rather sharply peaked about an angle θ_0 such that $\sin\theta_0 \cong \theta_0 \cong mc^2/E$ for all energies in the bremsstrahlung spectrum. The peak is broadened and displaced to larger values of θ by multiple scattering of the electrons in the radiator.

Three earlier experiments, attempting to verify the theory in the energy region of interest to us, have been published. All used deuterium photodisintegration detection in one form or another, and all used betatrons as sources of photons. Phillips[4] obtained results that indicated a second direction of prominent polarization as well as that predicted by the theory; Muirhead and Mather[5] observed no polarization; Tzara[6] reports observing a polarization in excess of 50% (under the definition above). Motz[7] has very recently reported an experiment verifying polarization in a lower energy region.

It is evident that if the polarization is to be detected, or if this property of the bremsstrahlung beam is to be used, the incident electrons must be very well collimated, and the possibility of multiple scattering in the target must be sharply restricted. The first requirement was met by the use of the 35-Mev electron linear accelerator at Stanford University. The second requirement was met by the use of a very thin radiator of low atomic number (described below).

24-Mev electrons emergent from the linear accelerator traveled down an evacuated tube and struck a 1-mil aluminum radiator in which the bremsstrahlen were produced. The electrons that passed through the radiator were then deflected by a magnetic field in the evacuated region and caught in a thick carbon beam stopper. The latter was heavily shielded with iron and paraffin. The bremsstrahlen emerged from the evacuated system through an aluminum window and a thin lead filter (which was introduced to reduce low-energy background), and passed through the intervening air to the detector. A portion of the deflecting field for the main beam of electrons was used to remove secondary electrons produced in the window and filter.

The detector was constructed as follows: six 200μ Ilford C.2 emulsions on 1-by-3-inch glass supports were arranged side by side to form a 3-by-6-inch rectangle. A second set of six plates was arranged identically. A double-decker sandwich of three thin stainless steel foils and these two sets of plates was mounted perpendicular to the axis of the beam of photons, with the emulsion side of each set of plates faced toward the radiator. The set of six plates that was to be nearer the radiator was soaked for several hours prior to exposure in D_2O; the set directly behind it in the sandwich was similarly loaded with H_2O. During exposure, the plates in both sections of the plate holder were kept wet. The entire plate holder was cooled with ice water during exposure, to reduce fading and to preserve the emulsion.

Detection was by means of the electric dipole photodisintegration of the deuterons in the heavy-water-loaded plates. The maximum of the cross section for this process occurs for incident photons of roughly 5 Mev, at and above which energy the magnetic dipole photodisintegration cross section is small. The useful proton tracks in the heavy-water-loaded plates were found to have ranges corresponding to photon energies between 4 and 8 Mev. The ordinary-water-loaded plates were exposed simultaneously in order to evaluate the background of protons due to all other effects. The 5% background they indicated has been subtracted from the results we quote below.

Pending further scanning and improvement of statistics, we report values of $P(\theta)$, for $E=24$ Mev and $k=4$ to 8 Mev, calculated from total photoproton track counts in the quadrants centered on the directions $\perp$ and $\|$ in Fig. 1. On the basis of 922 tracks, we find

$$P(\theta_0)=0.242\pm0.081 \quad \text{(from 396 tracks)},$$
$$P(1.6\,\theta_0)=0.157\pm0.095 \quad \text{(from 260 tracks)},$$
$$P(2.5\,\theta_0)=0.123\pm0.102 \quad \text{(from 255 tracks)}.$$

The errors quoted are standard deviations.

We wish to thank the members of the Hansen High-Energy Physics Laboratory at Stanford University, particularly Dr. W. C. Barber, for the use of and help with the accelerator, and Dr. Walter H. Barkas and Dr. A. C. Helmholz of this laboratory for helpful guidance.

* This work was done under the auspices of the U. S. Atomic Energy Commission.

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Long-Lived Lead-205†

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(Received March 15, 1956)

Several investigators[1–3] have placed limits on the Pb^{205} half-life. Measured lower limits on the K-electron capture half-life of Pb^{205} indicate that if this were the major mode of decay one would expect Pb^{205} in natural lead.[4] From the absence of Pb^{205} in nature one concludes that it must decay by capture of L- or higher shell electrons.

In view of the possibility that extremely old lead ores contain detectable quantities of radiogenic Tl^{205} and the interesting application of such measurements[5] to the

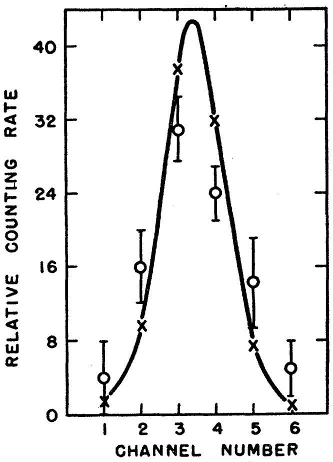

FIG. 1. The circles (o) give the gamma spectrum associated with the decay of Pb^{205} (1.8 counts/minute). The smooth curve drawn through the crosses (×) is the L—x-ray spectrum of lead measured from a mixture of electron-capturing bismuth isotopes.

time interval between the formation of the elements and the deposition of ores, we have continued to search for Pb^{205}. The present note describes experiments in which 1.8 counts/min of 11-kev gamma activity is interpreted as thallium L—x-rays associated with the L-electron capture of Pb^{205}.

Normal lead was bombarded with 1500 μa hr of 21-Mev deuterons in the Argonne cyclotron. The bismuth activities were chemically separated[6] and absorbed on a Dowex anion resin column. Lead was eluted from the column with 0.1N HCl many times during the first three days.[6] After a growth period [Bi^{205} (14-day)→ Pb^{205} by electron capture] of two weeks the lead was again eluted, given further chemical purification and mounted for counting. Pb^{203}, decay product of the Bi^{203} on the column, served as a chemical tracer, and was given time to decay before the Pb^{205} counting began. The Pb^{205} radiations were examined with a gamma scintillation spectrometer employing an $\frac{1}{8}$-inch sodium iodide crystal with a beryllium window. The results are shown in Fig. 1.

Assuming the yield ratio of Bi^{205}/Bi^{203} is proportional to the Pb^{206}/Pb^{204} isotopic ratio in normal lead [the $Pb^{204}(d,n)Bi^{205}$ cross section is small compared to the $Pb^{206}(d,3n)Bi^{205}$ cross section and from threshold calculations it seems reasonable to assume that the $Pb^{207}(d,4n)Bi^{205}$ cross section is negligible], we calculate that the L-electron capture half-life of Pb^{205} is approximately 5×10^7 years.

We also examined in the L—x-ray energy region a lead sample[7] enriched in Pb^{204} which had been neutron irradiated in the Materials Testing Reactor and chemically purified by the authors of reference 2. L—x-rays were also observed in this sample. With the aid of the above half-life and the intensity of the L—x-rays in the neutron-irradiated lead sample, the calculated neutron capture cross section of Pb^{204} agrees, within our experimental errors, with the pile oscillator measurement of Pomerance.[8]

We wish to thank D. W. Engelkemeir for the use of his scintillation spectrometer and many helpful suggestions. We also are indebted to W. J. Ramler and J. P. FitzPatrick for the cyclotron bombardments and preparation of the lead targets.

† Based on work performed under the auspices of the U. S. Atomic Energy Commission.
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Mean Lifetime of Negative K-Mesons*

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(Received March 5, 1956)

A MEAN lifetime for K^--mesons has been determined by the method previously used[1] for the K^+-meson lifetime. Stacks of stripped 600μ Ilford G.5 nuclear emulsions were exposed to the focused K^--meson beam[2] of the Bevatron so that the particles entered parallel to the emulsion layers. The mesons were produced by 6.2-Bev protons on a copper target and emerged at 90° to the proton beam. A bending magnet was used for momentum selection of the particles. Particles of momenta from 285 Mev/c to 415 Mev/c were obtained in the various exposures used for this experiment. The distance traveled by the particles from the target to the emulsion stack was about 3 meters in all cases.

Plates were scanned independently by the Berkeley, Livermore, and M.I.T.-Harvard groups for K^--inter-

TABLE I. Results of determinations of mean lifetime of K^--mesons.

Group	Total proper time, sec	Number of decays in flight n	Mean lifetime τ_{K^-}, sec
Berkeley	3.96×10^{-8}	4	0.99×10^{-8}
Livermore	2.63×10^{-8}	3	0.88×10^{-8}
M.I.T.-Harvard	5.78×10^{-8}	6	0.96×10^{-8}
Total	12.37×10^{-8}		$\tau_{K^-}=(0.95_{-0.25}^{+0.36})\times 10^{-8}$