

escape of the annihilation radiation; the intermediate peak is due to escape of only one annihilation photon. The continuum of Compton electrons of lower energy than these peaks has riding on it a number of other peaks. The weak peak at 2.24 ± 0.04 Mev seems to be a photoelectric peak due to the capture gamma-ray of hydrogen in the paraffin. The peak at 0.83 Mev is that produced by the nuclear gamma-ray of polonium, while the peak at 0.52 Mev is that due to the excited state of Li^7 at 0.478 Mev. This radiation is produced by neutron capture in the boron shield.

Figure 2 shows the high energy section of the spectrum from 4.4 to 8.4 Mev. Integral counting shows that there is no significant number of pulses above this energy. The upper branch of this curve having a peak at about 6.4 Mev (gamma-ray energy 7.4 Mev) was obtained when a portion of the boron shield was

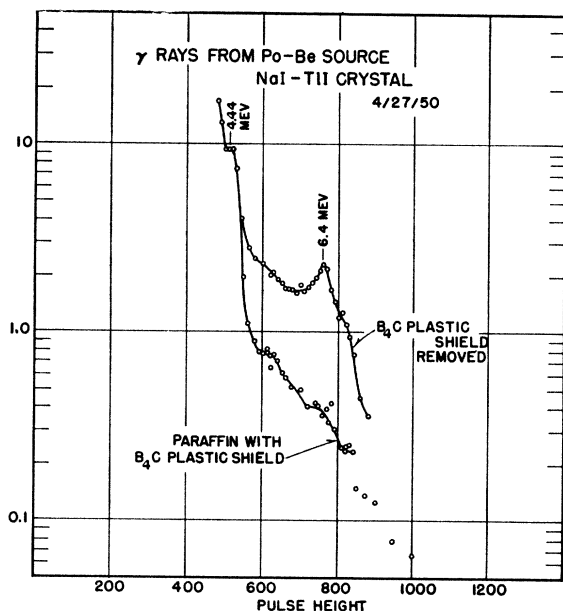


FIG. 2. Pulse distribution produced by a Po-Be neutron source between 4 and 8 Mev.

removed allowing the neutrons to strike the iron magnetic shield of the photo-multiplier. The small bulge in the shielded curve at about this same energy may well be due to neutrons escaping the paraffin and boron and reaching the iron.

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Variation of the Decay Time of the Fluorescence of Anthracene and Stilbene with Temperature

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SINCE many of the early discrepancies of fluorescence decay time measurements of scintillating crystals were resolved when the phosphor temperature was taken into account, it became of interest to investigate the fluorescence decay time for a given phosphor over a wide range of temperatures. Kelley and Goodrich¹ published measurements of the decay time of anthracene in the temperature range 78 to 308°K; they found a linear variation of the decay time in this temperature range and extrapolated their linear curve finding a zero time intercept at 0°K. A report of preliminary data from this laboratory² gave the results of measurements of the decay time of anthracene at 290, 80, and 4°K; these

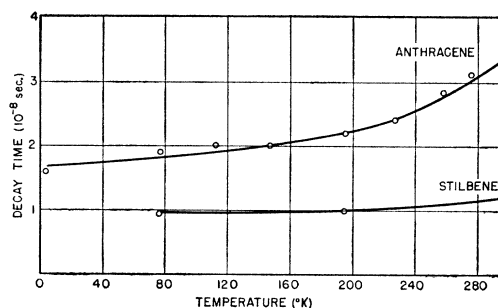


FIG. 1. Variation of the decay time of fluorescence with temperature.

results were in substantial agreement with those of Kelley and Goodrich at the two higher temperatures.

In order to extend the knowledge of the variation of the fluorescence decay time with temperature, a series of measurements have been made on an anthracene single crystal in the temperature range 4 to 298°K and on a stilbene single crystal in the range 78 to 298°K. The phosphor was mounted on the end of a quartz bar eight inches from the photo-cathode of a 931-A photo-multiplier; the phosphor was placed in the desired temperature bath while the photo-multiplier was operated at room temperature. A 10- μC Ra source was used for excitation, and the output of photo-multiplier was fed into a shorted coaxial line apparatus³ to measure the decay time.

The results of these measurements are shown in Fig. 1, and they indicate within the limits of experimental error (± 10 percent) that the decay time approaches a constant value at low temperatures. In the case of stilbene, measurements taken at widely spaced temperature points show its decay time to be almost a constant from dry ice temperature to room temperature. It should be noticed that variation of the stilbene light output with temperature is also approximately constant.⁴ A suitable explanation for the variation of apparent time of decay with temperature can be made in terms of additional metastable states in the crystal. However, without further spectroscopic information such conclusions may not be warranted.

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The Low Energy Neutron Spectrum from $\text{Li}^7(d,n)\text{Be}^8$

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THE neutron spectrum from the $\text{Li}^7(d,n)\text{Be}^8$ reaction has been investigated by several observers, but the presence of the Li^6 isotope made it infeasible to interpret the low energy portion of the spectrum unambiguously. Staub and Stevens¹ observed the spectra in a cloud chamber using both recoil protons and recoil α -particles to determine the energy of the neutrons. With both gases they found a plateau which they attributed to the continuous distribution of neutrons from $\text{Li}^7+d \rightarrow \text{He}^4 + \text{He}^6$, $\text{He}^6 \rightarrow \text{He}^4 + n$, and an increase in intensity at about 1.5 Mev, but with the helium they also observed a group at 5.5 Mev which was not present in the proton spectra. Richards² made the first investigation of the spectra using photographic plates but he used such large energy intervals that the resolution was poor in the low energy region. Green and Gibson³ have investigated carefully the high energy portion of the spectra at several angles using photographic plates and have determined the shape of several of the groups more accurately than did previous investigators.

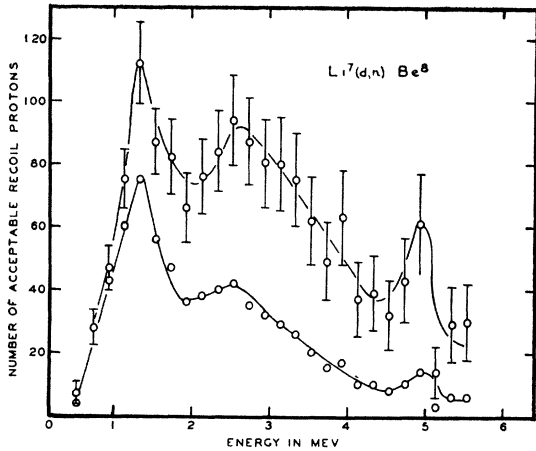


FIG. 1. Low energy neutrons from the disintegration of Li^7 by deuterons. The curve on which the probable errors have been indicated has been corrected for variation with energy of $n-p$ scattering cross section and acceptance probability.

A 100-kev thick target of Li_2SO_4 , in which the Li was 99.8 percent Li^7 , was bombarded with 1.1-Mev deuterons from the Bartol Van de Graaff generator, and Ilford C_2 plates 10 cm from the target at 0° to the beam were irradiated with the reaction neutrons for approximately 5 μhr . The recoil protons with ranges less than 210μ and an acceptance angle of 15° were counted. The angle between the direction of the beam and the recoil proton in the horizontal plane of the plate were recorded and the energies corrected according to the relation $E^2 = E_n^2 \cos^2\theta$. Seven hundred tracks were measured and these are plotted in 0.2-Mev intervals in Fig. 1.

Besides the continuum of neutrons from $\text{Li}^7 + d \rightarrow \text{He}^4 + \text{He}^3$, $\text{He}^3 \rightarrow \text{He}^4 + n$ there are two groups of neutrons which must arise from the reaction $\text{Li}^7 + d \rightarrow \text{Be}^8 + n$, at 1.36 and 4.9 Mev and give levels in Be^8 at 14.7 and 11.1 Mev; neutrons from carbon would give a group at approximately 0.8 Mev. The general shape of the curve agrees with that of Staub and Stevens, both curves having a peak at approximately 1.5 and 5 Mev besides the continuum.

* Assisted by the joint program of the ONR and AEC.

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A Measurement of the Positive π - μ -Decay Lifetime*

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THE lifetime of π -mesons was first measured by Richardson¹ and later by Martinelli and Panofsky.² The method was the same in both cases: the fraction of π -mesons surviving various

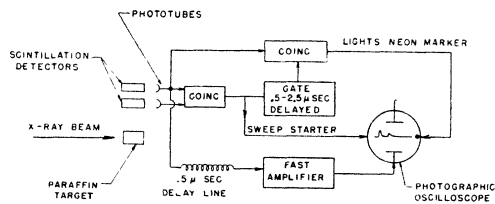


FIG. 1. Block diagram of apparatus.

times of flight was measured by placing photographic detectors at various path lengths from a target in which π -mesons were produced.

In the experiment reported here we have observed the decay of π -mesons through the light emitted by a *trans*-stilbene crystal in which the decay events occur. The mesons were produced in a paraffin target which was placed in the x-ray beam of the 340-Mev synchrotron. The mesons of interest here passed through the first crystal and came to rest in the second crystal. There were three bursts of light from the second crystal when (1) the meson came to rest, (2) the (positive) π -meson decayed to a μ -meson which also came to rest in the crystal, and (3) the μ -meson decayed to a positron which escaped from the crystal. Photo-multiplier tubes were used to detect the light from the stilbene crystals.

As outlined in Fig. 1, a coincidence between the two detectors was used to start the sweep (10^{-8} sec./mm) of an oscilloscope and to initiate a delayed gate circuit (gate open from 0.5 to 2.5 μsec). The output of the second detector was delayed 0.5×10^{-6} sec., amplified in a fast distributed amplifier, and fed to the vertical deflection plates of the oscilloscope. The oscilloscope traces, which were recorded photographically on a continuously moving film,

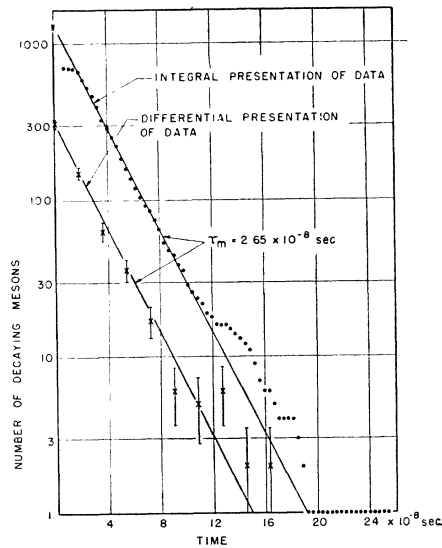


FIG. 2. Decay rate of the positive π -meson. The zero-time point on the integral curve represents all marked traces minus accidental traces. The zero-time point on the differential curve represents those traces with pulse separation between 2.17 and 3.98×10^{-8} sec., the next point those between 3.98 and 5.79×10^{-8} sec., etc.

showed in every case the pulse which initiated the sweep. If the responsible particle was a π^+ -meson which stopped in the crystal, and if the meson lived at least 2×10^{-8} sec. before decaying to a μ -meson, then two pulses were seen on the trace. Measurement of the separation of these two pulses determined the life span of that meson. On some traces a third pulse was seen due to the μ -meson decay, although in most instances the sweep was finished before the μ -meson decayed. The purpose of the 0.5- to 2.5- μsec . delayed gate was to detect electronically the μ -meson decay. When a pulse fell within this gate time a neon bulb at the edge of the oscilloscope face flashed.

We consider only those pulses marked by a neon bulb flash. By so doing, we use a group of pulses constituted as follows. Five percent are background due to accidental coincidences of extraneous pulses with the delayed gate; three percent are μ -mesons formed by π -mesons which decayed in flight; 92 percent (1302 in number) are π^+ -mesons stopped in the crystal. A total of 554 traces showed two distinct pulses whose separations could be measured with certainty.