruptly with no visible star or scatter.

The average nuclear area for the elements in a G-5 emulsion is equivalent to a mean free path of 23 cm. Within the limits of the poor statistics it appears that the cross section for large angle scattering and star production of 20–38 Mev π^--mesons in emulsion are each roughly equal to one-half of the nuclear area. The disappearance of mesons in flight may be evidence for charge exchange scattering on a proton, although we cannot rule out the possibility that there was a star in which only a neutron was emitted, or a large angle scatter in which we were unable to follow the outgoing meson.

TABLE I. Observed scattering for 20–40 Mev π^--mesons in emulsion.

Scattering angle			Meson energy (Mev)	
Horizontal projection	Actual	No. events	By position in plate	By grain count (±5 Mev)
5°– 9.9°	1@46°	96	1@36.0	40
10°–19.9°		29		
20°–29.9°	1@30.5	2	1@35.0	35
29°	36.6	1	34.5	40
30°	35	1	26.5	40
40°	48	1	37.0	40
47°	76	1	36.0	25
108°	105	1	28.5	30
119°	112	1	32.0	25
143°	123	1	37.0	<20*
158°	154	1	26.0	30
171°	155	1	36.0	25
178°	160	1	34.5	40

* Definitely inelastic scattering.

Scatters less than 30° for 30 Mev π-mesons can certainly not be considered as "nuclear," since either Coulomb scatter or decay in flight could result in nearly that angle. Grain density *versus* scattering measurements cannot distinguish with certainty between a π-scatter and a π-μ-decay in our energy region. The mean free path for decay in flight is approximately 230 cm. A frequency plot of scatters between 5° and 30° is in agreement with single Coulomb scattering.

Dr. G. Bernardini of Columbia University has kindly communicated to us the prepublication results on a very similar experiment being performed on the Columbia cyclotron. The two experiments show a difference in relative numbers of stars *versus* scatters which seems to be outside of statistics. We believe that this is probably due to a difference in scanning techniques. Bernardini scans an area of plate looking for stars and scatters whereas we follow individual tracks to determine what happens to them.

We wish to express our appreciation to O. Piccioni who originally suggested the experiment, and to L. W. Alvarez for helpful discussion. Edith Goodwin has done much of the plate scanning.

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The Branching Ratio of K^{40} Radioactive Decay

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The ratio of K-capture to beta-emission for the naturally occurring radioactive isotope K^{40} has been determined using the mass spectrometric isotopic dilution method.[1] In this method the amounts of the daughter isotopes A^{40} and Ca^{40} in a geologically old potassium sample are determined by addition of a known quantity of a tracer isotope of the element in question, and determining the element content of the ore from the resulting change in the isotopic composition of the tracer material. Previous measurements of the branching ratio have used counting techniques or age data to get the beta-decay rate, and counting techniques or argon extraction data to get the K-capture.[2–7]

The sample used in this investigation was a 1×10^8-year old KCl sample from the Stassfurt sylvite deposits. The sample was divided into four aliquots. Two were used for the A^{40} content and two for the Ca^{40} content. The agreement between the various runs